

# Annual Report 2018-19



Government of India  
Department of Science & Technology  
Ministry of Science & Technology  
New Delhi

*Cover page shows a picture of first Supercomputer '**Param Shivay**' designed and built under National Supercomputing Mission dedicated by Hon'ble Prime Minister Shri Narendra Modi to the scientific and research community of the nation. The supercomputer named "PARAM Shivay", uses more than one lakh twenty thousand compute cores (CPU + GPU cores) to offer a peak compute power of 833 TeraFlops.*

# Annual Report

## 2018-19



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## Overview

The Department of Science and Technology (DST) functions as the nodal agency to connect science and technology sector to Government verticals. DST provides the largest extramural research and development support in the country to strengthen national S&T capacity and capability through a competitive mode to scientists cutting across institutions and disciplines. This strategically important function mutually reinforces outcomes of our country's educational, scientific and industrial R&D initiatives and helps transform the S&T landscape of the country.

While a detailed account of achievements of Department's activities during the year is presented in relevant chapters, some of the major achievements and initiatives of 2018-19 are briefly presented in the following sections:

**Fund for Improvement of S & T Infrastructure (FIST)** in Universities and Higher Educational Institutions is currently operated in competitive mode of support at four levels. The financial support circumscribes four basic purposes i.e. Equipment, Networking & Computational Facilities, Infrastructural Facilities and Maintenance. Depending on the level, the total financial support is limited to Rs 1.50 Crore, Rs 3.0 Crore, Rs 10.0 Crore and Rs 20.0 Crore for Level 0, Level I, Level II and Level III, respectively. 145 proposals out of 777 were identified through the evaluation process of the Program to consider financial support of varying quantum's at a total budget of about Rs 182.23 Crores for 5 years.

**“Promotion of University Research and Scientific Excellence (PURSE)”** is a proactive measure of DST to build the research capacity of performing Indian Universities. Using transparent criteria forty-four (44) performing universities have been supported ranging from Rs 30.0 Crores to Rs 6.0 Crores for 4 years' period based on publication output in Scopus International Database.

**Sophisticated Analytical Instrument Facilities (SAIF)** have been established in different parts of the country to provide services of the facilities of sophisticated analytical instruments. There are at present 15 Nos. SAIF Centres in the country. About 19,000 researchers from all over the country utilized and benefitted from the facilities. These SAIF Centres have analyzed more than 1,25,000 samples during the year and have generated a revenue of about Rupees 10.40 crores in this year

**State S&T Programme** facilitates states to achieve the specific S&T objectives at their level. 28 State Councils for S&T were supported by providing grant in aid of Rs. 22.16 Crores. 36 new projects/programme were supported to address the State Specific S&T challenges, S&T surveys and studies in the tune of 19.40 Crore. Model Village establishment projects were initiated in the States: Uttarakhand (6), Meghalaya (3), Arunachal Pradesh (3) and Manipur (3)

Five **Policy Research Centers (PRC)** have been supported by DST in institutions across the country to understand STI processes for making effective policies, strengthen them and link these evidences to policy making.

**Centre for Human and Organizational Research Development (CHORD)** conducts national surveys to generate and make available information on manpower as well as financial resources devoted to S&T activities. A spin-off publication of the National S&T Survey entitled ‘**Directory of R&D Institutions 2018**’ was published. A Draft Policy Document on **Scientific Research Infrastructure Sharing Maintenance and Networks (SRIMAN)** has been drafted. The annual **Directory of Extramural R&D Projects** for the years **2015-16** and **2016-17** have been compiled and published together during this year.

Under “**National Programme for Training of Scientists & Technologists working in Government Sector**”, thirty-three training courses, benefitting about seven hundred and fifty scientists, were conducted under the programme. During the same period, under the **Women Component Plan**, eight courses, benefitting about one hundred and eighty women scientists, were conducted.

**KIRAN** (Knowledge Involvement in Research Advancement through Nurturing) embraces women-exclusive schemes of DST with the mandate to bring gender parity in S&T through various mechanisms. 348 projects out of 1022 applications were recommended with extensive as well as intensive scrutiny for support under WOS-A. Approximately 45% selected women scientists with break received Ph.D degree with the help of WOS-A during the tenancy of their project. Total 50 projects were recommended out of 720 proposal received under under WOS-B. Total of 104 women joined the 10th batch of WOS-C for one month orientation programme held at New Delhi in June 2018 followed by 11 months on-job training at various agencies located throughout the country.

**Indo-US Fellowship for Women in STEMM:** 20 selected candidates screened out of 1102 applications visited 20 leading institutions across the United States for being fostered and trained in their labs

Since the inception of **CURIE (Consolidation of University Research for Innovation & Excellence in Women Universities)** programme in 2009, eight (8) women universities have been supported to strengthen R&D infrastructure & facilities including Indira Gandhi Delhi Technical University for Women, Delhi & Rama Devi University for Women, Bhubaneswar covered during this year. To establish Artificial Intelligence Facility in CURIE Beneficiary Universities, **CURIE-AI** is launched during 2018-19. This support was given to Six (6) women universities. It is expected that 10,000 girls are going to be benefitted with this component.

Fifteen (15) pilot projects under **Vigyan Jyoti** were implemented in premier educational institutions in different parts of the country in which three weeks’ residential programme was conducted for meritorious girls studying in class IX and XI. Around 450 students were mentored to pursue higher studies and careers in Science & Engineering.

**Cognitive Science Research Initiative (CSRI)** provides support for multi-centric mega projects, individual projects, Post-Doctoral Fellowship (PDF) and also facilitates infrastructure development, sharing of experiences and networking activities. 44 individual projects and 12 CSRI-PDF projects have been supported during the year.

**Science and Technology of Yoga and Meditation (SATYAM)** aimed to foster scientific research on the effects of yoga and meditation on physical & mental health besides on cognitive functioning in not only in patients with disorders but also in healthy people. Against 3rd Call for Proposals made in 2017, DST received 214 research proposals from across the country. Out of 214 proposals received in SATYAM against 3rd call, 17 Projects have been recommended for financial support.

**Innovation in Science Pursuit for Inspired Research (INSPIRE)** is to attract talent to the study of science from an early age and build the required human resource pool for strengthening and expanding the R&D base and the Science & Technology (S&T) system of the country. 132 INSPIRE Internship camps were organised for students of Class XI pursuing science in any school. So far, more than 1,00,000 INSPIRE-SHE Scholars have been offered the scholarships to pursue a career in sciences. 12,380 INSPIRE scholarships were offered during the year. Out of the 8000 INSPIRE Fellowships, 1000 INSPIRE Fellows received their fellowship during the year 2018-19. Besides this, 8INSPIRE Fellows, working as Senior Research Fellows, were selected for participating in the 11th HOPE Meeting in Japan and 27 INSPIRE Fellows, also working as Senior Research Fellows, were selected for participating in short-term Research Internship Programmes at various Laboratories/Universities in UK under the Newton-Bhabha Programme. 159 INSPIRE-Faculty Fellowships were offered during the year.

Under **Swarna Jayanti Fellowship** 14 Fellows have been selected through a three-tier rigorous screening process from 392 applications.

New Programme of **International Bi-lateral Cooperation** in the field of Science, Technology and Innovation with Uzbekistan, France, Indonesia, Israel & Portugal was initiated. DST in collaboration with Department of Biotechnology, organized a Global Indian Science and Technology Stakeholders Meet (GIST) as a part of the India International Science Festival-2018 held in Lucknow during October 5-6, 2018.

The highlights of **International Multilateral and Regional S&T Cooperation** include the **BRICS Science, Technology and Innovation (BRICS STI) Cooperation**; India-EU Science and Technology Cooperation; India-ASEAN STI Cooperation; STI Engagements with the Group of Twenty (G20) countries. India initiated Science diplomacy with joint collaborative programmes with developing countries on S&T sectors.

**National Mission on Nano Science & Nano Technology** supported 21 new individual scientist-centric R&D projects during the year. 50 new proposals from various institutes/university across the nation are benefited under Technology development. The development work of India-motivated beamline has been completed

Activities under **Mega Facility for Basic Research** include its support for Antiproton and Ion Research (FAIR), Darmstadt, Germany, Experiments at the Large Hadron Collider (LHC) at CERN, Geneva, India-based Neutrino Observatory (INO), Madurai, Thirty Metre Telescope (TMT) Project, Laser Interferometer Gravitational-Wave Observatory (LIGO) Project, Accelerator-based Research Facilities, etc.

Under **Climate Change Programme**, two national missions on climate change under National Action Plan on Climate (NAPCC), viz., National Mission on Strategic Knowledge for Climate Change (NMSKCC) and National Mission for Sustaining the Himalayan Ecosystem (NMSHE) are being implemented. Several new initiatives were launched as part of these missions, during the year 2018-19. These include; one Centre of Excellence, at Divecha Centre for Climate Change, IISc, Bangalore; two National Knowledge Network programmes one each on Urban Climate and Himalayan cryosphere; One Human Capacity Building Programme at National Institute of Disaster Management (NIDM), New Delhi; Three State Climate Change Cells one each in Gujarat, Bihar and Assam; 6 State Knowledge Network programmes in the Himalayan States of J&K, Himachal Pradesh, Assam, Arunachal Pradesh, Meghalaya and Manipur and 8 fellowships under Indo-US Fullbright-Kalam fellowship programmed.

The first Supercomputer named “PARAM Shivay”, designed and built under “Build” approach of **National Supercomputing Mission (NSM)** by C-DAC at Indian Institute of Technology (BHU), Varanasi was dedicated by Hon’ble Prime Minister Shri Narendra Modi. The supercomputer uses more than one lakh twenty thousand compute cores (CPU + GPU cores) to offer a peak compute power of 833 TeraFlops.

The **Integrated Cyber Physical Security (ICPS)** programme initiated during the year 2018-19 supported several projects in the areas of Data Science Research Initiative (DSRI), Internet of Things Research Initiative (IoTRI), Cyber Security for physical infrastructure (CSRI), Quantum Enabled Science and Technology (QuEST).

A new project was sanctioned for development of novel technologies. 40 new projects were sanctioned to promote development of advanced manufacturing technologies. A compendium of 38 technologies supported under Waste Management Technologies (WMT) programme was released and shared with the participants. 38 new proposals were recommended for support under **Science and Heritage Research Initiative (SHRI)** envisaged for R&D activities for conservation of Heritage objects. 17 new projects were sanctioned for development of biomedical devices. 11 new projects were sanctioned for development of new devices.

Under **Drugs and Pharmaceuticals Research Programme (DPRP)**, 22 project proposals have been recommended out of 159 proposals for financial support with the aim of enhancing capabilities of institutions and Industry towards development of New Drugs in all systems of medicine.

**Patent Facilitation Programme (PFP)** has provided financial support to 24 Patent Information Centers established at various State Councils to the tune of Rs. 6.5 Crore. During the period 16 Indian Patents have been granted to respective applicants and facilitated filing and prosecution of the patents.

Seven new test facilities were granted the **Good Laboratory Practice (GLP)**-compliance status. As on date, there are 50 GLP certified test facilities in the country.

**Clean Energy Research Initiative (CERI)** covers the research spectrum of entire gamut of clean energy viz. smart grid, off grid, energy storage, building energy efficiency, cleaner fuels, clean coal and energy materials. It envisages to successively enhance Technology Readiness Level (TRL) of

promising options in partnership with industries and other stakeholders. It is contributing to the Mission Innovation, a global initiative of 25 countries to dramatically accelerate global clean energy innovation. **Water Technology Initiative** aims to find out appropriate technological solutions through field level interventions to demonstrate technical, social, environmental and eventually economic sustainable solution for water challenges. Several technologies have been developed and deployed under the programme.

**Natural Resources Data Management System (NRDMS)** Programme aims at promoting R&D in emerging areas of Geospatial technologies and applications. The programme includes State Spatial Data Infrastructure (SSDIs) established in 10 states, Village Information System in about 120 villages, Coastal Hazard and Risk Assessment Disaster Mitigation Programmes and several other geospatial technology areas.

DST has been pioneer in establishing a network of **Technology Business Incubators (TBI)** and Science & Technology Entrepreneur's Parks (STEP) across the country. These startup incubators support and nurture knowledge driven innovative start-ups into successful enterprises. During 2018-19, new Technology Business Incubators (TBI) under NIDHI program has established 11 TBIs. NIDHI-Centre of Excellence (NIDHI-CoE) are established to provide an enabling environment to technology based new enterprises which are high risk and high growth ventures. 18 Accelerator Program were organized by various TBIs wherein mentoring support was provided to 438 ideas, 66 ideas got seed funding, 49 ideas were absorbed by TBI's for further Incubation & 40 ideas raised external validation.

**National Council for Science and Technology Communication (NCSTC)** largely aims at communicating and popularizing science and technology (S&T) to masses and stimulate scientific temper amongst them. As part of the new initiatives, DD Science-a Dedicated Science Channel on Doordarshan (National DD) and India Science - a Digital 24x7 Science Channel (Using Internet TV Applications) were launched. National Children Science Congress 2018, Bharat Vigyan Darshan, India International Science Festival 2018, Science Exhibitions on Wheels, Initiative for Research and Innovation in Science (IRIS), Rashtriya Kishore Vigyanik Sammelan and Science & National Teachers' Science Congress (NTSC) are the other important programmes. A new initiative Augmenting Writing Skills through Articulating Research (AWSAR) was launched to utilize the latent potential of PhD scholars and Post-doctoral fellows (PDFs) towards science communication.

**Science for Equity for Empowerment and Development (SEED)** scheme supports several field based programs with the application of S&T linked to directly benefitting the society has been implemented under. Long term Core Support is extended under Technological Advancement for Rural Areas (TARA) programme to 26 S&T based NGOs primarily to provide affordable technological solutions to challenges in rural as well as remote areas. About 52 projects have been recommended for support under Scheme for Young Scientist and Technologists (SYST) focused towards encouraging, nurturing and mentoring young scientists addressing societal challenges through S&T based solutions. A total of 24 new projects with strong social component were supported under Tribal Sun Plan (TSP).

Five **Technical Research Centres (TRCs)** were established in 5 DST institutions in 2015-16. The TRCs have developed and transferred some significant technologies to industry during the period.

The Exhibition Cell of DST participated in five major national and international events during the year.

The Department of Science and Technology nurtures 25 **Autonomous Bodies (ABs)**. These include 16 research institutions, 4 specialized knowledge institutions and S&T service organizations and 5 professional bodies. These institutions have a long and varied history and their variety of activities significantly contribute to the S&T eco-system of the country. The activities and achievements of the autonomous institutes during the year are presented in the report.

The **Science and Engineering Research Board** has come up with several innovative programmes and schemes to identify potential scientists and support them for undertaking R&D in frontier areas of Science and Engineering. The Board interventions are primarily focused to expand the research base in the country without compromising the quality of research. Special attention has been given to invest in young minds; and, to strengthen new areas of science. Some of the important programmes include flagship programmes like Early Career Research Award, National Postdoctoral Fellowship, Ramanujan Fellowship, Visiting Advanced Joint Research (VAJRA) Faculty Scheme, IMPRINT (Impacting Research Innovation and Technology), Mathematical Research Impact Centric Support (MATRICS) Scheme, International Travel Support (ITS) scheme, etc. SERB Board has adopted a Scientific Social Responsibility (SSR) policy as an integral part in SERB Programmes. Introduced a new scheme titled 'SERB Research Scientist (SRS)' for the awardees of INSPIRE Faculty and Ramanujan Fellowships, who fail to secure regular positions after completion of the regular tenure of five year. SERB connects the S&T system through 34 Schemes and Programmes catering to different segments of S&T ecosystem.

A **Data Management Cell (DMC)** was set up in the Department of Science & Technology in 2018 to have a mechanism of monitoring, evaluation and course correction, wherever required for the schemes and programmes of DST. An innovative idea of a 'Data Wall' was introduced by DMC on which a detailed visual analysis of a scheme/programme is projected to provide insights to all the stakeholders and also to the public.

The Department has made every effort to utilize the allocated budget fruitfully to implement its planned activities and programmes during the year.

## Chapter 1

**S & T INSTITUTIONAL & HUMAN CAPACITY BUILDING****1.1 R&D Support (FIST, PURSE, SAIF)***1.1.1 Fund for Improvement of S & T Infrastructure in Universities and Higher Educational Institutions (FIST)*

**“Fund for Improvement of S&T infrastructures in Universities and Higher Educational institutions (FIST)”** Program is the major infrastructure augmentation program of Government which facilitates support towards augmenting higher education and research largely at the university and academic sectors by augmenting basic infrastructural facilities for teaching as well as for conducting research in basic or applied science areas.

Currently, the Program is operated in competitive mode of support at four levels i.e. Level 0, Level I, Level II and Level III covering six subject areas (Life Sciences, Physical Sciences, Chemical Sciences, Engineering Sciences, Earth & Atmospheric Sciences, Mathematical Sciences) and PG Colleges. While support under Level 0 is provided to all PG Science & Applied Science Departments as a composite project in “Colleges as a whole” mode, supports under Level I/ Level II/ Level III are meant for Science/ Applied Science Departments of Universities/Academic Institutions. The financial support circumscribes four basic purposes i.e. Equipment, Networking & Computational Facilities, Infrastructural Facilities and Maintenance. Depending on the level, the total financial support is limited to Rs 1.50 Crore, Rs 3.0 Crore, Rs 10.0 Crore and Rs 20.0 Crore for Level 0, Level I, Level II and Level III, respectively.

**Highlights of activities during 2018-19**

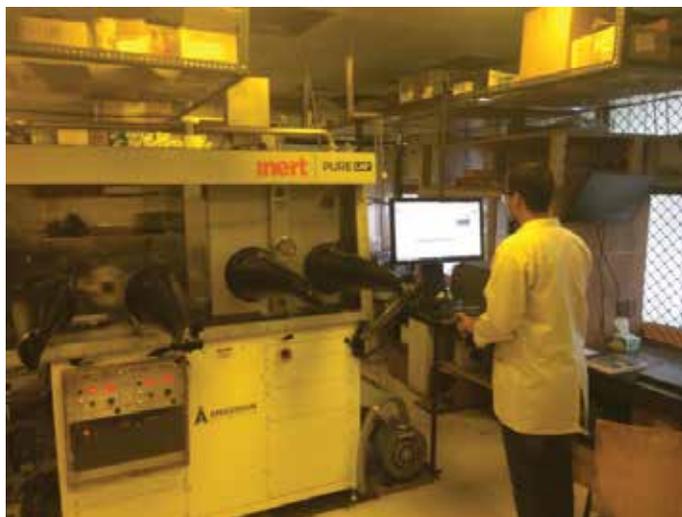
The 18th round of operation was initiated and fresh proposals were invited in May 2018 through advertisements from eligible S&T related departments from universities and academic institutions as well as PG Colleges for considering support under this program. During this year, 777 new proposals in all levels were received in the current financial year. Nine departments were visited for on the spot evaluation by Subject Expert Committees and finally 145 proposals were identified through the available mechanism of the FIST Program to consider financial support of varying quantum's at a total budget of about Rs 182.23 Crores for 5 years. Apart from the process of evaluation and identification of new proposals to consider of support, progresses of 197 ongoing projects at departments and PG Colleges were also reviewed. DST also adopted some pro-active measures towards encouraging research at the College level by making provision of additional support to the performing colleges.

Besides the new proposals, grants to the ongoing projects were also released during this year. So far, nearly 2817 S&T departments and PG colleges have been supported with a total investment of about Rs 2850 crores.

### Outcome

Ever since its beginning, the FIST Program has provided sustainable funding over last seventeen years that has made deep impacts in many departments across the country to carry out advanced research in contemporary areas of science and technology and also set-up modern teaching facilities. The researchers are benefited so that their potential is tapped for scientific advance and innovation. FIST Program has been instrumental in establishing state-of-the-art facilities for performing high end research and have thus benefited academicians and researchers across the country. Some of the major facilities installed/recommended for support under the Program are: Automated DNA Sequencers, Ultracentrifuges, FACS, Scanning Probe Microscope, Molecular Imaging System, Thermo-mechanical Simulator, Liquid Nitrogen Plant, Liquid Helium Plant, High Resolution Powder X-ray Diffractometer, Single Crystal X-ray Diffractometer, 400 MHz & 500 MHz FT-NMRs, Mass Spectrometer, Universal Testing Machines (UTMs), EPMA, Confocal Microscope, Field Emission Scanning Electron Microscope, High Resolution Transmission Electron Microscope, Protein Sequencing Platform etc

Under the Networking facilities, support is provided for creation of Central Computer Lab in the Departments which includes Hardware, Software's and Cloud Computing infrastructure. The Program has benefited Communication technology based infrastructures such as Grid Computing, Networks and Communications systems, Cloud in many engineering Departments. The Departments of small colleges and Universities have also been supported with grant to acquire Books for the Departmental Library.

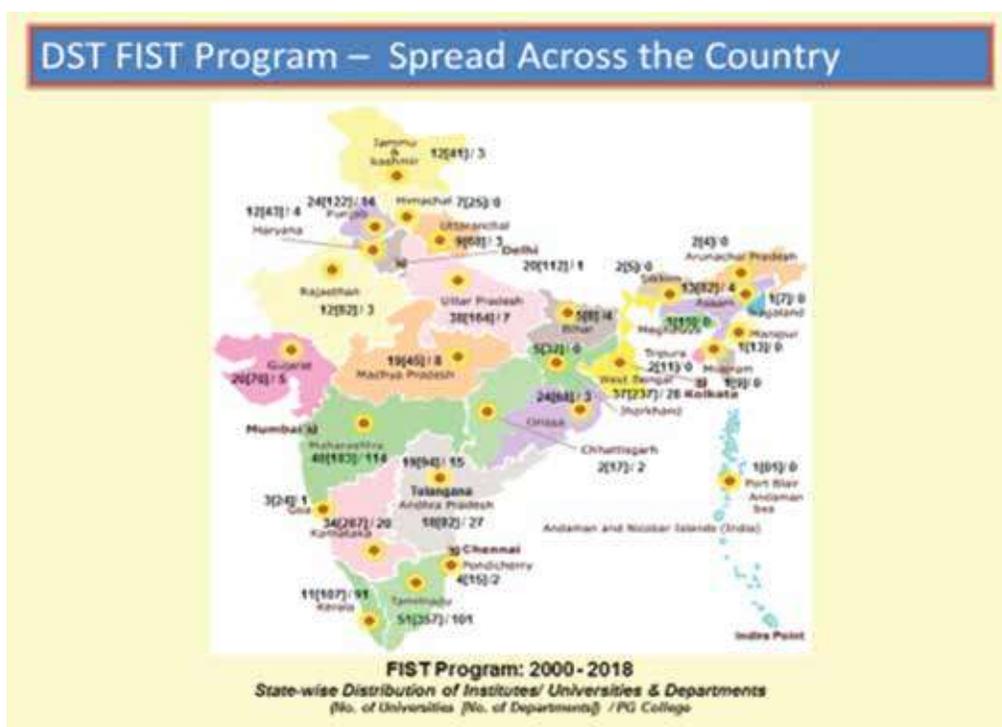


**Device fabrication facility supported by DST-FIST program at Department of Electrical Engineering, IIT Delhi.**

FIST Program has significantly contributed to the enhancement of teaching and research infrastructure in many Engineering Institutions such as Indian Institute of Technology (Delhi, Kanpur, Guwahati, Chennai, Mumbai, Kharagpur, Roorkee, Gandhinagar, Patna, Dhanbad, Indore, Ropar and Mandi),

Indian Institute of Science, Bangalore, National Institutes of Technology (Warangal, Tiruchirappalli, Suratkhil, Calicut, Silchar, Kurukshetra, Durgapur, Agartala, Jaipur, Rourkela, Srinagar, Surat, Raipur and Tripura), many Private Engineering Institutions such as Birla Institute of Technology, Thapar Institute of Engineering, Vellore Institute of Technology etc., University Departments and Engineering Colleges across the country.

The infrastructure provided by FIST Program has benefitted many prestigious medical/ veterinary/ paramedical institutions and Agricultural Universities in the country.



### 1.1.2 Promotion of University Research and Scientific Excellence (PURSE)

“**Promotion of University Research and Scientific Excellence (PURSE)**” is a proactive measure of DST to build the research capacity of performing Indian Universities. The main objective of the scheme is to pro-actively support for strengthening the R&D base of the performing Universities in the country with adequate financial support and associated flexibility. It is formulated on the basis 10 years aggregate publications and h-index towards creating and nurturing the research ecosystem among performing universities in the country.

Using transparent criteria forty-four (44) performing universities have been supported ranging from Rs 30.0 Crores to Rs 6.0 Crores for 4 years’ period based on publication output in Scopus International Database, for the four study periods 1996-2006, 1998-2008, 2000-2010 and 2002-2012. The criteria for support in PURSE Program are revised as given in table below:

**Table- 1: Criteria for Support in PURSE Program**

<b>Initial h-Index (2008-2015)</b>	<b>Revised h-index (2016-onward)</b>	<b>Research Grant for 3 years</b>
More than 50	More than 70	Category A (Rs 30.0 cr.)
40-49	60-69	Category B (Rs 15.0 cr.)
30-39	50-59	Category C (Rs 9.0 Cr.)
26-29	45-49	Category D (Rs 6.0 cr.)

#### Highlights of activities during 2018-19

Under PURSE program large investments have been made to encourage, nourish and sustain research performance of the leading universities. The support under PURSE has been provided to forty four Universities under PURSE to acquire research equipments, research man-power cost, augmentation of computational facilities, establishing research infrastructure, acquiring research consumables, fund for travel, organizing workshops and conferences, contingencies and maintenance of the facilities. Around Rs 70 Crores was invested by Department of Science & Technology in nurturing the PURSE supported Universities in the financial year 18-19. Total investment of Rs 1220 crore was planned for performing Universities identified under PURSE, so far an amount of Rs 800 Cr has been made available to the performing Universities this scheme.

Regular reviews of the PURSE Projects at various Universities have been performed in FY 18-19. Eighth meeting of Programme Management Board (PMB) on PURSE was organized in October 2018. The PURSE Projects at Twenty Seven Universities were reviewed and mid course corrections were suggested. Review rating of Excellent, Very Good, Good and Satisfactory were provided to the PURSE Projects in this meeting.



**Stochastic Technical Retroscope Microscopy (STORM) facility at  
Jawaharlal Nehru University, JNU, New Delhi**



### Analytical and Preparative HPLC and Gel Permeation Chromatograph at University of Mysore, Karnataka

#### 1.1.3 Sophisticated Analytical Instrument Facilities (SAIF)

Many academic institutions including Universities in the country still lack the existence of specialized facilities to carry out both basic and advanced research in contemporary areas of science and technology. The Department has thus setup Sophisticated Analytical instrument facilities (SAIFs) in different parts of the country to provide services of the facilities of sophisticated analytical instruments to the researchers in general and specially from institutions which do not have such instruments and enable them to pursue R&D activities requiring such facilities and keep pace with the developments taking place globally.

There are at present 15 Nos. Sophisticated Analytical Instrument Facility (SAIF) Centres in the country viz. at IIT, Chennai; IIT, Mumbai; CDRI, Lucknow; Panjab University, Chandigarh; NEHU, Shillong; IISc., Bangalore; AIIMS, New Delhi; Gauhati University, Guwahati; CVM, Vallabh Vidyanagar; Sophisticated Test and Instrumentation Centre (STIC), Kochi; IIT, Patna; IEST, Shibpur; Shivaji University, Kolhapur; M.G. University, Kottayam; and at Karnataka University, Dharwad.

Highlights during financial year 18-19

An initiative has also been taken to set up three super special SAIF Centres with the latest state-of-the-art instruments for cutting edge research in the country. These Centres are also being set to meet the ever increasing scrutiny by the regulators in industry, the environment and medicine in validation and also in research and development for more accurate, precise and reliable scientific data and results and to reduce dependency on the overseas Analytical Servicing laboratories. It is anticipated that the with the start of these Centres, the researchers in the country would benefit to a greater extent.

These SAIFs are equipped with instruments such as Nuclear magnetic Resonance Spectrometers, Scanning Electron Microscopes, Transmission Electron Microscopes, Secondary Ion Mass Spectrometer, ICP, EPR Spectrometers, Mass Spectrometers, X-ray Diffractometers and Thermal

Analysis Systems etc. to meet the needs of the researchers in various areas of Science and Technology. The instrument facilities at the SAIFs are accessible to all the users irrespective of whether they belong to the host institutes or are from the outside the host institutes and are being used extensively by the researchers from Academic, R&D labs., and Industry all parts of the country.

a) Instrument Facilities Strengthened at Various SAIFs

Instrument facilities were strengthened during the year in the areas of Electron Microscopy, Nuclear Electron Microscopy, X-Ray Diffraction, High Resolution Mass Spectroscopy to meet the current and emerging needs of Research Community.

Some of the major Instrument facilities installed at the SAIFs during the year are UV-VIS-NIR facility at IIT, Chennai; SAXS facility at IIT, Mumbai; Cryo TEM Facility at AIIMS, New Delhi, XRD and ICP-OES Facility at SICART, CVM, Vallabh Vidyanagar. LC-MS Facility at M.G. University, Kottayam; TEM at Shivaji University, Kolhapur; XRD (Powder) at Karnatak University, Dharwad etc to make them more useful to the users. Some of the facilities like Dual Beam FIB-FEG SEM with facilities for preparation of high end TEM samples at SAIF IIT, Mumbai; Nano LC-MS/MS with other facilities at SAIF Panjab University, Chandigarh are being added to further strengthen them.



**Small Angle X-ray Scattering (SAXS) instrument at SAIF IIT, Mumbai**

SAXS is an analytical characterization tool used to determine the structure of particle systems in terms of averaged sizes or shapes. The materials can be solid or liquid and they can contain solid, liquid or gaseous domains (so-called particles) of the same or another material in any combination. The method is accurate, non-destructive and usually requires only a minimum of sample preparation. Applications are very broad and include the metal, cement, oil, polymer, plastics, food and pharmaceutical industries and can be found in research as well as in quality control.



**ICP-OES instrument at SAIF at SICART, Vallabh Vidhyanagar**

b) Analysis Provided/Usage of the facilities

The instrument facilities at SAIFs are meeting the analytical needs of scientist in various areas of S&T. A wide range of Analytical techniques/methods for chemical/material analysis/testing/ characterization including qualitative/quantitative elemental, molecular/compound analysis, structure determination, microstructure analysis and surface topographic studies, study of physical, optical and electrical properties of materials etc. are available to pursue research in various frontline areas of S&T.

About 2000 research papers (partial number) were published by the users of the SAIFs with the support from these facilities. About 19,000 researchers from all over the country utilized and benefitted from the facilities provided by the SAIFs during the year. These included researchers from almost all the Universities from the country. More than 85% users are from the academic sector. These SAIF Centres have analyzed more than 1.25,000 samples during the year and have generated a revenue of about Rupees 10.40 crores in this year.

c) Workshops/Training Programs/Short term courses organized

About 40 workshops and training programs were organized by the SAIFs during the year towards the use and application of various instruments and analytical techniques to create awareness among the research community about them and on maintenance/repair/operation of instruments for technicians. About 300 participants attended these workshops/training programs.

### 1.2 State S&T Programme

Department is playing a proactive role and encouraging State S&T Councils to address location specific S&T related issues by liaising with Central/State academic institutions & laboratories through State S&T Programme. This facilitates States to achieve the specific S&T objectives at their level. Also, core support is provided to the State S&T councils for their S&T human resources and some infrastructure besides funding support for location specific research, technology development and demonstration. The programme also supports studies and surveys on local S&T related issues etc.

Summary of the activities being implemented in various States under the State S&T Programme during 2018-19:

- 28 State Councils for S&T were supported by providing grant in aid of Rs. 22.16 Crores.
- 36 new projects/ programme were supported to address the State Specific S&T challenges, S&T surveys and studies in the tune of 19.40 Crore.
- The process initiated for establishment of 3 new Technology Demonstration Centres (TDC) at:
  - Arunachal Pradesh State Council of Science & Technology (APSCST), Dept. of Science and Technology, Govt. of Arunachal Pradesh, Itanagar- 791 113.
  - Tamil Nadu State Council for Science and Technology, DOTE Campus, Chennai – 600025, Tamilnadu.
  - Meghalaya State Council for Science and Technology, Shilong
- The Annual Conclave of the State S&T Councils was organized at State Council for Science Technology & Environment, Himachal Pradesh, Shimla-9, Himachal Pradesh during 7th-8th June, 2018 to review the progress of various State S&T Councils. 27 States participated in the Conclave and discussed the future course of actions to be taken for S&T development in States.
- A Standing Finance Committee (SFC) was constituted for the formulation of the SFC document of the State Science & Technology Programme under the chairmanship of Secretary, DST. The Committee recommended for the continuation of the programme for a period of 3 years from 01.04.2017 to 31.03.2020 with a total budget of 186.0 Crore.
- Model Village establishment projects were initiated in the States: Uttarakhand (6), Meghalaya (3), Arunachal Pradesh (3) and Manipur (3)
- Student Project Programme (500 Final year B.Tech/ BE students) supported in each of the States of Tamilnadu, Kerala, Karnataka, Himachal Pradesh and Telangana. State Govt. also contributed by funding Rs.60.00 Lakhs for three years.

Some of the major technologies developed and demonstrated in various States:

### I. Development of Solar Thermal Assisted Rapid Bulk Milk Cooler implemented by MNIT, Jaipur in the State of Rajasthan.

An effective real size solar thermal power assisted rapid bulk milk cooler has been developed to meet out the milk cooling requirements for an average small village in Rajasthan. The average time required to cool milk from 35 °C to 04 °C was 2 hours 30 minutes, which was well within the time frame suggested by international standards. The demonstration of the unit has been planned at Milk cooperative society.



**Schematic of the Solar Thermal Assisted Rapid Bulk Milk Cooler**

### II. Community Based Integrated Water Filter System for Clean Drinking Water demonstration at village Ruma of Kanpur, Uttar Pradesh based on the technology developed at Indian Institute of Technology, Kanpur.

The design, development and optimization of three-staged integrated water filter system at lab scale and field trial pilot scale has been realized. The three stage filter is composed of ceramic based material and functionalized sand used in different compartments of the filter. The integrated filter showed high efficiency for removal of hardness, heavy metals (arsenic and chromium) and microbial contamination in both lab as well as field trials. This is a low-cost filtration system since it runs on gravity alone and has a high flow rate to meet the required demand at community level. The demonstration of the unit at two schools is being planned.





**Planting of G1 seed tubers by Md. Hasibul Rahman of Village Ulla**

#### **IV. Development of Marble Dust Filled Reinforced Polymer Composite for Wind Turbine Blade implemented by Collage of Technology & Engineering, Udaipur in the State of Rajasthan.**

In-house low cost Vacuum Assisted Resin transfer molding (VARTM) setup for fabrication of wind turbine blade materials was developed under the project. The 3-D CAD model and simulation of wind turbine blade has been carried out and compared the simulated results with the existing wind turbine blade. Glass fiber reinforced polymer composite with 20 wt.% filler content shows slightly superior properties for wind turbine blade material with existing materials. Based on the concept of the project registered a start-up “Vincenzo solutions Private Limited” in MNIT Innovation and Incubation centre (MIIC) Jaipur.



**In-house developed VARTM setup In-house developed wind turbine blade**

#### **V. Installation & Evaluation of Water Filtration units at Public Ponds in SC/ST areas in Imphal West District of State Manipur by Manipur Council for Science & Technology, Manipur**

Under this project 5 (five), Ultra Water Filtration Units of 2000 litres capacity each developed by Bhabha Atomic Research Centre (BARC) have been installed at 3 (three) Schedule Tribe villages and 2 (two) Schedule Caste villages in the Imphal West District of Manipur. The polysulfone membrane filtration system is designed in a compact manner in a stainless steel container (300 mm x 350 mm) containing 23 Cartridges (45 mm diameter, 250 mm length). The Raw Water tank is placed overhead at a head difference of about 3 m with the membrane filtration system. Water from the public pond is pumped into the Raw Water tank via the desilting tank. The Raw Water flows gravitationally through the membrane filtration system and finally the filtered water is collected in a drinking water tank. The water filtration rate of the filtration unit is 90-100 litres per hour. Since the installation of the water filtration units, the water of community ponds in the remote SC/ST villages have been changed into drinking/potable water. Further, people in these villages got training on operation and maintenance of the BARC-UF Water Filtration System.



**Water Filtration Units installed at SC/ST villages, Manipur**

#### **VI. Pilot village level deployment of a wireless sensor network based animal development monitoring scheme for rural/semi-rural dairy operations implemented by Indian Institute of Technology Delhi at Bhopal, Madhya Pradesh.**

During the project the entire Sabarmati Ashram Gaushala (SAG) campus, Ahmedabad which has around 400 cows in 5 animal sheds has been provided with a WiFi network using two WiFi Access

Points (AP) and a WiFi Client.. The APs, Clients and Cascaders are solar powered thus making it independent of SAG's power supply. The weights measured on a Weighing Machine and animal ID are simultaneously displayed on an LCD Screen of the device as well as sent to the Server over the WiFi Network. A Radio Frequency Identification (RFID) wand is used to read the ID of the animal during the measurement of weight. Each cow inside the sheds has a Pedometer which counts the number of steps walked by the cow and reports it to the Cascader installed in the respective cow shed. This step count data was analyzed at Wisekar to determine if a cow is in oestrus and conveyed to Animal Scientist in-charge immediately. An Android application 'Smart Farm' is developed to accomplish this task. SmartFarm can receive data from Wisekar through Google Cloud Message (GCM) Servicing and generate appropriate notifications to inform events like oestrus detection, lameness detection, etc.



**Weighing machine installed in the campus A cow with a Pedometer on its rear left leg**

## **VII. Improving sustainable energy access among SC/ST households in Chamarajnagar district of Karnataka –a pilot study implemented by TERI, Bangaluru in the State of Karnataka.**

The project aimed to improve the indoor air quality among 425 SC&ST households through provision of clean energy solutions for cooking and lighting in six villages at Bhogapura Grama Panchayat, Chamarajanagara district, Karnataka. The activities included implementation of integrated domestic energy systems (improved forced draft cook stoves, solar home lights and mobile charging), training of local entrepreneurs, stakeholder awareness, user training, establishment of service center, monitoring and assessing the performance of devices and project outcomes. The improved cook stove resulted in 43.90% savings in fuel wood, which translates into 366.01 tonnes of savings in fuel wood and 669.79 tonnes of CO<sub>2</sub> reduction among beneficiary households. In addition, several advantages like faster cooking, less smoke, easy fuel processing, reduction in drudgery for women, reduced health risk for women were observed. Use of solar lights resulted in 40% savings in monthly electricity bill, reduced usage in kerosene (up to 3 litres per month) for lighting, indicating a potential to save an average of 4500 litres of kerosene per annum and reduction of 13.5 tonnes of CO<sub>2</sub>. Nearly 2000 stakeholders were made aware of the importance and utility of renewable energy.



**Conducting Awareness programme at Kallahalli village, Chamarajanagara district, Karnataka**



**Construction of low cost forced draft cook stove at Kellamballi village by local masons, Chamarajanagara district, Karnataka.**



**Low cost forced draft cook stove using by women at K Mookahalli, Chamarajanagara district, Karnataka**



**Children are studying under solar lighting in un-electrified households at Bhogapura village, Chamarajanagara district, Karnataka**

#### **VIII. Establishment and Demonstration of a compressed biogas (CBG) production technology developed by Indian Institute of Technology, Delhi at Sharda Vihar Jankalyan Samiti, Bhopal, Madhya Pradesh.**

The available cow dung was utilized for compressed biogas production for operation of vehicles that are being run the Samiti, and also to support the organic farming in its premises. The availability of the cow dung in Kamdhenu Gaushala is around 2.5 tonnes per day. This plant produces nearly 40 kg of compressed biogas (equivalent to compressed natural gas – CNG) per day from 100 m<sup>3</sup> of biogas per day. Apart from compressed biogas the biogas plant also provides 200 kg of dried bio-fertilizer which is being used by the Samiti for organic cultivation of farm produce.



**A visual of installed biogas production plant.**

**IX. Project entitled “Rural women empowerment and sustainable growth implemented by MNIT, Jaipur in the State of Rajasthan**

The project aims at spreading awareness about sanitation and menstrual hygiene and to make the rural women economically self-sufficient. More than 1500 women showed interest in learning about the work; nearly 1000 adolescent girls and women changed their sanitary habits. In the project almost 120 women involved themselves in manufacturing and marking of handmade sanitary napkins.



**A Schematic of the rural Women’s making the Sanitary Pads**

**X. Establishment of Tribal Resource Centre (TRC) for Chakrota Tribe in Rikhad Village, Chakrata, Dehradun, Uttarakhand State implemented by HESCO, Dehradun**

The Tribal Resource Centre (TRC) has been established at Rikhad Village, Chakrata in district

Dehradun and it served tribal community and around 10 villages of the region. This centre acted as connecting point between tribal community and the resources persons and a base for their interaction, enhancement and development, with new science and technology inputs. The success of tribal resource centre can be calculated with the benefits that they have reaped from this centre be attending various trainings. This centre has not only added to their knowledge and understanding but has uplifted their economic level as well.

Now the tribal resource centre (TRC) is being run by the community. The community have been trained in different disciplines i.e. post harvesting technology, agriculture, Horticulture, bio-farming, energy and water conservation etc. and will trained others for future also.



**Tribal Resource Centre (TRC) at Rikhad, Chakrata, Uttarakhand**

**XI. Project entitled “An Empirical Investigation of Ergonomic Interventions in Handicraft Industry in Rajasthan with a special reference to Gems and Jewellery Industry’ has been implemented by MNIT, Jaipur in the State of Rajasthan.**

Under this project, through ergonomic interventions at an experimental setup, eliminated the vulnerable working postures of polishers, reduced fatigue due to work and perceived pain/discomfort from high to low, increased workers’ daily productivity by 15.29% and utilization of gemstone polishing wheel by 40% and enhanced quality of work.

### **1.3 Policy Research Cell**

The Department is mandated to develop and deliver public policy support for the promotion of R&D in the country. Science, Technology, and Innovation (STI) are recognized to play a significant role in advancing human, social, and economic development to meet the aspirations of people. To understand STI processes for making effective policies, strengthen them and link these evidences to policy making, five DST-Centers for Policy Research (CPRs) established in academic institutions across the country were given continued support. The Centres undertake research in number of key areas relevant to the

country, train young scholars in STI policy research, and contribute towards better STI policy making by providing inputs to Government agencies/departments. The DST-CPRs are also engaging itself with stakeholders, national and international experts to develop policy related papers. Apart from this, STI Fellowships at post-doctoral level was also initiated to generate critical mass of policy researchers. It has provided an opportunity to develop the skills of young-scientists and engineers who are interested in engagement with the STI policy domain as STI policy researchers. This year, four new STI Fellows at post-doctoral level were selected.

During the year, all the DST-CPRs continued their ongoing work in their identified thematic areas. They also organised conferences/seminars/meets involving scientists engaged in industry oriented research, societal sectors etc. A discussion meeting of the national level Expert Panel constituted for drafting Policy on Technology led Innovation was organised at IIT Delhi.

DST-Centre for Policy Research at Panjab University, Chandigarh, in association with the Royal Academy of Engineering, UK and Ministry of Commerce and Industry, GoI, New Delhi organized a two day 'India-UK Industry-Academia Symposium' entitled, 'Working in Systems not Silos: Driving Growth and Innovation through Industry-Academia Partnerships' during April 16- 17, 2018. The joint symposium aimed at providing a platform as well as an opportunity for sharing lessons and experiences for enhancing Industry-Academia (I-A) collaborative research ecosystem in both the countries.



**Fig. From L to R: Prof. Sir William Wakeham (Royal Academy of Engineering, UK), Prof. Anil D Sahasrabudhe (Chairman, AICTE, GoI), Prof. Arun Grover (Fmr. VC, PU, Chd.), Dr. Vinod K Paul (Member, NITI Aayog, GoI), Mr. Andrew Ayre (British Deputy High Commissioner, Chd.) and Dr. Neeraj Sharma (Head, Policy Research Cell, DST, GoI)**



**Fig. Prof. K. VijayRaghavan, Principal Scientific Adviser to the GoI, visited DST-CPR at Panjab University and interacted with faculty and staff of the Centre. He appreciated the work done by the Centre and gave many suggestions for an effective output/ outcome.**

DST- Centre for Policy Research at Indian Institute of Science (DST-CPR-IISc) in association with United Nations University- Maastricht Economic and Social Research and Training Centre on Innovation and Technology (UNU-MERIT), conducted a 5-day capacity-building program (Design and Evaluation of Innovation Policies - with a specific focus Scientometrics) during 25-29 March 2019.



**Fig. Prof. K. VijayRaghavan after the keynote address on building national STI data architecture at DST-CPR at IISc Bangalore**

In parallel to the training programme, a high-level meeting was also facilitated to enhance engagement between India and OECD on STI Indicators and Policy. This meeting resulted in India receiving official invitation to join OECD – Committee of Science and Technology Policy (OECD-CSTP) as a Participant.

Department participated in ASIAN STI THINK TANKS NETWORK (ASTN) Roundtable and 4th Asian Innovation Forum meetings during July 09-11, 2019, co-hosted by Korea Institute of S&T

Evaluation and Planning (KISTEP) and S&T Policy Research and Information Center (STPI) at Taipei, Taiwan. To understand USA's Science & Technology Landscape, Science & Diplomacy, a one week experiential visit for STI Postdoctoral fellows was organised to American Association for the Advancement of Science, Washington DC, USA. They also interacted with National Institute of Health (NIH) and National Science Foundation (NSF), USA.

Release of Research studies/books: The following research studies completed by DST-CPRs and publications were launched by Dr. Harsh Vardhan, Hon'ble Minister for S&T on May 11, on occasion of National Technology Day held at Vigyan Bhawan, New Delhi.

- (i) Enhancing S&T-based Entrepreneurship: The Role of Incubators and Public Policy
- (ii) STI for Inclusive Growth in India: Building Strategic Perspective from Evidences' and
- (iii) Mapping of a Patents and Research Publications of Higher Education Institutes and National Research Laboratories of India"



**Fig. Publications launched by Dr. Harsh Vardhan, Hon'ble Minister for S&T , National Technology Day, Vigyan Bhawan, New Delhi**

#### 1.4 Centre for Human and Organizational Research Development (CHORD)

Centre for Human and Organisational Resource Development (CHORD) division formerly National Science & Technology Management Information System (NSTMIS) continued its efforts of generating and making available information on resources both manpower as well as financial devoted to scientific and technological (S&T) activities by conducting national surveys both through in-house as well as sponsored studies.

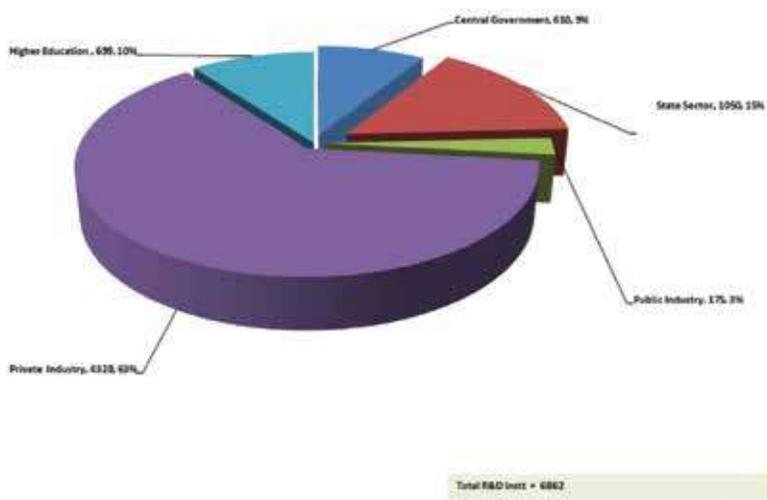
##### 1.4.1 S&T Resources Studies

The data collection for National Survey 2017-18 on resources devoted to research and development activities (launched both in print and e-mode) is in progress. A response rate of more than 50% has been achieved so far with the target population of more than 6000 R&D organizations comprising of public sector, private sector, MNCs, higher education, SIROs and NGOs spread across the country.

Checking of consistency of survey data as received and e-reminders to enhance the response rate is in progress. Based on the outcome of the survey, the next issue of national publication “Research and Development Statistics” is likely to be published next year which would serve as an evidence base for the policy formulation in the S&T sector.

The division brought out a spin-off publication of the National S&T Survey entitled ‘**Directory of R&D Institutions 2018**’. The present directory is eleventh in the series containing list of around 6862 R&D institutions with complete addresses arranged alphabetically by S&T sectors. Details on various communication modes such as phone, fax, email, web site addresses have also been provided, wherever possible. The Directory is widely used by professional engaged in policy making, planning science, administration, industry, teaching and research apart from other stakeholders in the S&T sector.

### Distribution of R&D Institutions in India, 2018



**Bibliometric Studies** were commissioned on India’s research output, collaboration and comparative performance based on the global databases SCI and SCOPUS to bring out a new set of Bibliometric Indicators for the time window 2011-2016. These studies/reports serve as an evidence base leading to evaluation and monitoring of scientific research for policy planning.

A Brainstorming Session on “**Guidelines on Ethical Practices in Bibliometrics**” was held at University of Hyderabad, Hyderabad in September, 2018 with various stakeholders and experts to discuss various issues including strategies to combat menace of Predatory journals affecting the Indian scientific research publications. The outcome of the BSS led to many important suggestions such as formation of a regulatory body (representing a consortia of various stakeholders) on good practices in research publishing, alternative mechanism of publishing research papers by public research organizations, use of advanced technology etc.

Another Brainstorming Session was held at Udaipur in July, 2018 with experts on **Social Scientific Responsibility (SSR) in S&T** to discuss various issues such as definition, different types of SSR activities, level/mode of operation, measurement/developing suitable indicators etc, so as to evolve a study proposal for assessing existing status of SSR in India, documentation of best practices, its impact and associated policy recommendations.

Considering the importance of innovation, the department is planning to launch the next **National Innovation Survey (NIS)** in collaboration with UNIDO, Austria. A series of meetings were held with stakeholders and experts to discuss various aspects of the NIS proposal submitted by UNIDO so as to build synergy with relevant stakeholders, avoid overlaps and explore possibility of its co-funding. Based on the experts and stakeholders inputs, the UNIDO has submitted the final proposal for consideration by the department.

The division participated in the meeting on **R&D Ecosystem** held on 7th December 2018 in NITI Aayog, New Delhi and was attended by **Principal Scientific Adviser (PSA) to the Government of India** and other stakeholders from Central Scientific Ministries and Public Sector Units etc. It discussed establishing synergy among the efforts and related work carried out by various central government ministries/departments and other stakeholders present in the meeting as a part of the strategy for future plan of action for timeliness and better outcome in the context of development of STI indicators in the country.

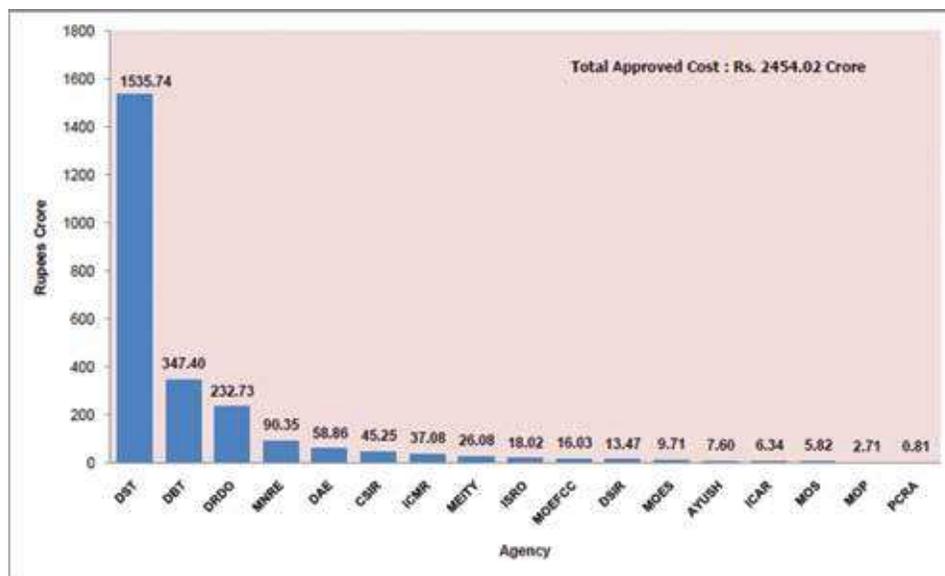
#### *1.4.2 S&T Policy*

The Division framed a Draft Policy Document: **Scientific Research Infrastructure Sharing Maintenance and Networks (SRIMAN)** after detailed deliberations with experts and stakeholders in the S&T sector. The policy primarily focuses on access and sharing apart from addressing issues such as procurement, maintenance, disposal, capacity building etc., for effective utilization of public research infrastructure in all scientific departments and research organizations. The first Steering Committee meeting towards finalization of Draft SRIMAN Policy Document was held on 14th November, 2018 in New Delhi followed by series of workshops with stakeholders across the S&T sector in the country. The inputs of the stakeholders' workshops have been incorporated towards finalization of the policy document.

#### *1.4.3 Information System/Database Activities*

With a view to disseminate information on sponsored research and development (R&D) projects for the benefit of different stakeholders, NSTMIS since 1990-91, has been continuously engaged in compiling information on extramural R&D projects funded by various central S&T agencies and publishing an annual **Directory of Extramural R&D Projects**. The latest directories for the years **2015-16** and **2016-17** have been compiled and published together during this year.

## Extramural R&amp;D by Central S&amp;T Agencies, 2016-17



The women participation in extramural R&D projects increased significantly to 24% in 2016-17 from 19% in 2004-05 due to various initiatives undertaken by the Government in S&T sector. In absolute terms, 941 women Principal Investigators (PIs) availed extramural R&D support during 2016-17. Further, women Co-PIs participation in extramural R&D projects was 18% during 2016-17.

#### 1.4.4 NSTMIS Sponsored Studies

As a part of its outreach research programme, NSTMIS has sponsored several research studies/projects to various stakeholders' viz. research institutions, universities, colleges, NGOs and consultancy organizations spread across the country.

The **Program Advisory Committee (PAC)** of experts for implementation of NSTMIS Scheme met twice during the year to consider the projects submitted under the scheme for financial support. At present, there are 80 on-going projects out of which 30 new projects are initiated and 7 projects got completed during 2018-19. List of select projects approved by the PAC for support were in areas as below:

- Green Chemistry in Indian Chemistry Journals: A Comprehensive Bibliometric Study
- Intellectual Property Rights Policy and Innovation in Higher Education Institutions (HEIs) in India
- Contribution of India on Climate Change Research in Comparison with major countries: A Bibliometric Study of 30 years (1997-2016)
- Research Performance of Indian Women Scientists in Research Laboratories: A Scientometric Study

- Quantitative assessment of Public health nutrition (PHN) educational and research infrastructure in India
- Promoting innovation in rural entrepreneurs and artisans in Andhara Pradesh
- Assessing the impact of doctoral program in science & technology on career outlook and stimulating high impact research
- A study on hazard risk assessment of firework industries in Sivakasi Virudhunagar, District Tamil Nadu
- Investments in knowledge & Innovation and its impact on knowledge cluster and network in Indian cities
- Mapping of IPRs and its management in academic/research institutions: A study on agricultural research sector in India

Some of the select sponsored studies completed during the year were:

- Industrial Research, Development and Innovation in Public Sector Enterprises
- Linking R&D activities and firm performance: A study of Indian manufacturing sector
- Technology Business Incubators in India: An exploratory study on their contribution to National R&D Efforts
- Assessment of current status of Research and Development in the Higher Education Institutes in Delhi and NCR: A pilot Study
- Implementation of Quality Management practices in performance improvement of Micro, Small and Medium Enterprises through Academic Intervention: A step towards Industry Institute Interaction

The division further held review meetings of the on-going sponsored research projects at BHU, Varanasi, Punjab State Council for Science & Technology, Chandigarh and Indian Institute of Science (IISc), Bangalore. In addition, network projects involving multiple agencies are being evolved and catalyzed by conducting Brainstorming Sessions (BSS) in areas such as **Impact of Government Policies on Improvement of Status of Women in Science** and **Impact of DST-FIST programme**. The completed project reports/studies are available in public domain through a **web-based digital repository** (<http://www.nstmis-dst.org/NSTDRepository.aspx>).

#### *1.4.5 International Collaboration*

The Department has actively participated and contributed in the UNESCO Institutes of Statistics (UIS) and Organization for Economic Cooperation and Development (OECD) meetings for the development and revision of standards/concepts/definitions used for collection of Science Statistics and development of Science, Technology and Innovation Indicators. The department also provided information for the country on Science & Technology Indicators to UNESCO Institute for Statistics for the Global database on S&T Indicators and other related publications such as UNESCO Science Report etc.

### 1.4.6 Training Scientist And Technologists Working In Government Sector

During the X Plan, Department of Science & Technology, in consultation with DOPT, other Scientific Departments and other organizations, initiated an ambitious project for human resource development namely “National Programme for Training of Scientists & Technologists working in Government Sector”. The programme was devised to meet challenges of nation development and international competitiveness in the field of Science & Technology. The efficacy of the Scheme led the Department to continue it through the XI and XII Plans and up to 2018-19. The programme has a component exclusively for women scientists.

The programme intends to provide Scientists & Technologists a better understanding of their professional responsibilities, enhance their professional knowledge and skills needed for their enhanced performance both as individuals and as integral elements of their organisations. It also intends to create awareness of emerging technological, economic and social development, infuse scientific temper in society and generate responsiveness among scientists to the challenging needs of a resurgent nation and growing aspirations of its citizens. The programme also provides a structured forum for peer-to-peer interaction, experience-sharing and exchange of views among scientific community for better networking and synergy.

The programme is targeted towards scientists or technologists holding scientific posts or working in scientific ministries or departments of Govt. of India or State Governments; Autonomous Institutions or Public Sector Undertakings of Central or State Governments, Research and Development Institutions or Research Laboratories of Central or State Governments, Central or State Universities as well as State Science & Technology Councils.

During the year 2018-19, thirty-three training courses, benefitting about seven hundred and fifty scientists, were conducted under the programme. During the same period, under the Women Component Plan, eight courses, benefitting about one hundred and eighty women scientists, were conducted.



**Participants of Science, Technology & Innovation Policy conducted by National Institute of Advanced Studies, Bangalore (19-30 November 2018)**

## 1.5 KIRAN Programme for Women Scientists

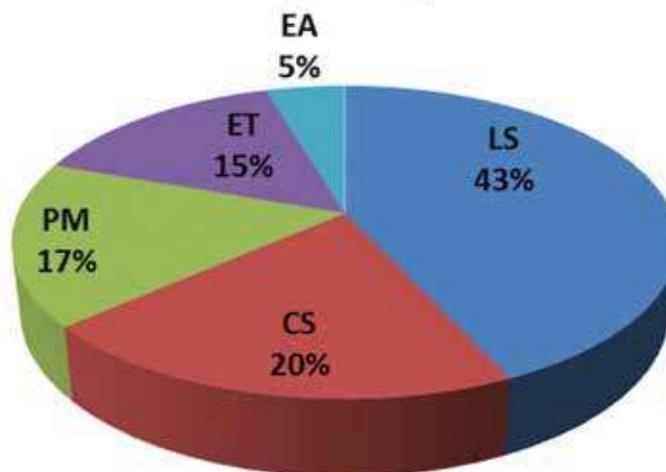
KIRAN (Knowledge Involvement in Research Advancement through Nurturing) embraces women-exclusive schemes of DST with the mandate to bring gender parity in S&T through various mechanisms. KIRAN paves the way to women scientists for building their career path by addressing crucial challenges (e.g. break in career primarily due to family responsibilities, self-employment, part time career, relocation, etc.) faced by them. The achievements of various programs under KIRAN during the year 2018-19 are as follows:

### 1.5.1 Gender Mainstreaming

#### a. Women Scientist Scheme-A (WOS-A)

WOS-A is aimed to provide opportunities to women scientists and technologists, who had a break in career, for pursuing research in basic or applied sciences in frontier areas of science and engineering. This year DST received 1022 new proposals and after extensive as well as intensive scrutiny, 348 projects (Life Sciences–150 out of 536, Chemical Sciences–71 out of 184, Physical and Mathematical Sciences–59 out of 90, Earth and Atmospheric Sciences–16 out of 30, Engineering Sciences–52 out of 162) were recommended. Subject-wise distribution of recommended projects is given in the Chart:

**Subject-wise Distribution of Recommended Projects Under WOS-A (2018-19)**



Approximately 45% selected women scientists with break received Ph.D degree with the help of WOS-A during the tenancy of their project which proves the relevance and popularity of the scheme. During the year, 145 ongoing projects, funded under this component, were also monitored.

#### b. Women Scientists Scheme-B (WOS-B)

WOS-B program provides opportunity to women scientists to think critically on societal challenges and impart S&T solutions through lab to land transfer of research, location specific research, etc.

Three subject areas viz. Agriculture & Allied Sciences (AAS), Health Food & Nutrition (HFN) and Engineering & Technology Development (ETD) have been selected for support projects under WOS-B. 137 proposals were screened in for presentation out of total 720 proposals received under WOS-B. Total 50 projects were recommended in three different subject areas viz. 18 projects in Agriculture and Allied Sciences (AAS), 21 projects in Health, Food and Nutrition (HFN) and 9 projects in Engineering and Technology Development (ETD). 24 ongoing projects were also been extended budgetary support. During 2018-19, total 1406 proposals have been received under WOS-B in 2018-19 and 318 project proposals were screened in for presentation before the Subject Expert Committees (101 in AAS, 147 in HFN and 70 in ETD).

Progress of 25 ongoing WOS-B projects was monitored in Group Monitoring Workshops. Some projects provide solution for health related problems through simple technology at an affordable cost e.g. detection of osteoarthritis in knee x-ray images using machine vision, early detection of breast cancer using novel infrared imaging, POC device to detect high risk HPV in cervical cancer patients, development of phonocardiography based stress classifier, etc. Few projects on technology development shows its importance in social life e.g. PVDF ultra filtration membrane for water purification, development of mosquito repellents from orange peel, production of poly-3-hydroxybutyrate using kitchen and food waste, development of robust interactive computing environment based on speech specifically for blind or people with poor vision, etc.

### **c. Women Scientists Scheme-C (WOS-C)**

WOS-C provides opportunity to women scientists for pursuance their career in the field of Intellectual Property Rights (IPR). It prepares them towards self-employment by providing on-the-job training in the area of IPR. Total of 104 women joined the 10th batch of WOS-C. One month orientation programme was held at New Delhi in June 2018 followed by 11 months on-the-job training at various agencies located throughout the country.

The training for 9th batch concluded in 2018. Out of the total women trained in 9th batch almost 50% of beneficiaries have been gainfully employed with IPR attorney law firms, government agencies, MNCs, KPOs, etc. A few have started on their own like freelancing of IPR work, IPR Consultancy and IPR firm. A total of 94 women from 9th & 10th batches (37 from 9th batch and 57 from 10th batch) have cleared the Patent Agent Examination held on October 28, 2018 conducted by the Patent Office of India. All these women have received the Prize Money of Rs.10,000/- each to women from 9th batch and Rs. 25,000/- each to women from 10th Batch. With this the total number of women from WOS-C Scheme clearing the Patent Agent Examination has gone up to 260. The process for selection of 11th Batch of women scientists is in process.



**(Women attending the Orientation Programme at New Delhi)**

### *1.5.2 Overseas Opportunity for Women in STEMM:*

#### **a. Indo-US Fellowship for Women in STEMM**

In 2017-18, DST in association with Indo-U.S. Science & Technology Forum (IUSSTF) initiated “Indo-U.S. Fellowship for Women In STEMM (WISTEMM)” program with an aim to provide opportunities to Indian Women Scientists, Engineers & Technologists to undertake international collaborative research in premier institutions in U.S.A, to enhance their research capacities and capabilities. The Indian Women Scientists within the age bracket of 21 to 50 years are eligible for this fellowship. There are two categories under WISTEMM: student internship and fellowship. 1102 applications were received in first call during 2017-18. The applications received were not only tall in numbers but were also of very good quality ‘subject specific & interdisciplinary’ contemporary research ideas as indicated in the proposal. Two-tier screening process was followed to screen the received applications of the first batch. 20 selected candidates (10 in each category) visited 20 leading institutions across the United States for being fostered and trained in their labs. These include universities like University of Alabama, Tuscaloosa, University of Wisconsin, Green Bay, Johns Hopkins University, Baltimore, Florida International University, Miami, Texas Tech University, Lubbock and others. The second call of WISTEMM is over and in process of finalization.

*1.5.3 Research Infrastructure and Facilities in Women Universities:*

**CURIE (Consolidation of University Research for Innovation & Excellence in Women Universities):** Since the inception of CURIE Programme in 2009, eight (8) women universities have been supported to strengthen R&D infrastructure & facilities. Out of 8, 3 Universities (Banasthali Vidyapith, Avinashilingam Women University and Sri Padmavati Mahila Vishwavidyalayam) got two-phase support and one got three phase support (Banasthali Vidyapith). This year, two Women Universities i.e. Indira Gandhi Delhi Technical University for Women, Delhi & Rama Devi University for Women, Bhubaneswar have been covered under CURIE.

**CURIE-AI Facility**

Artificial Intelligence is new boom in technology field and has great scope for skilled human resource. To harness this opportunity in favour of women, new component to establish Artificial Intelligence Facility in CURIE Beneficiary Universities is started in 2018-19. This support was given to Six (6) women universities. It is expected that 10,000 girls are going to be benefitted with this component.

*1.5.4 Training and Capacity Building:*

During 2018-19, Eight (8) training programmes have been organized under National Training Program specifically for women scientists & technologists working in Government covering multifarious themes. These programmes are related with managerial skills, leadership, Project management, internet of things, S&T for rural societies, entrepreneurship development, etc. More than 180 women benefitted through these programs.



Besides this, a hands-on training workshop for women scientists on 'Human Cell Culture Technology and its Applications in Cancer Research' was conducted at University of Mysore. The overall purpose of this training program was to equip the women scientists with the requisite scientific competency to understand and address the aspects related to cancer with the help of cell culture tools to delineate the molecular mechanism involved in pathogenesis of cancer. More than 20 women scientists have been trained in this important methodology of Life Sciences.

#### *1.5.5 Outreach Activities:*

##### **a. Sensitization Meetings:**

Two sensitization meetings have also been organized during 2018-19 to increase outreach of Women centric programmes of KIRAN. First meeting was conducted at Bhubaneswar on September 2018 wherein participants from aspirational districts of Odisha have also been participated. The second meeting was conducted at Dimapur in Nagaland during March 2019. The focus areas of these sensitization meetings are the parts of the country where representation of women scientists is less in KIRAN programmes. These workshops not only give flairs of all the women centric programmes to the participants but also include lectures on thrust areas, location specific problems, how to write scientific proposals, communication part, etc.

##### **b. Women Science Congress**

8th Women Science Congress (WSC) was held at Lovely Professional University, Jalandhar and sponsored by DST-KIRAN. Women Scientists from all over the country participated in WSC.

##### **c. Women Conclave**

DST celebrated International Women's Day by organising 'Women Conclave' on 8th March 2019 at Jawaharlal Nehru University, New Delhi. The main theme for this year's Women's Conclave was "Balance for better". It was concluded that collective action and shared responsibility are the keys for driving a gender-balanced world.

#### *1.5.6 Vigyan Jyoti:*

In 2018, Fifteen (15) pilot projects under Vigyan Jyoti were implemented in premier educational institutions in different parts of the country. Under these projects, three weeks' residential programme was conducted for meritorious girls studying in Class IX and XI wherein around 450 students were mentored to pursue higher studies and careers in Science & Engineering. In order to inculcate scientific temperament at early stage, one pilot project was also conducted for students (both girls and boys) of Class VI to VIII with focus on learning of scientific principles through live models. Sixty (60) students were benefitted by this project

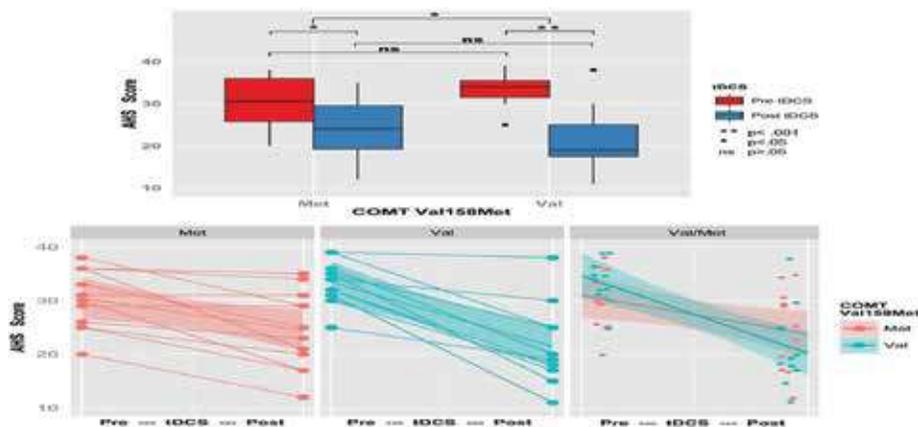
### 1.5.7 Cognitive Science Research Initiative (CSRI)

Cognitive Science Research Initiative (CSRI) provides support for multi-centric mega projects, individual projects, Post-Doctoral Fellowship (PDF) and also facilitates infrastructure development, sharing of experiences and networking activities.

During the year, 44 individual projects and 12 CSRI-PDF projects have been given financial support. Budgetary support has also been extended for 24 ongoing projects. In 2018, Call for proposals was also made against which DST received 401 individual project proposals and 88 applications for PDF. The Task Force of CSRI has recommended 47 projects for support and also recommended 9 projects with minor revision for budgetary support. The Expert Committee has recommended 18 projects under CSRI-PDF. Extension of budgetary support to the recommended case is in the anvil. The highlights of some of the completed projects are:

#### a) Understanding the neural basis of Hallucinations in Schizophrenia:

The neural correlates of treatment-resistant auditory hallucinations in schizophrenia patients have been evaluated by transcranial direct current stimulation (tDCS) with novel composite application of eye-tracking and connectivity measures. Present study also examined potential insight facilitation effects of add-on tDCS in schizophrenia patients with persistent auditory hallucinations despite adequate antipsychotic treatment. Examination of relationship between change in insight and change in severity of auditory hallucinations showed a significant positive correlation between improvement in insight and improvement in auditory hallucinations. This is the first study suggesting potential genetic effects of COMT polymorphism on the clinical benefits of add-on tDCS in treatment of persistent auditory hallucinations in schizophrenia.



**Fig. tDCS resulted in significant improvement in eye movement parameters (i.e. antisaccade final eye position gain, improvement in velocity and position gains of smooth pursuit eye movements) in schizophrenia patients. The project observations support application of tDCS in treating persistent auditory hallucinations and has therapeutic potential of tDCS in early course schizophrenia.**

### b) Modelling the cerebellar information code in large scale realistic circuits:

The overall objective of this project was to generate one among the first realistic models of a whole brain network particularly cerebellum. A new tool LFPsim was developed for NEURON-based models which allows several mathematical modelers to reconstruct local field potential. Mathematically reconstructed firing patterns for both auditory and visual granule neuron responses were extracted and decoded. The novelty of this work was estimating inter-spike interval and inter-burst-interval for different sensory patterns. The multiple inputs contribute to granule neuron activity in the cerebellum helps to explore the role of inhibition and plasticity in processing of diverse inputs. A detailed subcellular modeling of communicating dopamine behavior at molecular level to circuit properties using biophysical model has been developed to help connect and predict Parkinson's disease.

#### 1.5.8 Science and Technology of Yoga and Meditation (SATYAM)

Science and Technology of Yoga and Meditation (SATYAM) aimed to foster scientific research on the effects of yoga and meditation on physical & mental health besides on cognitive functioning in not only in patients with disorders but also in healthy people. Against 3rd Call for Proposals made in 2017, DST received 214 research proposals from across the country. Out of 214 proposals received in SATYAM against 3rd call, 17 Projects have been recommended for financial support. DST received 456 proposals in 4th Call of SATYAM for the year 2018-19 which are under finalization.

### Findings of Completed Project in SATYAM

#### a) Understanding basic muscle functions while performing various yoga postures

The study was performed in Biomechanics Lab, Indian Institute of Science (IISc), Bangalore on (40 – 60) healthy participants age between (21 – 60) years including male and female. The orientation is verified before mounting the sensors. The data is collected for approximately 110 seconds and subjects stayed in final position for 20 seconds with normal breathing and relaxed mind. The same procedure is followed for various Yogasanas namely Trikonasana, Vrikshasana, Veerabhadrasana-1, Veerabhadrasana-2, Veerabhadrasana-3, Parsvakonasana. PI has proposed a novel method and mathematical metrics to quantify and measure the correctness in the performance of yoga asanas (in terms of stability and steadiness) based on sEMG signals. This method will help distinguish between an expert and a novice in the field of yoga and will be able to assess the correctness of performance. This paves way for making appropriate corrections, thus enabling practitioners to derive maximum benefit from the asanas. This will elucidate the kinds of muscles that the performer can target.





require long durations of focusing, and (ii) particularly in persons with diagnosed hypertension or other signs of raised sympathetic activity required to focus their attention.

### **Support for Conferences/Workshops:**

DST supported four conferences under CSRI-SATYAM during 2018-19 viz. 5th annual conference of the Association for Cognitive Science, International Symposium on ‘Bilingualism and Cognition’, International Conference on Cognitive Science and Artificial Intelligence and Techno-Wellness Workshop on Healthy Spine

## **1.6 INSPIRE**

The aim of the “Innovation in Science Pursuit for Inspired Research (INSPIRE)” Scheme of the Department of Science and Technology (DST) is to attract talent to the study of science from an early age and build the required human resource pool for strengthening and expanding the R&D base and the Science & Technology (S&T) system of the country.

### *1.6.1 The INSPIRE Internship /*

This component of this Scheme aims at providing exposure to young science students by organizing Science Camps either during the summer or winter days. Close to 132 INSPIRE Internship camps were organised for students of Class XI pursuing science in any school. The students were provided opportunity to interact with science icons from India and abroad. The INSPIRE Internship Science Camps that were organized covered the entire length and breadth of the country and were held with the cooperation of academicians and scientists from a wide cross-section of institutions.

### *1.6.2 The Scholarship for Higher Education (SHE)*

This component aims at enhancement in the number of talented youth who take up higher education in science-intensive programmes by providing scholarships and mentoring through summer attachment with performing researchers. The Scheme offers 12,000 Scholarship every year @ Rs 0.80 lakh per year for undertaking Bachelor’s and Master’s-level education in natural and basic sciences to meritorious students in the age group of 17-22 years. The main feature of the Scheme is its support for mentorship to enable the students to carry out research during vacation period. So far, more than 1,00,000 INSPIRE SHE Scholars have been offered the scholarships to pursue a career in sciences. During 2018-19, against 21,156 SHE applications, 12,380 INSPIRE scholarships were offered to the selected candidates based on their performance (top 1%) in + 2 examinations of State/Central School Examination Boards and in various competitive examinations, for pursuing academic programmes at undergraduate/integrated post-graduate levels in basic and natural sciences (Fig.SHE-1). The gender-wise distribution of the INSPIRE SHE Scholars is given in Fig.SHE-2.

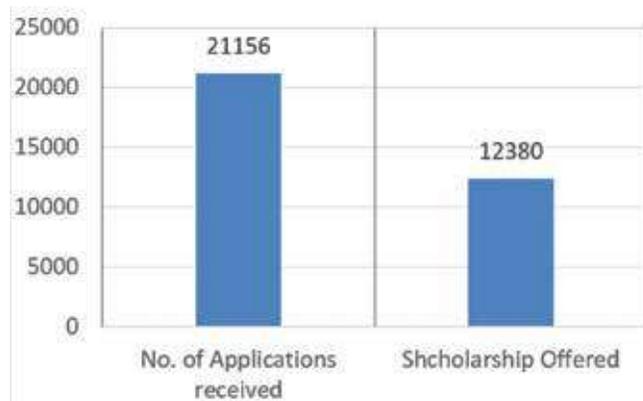


Figure: SHE-1

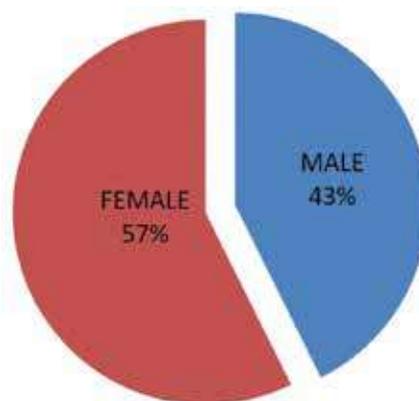


Figure: SHE-2

### 1.6.3 The INSPIRE Fellowship Scheme

It is the third component under which 1000 Fellowships are offered to students in the age group of 22-27 years for pursuing doctoral degree. This Scheme is open to (i) students having secured 1st Rank in basic and applied sciences including engineering, medicine, agriculture and veterinary sciences in the M.Sc.-level examinations of universities and other academic institutions of national importance and (ii) INSPIRE SHE Scholars having 70% marks in aggregate in the M.Sc.-level examinations and who are eligible for admission to the Ph.D. programme in any recognized university/academic institution of the country. The fellowship is tenable for a maximum period of 5 years (2 years as JRF and 3 years as SRF) or completion of the Ph.D., whichever is earlier, for pursuing full-time PhD programme. The fellowship amount is governed by the GOI norms and regulations as applicable from time-to-time. So far, about 8000 students have been awarded the INSPIRE Fellowship. Out of these, 63% are women (Fig. IF-1) and the subject-wise distribution of INSPIRE Fellows is given in Fig. IF-2. Out of the 8000 INSPIRE Fellowships, 1000 INSPIRE Fellows received their fellowship during the year 2018-19. Besides this, 8 INSPIRE Fellows, working as Senior Research Fellows, were selected for participating in the 11th HOPE Meeting in Japan and 27 INSPIRE Fellows, also working as Senior Research Fellows, were selected for participating in short-term Research Internship Programmes at various Laboratories/Universities in UK under the Newton-Bhabha Programme. The Newton-Bhabha Programme is reciprocal in nature and 3 Fellows from the UK also undertook Research Internship Programmes in Indian institutions.

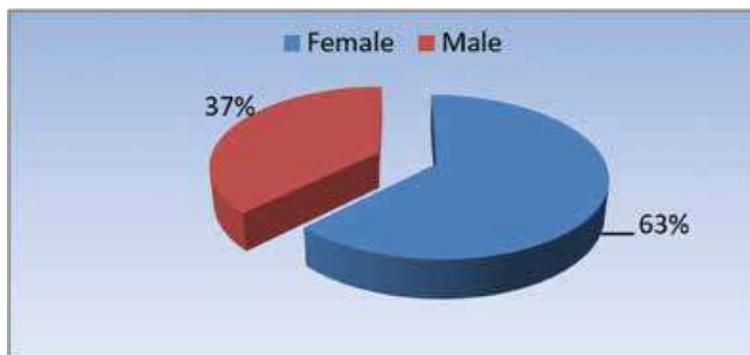


Figure:IF- 1

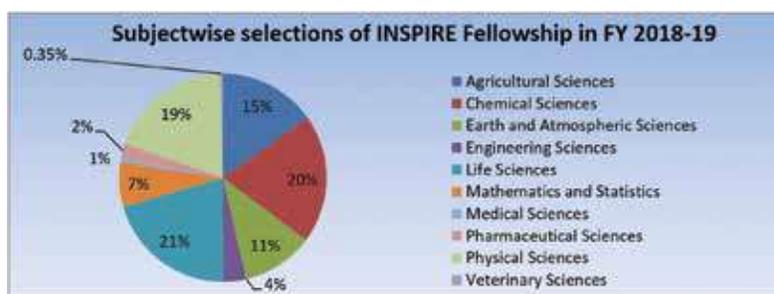


Figure: IF-2

#### 1.6.4 The INSPIRE Faculty Fellowship

This component provides opportunities to post-doctoral researchers in the age group of 27-32 years for 5 years in both basic and applied science areas, including engineering, agriculture, veterinary and medicine, to carry out independent research. It aims at the following:

- To provide attractive opportunities to young achievers for establishing themselves as independent researchers so that they are able to embark on long-term research careers.
- To provide high-quality scientific manpower to the scientific and educational institutions, specially the central and state universities.
- While this component does not guarantee a regular job position after 5 years, it provides an opportunity for carrying out independent research.

So far, 1244 INSPIRE Faculty Fellows have been supported under this component. During 2018-19, 159 INSPIRE Faculty Fellowships were offered, out of which 122 Faculty Fellows have already found their host institutions, and the rest are in the process of finding their host institutions. The gender-wise distribution of the INSPIRE Faculty Fellows is given in Fig. IFA-1. The subject-wise distribution of the INSPIRE Faculty Fellows is given in Fig. IFA-2. Out of the 1244 INSPIRE Faculty Fellows supported so far, 549 have secured regular employment.

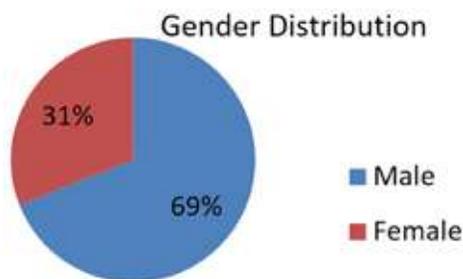


Figure-IFA- 1

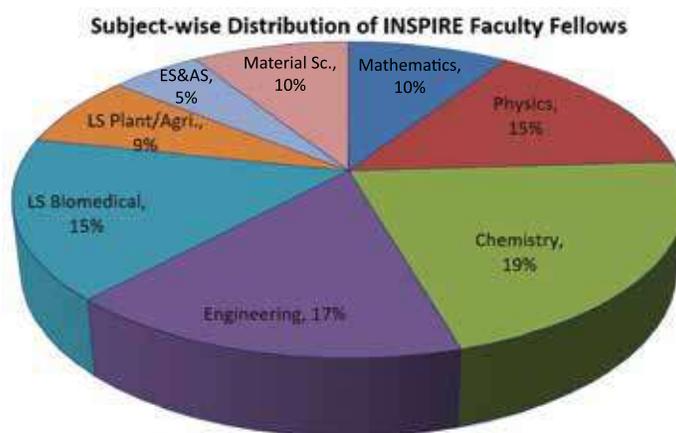


Figure-IFA- 2

### 1.7 Swarna Jayanti Fellowship

On the occasion of 50th year of India's Independence, 1997, the SwarnaJayanti Fellowship Scheme had been launched to support young scientist to enable them to pursue research in frontier areas of science and technology. The scheme offers Rs.25,000/- per month for 5 years with project grants for equipment, consumables and international travel to enhance their research capability.

The exposure through the SwarnaJayanti Fellowship Scheme has enabled the fellows in achieving higher scientific recognition. Some of the advanced areas of S&T got recognized due to support to the Young Science Leaders as SwarnaJayanti Fellows like for the INO-India. During a survey, it was found that most of the SwarnaJayanti Fellows have received the prestigious Shanthi Swarup Bhatnagar Prize.

During the year 2017-18, 14 Fellows have been selected under the Scheme through a three-tier rigorous screening process from 392 applications. The following 14 applicants were selected for SwarnaJayanti Fellowship for the year 2017-18:

S.No	Fellows Detail	Discipline
1.	<b>Dr. Sripada S. V. Rama Sastry</b> Indian Institute of Science Education and Research (IISER) Mohali, Mohali.	Chemical Sciences
2.	<b>Dr. Sebastian C. Peter</b> Jawaharlal Nehru Centre for Advanced Scientific Research (JNCASR), Bengaluru	Chemical Sciences
3.	<b>Dr. K. G. Arun</b> Chennai Mathematical Institute, Chennai	Physical Sciences
4.	<b>Dr. G. V. Pavan Kumar</b> Indian Institute of Science Education and Research (IISER) Pune	Physical Sciences
5.	<b>Dr. Girdhari Lal</b> National Centre for Cell Science, Pune	Life Sciences
6.	<b>Dr. Chandrima Das</b> Saha Institute of Nuclear Physics, Kolkata	Life Sciences
7.	<b>Dr. Arun Kumar Shukla</b> Indian Institute of Technology-Kanpur, Kanpur	Life Sciences
8.	<b>Dr. Mayank Vatsa</b> Indraprastha Institute of Information Technology (IIIT Delhi), New Delhi	Engineering Sciences
9.	<b>Dr Yogesh Singh</b> Chauhan Indian Institute of Technology-Kanpur, Kanpur	Engineering Sciences
10.	<b>Dr. Ashish Kumar Sen</b> Indian Institute of Technology-Madras, Chennai	Engineering Sciences
11.	<b>Dr. Punyasloke Bhadury</b> Indian Institute of Science Education and Research Kolkata, Mohanpur	Earth & Atmospheric Sciences
12.	<b>Dr. Ramananda Chakrabarti</b> Indian Institute of Science, Bengaluru	Earth & Atmospheric Sciences
13.	<b>Dr. Saket Saurabh</b> The Institute of Mathematical Sciences, Chennai	Mathematical Sciences
14.	<b>Dr. Parthanil Roy</b> Indian Statistical Institute, Bengaluru	Mathematical Sciences

## RESEARCH & DEVELOPMENT

### 2.1 International Bilateral Cooperation

Salient activities during the year

**Joint S&T Committee/ Council Meetings** were held with Austria, Belarus, Brazil, Bulgaria Denmark, France, Hungary, Italy, Netherlands, South Korea and Ukraine. These meetings were led to the renewal of new Program of Cooperation (PoC), Action Plans with various partner countries. Governing Body meetings of the bi-national Indo-U.S. S&T Forum (IUSSTF), Indo-French Centre for Promotion of Advanced Research (IFCPAR) and Indo-German S&T Centre (IGSTC) were also held during the year. New areas of S&T cooperation were also introduced for implemented through PoC.

**Bilateral Meetings** were held with Czech, Denmark, Egypt, Mexico, U.K and Uzbekistan to discuss ways to take advantage of all linkages and networks supported in the previous years, including joint solicitation for scientific research and technological development and innovation proposals. The other considerations highlighted during these meetings included exploring possibilities of establishing joint centres of excellence and inter disciplinary cross cutting ideas to promote futuristic bilateral cooperation.

**Ministerial meetings** were held with Denmark, South Korea, Sweden and Uzbekistan to discuss ways to rejuvenate ongoing bilateral S&T cooperation.

**About 352 joint projects and over 120 joint Workshop/ Seminars** were supported during the years.

**S&T Prime Minister Conclave:** An Agreement on Cooperation in the field of Science, Technology and Innovation between the Government of the Republic of India and the Government of the Republic of Uzbekistan was concluded on October 1, 2018 at New Delhi in the presence of the Hon'ble Prime Minister, Shri Narendra Modi and H.E. Shavkat Mirziyoyev, President of the Republic of Uzbekistan. Agriculture and Food Science and Technology; Engineering Sciences; Information and Communication Technology, Applied Mathematics and Data Science and Technology; Health and Medical Technology; Materials Sciences; Life Sciences & Biotechnology; Physics and Astrophysics and Energy, water, climate and natural resources were identified as potential areas for immediate collaboration.

**Technology Summit:** The 24th edition of the DST-CII Technology Summit was held in New Delhi during October 29-30, 2018 with Italy as partner country. Union Minister for Science & Technology and Earth Sciences, Dr Harsh Vardhan and Italian Deputy Minister of the Ministry of Economic Development, Dr Michele Geraci jointly inaugurated the Summit. The Prime Minister, Shri Narendra Modi and the Prime Minister of Italy, Mr. Giuseppe Conte addressed the valedictory session of the Summit on 30th October 2018.



**H E Giuseppe Conte      Shri Narendra Modi      Valedictory session of the Tech-Summit:  
Prime Minister of Italy      Prime Minister of India**

A tech leadership roundtable was held involving 20 captains of industry and academia each from both sides. This group discussed the key recommendations of the seven sessions of the summit and finalized the action points which were presented before the two prime ministers



**Members of the India-Italy Tech Leadership Roundtable with  
the Prime Ministers of both the countries**

### **S&T Ministers Conclave**

Korea: The fourth India-Korea Science & Technology Ministers Steering Committee Meeting was held in New Delhi on 9th July 2018. Hon'ble Minister of Science & Technology and Earth Science of the Republic of India and Minister for Science and ICT of the Republic of Korea led the Indian and Korean delegations, respectively. The Two Ministers reviewed bilateral science and technology cooperation between the two countries since last meeting of Steering Committee at Seoul in November 2015. The following decisions were taken during the meeting: i) establishing Indo-Korean Centre for Research and Innovation (IKCRI) in India, which will act as the hub for systematic operation and

management of all cooperative programmes in research and innovation between the two countries including innovation & entrepreneurship and technology transfer, ii) set up a Future Strategic Group, which will build a collaborative platform that can utilize the potential of our two countries towards fostering innovation and create impact which is of social and economic good. Both sides agreed for co-funding collaborative enterprise led joint R&D projects covering areas of digital transformation, future manufacturing, future utilities and health care.

**Sweden:** A meeting was held with Swedish Minister for Innovation and Enterprise at Malmo (Sweden) with Hon'ble S&T Minister of India on May 23, 2018 to review the status of ongoing activities in science, technology & innovation collaboration, explore new opportunities to expand the cooperation agenda and follow-ups of joint declaration on 'Innovation Partnership for a Sustainable Future' signed during the visit of Prime Minister of India to Sweden in April 2017. Both ministers committed to deepen ongoing collaboration through a strategic innovation partnership to address the societal challenges by providing technological solutions. The identified potential areas of interest in domains covering clean transport, clean energy, smart grids, smart industry and advanced manufacturing, medical sciences, circular and bio-based economy were also discussed.

**Uzbekistan:** A bilateral meeting between Hon'ble Minister for Science & Technology and Deputy Prime Minister of Uzbekistan H.E. Mr. Sukhrov Kholmuradov was held in New Delhi on June 27, 2018 to discuss ways to revive Indo-Uzbek bilateral S&T cooperation, which is presently dormant. Renewable Energy, Metallurgy, Physics, Biotechnology and ICT were areas of priorities for joint collaboration and support.

Global R&D Summit: Dr. Harsh Vardhan, India's Union Minister of Science & Technology, Earth Sciences and Environment, Forests & Climate Change, launched the 'India Ethiopia Innovation, Science & Technology Commercialization Programme' together with Engineer Dr. Getahun Mekuria, Ethiopia's Minister of Innovation and Technology, on the second and concluding day of the 'Global R&D Summit' held on February 21-22, 2019 in Hyderabad. Ethiopia, the biggest country in Africa with a population of more than 100 million, becomes the second country in Africa to benefit from the programme, first piloted and started in Rwanda in 2017. The Summit carried the theme of 'International Collaboration in Research and Development for Sustainable Growth' with Africa as partner continent and was organized by DST and FICCI also having Telangana State as a Summit Partner.



**Launch of the 'India Ethiopia Innovation, Science & Technology Commercialization Programme' during Global R&D Summit**

### **New Programme of Cooperation**

#### **New programme of cooperation was initiated with:**

**France:** The first Indo-French Joint S&T Committee meeting was co-chaired by Secretary, Department of Science & Technology and Director General, French Ministry of Higher Education, Research, and Innovation, respectively, on the Indian and French side, held on June 25, 2018 in New Delhi. The Joint Committee identified i) Energy Research (including energy storage, mobility, on and off grid and grid security), ii) Manufacturing, iii) Water & Waste management, Diabetes and Metabolic disease, iv) Biomedical devices, v) Antimicrobial Research, vi) Weather forecast & climate modeling, and vi) AI & IoT (for healthcare, agriculture, education and skilling, smart cities & infrastructure, smart mobility & transportation, and disaster management) as areas for future collaborations.

**Indonesia:** A Memorandum of Understanding (MoU) between the Government of the Republic of India and the Government of the Republic of Indonesia on Scientific and Technological Cooperation signed on May 30, 2018 at Jakarta, Indonesia.

**Israel:** The Department of Science and Technology and the National Technological Innovation Authority of Israel have jointly established a US\$ 40m "India-Israel Industrial R&D and Technological Innovation Fund (I4 Fund)" for a period of five years to support joint R&D projects aimed to co-develop innovative technology-driven products, services or processes that have potential for commercialization.

Under the first call for joint proposals launched in January 2018, four joint industrial R&D projects have been approved by the 2nd meeting of the I4F Governing Board. The announcements for the

same were done at the I4F Conclave held on 24-25 July 2018 jointly organized by DST, GITA and the Confederation of Indian Industry (CII) in collaboration with IIA. The projects awarded were in the areas of Agriculture, Energy, Healthcare, Information & Communication Technology (ICT) and Water. During the 3rd Governing Board meeting of I4F held on 6 March 2019 in Tel Aviv, Israel 3 projects were approved for implementation in the area of health, energy and ICT.

A total eleven joint proposals were received against second call for joint proposals. The third call for joint proposal was launched on January 15, 2019 and the final selection of projects will be announced in the 4th GB meeting.

**Portugal:** A 4 Million Euro Joint Science & Technology Memorandum of Understanding (MoU) was concluded with the Foundation for Science and Technology (FCT) of the Portuguese Republic on March 1, 2019 to strengthen and develop the scientific and technological cooperation in the fields of Scientific Research & Development, based on equality and mutual benefit of both the countries.

### **Bilateral Research Projects and Programs**

**Africa:** Department of Science and Technology and World Bank had kick off meeting of their collaboration to strengthen India Africa Science and Technology Initiative to boost capacity building through knowledge transfer for number of students enrolled in African Centre of Excellence (ACEs) masters and PhD programmes on March 11, 2019 at India International Centre, Delhi. Representatives from twelve African Centres of Excellence from African countries (Nigeria, Kenya, Uganda, Rwanda, Ghana, Ethiopia, Tanzania, Burkina Faso and Senegal) have participated and discuss with consortia of nine Indian institutions on the detailed modalities of this collaboration.

Indian Institute of Technology (IIT), Roorkee is the lead Indian institutions with other 6 IITs and 2 DST aided institutions (JNCASR and ARCI), focusing partnership on four themes i) Information and Communication Technology ii) Material Science and Renewable Energy iii) Water, infrastructure and environment management and iv) Railways.

**Bulgaria:** The ninth session of the India Bulgaria Joint Committee for Science & Technology Cooperation Meeting was held during August 8-10, 2018 at the Ministry of Education and Science (MES), Sofia, Bulgaria. The two sides were agreed to hold two workshops each year - one in Bulgaria and one in India in mutually acceptable areas of science & technology and support the exchange of up to 5 researchers under the age of 35 years for postdoctoral work in each other's country for up to 12 months during 2018-2021 period.

A total 61 joint proposals were received against call for joint proposals under following research themes: information and communication technologies; materials and material sciences; physics, including laser science and technology, nuclear physics, astronomy and space and technology research; chemical sciences; renewable energy; earth science, geophysics, climate studies, oceanology and environmental protection, including waste management; biotechnology, agriculture and food technology; healthcare, biomedical appliances, bioethics, pharmacy and traditional medicine and social studies related to science and technology. Result is under consideration for announcement.

**Canada:** A total 16 applications were received under the theme “Improving Occupant Survivability in Buildings during Fires”. Out of these, DST, India and Ministry of Science and Technology, IC-IMPACTS, Canada recommended four project proposals for support. Result was announced during the India-Canada Science & Technology Innovation Summit held at Indian Institute of Technology, Delhi on December 12, 2018.

**Czech:** A work Plan was concluded during the visit of Honourable President of India in September 2018 to foster joint S&T activities between both the countries. Call for joint proposals already announced to receive the proposals in the following areas: information and communication technologies; natural sciences and biotechnology, new materials and nanotechnology; medical sciences (including pharmaceutical sciences) and food safety and research of climate change, environment and energy.

**Egypt:** An India-Egypt Bilateral expert Meeting on ‘Agriculture Biotechnology’ was organized at Shillong, Meghalaya during September 10-12, 2018 under the India Egypt programme of Cooperation in science and technology. About 20 experts from various part of India and 4 experts from Egypt participated in the workshop. This workshop will provide platform for future Indo-Egypt collaborative research projects in the field of ‘Agriculture Biotechnology’.

**Korea:** The fourth India-Korea Science & Technology Ministers Steering Committee Meeting was held in New Delhi on 9th July 2018. Hon’ble Minister of Science & Technology and Earth Science of the Republic of India and Mr. You Young Min, Minister for Science and ICT of the Republic of Korea led the Indian and Korean delegations, respectively. The Two Ministers reviewed bilateral S&T cooperation between the two countries since last meeting of Steering Committee at Seoul in November 2015. The following decisions were taken during the meeting: i) establishing Indo-Korean Center for Research and Innovation (IKCRI) in India, which will act as the hub for systematic operation and management of all cooperative programmes in research and innovation between the two countries including innovation & entrepreneurship and technology transfer, ii) set up a Future Strategic Group, which will build a collaborative platform that can utilize the potential of our two countries towards fostering innovation and create impact which is of social and economic good. To begin with, both sides will be co-funding collaborative enterprise led joint R&D projects, covering areas of digital transformation, future manufacturing, future utilities and health care.

**Germany:** As a part of Indo-German science and technology cooperation, DST and Federal Ministry of Education and Research, Germany sanctioned three integrated joint projects with multi-institutional participation from India and Germany, viz., Sense4Metro, FloodEvac and Involve. These projects are to address issues pertaining to installing sensor in and around metro for monitoring of disasters, Disaster mitigation during floods including evacuation of people and Involving local people to volunteer during the disasters.

Under DST-DAAD (Germany) joint S&T call in all areas of STEM, including earth sciences, biological and medical sciences, total 32 joint projects have been recommended for support towards personal exchanges visits of faculty and students from both countries.

A desiccated joint call on Nano materials and technology was launched under DST-DFG cooperation and the proposals are now being evaluated from both sides.

The 10th Indo German Frontiers of Engineering symposium was organized by under DST-AvH cooperation in Potsdam, Germany during May 24-27, 2018. About 35 Indian scientist from India attended and discussed with their counter parts on themes Automotive and aerospace mobility, self-healing materials, future agriculture and Ambient assisted living and robotics for societal needs.

**Myanmar:** A Programme of Cooperation in the area of science & technology between India and Myanmar was signed by Ambassador of the Republic of India to the Republic of the Union of Myanmar and Union Minister of Education, Republic of Myanmar. President of India Shri Ram Nath Kovind and President of Myanmar Mr. U Win Myint witnessed the signing of POC in science and technology. This POC will provide future directions to ongoing cooperation with Myanmar in Science and Technology.

**Netherlands:** The sixth India-Netherlands Joint Working Committee was held on November 28, 2018 in New Delhi under the co-Chairmanship of Head, IBCD, DST and Executive Board, NWO. DBT, MeiTy, MEA and CII also participated from Indian side. It was discussed and decided that a comprehensive strategic agenda for the next 5 years would be made; a concrete bilateral programme in PPP in innovation would be developed; mission driven projects on water and agri food and mapping of post graduate/early career exchange would be initiated. It was also informed that Netherlands would be the partner country for the Technology Summit 2019.

DST-NWO Joint Programme on Urban Water Systems was launched in mid of 2018. The Joint call was initiated to provide funding for highly collaborative and interdisciplinary partnerships between Dutch and Indian research groups, within one coherent research programme that is made up of multiple subprojects. During the Second Joint Advisory Committee meeting of DST-NOW, held on 15th March 2019 through Digital Video Conference (DVC) between the Indian and Dutch side, one Indo-Dutch consortia proposal titled “Water for Change. Integrative and Fit-for-Purpose Water Sensitive Design Framework for Fast Growing Livable Cities” with IIT Roorkee as lead from indian side and Delft University of Technology as lead from Dutch side was awarded.

**Italy:** India-Italy Joint science and technology Committee meeting was held at New Delhi on 29th October 2018. Secretary Department of Science & Technology and Director General for Economic, Cultural Promotion and Innovation of Italian Ministry of Foreign Affairs Co-chaired the Joint Committee respectively on Indian and Italian side. The Joint Committee agreed to set up an India-Italy Platform for science and innovation for promoting and facilitating the establishment of Indo-Italian Centres of Excellence in selected areas of mutual strength such as cultural heritage preservation, renewable energy, life sciences, and geohazards. This initiative could not only link top universities, research institutes and industries of the two countries, but could also provide technological solutions to address common challenges. Both side agreed to support incubators and start-ups keeping in mind needs, priorities and strengths. It was also agreed to organize a bilateral Forum on Industry 4.0 and Advanced Manufacturing involving Academia and Industries including SMEs in Italy.

**Israel:** The ninth meeting of the India-Israel Joint Committee on Science and Technology was co-chaired by Prof. Ashutosh Sharma, Secretary DST with Prof. Alexander Bligh, Chief Scientist, Ministry of Science and Technology, Israel. The Committee reviewed and appreciated the India-Israel Scientific Cooperation in the areas of Big Data Analytics in Health Care and Security Cyber Space. The Committee also discussed the ‘Women in STEM’ workshop, which is scheduled to be held in India in 2019 and felt that such a workshop should aim on policies for women empowerment in science and technology, especially in areas under-represented by women researchers such as mathematics, engineering, artificial intelligence etc.

The 3rd Meeting of the I4F Governing Board (GB) was organised at Tel Aviv on 6th March 2019 and was co-Chaired by Prof. Ashutosh Sharma and Dr. Amiram Appelbaum, Chairman of the Board- Israel Innovation Authority, Govt. of Israel. The GB agreed and approved various activities to be taken under the Fund, which includes approval of three joint proposals for funding support under the second Call for Proposal in the areas of health, energy and ICT.

**Japan:** The 20th India-Japan Science Council Meeting was held during February 28 to March 1, 2019 in Tokyo, Japan. Twenty new projects out of total 111 projects in the areas of Fundamental Sciences; Material System Engineering; Natural Systems; Astronomy, Space, Earth System & Sciences; and Mathematics & Computational Sciences areas and 3 joint workshops were recommended for support.

**Russia:** Department of Science & Technology (DST) and Russian Foundation for Basic Research (RFBR) joint call in the areas of (i) Mathematics, Mechanics and Informatics; (ii) Physics and Astronomy; (iii) Chemistry; (iv) Biology and Medical Sciences; (v) Earth Sciences; (vi) Telecommunications and Computer Sciences and (vii) Fundamental of Engineering Sciences against which total 48 Joint Research projects were funded. Department of Science & Technology (DST) and Russian Science Foundation (RSF) jointly agreed to fund 20 research proposals, out of total 170 received against the joint call in the areas of (i) Mathematics, Computer and Systems Science; (ii) Physics and Space Science; (iii) Chemistry and Material Science; (iv) Biology and Life Science; (v) Basic Research for Medicine; (vi) Agricultural Science and (vii) Earth Science.

**Sweden:** The twelfth Nobel Memorial CEO Round Table was organized to create a platform for enhancing dialogue between Indian and Swedish Industrial leaders on vision and best practices in corporate start up collaborations on 14th Dec 2018 at New Delhi. The industrial leaders from both sides shared their experiences on joint innovative challenges and issues and how to address them with Intervention from both the governments. Prof. Ashutosh Sharma, Secretary DST participated in the Round Table. A joint call on Computer and Nanoscience was launched under DST-Swedish Research Council cooperation to invite proposals from Indian and Swedish scientists. The proposals are being evaluated now.

**Thailand:** Fifth India-Thailand Joint S&T Committee meeting was held in Bangkok, Thailand on February 19, 2019. Total 10 projects in the areas of (i) Human Health sciences (ii) Renewable Energy covering solar cells and PV reliability; (iii) Photonics covering elastomeric optics and optical devices (iv) Geospatial Technologies covering creation of GIS of towns in Thailand for urban development and (v) Astronomy & Astrophysics were recommended for joint support.

A workshop on India-Thailand Cooperation in Geo-Spatial technology was held at Surveyor General's Office, Survey of India, Dehradun from 19th to 22nd June 2018.

**United Kingdom:** The sixth India-UK Science & Innovation Council (SIC) Meeting was held in New Delhi on 26th July 2018. Dr. Harsh Vardhan, Minister of Science & Technology, Earth Sciences & Environment, Forests and Climate Change, India and Mr. Sam Gyimah, Minister for Universities Science, Research and Innovation, UK led the Indian and UK delegations respectively. Ministers agreed to work together on the UK India tech partnership announced by Prime Ministers Modi and May during PM's Modi's visit to the UK in April.

India-UK Round Table on 'Artificial Intelligence' was organized under the India UK programme of Cooperation in S&T at New Delhi on November 2, 2018. The objective of Round table was to identify themes/areas where both the countries could work together and think about possible sources of funding.

An India-UKIERI (UK India Education & Research Initiative) Joint call for proposals under the collaboration between DST and UK India Education & Research Initiative (UKIERI) was announced in November 2018 in the areas of cyber Physical System and Waste Management. Based on scientific merit, national priority of both the countries and scientific strengths of the project coordinators, total 11 proposals were recommended for support out of 104 received.

**Ukraine:** The Seventh Session of the India-Ukraine Joint S&T Committee meeting was Co-chaired by Head, International Bilateral Cooperation DST and Deputy Head, Department for International Cooperation and European Integration, Ministry of Education and Science of Ukraine, which was held at New Delhi on 9th October 2018. Both sides agreed to jointly fund 10 research projects in the areas of (i) Metals & Materials Science (ii) Computational Science (iii) Earth & Environmental Sciences (iv) Aerospace Engineering and (v) Biological Sciences.

### Other Activities

#### Bilateral Workshops/ Symposia and Training Programs

More than 25 workshops/ symposia and training programs were supported and organised in India and abroad in partnership with Egypt, Italy, Portugal, Germany, Japan, Thailand, South Africa and UK. Clean energy, nanofabrication, social security, self-healing materials, future agriculture, automobile and aerospace mobility, ambient assisted living and robotics for societal needs and interacted for future collaboration were few main research areas, which were covered in these activities.

The first introductory training course on 'Nanofabrication technology', supported by the Department of Science & Technology was successfully organized during September 1028, 2018 at the Centre for Nano Science and Engineering (CeNSE), Indian Institute of Science, Bangalore. The course was attended by 24 participants, mostly faculty members, senior scientists and research scholars from Sri Lanka, Bangladesh, Bhutan and Nepal.

**Industry Academia Conclave**

The Department of Science and Technology, Israel Innovation Authority (IIA), Global Innovation and Technology Alliance (GITA) and Confederation of Indian Industry (CII) jointly organized I4F Conclave in New Delhi on 25th July 2018. During the conclave, four joint Industrial R&D projects were awarded under the US\$40 million Industrial R&D and Technological Innovation Fund (I4F).

**India-Canada Science & Technology Innovation Summit**

India-Canada Science & Technology Innovation Summit was held at Indian Institute of Technology, Delhi on December 12, 2018. The objective of this summit was to develop a road map and intensify the India-Canada research exchanges, build capacity, and help communities with research outcomes.

**India International Science Festival-2018 (IISF-2018)**

Diasporas have emerged as powerful entities since they are recognized as ‘soft power’ in the realm of foreign policy strategy and as an agent or catalyst of economic development of countries of origin beside their active role in the host countries. Towards this, DST in collaboration with Department of Biotechnology, organized a Global Indian Science and Technology Stakeholders Meet (GIST) as a part of the India International Science Festival-2018 (IISF-2018) being held in Lucknow during October 5-6, 2018. Besides 20 scientists from various parts of world, delegations from Hungary, Kenya and Vietnam also participated in the deliberations on role of Science and Technology for transforming India.

**Meetings of DST supported International Centres**

Scientific Council (SC) and Industrial Research Committee (IRC) meetings of the Indo-French Centre for Promotion of Advanced Research was held at Grenoble (France) during May 14 – 19, 2018 and at Trivandrum (India) during November 19-24, 2018.

**Celebrations of S&T Bilateral Cooperation**

10 years of Indo-Dutch Science, Technology and Innovation cooperation was celebrated at New Delhi on 23rd May 2018, the programme chaired by Secretary DST and Deputy Director General, Dutch Ministry of Economy Development. During the meeting of Prime Ministers of India and Netherlands on 24th May 2018 at New Delhi the Leaders commended the 10th anniversary of the Indo-Dutch collaboration in Science, Technology and Innovation (STI). The two Leaders acknowledged the successful bilateral research cooperation between India’s Department of Science and Technology, Department of Bio-technology and Ministry of Electronics and Information Technology with the Netherlands Organization for Scientific Research (NWO) and the Netherlands Enterprise Agency (RVO). They recommended the organizations to structure their cooperation in sectors such as affordable medical devices, urban water systems, Big Data and Internet of Things (IoT).

### **Industrial-R&D Programs**

Call for India-Israel joint industrial R&D projects was announced under the India - Israel I4F programme (CFP -3), focusing on Agriculture, Energy, Health, ICT, Electronics and Water. I4F is a 40 Mn USD fund aimed at promoting, facilitating supporting joint projects leading to co-development and commercialization of innovative technologies benefiting both the countries.

Under the MoU with South Korea on Future Strategic Group signed during the visit of Korean President to India in July 2018, a call for proposals on India-Korea Applied R&D was jointly launched with Ministry of Commerce & Industries in the areas of (i) Digital Transformation, (ii) Manufacturing, (iii) Future Utilities and Clean Tech and (iv) Affordable healthcare.

As announced by the Hon'ble Prime Ministers of India and Italy, proposals were invited for Industry-Academia joint collaborative Industrial R&D proposals in the areas of (i) Advanced Manufacturing & Materials (ii) Aerospace (iii) Clean Tech (iv) Internet of Things and (v) Technologies for Cultural Heritage.

### **India Science and Research Fellowship (ISRF)**

As a part of our initiatives to engage with our neighboring countries to develop S & T partnerships, DST announced 5th Call of India Science and Research Fellowship (ISRF) Programme for the Afghanistan, Bangladesh, Bhutan, Maldives, Myanmar, Nepal, Sri Lanka and Thailand researchers to work in Indian Universities and Research Institutions. Awarded fellows would be visiting India for 3-6 month to undertake reserach in various areas of S & T during 2019-20. Last date for submitting application is January 31, 2019.

#### *2.1.1 Indo-French Centre for Promotion of Advanced Research (IFCPAR/CEFIPRA)*

Indo-French Centre for Promotion of Advanced Research (IFCPAR/ CEFIPRA), established in 1987 for international collaborative research in advanced areas of science and technology is being supportive by Department of Technology, Government of India and the Ministry for Europe & Foreign Affairs, Government of France since last more than 30 years.

During the year 2018-19, under the collaborative scientific research programme, 18 new proposals were recommended for support from the advanced inter-disciplinary research areas. Through this programme, new collaborative linkages were developed between seven IITs, three CSIR labs, three Indian Universities, TIFR, IISc, IISER with several French research Institutes, out of which seven institutions are new cooperation. There were 110 exchange visits wherein interactions between scientists and training of young researchers were supported. During the year, more than 100 publications in SCI journals resulted from ongoing & completed projects. Scientific interactions among 280 Indian and 70 French scientists and researchers in the various disciplines like Magnetism, Pancreatic Diseases, metagenomics and radiation damages were facilitated through seminars and workshops in both countries. During the year, 59 ongoing projects were successfully implemented under the programme.

In two meetings of Industrial Research Committee (IRC), proposal on “Design of flexible sweat sensors and stretchable batteries embedded in e-textile to monitor personal health and fitness parameters” was recommended. In addition, Knowledge-Product pathway had been catalyzed through 9 ongoing projects in the areas of urban mobility, anti-counterfeit printing techniques for medicine packaging, loop heat pipe for avionics and terrestrial applications, Piezoelectric Actuator Systems for Automotive, etc. under the Industrial Research Programme. Industrial seminar on “Robotics for rehabilitation (Robo-Rehab-2019)” in February 2019 brought together industrialist and scientists to exchange information and knowledge in the area of Robotics for different rehabilitation applications such as assisted mobility and assistance in daily living tasks.

Under High Impact Scientific Research Network Program, two network projects each in High Energy Physics (ENP) and Health Sciences were completed. Under High Energy Physics (ENP) project, for the first-time experimentalists and Theorists from both countries had a framework to collaborate. Under health science network project, evidence-based consensus guidelines on management of Haemolytic Uremic Syndrome in India were developed.

Under Indo-French Water Networking (IFWN) programme, the group of Grey water network was able to freeze parameters and prepare a prototype design which can be scaled up, under late phase of steady state condition so that sludge degeneration and its aerobic/anaerobic oxidation in endogenous respiration phase will prevent excess sludge generation. Another project Swachha Neer, the research group was able to conclude that use of composite membranes, nano-filtration techniques, absorbents and cellulose based materials could address the water related issues in the selected region to remove personal care chemicals/emerging pollutants from water. Membrane and adsorbent-based hybrid technique can be developed for desalination.

In order to strengthen human resource development, under the existing Raman-Charpak Fellowship-2018, 25 Indian and 1 French student were awarded to work in Indian and French laboratories. In addition, eight Indian doctoral students were trained under European School on Nano-Sciences and Nanotechnologies (ESONN) through CEFIPRA-ESONN Fellowship- 2018.

To promote Innovation through a PPP model of funding, project at IIT Madras was completed under the Saint Gobain Research, India (SGRI)-CEFIPRA program from the area of sustainable habitat. As a facilitator, under the DBT’s Biotechnology Industrial Research Assistance Council (BIRAC)-French Embassy Programme, two projects completed in Cardiovascular Diseases and one ongoing in Alzheimer’s Disease. A cost-effective, easy-to-use sensor platform to facilitate is being successfully developed at CIIRC, Jyothy Institute of Technology, Bangalore and was also reported in Times of India on April 23, 2019.

Under, Technology Development Board (TDB)-CEFIPRA-Bpifrance programme, project is ongoing in the area of Medical devices. A Business-to-Business Summit (B2B) was held for Bangalore based Industries, Startups and SMEs to disseminate information on CEFIPRA’s industrial programmes. A total of around 90 delegates including big and small aerospace/aeronautics industries from start-ups and Indian government sectors like research laboratory CSIR NAL, representatives from Indian Navy and Airforce participated in the one-day interactive event.

CEFIPRA had also organized the 2nd Indo-French seminar on “Women in Science” during September 2018 at CNRS headquarters, Paris, France. During the occasion, CEFIPRA’s book “Women in Science- in programmes supported by CEFIPRA” was released. Suggestions on how to attract young women to scientific careers & to eliminate gender inequality in the scientific profession were emanated and shared to Indian & French institutes associated with CEFIPRA.



### 2.1.2 The Indo-German Science & Technology Centre (IGSTC)

The Indo-German Science & Technology Centre (IGSTC) was established in 2010 to facilitate Indo-German R&D networking through substantive interactions among government, academia/research system and industries, thus fostering innovation for overall economic and societal developments in both the countries. Through its flagship program “2+2 Mode of Partnership”, IGSTC intends to catalyse innovation centric R&D projects connecting academia and industry for translation of research results into products/processes and services.

During the year 2018-19, IGSTC supported 19 joint projects in 2+2 mode with four more to start in coming weeks. These on-going projects covering important societally relevant areas of sustainable energy, advanced manufacturing and new materials, biomedical devices, water & wastewater technologies, energy materials, energy storage Environmental technologies, Production technologies, Material Sciences & nanotechnology, smart cities. Some of the projects have accomplished noteworthy results and technology transfer for commercialization is the next eventual step. To name few, project SIBAC has achieved significant breakthrough in corneal biomechanics and imaging techniques. Another project Sound4All has progressed with a prototype towards affordable largescale hearing screening.

IGSTC Call 2018 in the thematic areas Sustainable Production & Clean and Green Technologies attracted a large number of applications which will be reviewed in the coming months. Through these ongoing projects, a network of more than 80 project partners from academia and industry from India and Germany and approximately 250 scientists, researchers, engineers from both countries could be developed. In addition, these projects have created exclusive opportunities for young researchers at PhD/Post-Doc level – in total more than 90 young researchers are involved, enhancing scientific capabilities of India. More than 100 Joint research publications including conference proceedings have emerged and around 10 patents being filed.

The 10th Meeting of the Governing Body of IGSTC was held in Aachen, Germany on 22-23rd January 2019. The GB ratified the recommendations the Scientific Council and approved of all the seven (7) projects (in the 2+2 mode). These projects are in the overall thematic area Advanced Manufacturing and New Materials. GB approved to launch the new programme, Indo-German Industrial and Academia R&D Network Call to promote application oriented joint R&D activity by leveraging already existing infrastructure and funding available with the partners at both sides.

A major workshop, Helmholtz-Indian Platform on Science, Technology, Education and Research (HIPSTER) was organized by IGSTC on behalf of DST and Helmholtz Association, Germany during 12-14 February 2019 in Bangalore to create a platform connecting young scientists of the Helmholtz Institutes with Indian counterparts. The key outcome of the workshop is the White Paper in the topics viz. Georisks/Landslides-Marine Biochemistry, Physics of the Atmosphere, Plant Sciences, Epidemiology/Infectious Diseases/Oncology, Renewable Energy, Material Sciences and Artificial Intelligence.



Five workshops under the open workshop call of IGSTC in the areas of Advanced Manufacturing, Membrane Technology, Waste Management and Nanotechnology were organized in various parts of India. Around 250 Indian & German scientists, policy officers, young researchers benefitted from the above workshops.

A new programme IGSTC-CONNECT Plus in association with Humboldt Foundation was launched to support short-term research stays in India and Germany.

IGSTC continued handling of implementation of the DST-Max Planck Program on behalf of DST. This program has provided an excellent opportunity to the Indian young scientists to partner with the Max Planck Institutes in Germany. There are 13 Visiting Fellowships / Mobility Grants ongoing.

### *2.1.3 The Indo-US Science and Technology Forum (IUSSTF)*

The Indo-U.S. Science and Technology Forum (IUSSTF) is a bilateral body that acts as a catalyst to promote and support scientific collaborations between India and the U.S through partnerships amongst scientists, scientific institutions and the entrepreneurial community of both countries. The activities of IUSSTF are broadly grouped into four categories: (i) Scientific Networking; (ii) Innovation and Entrepreneurship; (iii) Research and Development & (iv) Visitations and Fellowships.

#### **Scientific Networking**

Emphasizing the importance of collaborative research in significant areas of science and technology, Nineteen **Indo-U.S. Bilateral Workshops** focusing research on Atmospheric and Earth Sciences, Engineering Sciences, Life Sciences, Medical Sciences and Physical Sciences were supported in 2018-19. Likewise to facilitate linkage and seamless connectivity among two research groups working on specific collaborations in both the countries, grant support was awarded to ten **Virtual R&D Networked Centres** in 2018-19. There are ‘two’ Calls for proposals for Bilateral Workshops and ‘one’ for Virtual Networked Centres, each year.

#### **Innovation and Entrepreneurship**

- IUSSTF provides grant-in-aid funding support to start-ups under the **United States India Science and Technology Endowment Fund (USISTEF)**. This program enables bilateral teams from India and United States to translate S&T driven innovations into distinct market opportunities. The Innovators are supported to develop and commercialize products under two broad categories i.e. ‘Health Citizens’ and ‘Empowering Citizens’. This year against its 9th Call for Proposals, IUSSTF received an unprecedented response of 389 applications. USISTEF has supported 38 joint U.S. India Entrepreneurial Projects through the 9 calls; six projects were selected for award in 2018-19 under the 9th call. The impact has been realized through launch of more than 16 co-developed products like Affordable Mechanical Ventilator, Solar Electric Tractor, Affordable Digital Braille Accessibility, Low-cost, Portable Auto refractor, Transformational Modular Roofing Solution, to quote a few.



**Pulmoscan (Left); Hand Cranked Defibrillator (Right)**

Other landmark programs include the **DST-Lockheed Martin India Innovation Growth Program (IIGP) and Women Entrepreneur Quest (WEQ)**. IIGP aims to create an ecosystem enabling entrepreneurs to develop technology-based solutions for betterment of society. 15 teams were awarded under the University Challenge 16 teams were awarded under the Open Innovation Challenge. Similarly, Women Entrepreneur Quest (WEQ) identified and rewarded 10 women entrepreneurs who are founders of technology start-ups by taking them for an experiential learning program in Silicon Valley.



**The IIGP 2.0 award ceremony held on 2nd August, 2018 at Hotel Taj Mahal, New Delhi.**

- This year the ‘**Make Tomorrow for Innovation Generation**’, a public-private partnership program was initiated by National Council for Science and Technology Communication (NCSTC), Department of Science & Technology, Govt. of India and Intel® with IUSSTF as the implementation partner. It is also supported by NITI Aayog - Atal Innovation Mission. Designed to work with schools, teachers and maker spaces to skill youth on creating indigenous technology-

based solutions for local communities, this program was initiated to nurture and develop an innovation ecosystem in the country. A series of 5 Rapid Prototyping Camps (RPCs) were held for students and teachers, the top 10 projects and were selected and felicitated in an award ceremony.



## Research and Development

IUSSTF supports a broad portfolio of R&D programs in key strategic areas that are of mutual interest to both countries. The current portfolio includes flagship programs like the Joint Clean Energy Research and Development Centre (JCERDC) -the second phase of PACE-R on Smart Grid and Grid Storage; in addition to various other programs such as Partnership for International Research and Education (PIRE) and Real Time River Water and Air Quality Monitoring.

- The Indo-U.S. Joint Clean Energy R&D Centre (JCERDC) is a joint initiative of the Ministry of Science and Technology, Govt. of India and the U.S. Department of Energy, based on a public-private partnership model of funding and is a first-of-its-kind initiative that has brought together more than 100 Indian and U.S. academic and industrial partners to work jointly in the space of clean energy research. The project titled “UI-ASSIST: U.S.-India collaborative for smart distribution System with Storage” under the Smart Grids and Energy Storage track, was awarded under the JCERDC: Phase II. Support was continued to the project after reviewing its progress thus far.



The UIASSIST project team

- Recognizing the importance of developing online **River Water and Air Quality Monitoring (WAQM)** systems, DST and Intel Corp. collaborated to initiate research in this area. Four projects were identified for award in 2017-18 of these two have been funded under ‘Air’ and ‘Water’ Quality Monitoring categories respectively. Funding to these projects were continued after reviewing the scientific outcomes of the four awarded projects and monitoring their progress in conformity with the milestones, targets and objectives, and also assessing the global developments impacting the domain of the Projects.
- The **Science and Engineering Research Board (SERB)** entered into a formal understanding with NSF to partner for the PIRE program. IUSSTF is the implementation partner for the program on behalf of SERB.

### Visitations and Fellowships

With a spirit to promote Research and Capacity building in frontline areas of Science & Technology, IUSSTF implements several Visitation Programs. The aim is to provide Indian & American researchers scientific exposure, access to world class facilities, interact with peers and build long-term R&D linkages & collaborations. During this year IUSSTF in along with several Federal agencies, Industry, Professional Bodies and Not for-profit Organizations administered 15 Visitation Programs. These programs provided opportunity to almost 226 Indian and US student & researcher to exchanges visits through programs namely, SN Bose Fellowships, Viterbi-India program, Research Internship in Science and Engineering, Bhaskara Advance Solar Energy Research Fellowships, Graduate Research Opportunities World Wide (GROW)-India, Initiative for Research and Innovation in Science (IRIS), for Indian and U.S. Researchers and Others.

## 2.2 International Multilateral and Regional S&T Cooperation

The mandate of DST was sustained in respect of coordination of India’s international STI cooperation frameworks with regional, multilateral entities ; India’s positions on S&T aspects of UN and its Specialized Agencies and other International Organizations; and India’s participation in Global S&T Platforms. This role was fulfilled in close consultation with Ministry of External Affairs, Government of India besides interactions with relevant stakeholders including Ministries. The significant achievements during the year are briefly described below.

### 2.2.1 BRICS Science, Technology and Innovation (BRICS STI) Cooperation

Under the framework of BRICS Memorandum of Understanding in Science Technology and Innovation 18 BRICS Collaborative Projects in areas of Material Science including nanotechnology, Biotechnology and Biomedicine, Water Resources and Pollution Treatment, New and Renewable Energy, ICT and High Performance Computing, Prevention and monitoring of natural disasters were funded for its implementation.

The **6th BRICS STI Ministerial** on the theme: Leveraging BRICS Science, Technology and Innovation to Enhance Inclusive Growth and Development on 2-3 July 2018 at Durban, South Africa endorsed implementation of 31 new BRICS R&D projects under BRICS Framework Call for Proposal 2017 with India partnering in 26 projects, exploring the scope of establishing a 'BRICS Vaccine Research and Development Centre', BRICS partnership on New Industrial Revolution with focus on innovation ; BRICS Virtual Centre and Integrated Hub for BRICS Innovation collaboration on ICT and High Performance Computing; and a BRICS Technology Transfer Centre.



**6th BRICS STI Ministerial Meeting in Durban on 3 July 2018**

**BRICS collaborations in Research Infrastructures Development :** As a step towards development of BRICS Global Research Advanced Infrastructure Network' (GRAIN), a BRICS Research Infrastructure platform/ Web Portal has been created that will include research infrastructures that countries voluntarily want to give access to stakeholders of other BRICS countries.

**Under BRICS Cooperation in Science Technology and Innovation led Entrepreneurship,** an iBRICS (Innovation BRICS) has been proposed to be developed .iBRICS would be a network of main Science Parks, Technology incubators, accelerators of the BRICS Countries aimed at fostering dialogues and information sharing; capacity building of science park managers, Cross incubation and soft landing of start ups in the BRICS countries.

**India- BRICS Cooperation in Astronomy:** Under BRICS collaboration on Astronomy, detailed proposals in the subject areas of optical transient network; neutral hydrogen cosmology; and big data as applied to large telescopes have been called.

**BRICS Young Scientist Conclave:** 27 Young Indian Scientist / Innovators participated in 3rd BRICS Scientist Conclave held in Durban (South Africa) during 25-29 June 2018, on the 3 themes

namely Energy, Water and Use of ICT for Societal applications. One Indian innovator aged 23 years was awarded the “BRICS most promising Innovator” during the BRICS Young Innovators Award competition held during the Conclave. India also hosted the BRICS Young Scientist (YS) Conclave Alumni meeting at National Institute of Advanced Studies (NIAS), Bangalore during 2-3 December 2018 .

### *2.2.2 India-EU( European Union) Science and Technology Cooperation*

India (Department of Science and Technology-DST and Department of Biotechnology-DBT) and European Commission Directorate for Research and Innovation have agreed to co-invest about 15 million euro each for supporting joint research and demonstration projects in the areas of wastewater treatment, drinking water purification and real time water quality monitoring in Indian field conditions. As a part of this initiative, a meeting of the representatives of Funders from EU and Government of India (DST & DBT) and project Consortium from India and Europe was held in New Delhi on 14-15 February 2019 to structure and execute the activities of seven water projects being jointly supported by India and EU. The deliberations have culminated in listing the major European technologies to be implemented and adopted in India and enhancement of their treatment capacities.

The European will provide the details of technology and also supports in testing, validation and replication while the Indian consortia will work out modifications to adopt and integration to local conditions and replication in India. The technologies will emerge as low O & M systems embedded with automation and real time monitoring and decision support for an effective management of water resources both from quantity and quality perceptions. This eventually can lead to open up new business avenues.

### **India EU Joint S&T Steering Committee Meeting**

India hosted the 12th India-EU Joint **S&T** Steering Committee Meeting on 1st March 2019 under the co-chairmanship of Secretary, Department of Science and Technology and DG Research and Innovation of European Commission. The Meeting reviewed the progress such as implementation of seven India-EU water projects. worth co-investment of 30 million euro, mobility of Indian Young Scientists for working with European Research Council grantees researchers and recent launch of India-EU Vaccine Program. Both sides agreed to collaborate in different thematic areas such as smart grids; cyber physical system; ICT; bio-economy; health research including brain research; polar science. Further, to promote networking of innovators and entrepreneurs, both sides considered creation of India-EU Joint Innovation Centre.



**Fig. 12th India-EU Joint Steering Committee Meeting in New Delhi on 1 march 2019**

The India-EU Agreement for Scientific and Technological Cooperation originally signed in 2001 and renewed two times, in 2007 & 2015 is valid till May 2020. Both sides agreed to further renew the agreement and to include the renewal of the agreement as a deliverable in the next India-EU Summit

### *2.2.3 India-ASEAN STI Cooperation*

**1st ASEAN-India InnoTech Summit:** The 1st ASEAN-India InnoTech Summit was hosted by India in New Delhi during 29-30 November 2018, inaugurated by Dr Harsh Vardhan, Hon'ble Minister of Science & Technology. The main objective of the Summit was to exhibit and build networks between Indian and ASEAN researchers, About 250 delegates from India and about 65 delegates from ASEAN Member States attended the event. Hon'ble Minister of Science & Technology announced that the InnoTech Summit shall be organized annually.



**Fig. Inauguration of the 1st ASEAN-India InnoTech Summit held in New Delhi on 29th November 2018**

**ASEAN-India Grass-root Innovation Forum** event was organized in Jakarta, Indonesia during 27-30 September 2018. The event included Innovation Competition (Students and Grass-root Innovators) and a workshop on Innovation ecosystem in India and ASEAN. Two Innovators from India won second prizes in each category of Students and Grass-root Innovators. Seven India-ASEAN projects were awarded grants under ASEAN-India Science and Technology Development Fund (AISTDF) for period of 2 years in the areas of Physics, Material Sciences, Biotechnology and Electronics with a total funding support of about Rs. 1.5 Crore. 31 ASEAN School Children and Teachers participated in the 26th National Children Science Congress (NCSC) -2018 held at Bhubaneswar, Odisha during 27-31 December 2018.

The 12th Meeting of ASEAN-India Working Group on S&T(AIWGST) and 6th Meeting of the Governing Council of ASEAN-India S&T Development Fund (AISTDF) held in Bangkok, Thailand during 18-19 February 2019 led from India by Secretary DST. reviewed the progress of on-going ASEAN-India S&T Innovation (STI) cooperation. It prioritized the areas of collaboration as Bio-medical devices; Agriculture and Food Science & Technology; ICT and Cyber Physical systems. The thematic ASEAN Network and Centres would open for Indian collaboration. It was decided to organise 2nd edition of ASEAN-India InnoTech Summit and ASEAN-India Grassroots Innovation Forum events in Philippines during second half of 2019. The AIWGST also agreed for early conclusion of the ASEAN-India MoU for Cooperation in the fields of Science & Technology



**Fig. Prof Ashutosh Sharma, Secretary DST with his ASEAN counterpart Dr Rowena Guevara, Secretary, Department of Science & Technology, Philippines at 12th Meeting of the ASEAN-India Working Group on Science & Technology (AIWGST)**

#### 2.2.4 STI Engagements with the Group of Twenty (G20) countries

##### **Participation in the Inter-Ministerial Meeting on the G20 issues**

Science Technology and Innovation related aspects were included in the developmental agenda of G20 on the initiative of India and other developing countries. Subsequently G20 STI Ministers adopted a G20 Innovation Action Plan in 2016. DST participated in the Inter-Ministerial Meetings convened by the Dept of Economic Affairs, to discuss India's position/priorities on various agenda items in the G20 Japanese Presidency during 2019 and to deliberate on the future interventions/positions and concerns.

'Guiding Principles have been developed for the Development of STI for SDGs Roadmaps' floated by the Japanese Presidency of G20 in 2019. Ministry of Electronics and Information Technology (MEITY) and Department of Science and Technology (DST) have been included in the G20 Digital Economy Task Force (DETF). Synergies with Interdisciplinary Cyber Physical Systems (ICPS)' recently launched "by DST would be utilized to foster and promote R&D in the area. A study Report on Society 5.0 – the theme of 2019 G20 Presidency - will be prepared jointly by NITI Ayog, MEITY and DST

##### **Shanghai Cooperation Organization (SCO) S&T Working Group Meeting**

Pursuant to India becoming a full member of Shanghai Cooperation Organization(SCO) and joining the SCO Agreement on Scientific and Technological Cooperation in 2017., The SCO S&T Working Group meeting held on 11-12 September 2018 in Beijing, China, finalised the draft Plan of practical measures ("Roadmap") on Cooperation of Scientific Research Institutions of the SCO Member States for 2019-2020. This Roadmap has finally been adopted by all SCO Member States. The Roadmap envisages mobilization of resources for joint R&D projects, exchange of experts and scientists, exchange of experts and scientists.

#### 2.2.5 DST initiative on Promoting Science Diplomacy

##### **Launch of the Joint Programme in 'Science Diplomacy':**

A joint Programme in Science Diplomacy was initiated by DST for implementation by the Research and Information System For the Developing Countries(RIS) New Delhi and the National Institute of Advanced Studies (NIAS) Bangalore, at a cost of Rs 151,50,000/- for three years. It aims at realizing the potential of science diplomacy in areas of critical importance for national development through, inter-alia, (i) enhancing capacity in science diplomacy, (ii) utilization of expertise of experts in selected fields, (iii) providing policy STI inputs, and (iv) conducting research on strategic affairs in science and technology. Secretary DST inaugurated the programme formally launched on May 7, 2018 at the RIS, New Delhi. RIS has since brought out Draft reports on select topics, launched a Forum for Indian Science Diplomacy (FISD) and a web site ([www.fisd.in](http://www.fisd.in)) and fortnightly new Alerts on Science Diplomacy are being issued.



### Launch of RIS NIAS Science Diplomacy Project

#### 2.2.6 Rewarding Excellence in Mathematics in the Developing Countries

#### Award of Ramanujan Prize 2018

In order to Promote Mathematics in developing Countries and enlarge the Legacy of Ramanujan - the Great India Mathematician-, the ICTP ‘Ramanujan Prize of US\$ 15000, instituted in 2005 by International Centre for theoretical Physics (ICTP), Trieste for outstanding contributions by Young Mathematician/Staticians from the developing countries, is being funded by the Govt of India (DST) since 2014. Award for the years 2014 to 2018 have since been bestowed on mathematicians from Argentina, Brazil, China and India. Dr. Ritabrata Munshi from Indian Statistical Institute (ISI) Kolkata/TIFR Mumbai) was selected and awarded the 2018 Ramanujan prize in recognition of his work in Number Theory.



**Dr Ritabrata Munshi, winner of Ramanujan Prize 2018**

### **Extension of MoU between ICTP, IMU and DST on funding of Ramanujan Prize**

On request from ICTP, a review of the award of Ramanujan Prize was undertaken. The prize is now well known and valued throughout the world, particularly in the developing countries, as reflected from the number of nominations from countries in different continents. The awardees including the two from India have tremendously progressed in their careers. Recognition of the work of the developing countries young mathematicians through the Ramanujan Prize will further encourage the students take up mathematics as research career, encourage the mathematicians and improve the level of Mathematics in the developing countries. DST agreed to extend the existing MoU between ICTP, IMU, and DST for funding of the Ramanujan Prize for a further period of five years from 2019 onwards

#### *2.2.7 DST engagement with the Global S&T Platforms*

### **DST outreach with Japan through the STS Forum Japan :**

DST co-organised the 4th Science and Technology in Society Forum Japan- India Workshop on 27th February 2019 in New Delhi, attended by the Policy makers, heads of organisations, academicians, researchers, industry leaders and entrepreneurs from India and Japan. The Workshop dwelled upon two Sessions: 1: “Start UP and Innovation Ecosystem driven by Science and Technology” and 2: “Society changed by IoT and IoE”. Secretary DST also participated and chaired the Session 1, shared the start up scenario in India and various initiatives taken by the government in developing an enabling start-up ecosystem in India.

The Workshop recommended exploring India-Japan partnerships in Tech-based innovation, commercialization of open innovations, joint innovations in natural disaster resilience, education in entrepreneurship, and establishing market plan connecting innovations targeted around TRL7. Japanese strength was sought to be leveraged in heavy engineering, automobiles, precision engineering, sensors, robotics, product quality and linked with Indian competitiveness in IT systems. Joint start-up hubs, annual entrepreneurship summits, engineering design conclaves, best practices exchange and mentoring of technopreneurs, connecting ideas to the investors and business world, were other outcome recommendations.

### **India engagement towards World Wide Development of Research Infrastructures**

A significant topic of World Wide Development of Global Research Infrastructures is being deliberated by a Group of Senior officials from G8 countries and emerging Economies. DST is contributing to the Group(GSO-GRI), and participated in its 11th meeting hosted by the National Science Foundation, in USA in May 2018. The Group has since proposed a framework for co development and management of Global Research Infrastructures and is testing the framework on select Large scale Research Infrastructures offered by the Group members. ‘India has earlier proposed the India leg of Laser Interferometric Gravitational Wave Observatory (LIGO) for possible global participation. **LIGO has since been selected as a future case study by the GSO-GRI** for testing the framework of development of Global Research Infrastructures.

### **Research & Training Fellowship for Developing Country Scientists (RTF-DCS)**

The 3rd Phase (2018-2023) of Research & Training Fellowship for Developing Country Researchers (RTF-DCS) was launched for another 5 years starting from April 2018 aimed at 60 Fellowships to developing countries scientists to carry out their research work at any of the Indian research/ academic institute/ university for a period of 6 months.

### **2.3 National Mission on Nano Science & Nano Technology**

Nano Mission is an umbrella programme with envision to promote and develop applied potential of frontier areas of research for national development. Its major focus is on supporting the Basic Research Promotion, Infrastructure Development for Nano Science & Technology Research, Nano Applications & Technology Development Programmes including Joint Industry-Institute Partnership Programme, International Collaborative Programmes in Nano S&T and Human Resource Development in this area through Fellowships thereby cater the government initiatives like Innovate India, Make in India, Namami Gange, Startup India and Swatch Bharat.

Nano Mission is continuously successful in its Phase II towards creating an ecosystem for Nano S&T research in the country. The support under Nano Mission, extends to create skilled human resources, projects related to Nano Science and Technology and building infrastructure of Nano S&T Labs at several Institutes spread across the country. The efforts of Nano Mission are evident through India's global ranking based on the publications in SCI Journals. It was 9/10th in 2001, became 6th in 2004-05, 3rd from 2013-14 and consistently holding this position thereon. The capability and capacity growth is evident from India's 16th rank in USPTO in 2016 patents. There is an unprecedented growth by 36.36% in the area of Nano S&T in number of patents granted in 2016 as compared to 2015 figures.

In recent years, Nano Mission apart from continuing basic R&D support, it also started focus more on creating suitable environment to attract technology relevant projects. This is being achieved through an active dialogue with the Industry either by co-funding partially the industry sponsored relevant projects in Nano S&T or by supporting incubators and start-ups in the area in close consultation with other Innovation Programmes in DST and other Departments/ Ministries. Also identifying feasible technologies and funding prototype development with Industrial involvement and transfer them to start-ups or collaborating industry.

#### *2.3.1 Basic Research Promotion*

#### **Basic Research Promotion:**

Twenty one (21) new individual scientist-centric R&D projects were funded during the year 2018-19

#### **Some prominent R & D areas supported under Nano Bio Stream:**

- Development of a Novel Immunomodulator for Leishmaniasis
- Femtosecond laser processed spider silk as a novel 3D-scaffold for liver tissue engineering

- Development of nanoconjugates for site specific delivery of Curcumin and siRNA to lung Cancer cells
- Targeted theranostic nanomedicine for effective therapy of drug-resistant tuberculosis
- Nanoscale interfacial magnetic skyrmions and its applications in memory devices
- Design and Exploration of Cyclic Peptide Nanotubes as Potent Antibiotics
- A nanobionic approach for enhancement of plant photosynthesis
- Decellularized dental follicle matrix/nano bioactive glass ceramic composite graft

Support to 5 ongoing Post Graduate programmes [M.Sc./M.Tech in Nano Science & Technology] continued this year for candidates with NET/ GATE/ GPAT qualifications, since we have closed support to the earlier cases from 2017 and no new applications are entertained from 2018 onwards.

### 2.3.2 Technology Development

During last year report it was highlighted as additional focus will be given to encourage technology driven research. In this financial year it was majorly accomplished. Apart from extending the support of ongoing projects 50 new proposals from various institutes/university across the nation are benefited in the current term. The demographic distribution of the organization is shown in Figure -1. There is a fivefold increase than the previous year sanctions. It is clear from the figure many new institutes are covered under NanoMission umbrella program, this institutes are spread across the nation from Srinagar to Trivandrum and Gandhinagar to Jorhat. Importantly funding has been dispersed to a wide spectrum of applied technological research such as targeted drug delivery, sensors for diseased cell detection, agro-ecosystem, futuristic Nano alternate fuels, Nano-electronics, non-volatile memory, Li & non-Li ion batteries, water treatment, photonics, spintronics, 2D layered materials and nano photovoltaic.



**Figure - 1 shows the national representation of various institutes/university funded under Nano Technology scheme.**

### 2.3.3 *Projects Reviewed during the year:*

During the period 2018-19, based on the decision by NSAG, a separate review Committee was constituted which that evaluated 63 ongoing or completed projects of Nano Science stream were reviewed mid-way and the Committee graded them as follows:

- |      |                                 |               |
|------|---------------------------------|---------------|
| i.   | Outstanding/ Excellent progress | : 13 projects |
| ii.  | Very Good progress              | : 21 projects |
| iii. | Good progress                   | : 22 projects |
| iv.  | Satisfactory or Fair progress   | : 7 projects  |

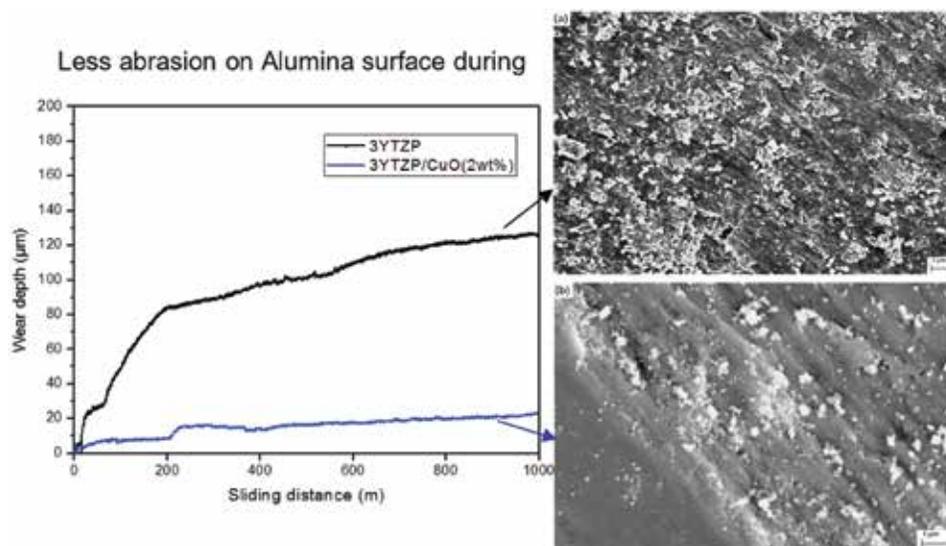
The Nano Applications and Technology Advisory Group (NATAG), itself reviewed 10 of the on-going projects and their ratings of these projects is as follows:

- |      |                                 |              |
|------|---------------------------------|--------------|
| i.   | Outstanding/ Excellent progress | : 1 project  |
| ii.  | Very Good progress              | : 5 projects |
| iii. | Good progress                   | : 3 projects |
| iv.  | Satisfactory or Fair progress   | : 1 project  |

### 2.3.4 *Highlights of some research outcomes – Applications projects from the ongoing and completed projects in the current financial year are briefed below*

#### **a. Development of self-lubricating nano-composite for wear resistant applications**

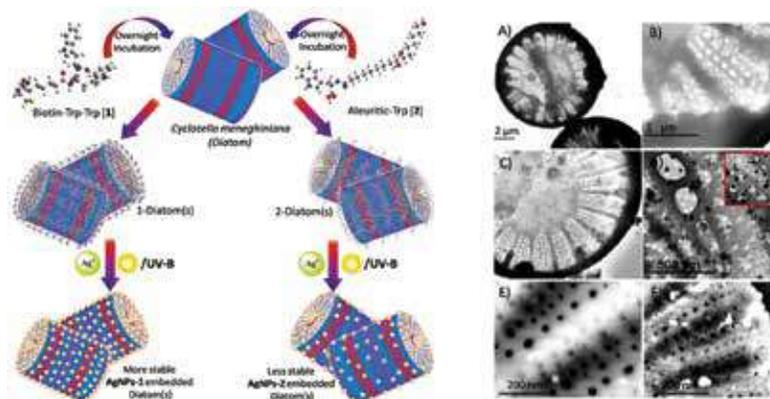
Wear and tear is a major issue in materials that are exposed to aggressive environment such as machinery components, cutting tools and aerospace structural materials. Ceramics like Alumina, Yttria and Zirconia are used in as structural components in the high temperature and aggressive environment. In this project, phases like CuO, CaF<sub>2</sub>, MoS<sub>2</sub> and graphite have been added as a filler material in the ceramic matrix to study its self-lubrication property and thereby expected to prevent the tools and structural components from premature failure during its service life. This study revealed that addition of CuO nano fillers reduced the wear and tear property of Alumina by a magnitude of fivefold. The micrograph in the Figure - 2 is showing surface morphology without and with the addition of CuO as nano composite. It was revealed that adding CuO reduced the fracture of Alumina and the surface smoothness and integrity are retained.



**Figure - 2:** Left plot indicate the resistance to wear of the Alumina, Right top – indicate the rough worn out surface without addition of CuO, Right bottom - with CuO surface is retained and wear is low. Source: ASME Journal of Tribology (2019)

#### b. Construction of Diatom solar panels for biofuel production

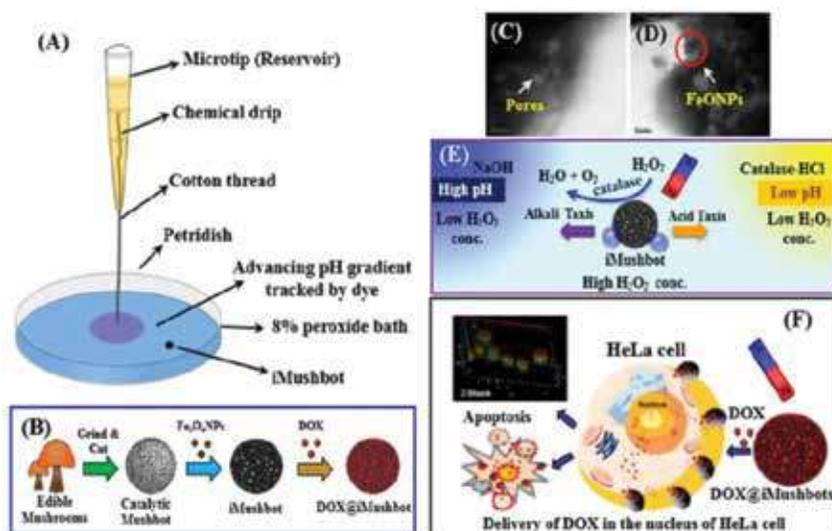
Diatom has abundant oil content therefore it could serve as an alternative source for rapidly depleting fossils fuels. In this project it has been demonstrated developing Ag nanoparticle on the Diatom surface that can be used as dye sensitized solar cell. The process follow of Ag NP fabrication is shown in the Figure – 3. Also there is an effort to produce biofuel from Diatoms via harvesting sunlight energy by using portable mobile units at the road side vendors and gram phanchayats. Currently the prototype is being worked out and in the process of patenting the design.



**Figure – 3:** Left - Optimized structure of Biotin-Trp-Trp and Aleuritic-Trp peptides. Right - Microstructure of dye sensitized solar cell via doping Ag NP. Source: Journal of Molecular liquids 249 (2018)

### c. Design and development of intelligent catalytic nanobots

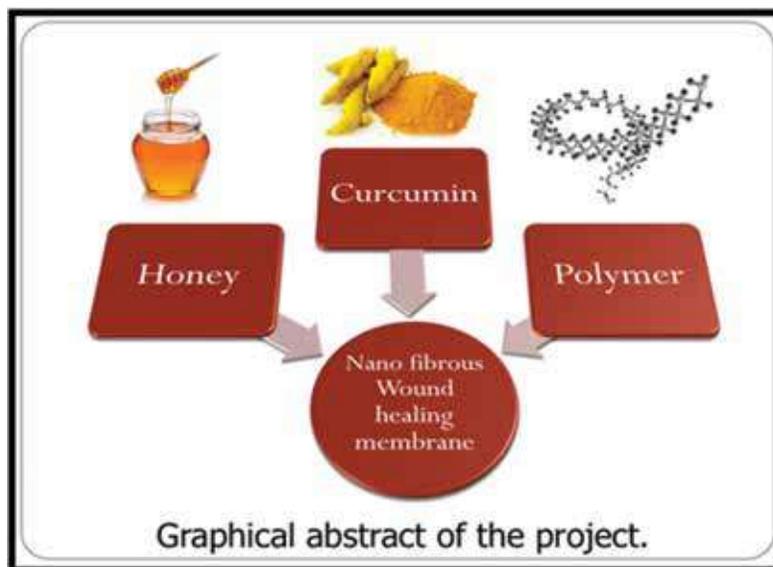
This proposal is to develop artificial nanoscopic multi-functional objects, which are self-sufficient to sense and perform a host of specific activities. Micro/Nanoscale objects can harness chemical energy to facilitate autonomous motion when submerged in a reacting medium. In-vitro studies are employed for carrying, sensing, and delivering essential micro/nano/molecular elements to the targeted locations. Here suitable nanoscopic polymer particles are identified and characterized. Further demonstrated the functional groups attachment (internally or externally) or chemical components to the motor that have specific activities as sensors, drugs etc. Then movement of these objects with the help of internal and external fields and control the motion of them with the help of internal fields such as chemical potential gradient or external fields such as electromagnetic field (Whole process is shown in the schematic figure – 4). Also the control migration of them inside a confined space such as networks of microchannels thereby the biocompatible nanobots are identified to carry important chemicals to targeted places. For example, site specific quantitative observation of cancer cells inside a body and releasing drugs. Computational model has been used to uncover the fundamental details of this migration and to find out the contribution from the surface and the volumetric forces.



**Figure – 4 (A-F) shows the process flow of FeNP nanobot synthesis, micrograph of FeONP, drug loading, mechanism of moving using magnet and delivery of attach drug to a specific site in the cell cluster. Source: ACS Biomaterials Science & Engineering, 3, 1627 (2017)**

#### 2.3.5 Highlights of some research outcomes – Nano Science projects from the ongoing projects in the current financial year are briefed below

Under the project, "Development of Nano fibrous Membrane for Wound Healing by Controlled Release of Indian Honey and Curcumin" - A membrane has been developed at South India Textile Research Association (SITRA), Coimbatore which could be used on wounds with infection and exudates. Besides, it could also be used on dry wounds thereby improving the healing.



In another project, entitled, "A promising nanoformulation encapsulating human mitochondrial peptide deformylase inhibitor against non small cell lung cancer", PGIMER, Chandigarh has developed a novel tumor targeted human serum albumin nanoformulation encapsulating Actinonin, a human peptide deformylase inhibitor; Paclitaxel and Pemetrexed for its application against non small cell lung cancer.

This group claims to be the first to demonstrate that Actinonin significantly down regulates TRAP1, a mitochondrial chaperone protein which is cytoprotective in many cancerous states. The developed nanoformulations evaluation for their pharmacokinetics and therapeutic efficiency in the murine model of lung adenocarcinoma is underway.

### 2.3.6 INTERNATIONAL COLLABORATIONS

The **Indian Beamline for Nano Science and Technology at PETRA-III, DESY, Germany – Phase II** project has completed successfully on 31.03.2019. This was executed through Saha Institute of Nuclear Physics (SINP) until 31st March 2015 and then transferred to Jawaharlal Nehru Centre for Advanced Scientific Research (JNCASR). The project completed its tenure on 31st March 2019.

**Major accomplishments of this joint venture are listed below:**

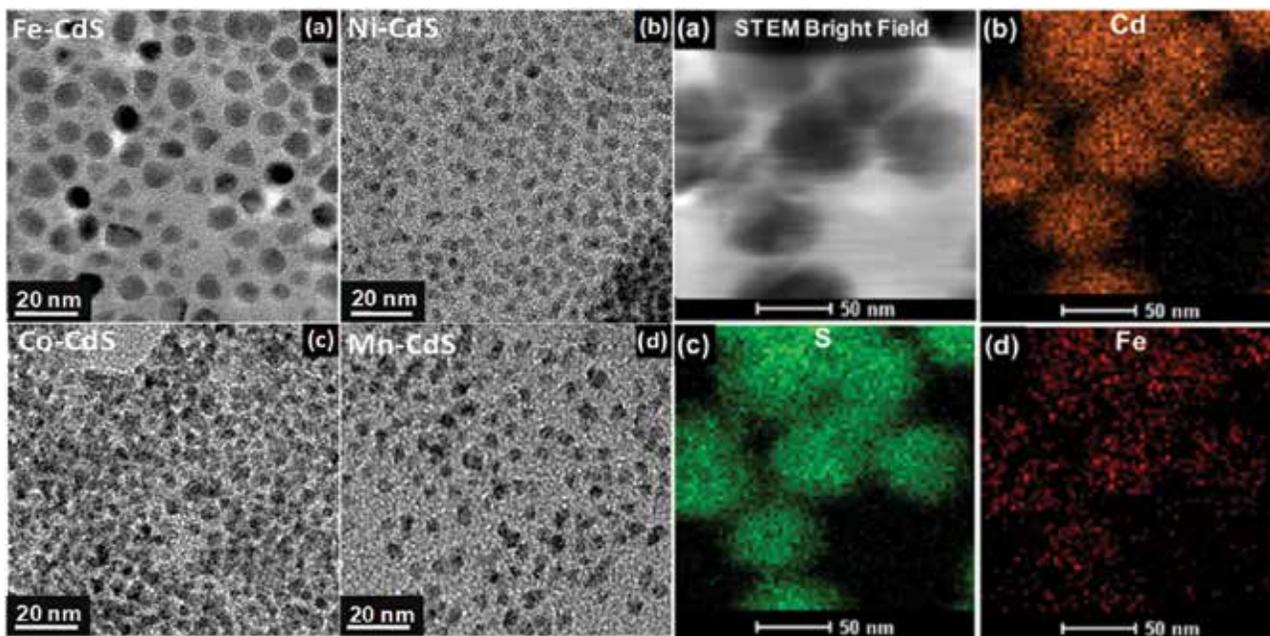
- The development work of India-motivated beamline has been completed. The job was carried out by DESY scientists and couple of Indian post-doctoral researchers were involved. The beamline was inaugurated by Hon'ble Minister for Science & Technology and Earth Sciences GoI and it is fully operational now. We have been allocated 758 days of beamtime by DESY in their existing 24 beamline which has been utilized fully by 64 institutes across India in the Phase-I.
- Right from the inception of this project we have given large fraction of beamtime to new users and as a result the number of synchrotron users in material research has increased almost 3-times

and several high-quality PhD thesis-work have been completed. At present users from 64 research institutes across India avail this facility. Ninety high quality papers have been published from the 450 beamtime-days. Experiment carried out between later half of last year and middle of this year has consumed another 200 days of beam time and publications from these experiments have not appeared so far.

- In the second half of 2018 we have been allocated another 120 days of beam time. On an average Indian users are publishing a paper with about 5 days of beam time and this is at par with international standard.

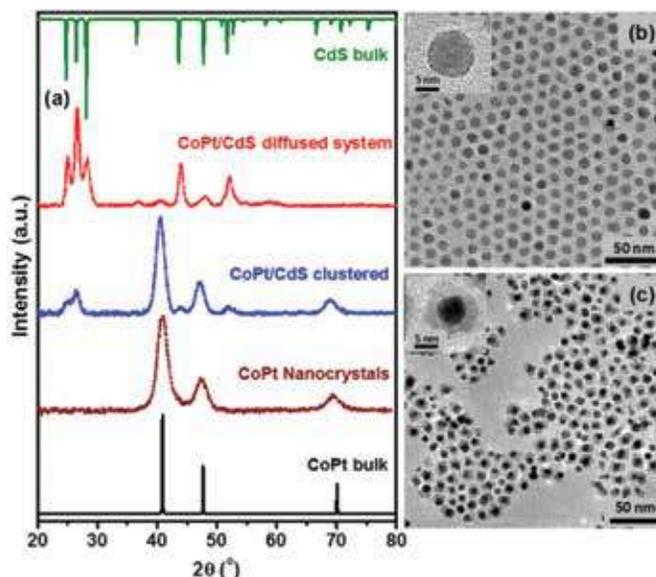
Overall, there were visits of about 500 Indian scientists from 64 Institutes of India and around 300 new synchrotron users in India were generated.

Apart from this, we have MOUs signed with KEK Photon factory, Japan for use of Photon beams by the Indian Scientists and many of our scientists who have experiments to be done on this have been supported for their visit to Japan. This is the 2nd year of this Phase-II collaboration with KEK Photon factory which is under way and we plan to train more Indian scientists from Universities and Institutes to make use of the DST support through JNCASR. Sample of research quality by use of beamline facility is demonstrated through the publications from JNCASR. These articles confirm the synthesis of uniformly doped magnetic materials in nanocrystals exhibit some unprecedented opportunities to understand DMS materials.



Uniform Distribution

Uniform doping in nanocrystals



### Co-Pt/CdS core/shell and diffused

We have also entered into an Agreement with Rutherford Appleton Laboratory (RAL), UK in January, 2015, for supporting Indian Scientists interested in using the ISIS facility for research in Nano Science & Nano Technology area. Under this a support of we have a commitment for India's contribution towards development of India motivated beamline "ZOOM" at a cost of UK Pounds 2 million and some funds for Rs 635 lakh under Recurring expenditure for various heads.

The JN Centre for Advanced Scientific Research does organise a User workshop for training of scientists who have used the KEK Facility in Japan and also the RAL Facility in UK on yearly basis. While the Scientists share their experiments with other aspiring Scientists who are invited to take part in this workshop, the evolution of Standard Experimental procedure also is worked out by the Coordinators. A leaflet for the use of all these facilities has since been hosted on the DST website and we have received 3-4 queries from scientists who want to make use of these facilities in near future.

We had finalised holding the holding of Nano India-2019 at Mahatma Gandhi University, Kottayam during April, 2019. The preparations for this have begun. In order to encourage Nano S&T start-ups, a proposal for setting a TBI in CeNS, DST Aided Institution at Bengaluru is in advance stage of processing.

#### 2.3.7 New Visiting Faculty Associateship programme to be initiated 2019-20

Under the Nano Science & Nanotechnology we have created 12 thematic Units and several experimental facilities including 4 Computational Materials Science facilities whose tenure has been extended till 31.08.2020. We would like to train young promising faculty in their areas by allowing their nurturing at these Centres for 2-3 months during their Summer Vacation and Winter Vacation period. Each participating Centre/ institution would be provided funds, if required for at least 2 Associateships

every year with provisions of travel support (2nd AC), subsistence allowance per month for being away from their normal place of Stay to the Associates and boarding and lodging expenses along with some nominal research expenses of Rs 5 lakh to the each of the Centre for Chemicals for Visiting Associates. These candidates will be from Colleges or Universities and will be assigned Centres based on their requirements.

## 2.4 Mega Facility for Basic Research

This programme is aimed to create Mega Science facilities and launch Mega Science projects in and out of the country to improve access to such state-of-the-art facilities for the Indian scientific community, especially from the academic sector. Because of technical complexities and requirement of large resources, such projects are manifestly multi-agency, multi-institutional and, most often, international in character. The Department of Science & Technology (DST) and the Department of Atomic Energy (DAE) have been jointly promoting most of such projects in the country. Under this programme, several important developments took place during the years, which are described project-wise below.

### 2.4.1 Facility for Antiproton and Ion Research (FAIR), Darmstadt, Germany

Support towards construction of the facility continued during the year and implementation of the project gained further momentum. While the civil construction work moved ahead at the project site in Germany; the work on building in-kind accelerator and detector items, viz., power converters, vacuum chambers, beam stoppers, superconducting magnets and advanced detector systems in the country also gained further momentum during the year. Some notable achievements made in the project are as under.

67 Power Converters made in India cleared Factory Acceptance Test by FAIR, Germany and the same are ready to be shipped to the project site.



**Fig. 1: Power Converter**

Large-size Gas Electron Multiplier (GEM) chambers made in India took first data in the initial phase of FAIR experiment with Ag beam. The Conceptual Design Report for Beam Stoppers was cleared

by FAIR paving way for its fabrication. Indian efforts in designing of superconducting magnets were recognized by FAIR.

A 3-day Workshop on India's Participation in the Compressed Baryonic Matter (CBM) experiment was organized at Falta, West Bengal in February, 2019 with participation of about 40 participants including 6 participants from abroad.

The project also resulted in 7 papers in journals and 12 papers in conferences during the year.

### 2.4.2 Experiments at the Large Hadron Collider (LHC) at CERN, Geneva

#### a. Compact Muon Solenoid (CMS): Upgrade, Operation & Utilization

Indian scientists and research students continued their participation in CMS experiment. Some of the important physics results are listed below.

- ttH – Coupling of Top quarks with Higgs – justifying that even the heaviest of particle, i.e, top quark gets its mass from its coupling with the Higgs field.
- Observation of Higgs  $\rightarrow$   $b\bar{b}$
- Observation of BC(2S) and BC\* (2S)
- Observation of top quark in proton-lead (p-Pb) collision
- ZZ Production and H $\rightarrow$  ZZ production with 2018 Dataset
- Rare process of 4 top quarks being studied

India-CMS supplied 17 Gas Electron Multiplier (GEM) chambers to CERN as an in-kind item after completing its design, fabrication and testing in India. These will form part of the upgraded CMS detector.



**Fig.2: GEM GE 1/1 Detector**

An International Workshop on Silicon Detector Quality Control related to CMS Tracker Detector was organized at Delhi University in January, 2019. In this Workshop, about 30 scientists participated including 14 from abroad.

During the year, Indian researchers were joint authors of 135 collaborative research publications. The project also resulted in 10 Ph.Ds during the year. Prof. Brajesh Chandra Choudhary, India-CMS Spokesperson was nominated as one of the Advisors to the CMS Spokesperson and, hence, to the CMS Management Board.

#### **a) A Large Ion Collider Experiment (ALICE): Upgrade, Operation & Utilization**

Indian scientists and research students continued to participate in the ALICE experiment. Two major detectors made in India recorded more than 500 million p-p, Pb-Pb collisions. The new readout system was validated with test beam for muons. The design and development of Common Readout Unit (CRU) was completed during the year paving the way for its production by the industry.

During the year, Indian researchers were joint authors of 33 collaborative research publications. The project also resulted in 6 Ph.Ds and 15 journal publications during the year.

#### **b) Updating and Operation of Regional Worldwide Large Hadron Collider Computing Grid (WLCG) Grid system**

Support to this project continued during the year and the WLCG Grid continued enabling the scientists and research students to process the voluminous data obtained from the CMS and ALICE experiments.

#### **c) Associate Membership of CERN**

An Industrial Liaison Officer (ILO) was appointed. Efforts were made to connect Indian Industry with Market Surveys and Tenders floated by CERN. 8 Indian Companies participated in 10 Market Surveys and Tenders. The technology for producing high-tech GEM foils was transferred to an Indian industry.

##### *2.4.3 India-based Neutrino Observatory (INO), Madurai*

Support to 13 university groups for INO-related R&D work continued during the year. They continued detector R&D and prototyping during the year. The project resulted in 2 Ph.Ds. and 6 research publications during the year. The progress made by the university groups was also reviewed during the year.

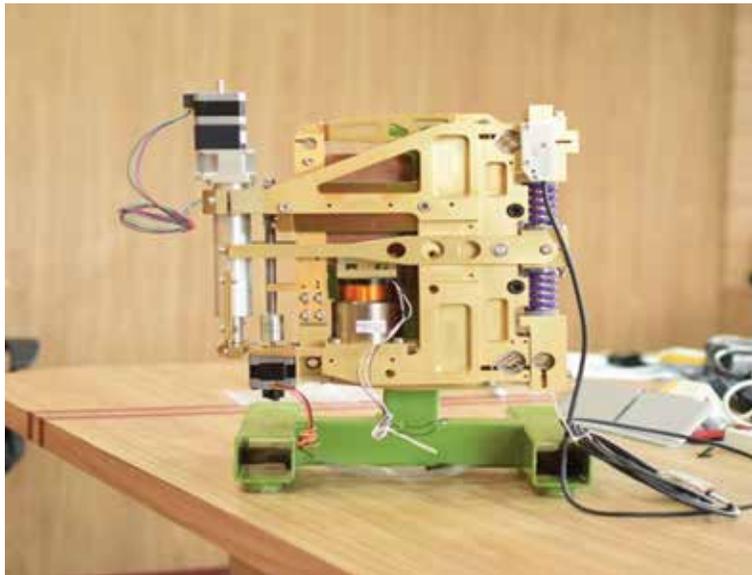
##### *2.4.4 Thirty Metre Telescope (TMT) Project*

Support to this project continued during the year. Legal hurdles regarding the project site at Mauna Kea, Hawaii got over, paving the way for start of civil construction. R&D and prototyping of in-kind items from India — Segment Support Assemblies, Actuators, Edge Sensors, Segment Polishing and Segment Coating, First Light Instruments, Observatory Software and Telescope Control Systems software continued in full swing. A state-of-the-art Optics Fabrication Facility at the CREST Campus of Indian Institute of Astrophysics (IIA), Bengaluru for fabricating TMT segments became ready during the year.



**Fig. 3: Optics Fabrication Facility at CREST Campus of IIA, Bengaluru**

20 Actuators made in India were shipped to the TMT Project Office, USA and these were undergoing performance and life tests.



**Fig.4: Actuator**

Prototype development of central diaphragm, an important component of the segment support assembly was successfully completed during the year. The preliminary design phase of Telemetry Control System Software was also completed. The Conceptual Design Phase Analysis of First Light Instruments was also completed. India was selected to take a lead in the development of a 2nd Generation Science Instrument, High Resolution Optical Spectrograph, with Japan, China and USA as the collaborating

countries. The development of Common Software Module, which is the backbone structure of TMT Observatory Software was completed and the same is undergoing testing at TMT Project Office.

An important International Meeting on 2nd Generation Science Instrument, High Resolution Optical Spectrograph (HROS) was organized in the country at IIA, Bengaluru with participation of about 25 persons including participants from Japan, China (remotely) and USA (remotely) in February, 2019.

On outreach front, one Workshop on TMT Science and Instrumentation was organized at Christ University, Bengaluru in February, 2019. Also, one 1:60 scaled model of TMT was fabricated. Two TMT researchers gave seminars on topics related to TMT.

Besides the scientific results and development work mentioned above, the project also resulted in 7 scientific and technical publications. The Executive Council for the project reviewed the progress made in the project during the year.

#### 2.4.5 *Laser Interferometer Gravitational-Wave Observatory (LIGO) Project*

Considerable progress was made in the project during the year. Acquisition of land has been almost completed. Preparatory activities like geotechnical, seismic and topographic studies at the project site in Hingoli district in Maharashtra progressed further. A Detailed Project Report was formulated and submitted. Civil construction for the prototype facility at RRCAT, Indore is in full swing. The projects on related R&D started in IITs and other institutions.



**Fig.5: Schematic of LIGO-India**

#### 2.4.6 *Square Kilometre Array (SKA) Project in South Africa and Australia*

India successfully participated in the Design Phase and process for participation in the Construction Phase started during the year.

*2.4.7 Utilization of Twin Indian Beamlines for Macromolecular Crystallography (XRD2) and High Pressure Physics (XPRESS) at the Elettra Synchrotron Facility, Trieste, Italy*

Utilization of twin Indian beamlines, XRD2 and XPRESS for carrying out frontline research in macromolecular crystallography and high pressure physics by the Indian scientific community continued during the year. 15 experiments on XPRESS and 16 experiments on XRD2 beamline were performed by Indian researchers from 16 institutions of the country. 15 research publications were also published.

*2.4.8 Accelerator-based Research Facilities*

**a. Low-Energy Ion Beam Facility at Kurukshetra University**

Support to the 200 KV ion beam facility at Kurukshetra University continued during the year and the facility continued to be utilized by users from neighboring institutions.



**Fig.6: Ion Beam Facility at Kurukshetra University**

During the year, beam time was provided to user research groups for carrying out a variety of experiments using Ni<sup>+</sup>, Ar<sup>+</sup>, N<sup>+</sup>, N<sub>2</sub><sup>+</sup>, B<sup>+</sup>, Au<sup>+</sup>, He<sup>+</sup> beams in the energy range of 50 to 200 keV having ion fluences ranging from 6x10<sup>12</sup> to 8x10<sup>18</sup> ions/cm<sup>2</sup> on different targets like Ni/Si/Bi and Si/Cr, Si/Cu thin films, TEM grids, Polyaniline thin films on quartz, Low-density Polypropylene, High-density Polypropylene, Si (111), Glass, Cr-39 polymer, Polycarbonate, Polyethylene Teraphthalate, Poly methyl methacrylate, Fullerene and Copper-Fullerene nanocomposite films on quartz and Si(100), CdSe Thin films on Si(100).

12 user research groups carried out 35 experiments using the facility. The project also resulted in 1 Ph.D., 18 research publications and 16 Conference papers during the year.

### a) High-Fluence Ion Beam Facility at Allahabad University

Support to high-fluence ion beam facility at Allahabad University continued during the year.



**Fig.7: High-Fluence Ion Beam Facility at Allahabad University**

During the year, 2 user research groups carried out 2 experiments on the facility. The project also resulted in 3 research publications and 1 Conference paper during the year.

### b) National Large Solar Telescope (NLST) project

During the year, land for the project site at Merak in Ladakh was acquired. The process of financial approval for the project advanced further during the year.

#### 2.4.9 Others

A School on Accelerator Science & Technology was organized by the Inter-University Accelerator Centre (IUAC), New Delhi with participation of 45 students and 24 scientists from different institutions in the country. The School also provided hands-on-training to the participants on topics related to particle accelerators

## 2.5 Climate Change Programme (CCP)

As part of National Action on Climate Change (NAPCC), DST has been entrusted with the responsibility of coordinating and implementing two national missions on climate change. These are: (i) National Mission for Sustaining the Himalayan Ecosystem [NMSHE] and (ii) National Mission on Strategic

Knowledge for Climate Change [NMSKCC]. The Climate Change Programme (CCP) of Strategic Programmes, Large Initiatives and Coordinated Action Enabler (SPLICE), Division is implementing these national missions.

*2.5.1 Major achievements and progress made during 2018-19*

New Programmes initiated/launched during the year:

As part of implementation of two national missions on climate change i.e., NMSKCC and NMSHE, following new programmes were initiated/launched during the year 2018-19:

- 01 Centres of Excellence,
- 02 National Knowledge Network programmes;
- 01 Human Capacity Building Programme
- 03 State Climate Change Centers/Cells,
- 06 State Knowledge Network programmes under HICAB
- 8 Indo-US Fullbright-Kalam fellowships

**A summary of above programmes is given below:**

**(i) 01 New Centre of Excellence**

As part of NMSKCC deliverables, DST supported the second phase of the Centre of Excellence at Divecha Centre of Climate Change, IISc, Bangalore with the objective to assess the state of Himalayan Glaciers in the country, to measure aerosol black carbon concentration at upper troposphere/lower stratosphere using high-altitude balloon-borne experiments, study their source w.r.t. aircraft emissions and their effect on stratospheric ozone layer. In addition, the centre will also carry out studies to ascertain climate variations during past millennium through different climate models and unravel the major modes of variation of the ocean-atmosphere system.

**(ii) 02 New National Knowledge Network Programmes**

During 2018-19, two new national network programmes have been launched in following thematic areas:

- Urban Climate
- Himalayan Cryosphere

**A summary of these network programmes is given below:**

**(a) National Network Programme on Urban Climate**

With the urban population expected to grow upto about 50% of the population in the next few decades, the country must be prepared to face the accompanying challenges due to increase in greenhouse gases contributing to climate change, air and water pollution, urban transportation, infrastructure, water supply and sanitation, urban floods and droughts and implications on energy and other resources. Densely populated cities in the country are already vulnerable to many of these typically urban issues. Visible impacts of increasingly warmer climates in cities due to urban heat island effect and human activities are already evidenced in the health, water and energy sectors. An in-depth scientific understanding of all interconnected issues related to urban climate is the urgent need in the country today. To address this need, a National Network Programme on Urban Climate is set up by DST under National Mission on Strategic Knowledge for Climate Change.

Proposals were invited from identified potential participants through a workshop conducted during 2017 at Bhubaneswar. These proposals were reviewed by experts for science and program requirements. They were presented to the science advisory team and ultimately projects were approved focusing on the city of Dehradun through IIT Roorkee, the city of Bhubaneswar and Hyderabad through IIT Bhubaneswar and IIT Hyderabad, and the city of Bangalore through IISc Bangalore. The network program has partners through IIT Bombay and IIT BHU as well as various state and national agencies.

The broad intent of the projects is to take science of current and future climate change and integrate that with current and future landuse, urban expansion and human intervention and finally develop future climate projections that are integrated with landuse change for specific extreme events such as urban heat wave, urban pollution and heavy rain flooding.

#### **(b) National Network Programme on Himalayan Cryosphere**

The glaciers and the seasonal snow melt feed numerous Indian rivers originating from Himalaya and support millions of people. However, snow and glaciers are sensitive to climate change and the ongoing climate change will potentially affect the water availability for millions of people living in North India. Therefore, comprehensive understanding of factors and processes affecting the Himalayan cryosphere is needed. Hence, a need was felt for an integrated program to study various aspects of Himalayan cryosphere. These are glacier retreat, glacier mass budget, glacier volume, snow water equivalent, snow albedo, river run off, glacier lake, snow avalanches and climatic parameters. This will require multi-disciplinary skills and such resources are distributed at various Indian institutions. Therefore, to bring scientists with various expertise on one platform and to explore a possibility of launching a National Network Program on Himalayan cryosphere, a national Workshop was organized on April 24, 2018 by Department of Science and Technology, Government of India and Divecha Centre for Climate Change at Indian Institute of Science, Bengaluru. Twenty-five experts from Twenty-three institutions across India participated in the meeting. The workshop brainstormed upon issues relevant to broad areas of Himalayan Cryosphere and discussed possible roles of potential partners. Nine potential investigators were identified by the workshop for inviting EoIs for the network programmed. Following the process of refereeing by independent experts, review by a Reviewers Panel and Expert Committee 6 proposals were finalized under Network Programme. These projects were sanctioned by March 2019.

**(iii) Human Capacity Building Programmes:**

During the year, a Human Capacity Building Programme (HCBP) in climate Change adaptation was sanctioned to National Institute of Disaster Management (NIDM), New Delhi to conduct trainings for different stakeholders. Main aim of the project is to enhance the capacity of professionals & researchers to analyze, plan, manage and evaluate different aspects of climate change related disaster management activities. The programme includes the training need assessment on aspects of extreme events and climate risk management for disaster resilience, and to design & develop training framework, resource materials on the theme. It also plans to sensitize the stakeholders through lessons of case/ field studies, specialized trainings & analysis as reference/ reading across various scales/ geographies.

**(iv) State CC Cells/Centres**

Three new State Climate Change Centers have been established/strengthened in the states of Assam, Gujarat and Bihar. The State Climate Change cells have been established in the State Government's nodal departments designated to implement State Action Plan on Climate Change. These centers have been assigned to undertake following major tasks:

- Vulnerability and risk assessment at district/sub-district levels
- Institutional Capacity building and R&D for data base/ Information generation
- Training programmes for stakeholders, and.
- Public awareness as per the requirements of state and national action plan on climate change.

**(v) State Network Programmes under HICAB**

State network programmes with 18 projects across seven Himalayan states were launched under the new programme named Human and Institutional Capacity Building Programme (HICAB) The programme focuses exclusively on the researchers, faculty and students of universities and academic institutions in the Indian Himalayan region. The HICAB programme was initiated with an email attached with a background note and an EoI format circulated to VCs/Directors of 38 Government Universities, IITs and NITs for seeking their expressions of interest and enrolment. In response, 20 out of the above 38 have responded. Further, DST conducted brainstorming sessions with the researchers from Academic institutions in different states (J&K, HP, Assam, Arunachal Pradesh, Meghalaya, Manipur). In which potential researchers/institutional partners from the institutions in the respective states along with broad areas of their interest, capacity to host different categories of programmes were identified. The programme has broad sub-the-mes such as Climate change vulnerability and impact, Meteorology, Glaciology and Hydrology, Bio-diversity and flora/faun, and Health and Livelihood has been identified under the programme. Further expansion of the programme to other states and initiation of other major programmes are underway.

### (vi) Indo-US Fulbright-Kalam Doctoral and Post-Doctoral Fellowships in Climate Change;

In a September 2014 Joint Statement, the President of the United States of America and the Prime Minister of India launched a new U.S.-India Climate Fellowship Program to build long-term capacity to address climate change related issues in both countries. In pursuance of this statement, the Fulbright-Kalam Climate Doctoral and Post-doctoral Fellowship programme was launched. The selection process for the third batch of 8 candidates was completed during 2018-19 and selected candidates have proceeded to US institutions for undergoing their respective courses. The selection process for the second batch of 10 candidates for above fellowship for the year 2019-20 is underway.

#### 2.5.1.2 Major outcomes from the Ongoing Programmes

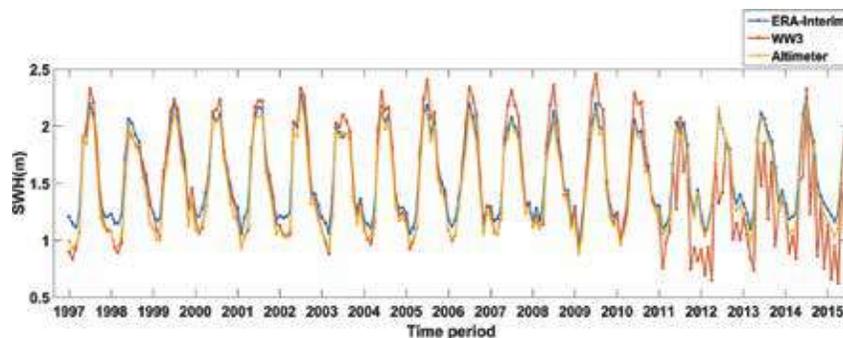
##### a. Centres of Excellence (CoEs)

##### i. Centre for Climate Change, IIT Delhi

The main objective of the CoE at IIT Delhi is to develop an India-Centric Climate Model (ICCM) through process improvements and region-specific customisation that will satisfactorily simulate the regional climate of India and can be used for future climate projections at district level to assess the impacts of climate change on agriculture, health, water resources, and the energy sectors. The model assessment step is done with the help of PCC and normalised RMSE computed with respect to MERRA and TRMM data. With appropriate customization, significant improvements are being achieved on the selected Community Earth System Model (CESM) which is a fully coupled numerical simulation of the Earth system consisting of atmospheric, ocean, ice, land surface, carbon cycle, and other components..

##### ii. CoE IIT Kharagpur

The temporal and Spatial variability of Significant Wave Height (SWH) and Significant Wave Speed (SWS) over the Bay of Bengal region- Comparison between ERA-Interim, WWIII, and Satellite Altimeter datasets revealed WWIII is consistently higher until 2011 as compared to ERA-Interim and Altimeter (Figure-1)



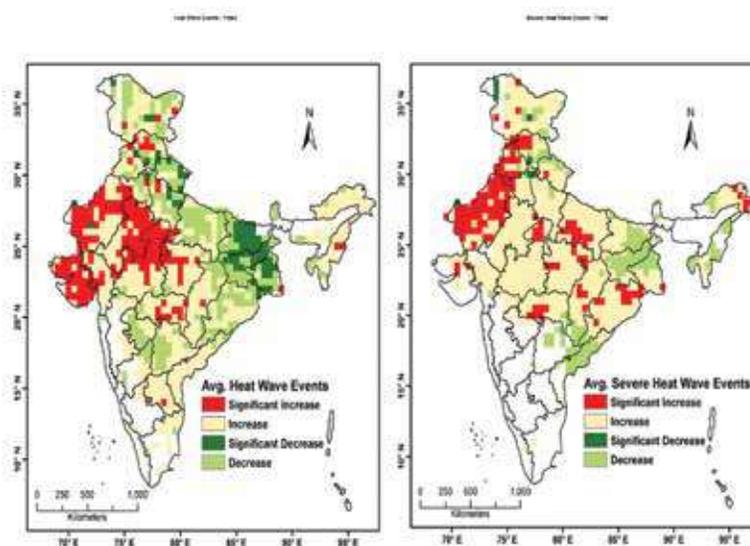
**Figure-1: Temporal variability of SWH over the Bay of Bengal region – Comparison between ERA-Interim, WWIII, and Satellite Altimeter datasets**

A model for wave propagation through mangrove forest in the presence of a viscoelastic bed is being developed which could improve understanding of wave propagation through mangroves in the coastal zone having muddy seabed and assist in mitigating coastal hazards.

### iii. DST-Mahamana Centre of Excellence in Climate Change Research

The Centre aims to assess the impacts and vulnerability in water, agriculture and health sectors due to climate variability and change and building long term capacity in the areas of climate research and multi-disciplinary fields in the region. Regional Climate Models at RCP 4.6 have been customized to simulate agro-climatic zones of Uttar Pradesh to assess their output and predict future events. Under impact assessment the different crop simulation models viz, DSSAT (CERES- Rice, CERES-Wheat, CANEGRO- Sugarcane, CROPGRO- Pigeon Pea), INFOCROP, hydrological models- SWAT, MODFLOW, and statistical health models- ARIMA, SARIMA, PCA, generalized additive models were used. Integrated agro-biotechnological interventions i.e. (AMF+BR) under reduced tillage has significantly reduced the microbial (18, 26, and 24%) and soil respiration (24, 22, and 19%).

An increase in spatio-temporal occurrence of heat waves and severe heat waves were found over India when used IMD criteria separately for plain, coastal and hilly regions (Fig).

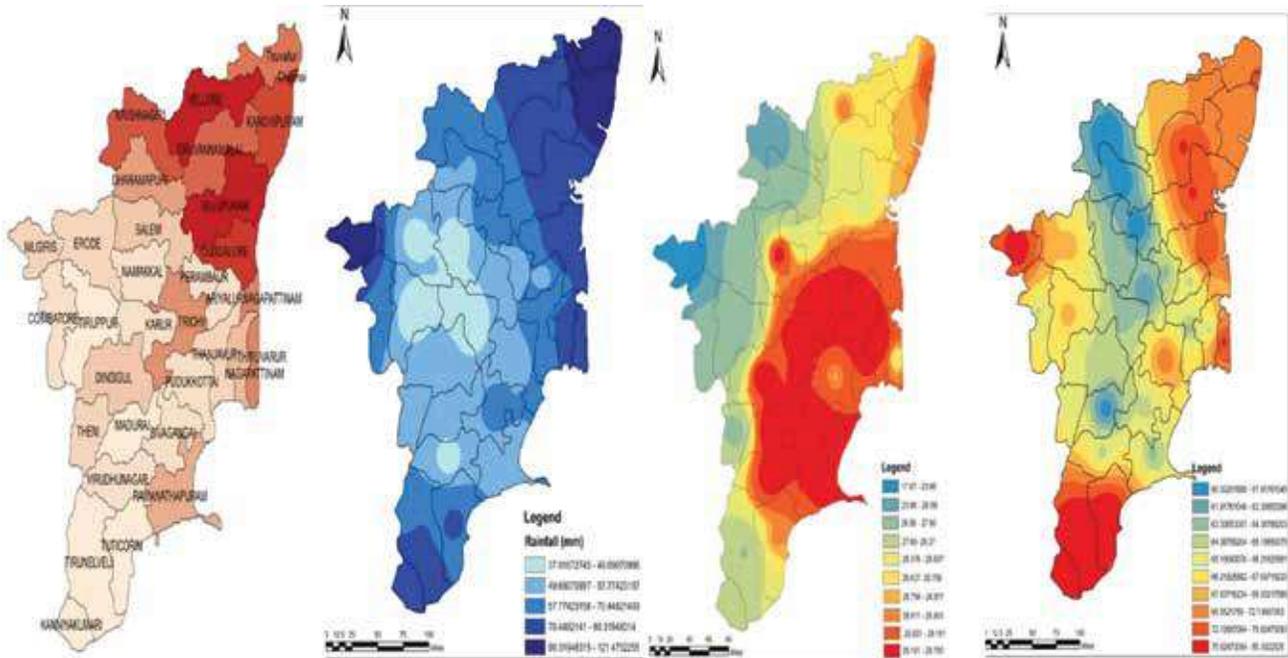


**Figure-2: Long term trend in seasonal a) Heat Wave Events b) Severe Heat Wave events over India for March – July during 1951-2016**

### iv. DST-ICMR Centre of Excellence for Climate Change and Vector-borne Diseases, National Institute of Malaria Research, New Delhi

The main focus of the centre is to determine the temperature thresholds for survival of vectors of major Vector-borne diseases (VBDs), modelling of projected scenarios of the VBDs and to set up a system for early warning of outbreaks for malaria and dengue.

A Spatio-temporal distribution of Scrub Typhus in Tamil Nadu in context of Climatic Parameters was determined.



**Figure-3: Map depicts district wise A) scrub typhus cases from January 2015 to December 2016 B) annual rainfall, C) Temperature and D) Relative Humidity**

#### b. Thematic Task Forces under NMSHE

##### **TF 1: Status of geo- resources and impact assessment of geological (exogenic) processes in NW Himalayan Ecosystem**

The taskforce has compiled a detailed inventory of 635 glacial lakes having largest concentration of supra-glacial lakes, for the Alaknanda. Similarly to assess the glacier lake outburst floods (GLOF) in the Spiti basin of the Satluj river, an inventory of glacier lakes have been prepared and each lake was mapped using High resolution satellite data of LISS III for the year 2018 for its potential breaching condition. A total 80 lakes have been identified and mapped where majority are of moraine dammed lake, with few supra-glacial lakes as well. The elevation band-wise snow cover variation using an improved cloud removal protocol for MODIS data was assessed and accordingly the snow cover duration and its variability has been studied. Declining trend in snow cover duration (SCD) was reported between 2000-2500 m a.s.l. elevation range followed by 2500-3000 m a.s.l. elevation range with no significant change above 4000 m a.s.l. (figure)

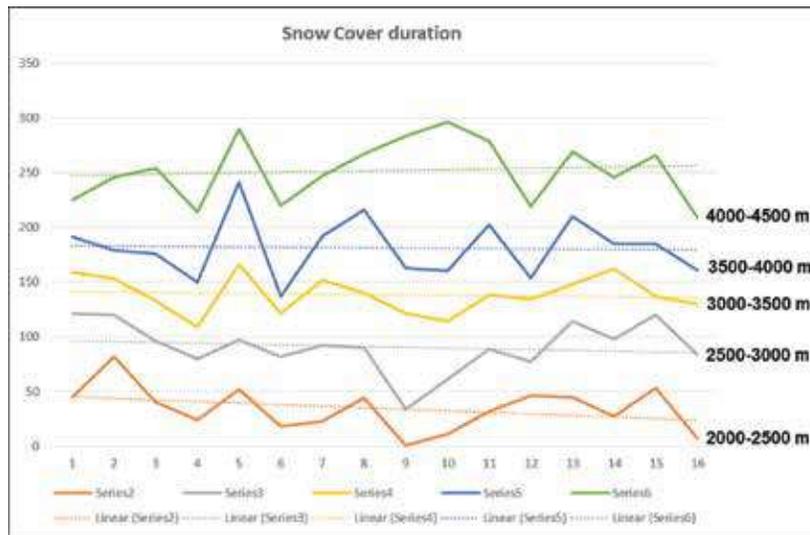


Figure-4: Elevation-dependent trend of snow cover duration

**TF 2: Integrated Hydrological Studies for Upper Ganga Basin up to Rishikesh**

Mapping the areal extent of snow cover is critical for flow forecasting for operational water resource management as snow cover area plays critical role in quantifying snowmelt. A semi-automated procedure for altitude- based masking of NSIDC MODIS snow extent maps has been developed by the Taskforce. Also Web application is being developed using open layers for display of real-time snow cover information in the study area. The Task force has identified vulnerable lakes in four study basins (Sutlej, Beas, Chenab and Ganga up to Rishikesh). Some vulnerable lakes shown in Figure

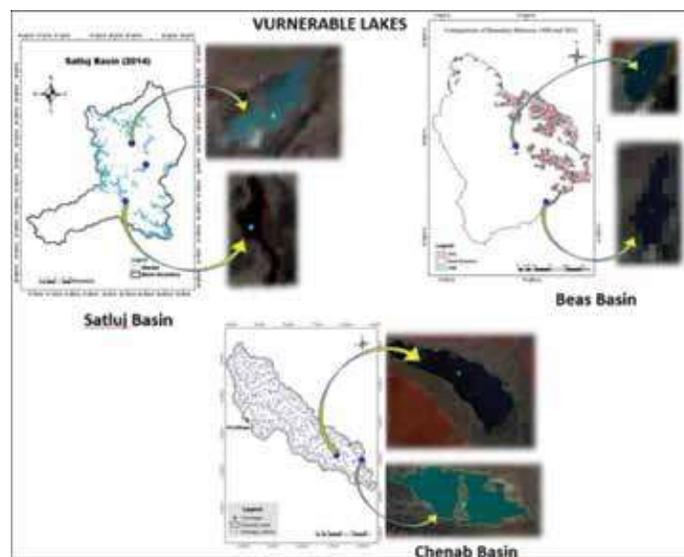


Figure-5: Few vulnerable lakes identified in different basins

In order to understand groundwater development prospects in the hilly areas Geological traversing from Dabrani to Gangotri has been done. To characterise the melt water and study the spatial and temporal signatures, detailed isotopic analysis was carried out. The results revealed that Alaknanda River is found to be more enriched than Bhagirathi River and the hot springs are more depleted in comparison to other groundwater sources.

### TF 3: Assessment and Monitoring of Climate Change Effects on Wildlife Species and Ecosystems for Developing Adaptation and Mitigation Strategies in the Indian Himalayan Region

So far the presence of 130 lichens, 30 nematode genera, 87 Odonata, 39 aquatic macro-invertebrate genera, 15 fish, 18 reptiles and 12 amphibians, 12 Galliformes and 39 mammal species have been confirmed from Bhagirathi Basin. The life history traits specifically the age-growth profiles of native snow trout (*Schizothorax richardsonii*) and non-native brown trout (*Salmo trutta fario*) populations in the tributaries of Bhagirathi and Beas river basins have been monitored. To detect amphibians nocturnal visual encounter survey in Bhagirathi River Basin and Teesta River Basin were conducted which has recorded thirty-one species of amphibians so far. The climate change vulnerability (household and village level) of the people residing in Uttarkashi and Tehri Garhwal district of Uttarakhand have been assessed.

### TF 4: Forest Resources & Plant Biodiversity

The task force is engaged in developing a database of forest resource and plant diversity in the IHR under a standard format. So far database of 1163 tree species, 2017 shrubs, 756 species of economically important trees, 242 Red Data species and 456 threatened (IUCN 2017) has been prepared. Representative Long Term Ecological Monitoring (LTEM) plots have been established for Uttarakhand (west Himalaya) representing sub-tropical, temperate and sub-alpine zones. Long term monitoring of forest ecosystems and assessment of forest cover changes in the IHR are underway. According to pilot studies conducted on forest vulnerability assessment the forest vulnerability index decreases with elevation (Figure) where the high vulnerability in low altitude forest can be linked to anthropogenic activities and low species richness.

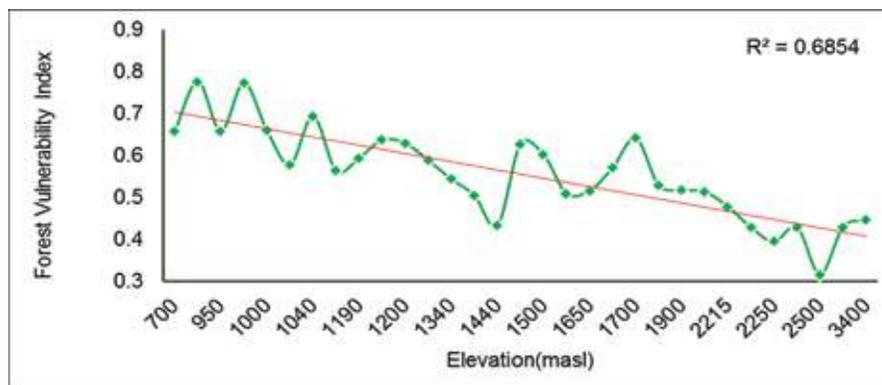


Figure-6: Decrease in forest vulnerability index with elevation

### **TF5: Convergence of Traditional Knowledge Systems for Integration to Sustainable Development in the Indian Himalayan Region**

A Common Methodology Framework (CMF) for documenting the Traditional Knowledge System (TKS) of the identified communities in an integrated and focused manner with emphasis on human ecology perspective has been developed. A rich database on the traditional conservation and utilization patterns of both wild and domesticated bioresources of the majority of the selected communities has been prepared. A profile document of 30 selected communities has been recently brought out by the Task Force highlighting their geographic distribution, population, religion, languages, major festivals, socio-economics, salient features of their TKS and the potential traditional practices (Indicative Best Practices) for up-scaling to broaden the range of livelihood options. Using tentative threshold values, the Task force has developed quantitative indicators of Traditional Ecological Knowledge and has been able to create an indicative baseline for monitoring the status of the selected TEK themes / parameters of some of the identified communities.

### **TF 6: Himalayan Agriculture**

The task force has developed close to 115 maps/yield trends and graphs pertaining to the status of agro-ecosystems and climatic trends in the Indian Himalayan Region (IHR). The distinct periodic regional moisture availability over North East India for supporting short to medium-term agricultural activities and long-term maintenance of regional hydrology in the IHR have been derived. Meteorological suitability for maize via ecological niche modeling of 39 maize were established. A refined multi-tier model for carp culture has been designed by constructing poly-cum-irrigation tanks for water storage and lined with polythene to control the seepage (Figure). Integrated farming systems e.g. Rice-duckery-fishery based farming system; gri-horti- duckery-fishery based organic farming system, Fish-pig-tuber crops based farming system introduced by the programme have resulted in increased farm income



**Figure-7: Lining the water storage tank**

**(ii) State Climate Change Centres (SCCCs) in the Himalayan and Non-Himalayan States/UTs:**

State Climate change cells 25 states/UTs have been established under the two national missions: 12 in the Himalayan region under NMSHE and 13 in the non-Himalayan region under NMSKCC. States in the Himalayan region include J&K, Himachal Pradesh, Uttarakhand, Nagaland Sikkim, Meghalaya, Mizoram, Manipur, Tripura, Nagaland, West Bengal, and Assam. The Non-Himalayan states/UTs include Punjab, Madhya Pradesh, Tamil Nadu, Telengana, Chhattisgarh, Karnataka, Kerala, Puducherry, Arunachal Pradesh, Haryana, Odisha, Maharashtra, Gujarat, Assam and Bihar. These SCCCs have been assigned with the mandate to carry out four common tasks viz., vulnerability & risk assessment; organising training programmes; public awareness programmes and building institutional capacity at state level, in addition to the priorities as per respective state action plans.

As per the mandate of all the SCCCs to carry out climate vulnerability and risk assessment, most of SCCCs in Indian Himalayan Region (IHR) had attempted to prepare their vulnerability profile which were not comparable due to non-uniformity in the indicators selected and were developed in reference to the IPCC 2007 framework. A need was realized for development of a common framework incorporating the updated IPCC 2014 framework to arrive at common vulnerability profile. The task to develop a common vulnerability framework, guidelines and manual was delivered by IISc Bangalore. Following which two State-Level Vulnerability Need Assessment Workshops were conducted by IIT Guwahati (March 2018) and IIT Mandi (April 2018) in eastern and western Himalayan states respectively. During these workshops the state representatives were provided with an overview of the vulnerability concept and common framework followed by discussion on source of data and methods of data collection. Eventually 20 indicators were selected which served as the basis for the hands on training provided to state officials in the Methodology Workshop held at IIT Guwahati during 10-14 September, 2018. The most significant outcome of the workshop was the first ever Pan-Himalayan vulnerability profile map covering the 12 IHR States developed under the common framework. So far, one manual on climate vulnerability and risk assessment (at Methodology Workshop, IIT Guwahati) and two reports on the vulnerability profile of the Indian Himalayan States (at COP24 Katowice and National Workshop on Climate Vulnerabilities, New Delhi) have been released. The outcomes of the above exercise have led to discussions on development of a strategy to extend the use of the Common Framework for rest of the Indian states.

**(iii) Global Technology Watch Groups (GTWGs)**

Global Technology Watch Groups (GTWGs) in 08 areas: Renewable energy, Clean Coal technology; Agriculture, Water; Sustainable habitat, Green India; Enhanced energy Efficiency and Manufacturing have been set up with the aim to groups to keep track of the state-of-the-art technologies in India and abroad and also to keep abreast of current and emerging technologies and their developments worldwide. GTWGs on first two technology areas are coordinated by National Institute of Advanced Studies (NIAS), Bangalore and IIT Madras whereas GTWGS on remaining 6 areas by TIFAC, New Delhi.

### 2.5.2 R&D manpower trained/generated (PhDs etc.)

A number of R&D programmes in some key areas of climate change science, adaptation and mitigation have been launched during the year. Several institutes working in these areas have been engaged in providing capacity building programmes involving research students leading to generation of trained manpower in the area of climate change sciences and technologies. Over 1000 scientists, experts and students and 200 institutions in the country are associated with CCP programmes/projects. Over 700 indirect jobs created through project staff/students fellowships.

### 2.5.3 International bi-lateral Programmes

#### a. Indo-Swiss Joint Collaborative Programme

Within the overall framework of S&T agreement between Government of India and Government of Switzerland, an Indo-Swiss Joint Committee for Scientific and Technological Cooperation was established by the two governments. In the first meeting of this joint committee held in Bern, Switzerland on 23rd September 2011, it was decided to develop a scientific cooperation between the two countries in Glaciology and related areas. The first phase of Indo-Swiss programme was launched in the year 2013 which continued until December 2015. The second phase of the cooperation began in January 2016, wherein, the Swiss agency for Development and Cooperation (SDC) through its Indian Himalayan Climate Adaptation Programme (IHCAP) programme has been working as a knowledge partner of DST in providing technical support for undertaking vulnerability and risk assessment, stakeholder training and public awareness programme to the 12 State CC Cells established under NMSHE. As part of this cooperation, a detailed district-wise vulnerability assessment has been carried out for all the 12 Himalayan States.

#### b. Indo-US Fulbright-Kalam Fellowships in Climate Change

An Indo-US Fulbright- Kalam fellowship scheme was initiated during 2015-16. During 2016-17 to 2018-19, three batches of six fellows (3 each in doctoral and post-doctoral categories) have already been awarded the fellowships and proceeded to their respective institutions in USA for undergoing courses. The selection process for the fourth batch of fellows is underway.

#### c. Indo-German research collaboration in climate change

A Joint Declaration Intent (JDI) was signed between DST and BMBF, Germany for supporting Indo-German Center for Sustainability at IIT Madras. A Centre of Excellence focusing on Climate Change Impact on Coastal Infrastructure has been supported at IGCS, IIT Madras for a period of 5 years. The Centre of Excellence has been formally launched recently on 15th April, 2019.

### 2.5.4 Important Events organised during the year:

#### a. Inauguration of the DST Centre of Excellence at IIT Kharagpur

DST has established Centre of Excellence entitled 'Vulnerability and Risk Assessment due to various

Environmental drivers in a Climate Change scenario over Eastern India’ at IIT, Kharagpur during the year 2016-17. Inauguration of the Centre of Excellence along with a review of the programme was held on 25 May, 2018 at IIT Kharagpur. Director, IIT Kharagpur inaugurated the centre in the presence of Prof SK Dube, Chairman, DST CCP Expert Committee & former Director, IIT Kharagpur & Dr. Akhilesh Gupta, Adviser & Head, Climate Change Programme, DST.

**b. Training Programme for developing vulnerability and risk assessment maps for Himalayan States at IIT Guwahati**

A hands-on training programme was conducted at IIT Guwahati during 10th to 14th September, to strengthen the capacities of the Himalayan States by carrying out a vulnerability and risk assessment. The training was jointly organized by the Department of Science & Technology, Govt. of India, the Indian Himalayas Climate Adaptation Programme (IHCAP), Indian Institute of Technology (IIT) Guwahati, Indian Institute of Technology (IIT) Mandi and Indian Institute of Science (IISc) Bangalore. Being the first of its kind, the workshop witnessed the participation of 100 representatives from all the 12 Himalayan states. Technical presentations were made by Prof. N. H. Ravindranath, IISc, Bangalore and his team on the common framework for vulnerability and risk assessment and the methods and steps involved to carry out an assessment. The participants worked on the selected indicators and data to develop vulnerability index and maps during the five day programme. At the end of the programme, vulnerability maps for the entire Himalayan region were developed using a common vulnerability and risk assessment framework. In addition, the workshop served as a platform to foster more dialogue and exchange of knowledge between the states.



**Figure-8: Participants of the training programme on vulnerability and risk assessment at IIT Guwahati**

**a. Inauguration of the DST Centre of Excellence at ICRISAT, Hyderabad**

As part of initiatives under NMSKCC, DST has established Centre of Excellence entitled “DST-ICRISAT Center of Excellence on Climate Change Research for Plant Protection (CoE-CCRPP): Pest and disease management for climate change adaptation” at ICRISAT, Hyderabad during the year 2017-18. The inauguration of the Centre of Excellence was held on 13th October, 2018 at 2:30 PM at ICRISAT, Hyderabad. Dr. Manga Rai, Former DG, ICAR inaugurated the centre in the presence of Dr Peter Carberry, Director General, ICRISAT; Prof SK Dube, Chairman, DST CCP Expert Committee & former Director, IIT Kharagpur & Dr. Akhilesh Gupta, Adviser & Head, Climate Change Programme, DST.



**Fig-9: Inauguration of Centre of Excellence at ICRISAT, Hyderabad**

**b. Side Events during Conference of the Parties (COP 24) at Katowice, Poland, 2-14**

The 24th session of the Conference of the Parties (COP 24) to the United Nation Framework Convention on Climate Change (UNFCCC) was held in Katowice, Poland during 2-14 December, 2018. On the sidelines of CoP24, several countries including India organised side events showcasing their significant achievements and progress made in climate action. The Departments of Science & Technology was given opportunity to organise two side events. These include a Side Event on “Technology Need Assessment and Innovations for Managing Climate Change” and other one on “Mountain Ecosystems-Himalayan Region” on 3rd and 4th December, 2018 respectively. Both the events were inaugurated by Hon’ble Minister for Science & Technology, Earth Sciences and Environment, Forest & Climate Change, Dr Harsh Vardhan. An “Executive Summary of Global Technology Watch Groups reports” and a report on “Climate Vulnerability Assessment for the Indian Himalayan Region using a Common Framework” were released on these occasions.



**Figure-10.: Release of an Executive Summary of Global Technology Watch Groups reports by Dr Harsh Vardhan, Hon'ble Minister S&T at the side event on “Technology Need Assessment and Innovations for Managing Climate Change” on 3rd December, 2018 at Katowice, Poland**

**c. The National Workshop on Climate Change Vulnerability Assessment for the States and Union Territories**

A National Workshop on Climate Change Vulnerability Assessment for the States and Union Territories of India was held on 14th and 15th March 2019 at Indian Habitat Centre, New Delhi. The workshop was jointly organized by the Indian Himalayas Climate Adaptation Programme (IHCAP) of the Swiss Agency for Development and Cooperation (SDC), the Department of Science and Technology (DST), Government of India, Indian Institute of Technology (IIT) Guwahati, Indian Institute of Technology (IIT) Mandi and Indian Institute of Science (IISc) Bengaluru where 20 states including the 13 Himalayan States participated. The results of the joint efforts of the 12 Himalayan States in adopting the Common Framework for Climate Vulnerability and Risk Assessment was presented in form of first-of-its-kind vulnerability profile maps by all Himalayan States and development of a strategy to extend the usage of the Common Framework to the whole country was discussed. A report titled “Climate Vulnerability Assessment for the Indian Himalayan Region Using a Common Framework” and a geoportal on based on the same were released at the workshop. The output as captured in the report is not only a process innovation but also demonstrates cooperation among the Himalayan States and with the Central Government.



**Figure-12: Report on “Climate Vulnerability Assessment for the Indian Himalayan Region Using a Common Framework” released at the workshop in presence of Prof. Ashutosh Sharma, Secretary DST.**

**d. Launch of DST’s Centre of Excellence at IDPCS, IIT Mumbai:**

As part of initiatives under NMSKCC, DST has established Centre of Excellence (IInd phase) entitled ‘DST - Centre of Excellence in Climate Studies’ at Inter-Disciplinary Program in Climate Studies, IIT Bombay. An event was organised at IDPS-CC, IIT Bombay on 19th March 2019 to formally launch the Centre of Excellence at IIT Bombay and also release a book published by Springer-published titled ‘Climate Change Signals and Response: A Strategic Knowledge Compendium for India’ which is a culmination of Phase I of the DST-funded Centre of Excellence in Climate Studies project. It also included a panel discussion, expert talks, and poster presentations pertaining to climate research.

**e. Launch of Centre of Excellence at IIT Madras**

DST’s Centre of Excellence (CoE) in Climate Change Impacts on Coastal Infrastructure and the Adaptation Strategies’ was launched at Indian Institute of Technology Madras on 15th April 2019. The CoE has been established under Indo-German Centre for Sustainability (IGCS) centre. The CoE is expected to play a major role in helping communities in India’s 7,500 km-long coastal line to prepare for the impact of climate change such as rise in sea levels and increased frequency of tropical cyclones. The CoE will carry out research studies on predicting climate change impact on coastal communities and strategically important coastal infrastructure such as ports, power plants and major industries. Studies will also be undertaken to evaluate the intensity and frequency of tropical cyclones and extreme rainfall events under futuristic warming scenarios and the corresponding effect on the coastal infrastructure.

## 2.6 National Super Computing Mission

The NSM was approved by the Government on 25th March, 2015 at a total cost of Rs 4500 crore over a 7-year period of implementation. The Mission is being jointly steered by the Department of Science and Technology (DST) and the Ministry of Electronics and Information Technology (MeitY) along with the Implementing Agencies viz. Indian Institute of Science (IISc), Bengaluru and Centre for Development of Advanced Computing (C-DAC), Pune.

The mission aims to enhance the research capacities and capabilities in the country by connecting them to the Supercomputer grid, with National Knowledge Network (NKN) as the back bone. The NSM intends to set up a grid of supercomputing facilities, using both “buy” and “build” approach at academic and research institutions across the country.

The first Supercomputer designed and built under “Build” approach of National Supercomputing Mission (NSM) by C-DAC at Indian Institute of Technology (BHU), Varanasi was dedicated by Hon’ble Prime Minister Shri Narendra Modi to the scientific and research community of the nation in order to strengthen the research and development activities in the country. The supercomputer named “PARAM Shivay”, uses more than one lakh twenty thousand compute cores (CPU + GPU cores) to offer a peak compute power of 833 TeraFlops.



**Fig: Param Shivay Supercomputer being installed at IIT-Varanasi**

The NSM will be setting up 5 Supercomputer Systems under Phase-I in the coming year. 20 more institutions have been identified for installation of Supercomputer systems in Phase-II. The other 2 systems under “Build” approach will become operational by July, 2019.

The focus of R&D is towards building capability to develop Exa-scale systems and research would be undertaken in the areas of System architecture, System software, Infrastructure management and scalable algorithms/libraries. The Executive Board (EB) of NSM has approved five R&D proposals with four of them aiming towards Exascale Computing and one for developing indigenous cooling system for supercomputers.

Under development of Human Resources, Short term and Medium term training courses have been conducted along with 1 day HPC Awareness programmes. The C-DAC had successfully organised an OpenACC HPC Hackathon. For further proliferation of these courses, two HPC nodal centres have been identified.

The Executive Board (EB) of NSM has also approved six application programmes in the following areas:

Genomics & Drug Discovery; Urban modelling; Flood early warning and Prediction; Reverse Time Migration for Seismic imaging; CFD Application; and Materials & Computational Chemistry

The mission supports the government's vision of "Digital India" and "Make in India" and would also generate highly skilled manpower for multi-disciplinary application development and also for meeting requirements of the scientific community

### 2.7 Interdisciplinary Cyber Physical Systems (ICPS)

The following are the broad thematic research domains under ICPS:

#### 2.7.1 Data Science Research Initiative (DSRI)

Data science encompasses the areas of Statistics, mathematics, Computer Science, Information Theory, Information Technology and artificial intelligence (AI). Data driven scientific discovery is an important emerging paradigm for computing in areas including social, service, Internet of Things, sensor networks, telecommunications, biology, health-care and cloud, environment and Social Systems. There are certain associated scientific challenges, ranging from data capture, creation, storage, search, sharing, modelling, analysis and visualization. The programme was initiated in the year 2018-19 and nearly 32 projects (8 proposals under individual category and 24 cluster proposals) have been initiated so far.

#### Expected outcomes:

- Tools and applications applied to Data Mining, Databases and Analytics
- Promotion of indigenous interdisciplinary research focusing on large-scale data analysis in India
- Quality Research Publications
- Patents
- 60 Ph.D's
- National/International research collaborations

### 2.7.2 *Internet of Things Research Initiative (IoTRI)*

The Internet of things (IoT) is the extension of Internet connectivity into physical devices and everyday objects. Embedded with electronics, Internet connectivity, and other forms of hardware (such as sensors), these devices can communicate and interact with others over the Internet, and they can be remotely monitored and controlled. The definition of the Internet of things has evolved due to the convergence of multiple technologies, real-time analytics, machine learning, commodity sensors, and embedded systems.

Research Challenges for IoT research are architecture, Identification, Communications, Network Technology & Discovery, algorithm, signal processing, Search Engine, Network Management, Low Power devices, Security, Robustness, Privacy, Cloud computing and edge Computing. Nearly 56 projects have been initiated. The programme was initiated in the year 2018-19 and nearly 32 projects (15 proposals under individual category and 17 cluster proposals) have been initiated so far.

#### **Expected outcomes:**

- Hardware and software systems leading to connected and smart IoT based system for our country's Economy, Society, Environment and global needs
- Promotion of cross disciplinary research and Innovation
- Quality Research Publications
- Patents
- 60 Ph.D's
- National/International research collaborations
- Capacity development (Human & Technology) for IoT specific skill-sets as per global standards

### 2.7.3 *Cyber Security for physical infrastructure (CSRI)*

CSRI is an attempt to define a national R&D agenda that will enable to develop Cyber Security technologies to secure/protect our National Information Infrastructure (NII) and National Critical Infrastructure (NCI). The R&D, testing, evaluation and other life cycle considerations are required to meet the Cyber Security challenges. The programme was initiated in the year 2018-19 and nearly 32 projects (13 proposals under individual category and 19 cluster proposals) have been initiated so far.

#### **Expected outcomes:**

- Promotion of interdisciplinary research in cyber-social systems in India
- Development of indigenous interdisciplinary technology for cyber-attack detection, prevention, and countermeasures

- Quality Research Publications
- National/International research collaborations
- Indigenously developed quality research prototypes/products to secure national IT Infrastructure
- Training to UG/PG/Scholars in the emerging field of Cyber Security.
- Patents
- 50 Ph.D's

#### *2.7.4 Indian Digital Heritage (IDH)*

Indian Digital Heritage project fused Advanced Technologies with Humanities for purpose of digital documentation and interpretation of tangible and intangible heritage of India. It is Technology for digital preservation and presentation. Its major deliverable is the development of generic set of technologies and tools that can be used for any heritage sites.

Achievements: Under this project a total of 37 generic technologies, 7 prototypes and scaled models have been developed and demonstrated. It also developed technologies relates to Murals, Knowledge bank, Interfaces, Intangible, Memorialization, Design, Crafts, the 3D Printing, Features, Resurrection, Ontologies, Representation, 3D Surface, Preservation, Immersion, Reconstruction, Haptic, Walkthrough, Scaling etc. There have been 3 Start-up Companies, 2 edited volumes, 20 peer reviewed journal publications are spawned off from IDH.

#### *2.7.5 Indian Heritage in Digital Space (IHDS)*

IHDS Research agenda aims to extend the power of digital technologies to well beyond monuments to art, architecture and all forms of cultural and historical knowledge. The recent developments in computer vision, graphics, audio and video technologies and user interface design offers the prospect of creating vivid experiences of the heritage for common users. It also has the capacity to provide analytic tools for the art-historian, the architect or any scientist who may be interested in conducting scholarly studies on the heritage. One of the focussed area of research is Under water studies of submerged cities like Dwarka and Poompuhar. The cluster programme was initiated in the year 2018-19 and nearly 30 Cluster proposals have been initiated so far.

#### *2.7.6 Epidemiology Data Analytics (EDA)*

It is a directed research initiative to develop a technology platform for Epidemiology Data Analytics. The objective is to carryout analytics over the health data, examine and evaluate data about epidemiology, estimate diseases burden, clinical trials being generated all over the country.

Expected outcomes will be a Health Data Analytics technology platform. Nearly 10 projects in a networked mode were supported so far.

### 2.7.7 *Quantum Enabled Science and Technology (QuEST)*

Quantum Enabled Science and Technology (QuEST), an R&D programme was initiated to develop core expertise in development of Quantum mechanics so as to realize Quantum Computers, Quantum Communication and Quantum Key Distribution (QKD). The programme was initiated in 2018-19. A National Network Programme was initiated with a total of 51 projects in the following four thematic areas:

- Quantum Information Technologies with Photonic Devices,
- Quantum Information Technologies with nitrogen vacancy and magnetic resonance,
- Quantum Information Technologies with ion-trap and optical-lattice devices and
- Quantum Information Technologies with superconducting devices and Quantum Dots.

#### **Expected outcomes:**

- Development and demonstration of 8-Q-bit quantum computers, Communication (Fiber & Free Space) & Cryptography
- Development of application specific quantum-algorithms.
- Development of advanced mathematical quantum techniques, algorithms and theory of quantum information systems.
- Also, 100 PhD's in the Quantum field, training to 2000 Undergraduate, Post Graduate and Scholars in the advanced algorithm and application development using quantum systems.

### 2.7.8 *Networked Programme on Imaging Spectroscopy & Applications (NISA)*

Imaging Spectroscopy & Applications (NISA) is a cluster based multidisciplinary Networked scheme to promote research on various aspects of Imaging Spectroscopy and Applications (ISA). This scheme is expected to evolve reference standards, protocols, database and research methodologies for adaptation in various fields relevant to society. This networked scheme has 37 projects in seven theme areas (such as geology, agriculture, forestry, water, snow and glacier ice, urban & built-in materials and algorithms). This Project was initiated in 2014. It mainly focusses on Development of Non-invasive methodologies for characterization, Quantification and spatial analysis. Technologies related to Crop health analysis, Mineral exploration, Forest cover estimation, Water quality analysis and terrain modelling has been developed and demonstrated.

Status/Outcomes: NISA-Hyperspectral Data Analyses Tool (Version 0.1 i.e. V.1 SW package) released. Around 30 domain specific algorithms developed, 10 technologies (prototype level), 7 thematic Spectral datasets created, 3 IPR filed, 30 publications, expected 50 PhD's. The project is in its last year.

### 2.7.9 National Mission on Interdisciplinary Cyber Physical Systems (NM-ICPS):

The Mission was approved and actions initiated in 2018-19. The NM-ICPS aimed at complete convergence with all stakeholders by establishing strong linkages between academia, industry, Government and International Organizations. The Mission will work with all the concerned Ministries/ Departments to identify their technology needs, develop solutions and technical support in CPS implementation.

Foundational technologies to realize CPS are Data Science & Predictive analytics, Internet of Things (IoT), Machine Learning (ML), Deep Learning (DL), Big Data Analytics, Robotics, Self -Monitoring, Analysis & Reporting Technology (SMART), Advanced materials, Sensor Networks, Quantum Computing, Quantum Communication, Quantum encryption (Quantum Key Distribution), Cyber Security for physical infrastructure but also including other infrastructure in the country, Geographical Information Systems (GIS), Block chain Technology and Artificial Intelligence (AI).

The Mission have four major activities i.e. Technology Development, Human Resource & Skill Development (including development of CPS technology application tools for education at elementary and high school level), Innovation, Entrepreneurship & Start-Up Ecosystem and International Collaborations.

The Mission targets the establishment of:

- 15 Technology Innovation Hubs (TIH) to focus on generation of new knowledge through basic and applied research in areas that is mandated to them. TIHs will be the source for fundamental knowledge/ technologies that will be needed to keep India prepared for the next generation of technologies
- 6 Application Innovation Hubs (AIH) to carryout translational research and work with Line Departments to develop prototypes, product development and implementations.
- 4 number of Technology Translation Research Parks (TTRP) with a focus to deliver products/ technology ready for deployment or commercialization, picking up from any of the previous technology readiness levels (TRL).

## Chapter 3

## INNOVATION TECHNOLOGY DEVELOPMENT AND DEPLOYMENT

## 3.1 Technology Development Programme

The Technology Development Programmes (TDP) aims to convert proof-of-concepts for technologies/ techniques/ processes/products into advance prototypes for validation and demonstration in field settings. The main objectives of the program include:

- Support R&D for development of innovative technologies in identified areas.
- Promote application of advanced technology for improving the performance and value addition to existing technology.
- Capacity building in the area of technology development in terms of human resource and infrastructure.

All the components under TDP are aligned to National priorities and ongoing National programmes. The sub schemes are:

- Advanced Manufacturing Technologies (AMT)
- Biomedical Device and Technology Development Program (BDTD)
- Device Development Program (DDP)
- Technology Development Program (TDP)
- Waste Management Technologies (WMT)
- Science and Heritage Research Initiative (SHRI)
- Sustainable Agro Technologies

**Advanced Manufacturing Technology (AMT):** 40 new projects were sanctioned to promote development of advanced manufacturing technologies.

**Waste Management Technologies (WMT):** The stakeholder consultation meeting of Industrial Hazardous and Non- Hazardous Waste Management Technologies; Bio-Medical and Electronic Wastes Management Technologies Urban & Rural Solid Waste Management including Plastics Agricultural waste/Stubble management (Waste to Wealth); and alternative to burning Management of Biomass (Agri waste and Municipal waste) into Bio resources was organized at Coimbatore, Vijayawada, Chennai, Nagpur and Chandigarh respectively under the banner of **DST's Swachhata action plan 2018-19** aligning to **Swachha Bharat Abhiyan**. Industry forums, local bodies, along with more than 1000 scientific participants from academic and research organizations including IITs NITs and CSIR laboratories interacted and benefitted from these workshops. A compendium of 38 technologies

supported under the programme was released and shared with the participants.

**Sanitary Landfill Reclamation:** A Scientific Advisory Committee (SAC) for Landfill Reclamation was formed on the request of Government of NCT. A site visit and a brainstorming meeting, to address the issues in dealing with Landfill Reclamation at Bhalswa SLF site was organised on 12th Oct. 2017 and for Ghazipur SLF site was organised on 15h Jan,2018. Detailed Scientific suggestions were submitted to the Delhi Government/Respective Municipal Corporation.

**Science and Heritage Research Initiative (SHRI)** envisages to Promote scientific R&D activities for conservation of Heritage objects which may include material deterioration process, preservation techniques, intervention technologies, new materials, processes for restoration and diagnostic technologies. 212 proposals were received against the call and 38 proposals were recommended by Experts for funding by the department.

**Biomedical Device and Technology Development Program (BDTD):** 17 new projects were sanctioned for development of biomedical devices. Some of the demonstrated technologies include: a non invasive screening device based on spectroscopy for monitoring skin perfusion and collagen content in scleroderma, a rapid serological test kit for Paragonimiasis and its morphological identification, an amalgamated/single unit alveolar distractor implant system for oral rehabilitation and a 3-lead wearable continuous rechargeable ECG monitoring device for arrhythmia and ischemia detection.

**Device Development Program (DDP):** 11 new projects were sanctioned for development of new devices. The devices such as electronic nose for fish quality assessment, Compact Portable Scanning Tunneling Microscope, a high-volume PM2.5 impactor sampler for air quality monitoring, a system for converting nonwoven fabric into fruit bags & a mechanised technique for fruit bagging for horticultural application were successfully demonstrated.

**Technology Development Program (TDP):** 1 new project were sanctioned for development of novel technologies. A Brainstorming session to identity new areas of researchable technologies with respect to agricultural engineering was held on 18 June, 2018 at NASC Complex, New Delhi organized by Indian Society of Agricultural Engineers.

Around 1200 project proposals were received during 2018-19 under various sub schemes of Technology Development Program and 107 new projects were recommended for funding by respective Expert Advisory Committees after stringent systematic evaluation. 35 projects were successfully completed and some leading technologies demonstrated in field are as follows:

#### **I. Advanced CNC Micromachining System with Integrated Micro-Tool manufacturing by Indian Institute of Technology, Delhi**

An advanced micromachining system (AMMS) with 4 conventional mechanical tool-based micromachining processes viz.  $\mu$ -milling,  $\mu$ -drilling,  $\mu$ -turning,  $\mu$ -grinding and 2 advanced unconventional ( $\mu$ -EDM,  $\mu$ -Laser Beam Machining) processes with integrated micro tool manufacturing and metrology is developed. AMMS has an indigenous developed unique control

system for traditional as well as advanced micro machining processes with 5-axes CNC motions and metrology. The system is also capable of fabricating micro-grinding tools and finishing of micro-parts using them. The potential areas for application include Defence, Medical Implant Manufacturer, Precision Manufacturing Industry, Automobile and Aerospace Industry.



**Fig. Advanced Micrommachining System**

## **II. Development of Low Temperature Co-fired Ceramic (LTCC) tape and pastes at Centre for Materials for Electronics Technology (CMET), Pune, Maharashtra**

CMET, Pune has set-up the first LTCC based package fabrication facility in the country. This is a glass ceramic based multilayer fabrication facility that can cater to the requirements of a wide range of applications including microwave circuits, bio-medical sensors, and varied types of. Packaging, including high density interconnects and Micro Electro Mechanical Systems (MEMS) and almost all types of integrated microsystem. Mutually compatible Tapes and paste compositions were developed. The images and the specifications are presented

**CMET's LTCC Tapes**



LTCC Tapes: 115-120 $\mu$ m  
 Tape casting: 10 m with 9" width  
 Useful width: 7-8"  
 Thickness: 115 to 120 $\mu$ m  
 Thickness uniformity: 1  $\mu$ m across central 5" width  
 Dielectric constant @100MHz: <10 (~6.0)  
 Dielectric loss@100MHz: <0.15%  
 Break down voltage: >1000V/25m

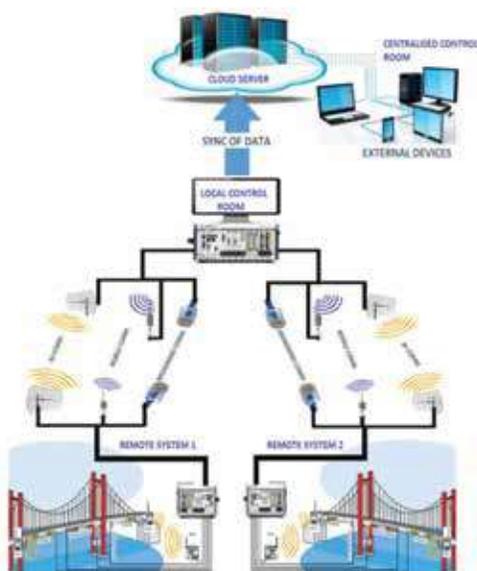
**CMET's LTCC paste**



Via fill: Ag-Pd and Ag pastes  
 Screen printing: Ag and Ag-Pd pastes  
 Sheet resistance for Ag-Pd paste: ~35m $\Omega$ //12 $\mu$ m  
 Sheet resistance for Ag paste: 4m $\Omega$ //8 $\mu$ m  
 Print resolution 150m

**III. Intelligent Remote Health Monitoring of Bridge Systems (IRHM) by CSIR-Structural Engineering Research Centre, Chennai; CSIR - Central Road Research Institute, New Delhi & Coimbatore Institute of Technology, Coimbatore, Tamil nadu**

Intelligent Remote Health Monitoring (IRHM) for bridge structures is a development of state-of-art-technology in structural health monitoring application developed to monitor and assess the structural health condition of structures/bridges. The system uses different type of sensors to monitor different parameters on the bridges / structures using the mode of communication such as broadband, 3G/4G and RF communications depending upon the availability. The developed IRHM system was used to demonstrate performance evaluation and damage detection on a bridge. Field level demonstration has been done successfully using the developed IRHM system on a bridge.



Remote health monitoring system

Demonstration of developed system in a bridge site

#### IV. Design and Development of Indigenous Dental Implant of Titanium by Institute of Medical Sciences, Banaras Hindu University, Varanasi, Uttar Pradesh

BHU dental implant is prepared from commercially pure Titanium and a large number of patients has been rehabilitated, even poorest of poor, due to its low cost which is less than 10% of the marketed ones. Further, a national seminar-cum-workshop was held at Trauma Centre, Banaras Hindu University on 14-16 July 2018 to popularize the device and methodology among clinicians of the country and trained clinicians using these implants. Multi-centric trial of this implant is about to start.

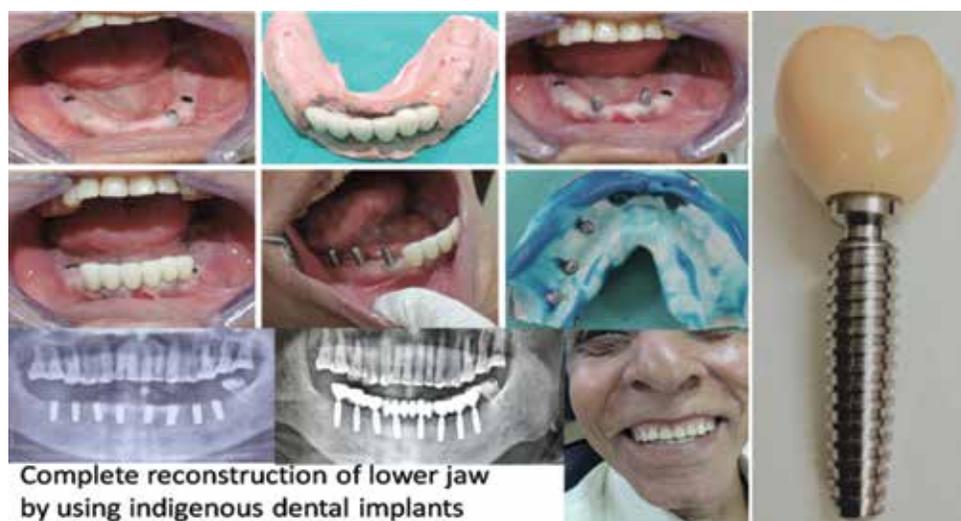


Fig. Rehabilitation of an elderly using indigenous implant

#### V. ORGAN: Low Cost Bio mechatronic Rehabilitative Solutions for Children with Congenital Hemiparesis by Central Scientific Instruments Organisation (CSIO), Chandigarh, Punjab

Hemiparesis is unilateral paresis, weakness of the entire left or right side of the body. The novelty features in the developed solutions include, development of unique methods for anthropometric scanning & fabrication, biomechatronic active and passive orthotics and variable therapy regimes for quantified rehabilitation. It is highly customized light weight and colorful orthosis for integrated rehabilitation approach



3D Printed Orthotic Hand

#### VI. Design and Development of Automated External Defibrillator (AED) by Anna University, Chennai, Tamilnadu

A fully automated external defibrillator (AED) has been designed and developed indigenously and type-tested successfully. The salient features include: (i) Audio prompts in English / Indian vernacular language (ii) Patient-impedance based accurate shock delivery (iii) Automatic repetition of AED cycle with pausing for CPR in-between (iv) Storage of AED related vital information in USB flash drive for cardiologist's reference. The vernacular language support will enable literally anyone to operate the device with utmost ease. The automatically adjusted shock energy level ensures that the patient does not suffer from insufficient / excessive shock energy. A patent has been filed on 10.5.2019 for the innovations in the project. The team is currently exploring commercialization possibilities with M/S Sosaley Technologies, Chennai and M/S Triphase Technologies, Bengaluru.



a. AED LAB PROTOTYPE



b. AED INDUSTRY PROTOTYPE

### VII. Audiometer Integrated with Digital Hearing-Aid by All India Institute of Medical Sciences (AIIMS), Raipur, Chattisgarh

The developed device integrates a low-cost screening Audiometer and Digital Hearing Aid which can be tuned according to the patient's audiogram and can be reprogrammed when required. First in class ideology of Integration of DHA with Audiometer is performed where Audiometer tunes DHA automatically according to Air Conduction thresholds at individual frequencies. Audiometer communicates to DHA via serial communication. The audiogram is displayed on the LCD screen and also stored in SD card/GUI desktop and can be printed.



(a) Audiometer



(b) Digital Hearing Aid

### VIII. Development of lateral flow device for species identification of snake bite by Rajiv Gandhi Centre for Biotechnology, Thiruvananthapuram, Kerala

A simple, rapid lateral flow assay for the detection of major Indian venomous snakes like *Naja naja* (Indian cobra) (IC), *Daboia russelii* (Russell viper) (RV), *Bungarus caeruleus* (common krait) (CK) and *Echiscarinatus* (saw-scaled viper) (SSV) is developed under the project. Currently, snake bite identification is not done by validated test before the administration of snake antivenin. The developed snake envenomation lateral flow assay (SELFA) is rapid to detect venom concentrations up to 0.1 ng/ml in spiked body fluids. The SELFA has a potential to be an on-field diagnostic test device to detect snake envenomation, thereby saving a lot of lives.

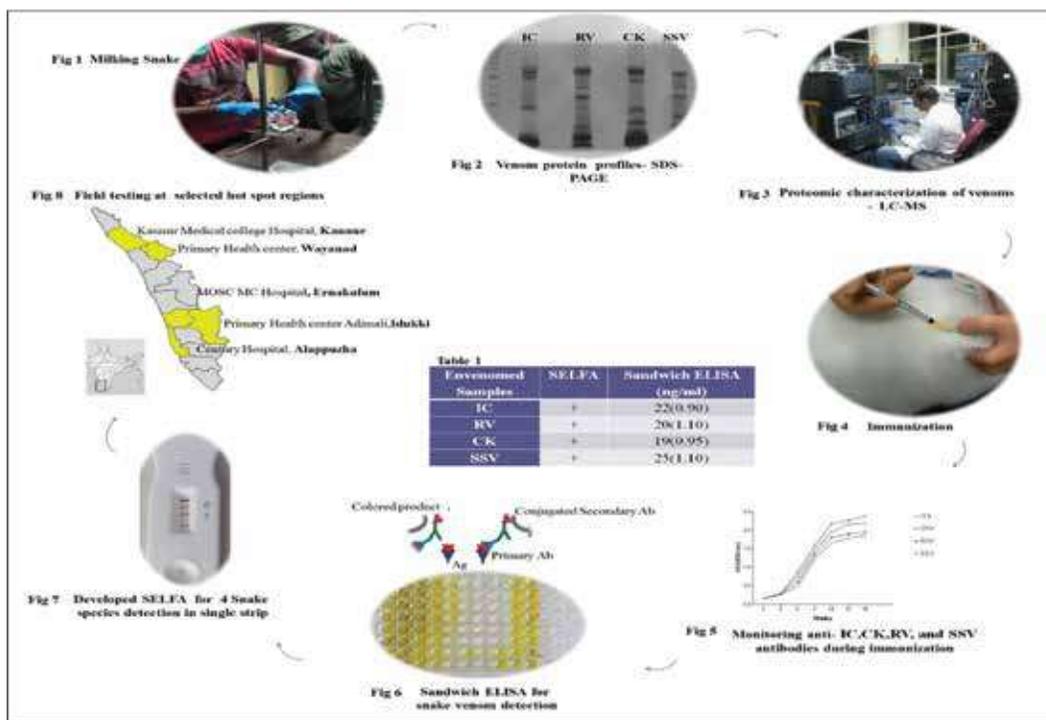


Fig. Development of lateral Flow device for snake venom

### IX. Low Cost Multimodal Microscope for Pathology and Microbiology Labs by Sri Sathya Sai Institute of Higher Learning, Anantapur Dist., Andhra Pradesh

Low cost Multimodal microscope has been developed which may be utilized at Primary and Tertiary Health Care centres for disease screening in the country. This optical imaging platform offers combined and independent imaging modes that include bright field, Fluorescence and Phase contrast techniques for screening various pathogens and microbes reducing the time for screening critical diseases like Malaria and Tuberculosis. Multimodal microscopes have been field tested in Primary Healthcare Centres at Yelumallapalli and Puttaparthi Mandal. The district health care officials (including secretary of Healthcare of AP state) have expressed interest to replicate this imaging platform in other PHCs in the Anantapur and other districts of Andhra Pradesh.



Fig. Low cost Multimodal Microscope: development and trials

#### **X. An Intelligent System for Automatic Supply of Fertilizer for Green House Environment by PSG College of Technology, Coimbatore, Tamil nadu**

The automatic fertilizer supply system was designed and implemented to reduce cost and labour for monitoring and maintenance of the greenhouse plantation. The automatic fertilizer supply system achieved higher productivity with low cost investments by calibrating the quantity of fertilizers and pesticides precisely through an accumulated knowledge base. The sensors deployed in the plantation measured the variation of the greenhouse parameters and adjusts the quantity of the supplies for the next immediate spraying cycle. The continuous monitoring and maintenance of the greenhouse with automatic fertilizer supply system improved the productivity.



**Fig. Automatic fertilizer supply system**

#### **XI. Floral preservation by freeze drying technology – standardization of treatments and process for value addition and enterprise management by Acharya N G Ranga Agricultural University, Guntur, Andhra Pradesh.**

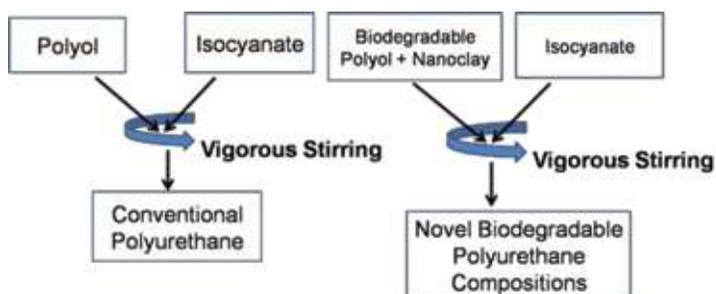
The technology was developed for value addition to perishable flowers to retain natural freshness for years with Freeze drying technology. Methodologies for stages of treatments - Hydration of flowers for quality assurance, pre-processing with non-hazardous chemical blends, freeze drying under controlled temperature and vacuum pressure in floral freeze dryer designed for research, post-preservation of processed flowers, protection processed flowers in cases for commercial use as treasure flowers - were established. Technical manual was developed and 14 young life members of ALEAP, India, were trained.



Freeze dried flowers

**XII. Development of Polyurethane based Biodegradable shoe-soles and Process Optimization thereof by CSIR-Central Leather Research Institute, Chennai, Tamil nadu**

Technology to prepare PU soles / footwear based on biodegradable polyol and environmental friendly nanofiller as well as commercial polyol and nanofiller by direct reaction injection molding process has been developed out of this project. One Indian patent has been filed. Title of the patent is “An improved Polyurethane Foam and the Process for the Preparation Thereof”.



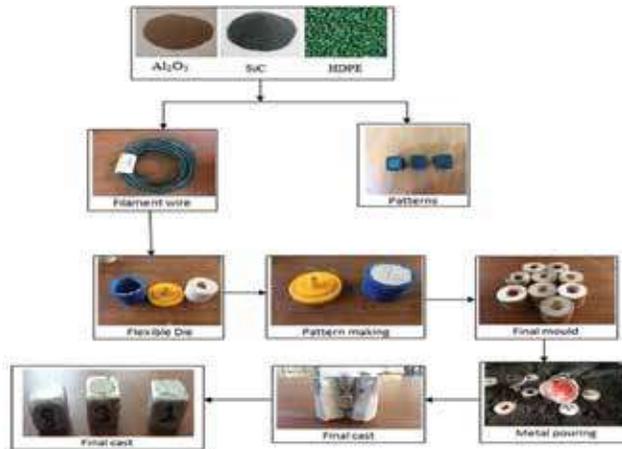
Polyurethane foaming process



Injection molded PU footwear from biodegradable PU and environmental friendly blowing agent

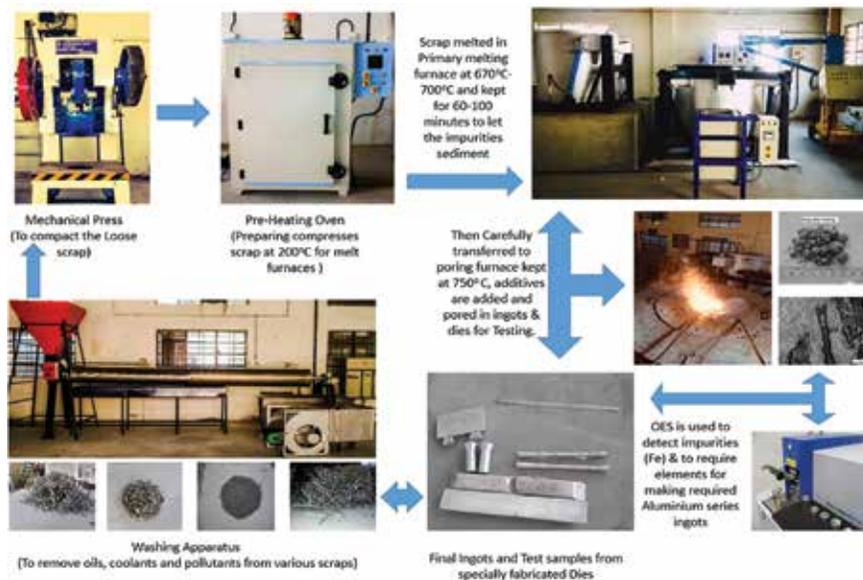
**XIII. Polymer Waste as Feed Stock Filament for Industrial Application by Guru Nanak Dev Engineering College, Ludhiana-141006, Punjab**

A novel method of additive manufacturing (AM) assisted investment casting (IC) has been developed and demonstrated (by using the patterns prepared from waste thermoplastics reinforced with ceramic particles) for development of metal matrix composite / functionally graded material. The specific benefit/outcome of this project is in application of two patents generated for waste management by development of hybrid process at low cost with high potential of re-usability.



**XIV. Technology Development of Recycling of Aluminium Alloys for Industrial applications by Sri Ramakrishna Engineering College, Coimbatore, Tamil nadu and CSIR-National Institute for Interdisciplinary Science and Technology (NIIST), Thiruvananthapuram, Kerala**

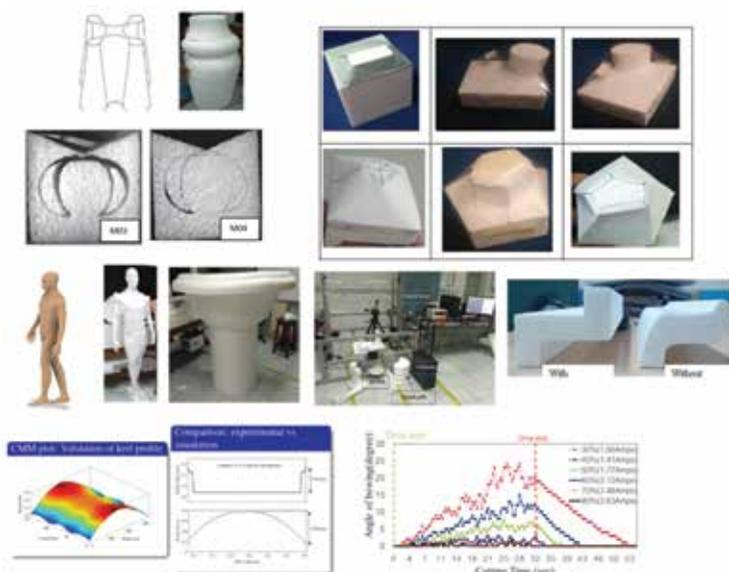
The group has developed a technology system for recycling aluminum alloys from commercial available scrap. To accomplish this recycling process various case studies had been conducted in from industries to optimize the recycling process based on inputs from the local industries in Coimbatore. By this process effective yield was achieved by recycling various aluminum scraps, their concern grade quality was not achieved, due to oxidation and allied losses incurred in the process, hence the technology is further enhanced to meet the requirements by adding suitable alloys and their performance reaches beyond the required mechanical properties.



**Process Flowchart**

### XV. Development of a machine for making large low-cost prototypes using a layered object manufacturing method at Indian Institute of Technology Madras, Chennai, Tamilnadu

This project has developed several key technologies that allow large life-sized complex shapes to be made in expanded polystyrene using simple 2-axis hot-wire cutting. The technologies developed involve (i) Computer-aided manufacturing (CAM) software algorithms to make a unique class of shapes and using novel surface techniques, (ii) power control to improve accuracy (iii) wire-bowing (wire-lag) detection and (iv) kerf width predictions. This project has developed two key CAM technologies for which patents have been filed. Besides, a third patent has been filed for power control during cutting at corners. In addition, two different technologies for wire-bowing (lag) detection has been made. A numerical thermal model is also developed to predict kerf width at higher accuracy. The technologies developed, via the patents, are readily available by the industry for further customization and deployment while the thermal model details and wire bowing detection methods can be seen in published academic literature.



Models created using Expanded Polystyrene

### XV. Design and development of technology for safe disposal of Hospital Solid Waste (HSW) through electric arc plasma by CSIR-Central Mechanical Engineering Research Institute (CMERI), Durgapur, West Bengal

The plasma arc driven HSW disposal technology for safe disposal of HSW has been developed with some unique components like Plasma hearth, secondary chamber, plasma electrodes and gas handling system etc. A 15kg/h plant is successfully running and fabrication of one 1 ton per day, plant is under active progress. The waste destruction efficiency of this plant is quite very high (~95%) that is due to application of very high temperature (~30000C) plasma arc system. The emitted gas has less toxins emission in the environment.



**Plasma arc assisted 15kg/h Hospital waste disposal plant at CSIR-CMERI**



**Plasma arc assisted 1 TPD Hospital waste disposal plant at CSIR-CMERI (under fabrication)**

**Recycling of Chrome Shavings, a Solid Waste from Leather Industry, for Production of Dehairing Protease by *Bacillus cereus* VITSN04:**

**XVI. Utilization of Polyvinyl Butyral (PVB) of Automobile Windshield Waste for making Protective Primer and Strippable/Peelable Coating by Shri Ram Institute, New Delhi**

The process has been optimized to recover Polyvinyl Butyral (PVB) from windshield waste. Recovered PVB has unique properties such as film forming, flexibility, thermal stability, water resistance, bonding and adhesion to various substrates. A technology has also been developed to make protective primer and peelable paint based on PVB. Primer can be used for coating of wooden surfaces, have good water resistance and can be used as a sub base for final paint. Further, PVB was also used in making strippable paint and can be used for protection of finished metal equipment. The cost of PVB based primer and peelable paint made is ~Rs 50/- kg whereas market available product is ~ Rs 100-250/- kg.



**Fig 1 Windshield Waste**



**Fig 2 Crusher**



**Fig 3 Rotary Separator**



Fig 4: Recovered PVB



Fig 5 PVB Peelable



Fig 6 Wooden PVB Primer

## 3.2 Technology Missions Division (CERI & WTI)

### 3.2.1 Clean Energy Research Initiative

Clean Energy Research Initiative (CERI) aims to develop national capacities and capabilities in developing research led competitive and cost effective clean energy and energy efficiency options for power and non-power applications. The areas of research are identified through stakeholder consultation based on national needs. The research spectrum covers entire gamut of clean energy viz. smart grid, off grid, energy storage, building energy efficiency, cleaner fuels, clean coal and energy materials. It supports both upstream end of research where knowledge, more advanced than the current practice in the industry finds a space. It also envisages to successively enhance Technology Readiness Level (TRL) of promising options in partnership with industries and other stakeholders. The programme has close linkages with concerned line ministries and stakeholders for identification of research needs. During the year 2018-19, several new dimensions were added to the programme to accelerate the pace of clean innovations to meet national needs, which are as under:

#### I. Mission Innovation

Mission Innovation (MI) is a global initiative of 25 countries to dramatically accelerate global clean energy innovation. Participating nations have committed to double their governments' clean energy research and development (R&D) investments over five years, while encouraging greater levels of private sector investment in transformative clean energy technologies.

##### a) Mission Innovation Challenge #1: Smart Grids:

- The IC#1 on smart grids is co-led by China, India and Italy. The Challenge targets innovation and deployment of reliable, efficient and affordable smart grids technologies at regional, distribution and micro-grids levels in various geographical areas to achieve the ability to accommodate 100% renewable based energy sources in power grids. In addition, IC#1 takes into account the aspects related to cross innovation, which focus on smart grids related fields such as power electronics, electric materials, simulations and ICT.

- A project on demonstration of MW scale solar energy Integration in weak grid using Distributed Energy Storage architecture (D-SIDES) project under Mission Innovation Challenge on Smart grids was launched at IIT- Roorkee.
- A 3rd Deep-Dive Workshop on Smart Grids was held during 20th – 22nd May, 2018 at Copenhagen, Denmark & Malmö, Sweden. India announced nine smart grids projects in collaboration nine MI IC1 countries. Six smart grids R&D verticals such as Storage Integration, Demand Response, regional Electricity Highways, flexibility options, New Grid architecture and control, power electronics identified were identified.
- Smart Grids R&D Conclave was organised on 27th August, 2018 at IIT Delhi, New Delhi to create possible collaboration among academic institutions, utilities and industries to exploit for its commercialization and deployment in real time. This Smart Grids Conclave brought together 151 participants with 86 participants from 22 academic institutions, 43 participants from 32 Industries and 22 participants from 18 utilities companies for discussion on various issues pertaining to deployment of smart grids.
- A 4th Deep-Dive Workshop on Smart Grids (Fig. 1) was held during 21st – 23rd November, 2018 at Rome, Italy. Smart grids Co-lead countries agreed to establish Smart Grid Innovation Accelerator platform to bring academic and industry on a common platform. A final document regarding six smart grids R&D program were officially launched and all the MI IC1 countries agreed to collaborate worked in the R&D programs. India is leading in two of the smart grids program and an active member in every task.



**Figure 1. Deep Dive Workshop on Smart Grids at Rome, Italy**

- To develop Indian smart grids network from Academia, Industry, Utility, Start-ups, and other key organizations, an interaction meeting on Smart Grids (Fig. 2) was organized on 28th December 2018. Target participants were smart grid experts from academia, industry, utility, and start-ups with responsibility for shaping national strategies in smart grid innovation.



**Figure 2. An interaction meeting on Smart Grids Network**

- A compendium on Smart Grids Innovation Challenge and Synergy on a global outreach report on Smart Grids was prepared. The compendium and synergy was released by Hon'ble Minister for Science and Technology, Forest and Climate Change and Earth Sciences, Dr. Harsh Vardhan on 22nd May, 2018 at Copenhagen, Denmark.

**b) Mission Innovation Challenge #2: Off Grid Access to Electricity**

- Innovation challenges on “Off grid access to electricity” has larger objectives to support significant reduction in price and increase performance of renewable power systems by 2020 for individual homes in off grid region and for remote communities. The objective is to demonstrate in diverse geographic and climate conditions, the robust, reliable, autonomous operation of renewable power systems less than at a significant lower cost than today.
- To accelerate the collaboration in off grid domain, DST on behalf of India had hosted Second International Stakeholders Meet on MI Challenge IC2: Off –grid Access to Electricity on 1-2nd Mach 2019 at IIT-Delhi, New Delhi invited all member countries. During the events more than twenty speakers shared their experiences who are working on various collaborated projects.
- A Pilot Project having Smart Control Architecture with Real Time Smart Meter Data has been setup at the corporate office of Bangalore Electricity Company Limited (BESCOM). The system architecture has the ability of intelligent monitoring of consumer load on distribution network. Activation /De-activation of the load can be done remotely to have better assets management.
- During the Second International Stakeholders Meet on MI Challenge IC2: Off –grid Access to Electricity on 1-2nd Mach 2019 at IIT-Delhi, New Delhi , the co-leads France and India jointly launched the release of Off Grid Innovation Challenge: Synthesis report -2019 highlighting the programmes, initiatives and leveraging capabilities and competence of participating MI countries. DST has leveraged the MI platform to collaborate across globe with Australia, Canada, France, Germany, Italy, Norway, Sweden, United Kingdom and United States of America to work on off grid solution. France has leveraged the platform to provide off grid solutions to Africa

**c) Mission Innovation Challenge #3: Carbon Capture and Utilization**

- This challenge aims to enable near-zero CO<sub>2</sub> emissions from power plants and carbon intensive industries. India launched a call on this innovation challenge which evinced good response. India and US also agreed to jointly develop research programme on this theme

**d) Mission Innovation Challenge #6: Clean Energy Materials:**

- Second International Meeting on Clean Energy Materials Innovation Challenge took place on February 21st -22nd, 2019 at IIT Delhi. Representatives of six countries (Austria, US, Korea, Norway and Italy) and European Commission attended besides International organizations such as IEA, UNIDO, WEC. Representatives of 78 Indian institutions and 18 industries also attended the 2 day event. The current status, barriers and R&D pathways for application in the area of photovoltaics, batteries, solar fuels, thermoelectric energy, wind power, energy efficient building material, power generation and power transmission were discussed.
- Dr. V K Saraswat, Hon'ble Member NITI Aayog released India Country Status Report on Clean Energy Materials Innovation Challenge IC6. The report includes institutional framework and current research scenario for clean energy materials with focus on materials for energy storage.

**e) Mission Innovation Challenge #7: Affordable Heating and Cooling of Buildings:**

- India launched Global Cooling Innovation Challenge to dramatically improve energy efficiency and climate friendliness of Residential Air Conditioning systems.

**f) Mission Innovation Challenge #8: Renewable and Clean Hydrogen**

- This challenge aims to accelerate the development of a global hydrogen market by identifying and overcoming key technology barriers to the production, distribution, storage, and use of hydrogen at gigawatt scale.
- DST represented India in the Renewable and Clean Hydrogen Challenge of Mission Innovation at Berlin, Germany.
- Department of Science and Technology participated in the Hydrogen Valley Workshop at Antwerp, Belgium bring together around 70 government officials and private stakeholders involved in nascent "Hydrogen Valleys" projects from Mission Innovation Hydrogen Challenge member countries to discuss lessons learnt, and critical success factors for accelerating and expanding hydrogen projects globally

**II. Initiative to Promote Habitat Energy Efficiency (I-PEEE)**

This initiative is geared to support enhancement of knowledge and practice to save energy in design, construction and operation of human habits.

A programme to develop efficient cooling solutions with low global warming potential refrigerants was formulated.

### III. Clean Energy Centres and Energy Storage Centres

An “Indo-UK collaborative technical workshop” on joint clean energy centres was held during 18th-20th September 2018 at Loughborough, United Kingdom which was attended by 54 participants out of which 31 representing 20 institutions from India and 23 representing 23 institutions from UK. The three joint virtual centers supported by India and UK disseminated their strategy to achieve advanced hybrid microgrids capable of operation in grid connected & isolated mode with seamless mode transition. The outcome of five Smart Energy Grids and Energy Storage (SEGES) projects supported jointly by India & UK was discussed and disseminated for exploring technology transfer and also to find new opportunities/avenues of collaboration towards development/deployment of clean energy technologies.

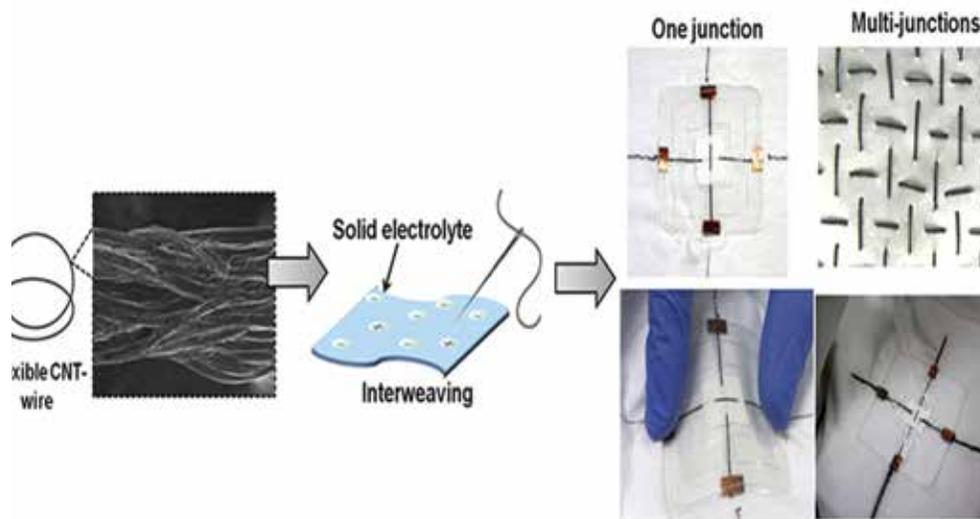
Dr. V K Saraswat, Hon’ble Member NITI Aayog launched four energy storage centres set up by Department of Science and Technology, Government of India nucleated at IIT Delhi, IISc Bangalore, NIFTDC Hyderabad and IIT Bombay. Hon’ble Member also unveiled pilot plant model of IITD-Thermax Methanol Demonstration facility marking the launch of programme on 22nd February 2019 at IIT Delhi.

### IV. Technology developed

#### a) Carbon nanotube coated cotton yarns to power wearable devices

In one of the DST supported projects, Dr. C Subramaniam Department of Chemistry at the Indian Institute of Technology-Bombay and his team have developed carbon nanotube coated cotton yarns (CNT-wires) that converts the electrical insulating yarn into a metallic conductor thereby behaving like a flexible and pliable electrode (Fig. 3). They combined electrode (CNT-wire) with the electrolyte sheet by a simple and elegant approach of interweaving the CNT wire across the electrolyte to create junctions. These junctions are supercapacitive in nature and can store electrical energy. Since the supercapacitors are created by sewing, they referred it to as “sewcap”.

The device is not only weave-able but also very flexible and can withstand all mechanical movements and duress that clothing undergoes during daily usage. Devices embedded in the clothes have possible applications like health-care monitoring, point-of-care diagnostics, military defense and homeland security.



**Figure 3. Carbon nanotube coated cotton yarns that are used in wearable electronics.**

#### **b) Solar Energy Centres:**

Under Solar Energy Research Initiative, two Centre have been anchored to accelerate the technological readiness level of the system/ devices:

- DST-Indian Institute of Technology Madras (DST-IITM) Solar Energy Harnessing Centre (DSEHC) has been established where faculties from different discipline working together for trapping, converting and storing solar energy. The inaugural launch of center was held on 25 January 2019 at IIT Madras by Dr. Harsh Vardhan, Honorable Minister of Science and technology & Earth Science.
- DST- Indian Institute of Engineering Science & Technology (IEST), Shibpur Solar PV HUB center has been set up to take on the development of emerging Photovoltaic technologies. The Centre has the state of art pre-commercial baseline facility established for fabrication and characterization of silicon solar cell and is expanding its collaboration with other academic institutes and industries.

#### **c) Research & Development on Clean Coal Technologies**

Two National Centres for Development of Advanced Materials and Manufacturing Processes for Clean Coal Technologies for Power Applications has been supported to develop processing and fabrication technologies namely, coating welding machining and new materials for the high performance power generating systems (HPPGS) in coal based power plants.

A consultation of Stakeholders from Ministry of Coal, BHEL, NTPC AUSC mission was held to identify priorities for Advanced Coal Technologies under Partnership to Advance Clean Energy - Research (PACE-R) for collaborative research with US-DOE.

**d) Research & Development on production and Utilization of Methanol & Di-Methyl Ether**

A meeting was held on April 20th, 2018 at IIT Delhi to review the progress of Methanol and DME for Research & Development projects and DST-MoR Project and also to discuss about the planning / implementation / roadmap of the projects recommended under Methanol

**e) Advanced Ultra Super Critical (AUSC) Thermal Power Plant –R&D Phase:**

The mission programme progressed as per schedule. Two DST projects also made good progress.

- Advanced Ultra Supercritical Test Rig-Investigation of the long term operation behaviour (Fire Side Corrosion) of tubes made of Super 304H and Ni-based Super Alloy (Alloy 617) for future high efficiency Power Plants. The material has been used for testing in Dadri Power Plant.
- Development of High Temperature Spin Test Rig and Accelerated Testing of Advanced Ultra Super Critical (AUSC) Steam Turbine Rotor Segments under Transient and Steady State Thermo-Mechanical conditions. The facility is under advanced stage of installation.

**f) Building Energy Efficiency**

The project entitled “Collaborative India-US Research Program: Improving Building Energy Efficiency (IBEE)” implemented by CBRI-Roorkee, CSIR-CGRI, Kolkata, IIT Roorkee and IIT Delhi and 39 projects supported under I-PHEE were reviewed.

Under Building Energy Efficiency Higher & Advanced Network (BHAVAN) Fellowship program 3 applications were selected under Students Internships and 7 applications for Fellowship.

**g) Materials for Energy Storage**

Dr. V K Saraswat, Hon’ble Member NITI Aayog released Technology Compendium on Materials for Energy Storage (MES) 2016 and R&D Compendium on Materials for Energy Storage (MES) 2017. The report presents portfolio of R&D projects taken up in this initiatives with the participation of several scientists, industries, utilities and other stakeholders from R&D laboratories, academia and industries related to Clean Energy.

**h) Hydrogen and Fuel Cell (HFC)**

The programme focused to develop transformational technologies that reduce the cost of hydrogen production, distribution & storage, diversity the feedstock available for economic hydrogen production, enhance the flexibility of the power grid, reduce emissions through novel uses of low-cost hydrogen during the year. 31 proposals were approved for funding with an approximate cost of Rs. 25 Cr.

*3.2.2 Water Technology Initiative:*

DST is implementing an initiative on Water Technology research and innovations to find out appropriate technological solutions through field level interventions to demonstrate technical, social, environmental

and eventually economic sustainable solution for water challenges. DST is supporting research and technology development in various water related areas. The research outcomes are expected to feed in and dovetailed with major national missions. DST moved into a thematic call based approach for soliciting proposals in identified water challenges of relevance to country. Several achievements made during the FY 2018-19 are as under:

## I. Technology Solutions

- Setting up of a test bed has been supported under Demand mission Projects call that aims to provide customized technological water solution by demonstrating futuristic and versatile Forward Osmosis (FO) desalination system to provide potable water in Narippaiyur test bed facility (Fig. 4) for the benefit of local villagers. It includes demonstration of Forward Osmosis (FO) based seawater desalination system and solar thermal energy storage system for round-the-clock plant operation, utilization of sea water from Bay of Bengal to produce potable water, integration of FO system and water storage tanks with existing solar thermal field and sea water intake and reject facility and demonstration of integrated systems to produce 20 m<sup>3</sup>/day potable water



**Figure. 4. Forward Osmosis (FO) desalination system to provide potable water in Narippaiyur test bed facility**

- A water solution for optimal operation of water supply schemes by use of scheduling and decentralized infrastructure has been implemented jointly by IIT Bombay and IIT Madras at Umberpada-Saphale village in Palghar district of Maharashtra. The Gram and Zila Panchayat is actively participating as the utility partners with the knowledge partners (IITB & IITM) under the intervention. The Karawale dam is the source for project water supply scheme for Umberpada-Nandade and 17 village Rural regional and beneficial for approx. 20,000 population after commission of the project.
- A pilot plant has been set up using Internet of things based water supply and distribution systems in the Coimbatore city. The project also envisages increasing the efficiency of supply system and thereby satisfying the consumer with undisturbed supply of water with good quality and quantity.

- A field project has been implemented at National Institute of Hydrology (NIH) Belagavi Karnataka, The Energy and Resource Institute (TERI) Bengaluru Karnataka and Visvesvaraya Technological University (VTU) Karnataka have collaborated to demonstrate the capability of RBF technique for producing clean and safe drinking water from local Tungabhadra river water in economic and sustainable model for rural community. The technology has now been successfully demonstrated to the local community, administrative bodies and public representatives and treated water has been supplied to the beneficiary village from the RBF wells. The project envisages low cost water treatment RBF technique and helpful to access to supply clean and safe drinking water for the local community.



**Figure. 5. Biosand Filter Technology (Jalkalp) for removing biological contamination and iron deployed in state of Bihar**

- Biosand Filter Technology (Jalkalp) for removing biological contamination and iron has been deployed in state of Bihar (Fig. 5). The intervention has developed household water filters (biosand filter and terracotta filter) for removal of arsenic, iron and biological contamination and deployed in districts of Bihar stricken with high incidence of Water borne diseases. The work also involved developing a unit for production technology for Terracotta Water Filter with the help of IIT, Jodhpur. Manual press moulding machine for production has also been developed and produced. So far 1506 households have adopted the JaKalp water filters and 412 villages have been approached for sensitization, awareness building and promotion of water filters as a solution of water contamination causing incidence of waterborne diseases.



**Fig. 6. 10 KLD capacity sensitive photo catalytic filters for visible light catalysis and carbon nano-mat fiber filter developed by MNIT Jaipur and MBM College of Engg, Jodhpur for treatment of the effluent of Common Effluent Treatment Plant, in Jodhpur**

- IIT Kanpur along with MNIT Jaipur and MBM College of Engg, Jodhpur have set up a pilot plant of 10 KLD capacity comprising sensitive photo catalytic filters for visible light catalysis and carbon nano-mat fiber filter for treatment of the effluent of Common Effluent Treatment Plant, in Jodhpur (Fig. 6).

## II. Technologies Developed

- A bilateral Indo-UK project has been jointly supported by DST-NERC to, CSIR-National Institute of Oceanography, Cochin, and Plymouth Marine Laboratory, UK under the Water Quality Research Program to identify the principal reservoirs of *Vibrio cholerae* and pathogenic viruses in Vembanad Lake in Kerala and to determine through in situ sampling if the *Vibrio* bacteria are associated mainly with particular types of phytoplankton, zooplankton, macrophytes or the surficial sediments, and study the dependence of the reservoirs on environmental conditions (temperature, salinity, light). Project has lead to the design of a prototype comprising of compact Secchi-disk (Fig. 7) for assessment of algal population along with a mobile application, to be provided to the stakeholders who will receive the Sechhi discs.
- For effective management and harvesting rain water for drinking and other domestic purposes, an handheld battery operated smart water quality measuring device (Fig. 8) has been developed. The developed smart system custom RF hardware and antenna and supports Bluetooth for faster data transfers with less energy consumption. The system Successfully tested the RF communications up to 30 meters with walls thickness of 6-9 inches.



Figure 7. Secchi disks produced for India -UK water quality Initiative for monitoring water quality in lake Vembanad



Figure 8. Handheld battery operated smart water quality measuring device developed by the CSIR-CEERI



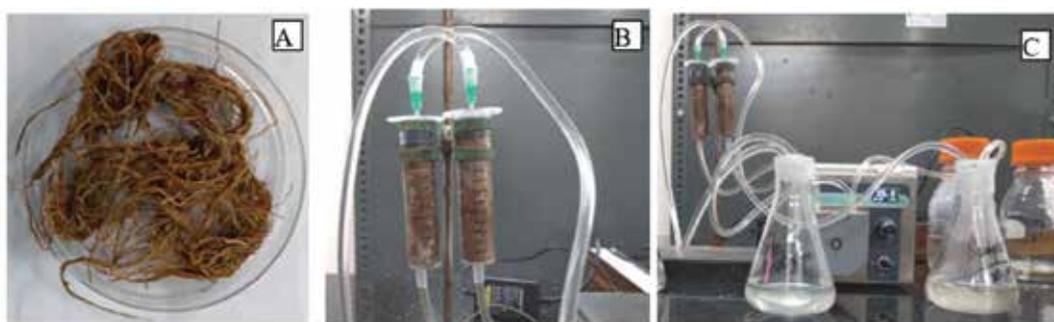
Fig. 9. Clockwise from top left -- Schematic of sub-network, Fabricated experimental facility and Distribution network equipped with necessary instruments.

- A research programme on Optimal Operation of Water Distribution Networks (Fig. 9) has resulted in development and deployment of a low power wireless sensor and actuator network for monitoring and control of water distribution networks in IIT Madras. The network consists of low cost water level measurement modules (remote node), relay nodes, gateway nodes and actuator nodes. This model will now be replicated in multi village and industrial township schemes.



**Figure. 10. Integrated domestic wastewater treatment system with multi-species and dual media constructed wetland**

- A pilot project for integrated domestic wastewater treatment system with multi-species and dual media constructed wetland (Fig. 10) has been established at Walchand college of Engineering, Sangli Maharashtra to treat the waste water from the college campus. The emerging concepts in constructed wetland viz. bio-rack and floating wetland have been incorporated to enhance treatment potential of hybrid wetland system in cost effective manner and optimal utilization of space. The performance evaluation study has been carried out throughout the year for different stages of treatment in both integrated systems and found satisfactory.



**Figure. 11. Evaluating and optimising uranium removal from groundwater by reductive precipitation with H<sub>2</sub>-based membrane biofilm reactor.**

- A lab scale project that focuses on evaluating and optimising uranium removal from groundwater by reductive precipitation with H<sub>2</sub>-based membrane biofilm reactor (Fig. 11) has been implemented at University of Kalyani, Kalyani.. The work studies the use of the rice root

for the removal of the uranium and reports >95% removal of U from water in 3 h and 25% removal of U from groundwater.

### III. Meetings and Events:

- The Union Minister for Science, Technology & Earth Sciences and Environment Forests & Climate Change and Earth Sciences Dr Harsh Vardhan launched two technology mission centres (Fig. 12) nucleated at Indian Institute of Technology Madras.

DST-IITM Water Innovation Centre for Sustainable Treatment, Reuse and Management (SuTRAM) for Efficient, Affordable and Synergistic Solutions will be looking into a sustainable approach for water resources protection and augmentation through wastewater treatment and reuse and storm water management.



**Figure 12. Launch of Water Technology Mission Centres set up by DST at IIT-Madras.**

DST-IITM-KGDS Water Innovation Centre for Test bed on Solar thermal desalination solutions set up at Naripaaiyur, Ramanathapuram, which aims to demonstrate the Solar powered Forward Osmosis to produce high quality drinking water from sea water in this coastal village to benefit approximately 10,000 population which faces severe drinking water scarcity.

- A Water Innovation Centre has been established under WTI for “Water Innovation Center: Technology, Research & Education (WICTRE)” by Indian Institute of Technology Bombay, Mumbai. The lead organisation is Indian Institute of Technology Bombay and has three partnering institutions named National Chemical Laboratory Pune, IIT Hyderabad and PDP

Gujarat in the networking virtual Water Innovation Centre that aims to create awareness about water contamination/purification along with to work on mapping of water stressed areas which are ecologically diverse, development of economical sensors for various chemical, physical and biological contaminants and understanding the microbial diversity and structure of the impacted waters. WICTRE has been inaugurated at IIT Bombay on 26th March 2019

- Indo-Netherlands research collaboration on Urban Water System - DST-NWO Joint Programme on Urban Water Systems was launched in mid of 2018. This call was initiated to provide funding for highly collaborative and interdisciplinary partnerships between Dutch and Indian research groups, within one coherent research programme that is made up of multiple subprojects.
- A Sandpit meeting was held as Phase -II on 27th to 30th November 2018 in New Delhi with participation of selected 15 Indian and 15 Dutch Participants. The vigorous brainstorming during the sandpit meeting resulted in evolving three consortia focusing on various aspects of Urban Water Management.
- DST-NWO Second Joint Advisory Committee meeting was held through Digital Video Conference (DVC) between the Indian and Dutch side to evaluate the short listed three full proposals under the DST-NWO Urban Water Systems Call on 15th March 2019 .
- DST and the University of Nebraska, Lincoln, USA had launched programme Water Advanced Research & Innovation (WARI) Fellowship phase –I in year of 2015 which completed its duration and objectives successfully. Now in view of positive outcomes so far and also in order to build capacity of Indian researchers for addressing water related issues, the continuation of the programme as WARI Phase II.
- DST-Intel had launched Joint Research Projects on “Collaborative Research on River Water and Air Quality Monitoring” in Public Private Partnership (PPP) mode in year of 2017. In which 4 projects were supported for River water and Air quality monitoring and which were reviewed and progress was as per milestones.
- 8 Indo-UK consortia on Water Quality Research programme were reviewed to monitor progress and achievements made so far. The review revealed some promising results already emerging from the various consortia projects.

### 3.2.3 Mitigation of Air Pollution

Air pollution is a major risk factor for heart disease, stroke, chronic obstructive pulmonary disease (umbrella term for several progressive lung diseases including emphysema) and lung cancer, and increases the risks for acute respiratory infections and exacerbates asthma. Air pollution in India is a serious issue with the major sources being fuelwood and biomass burning, fuel adulteration, vehicle emission and traffic congestion. DST is also making concerted effort in R&D towards mitigation of air pollution.

## Technologies Developed

An air pollution mitigating device WAYU (Wind Augmentation and purifying Unit) (Fig.13) was inaugurated by Hon'ble Union Minister Dr. Harsh Vardhan at ITO intersection and Mukarba Chowk on 25th September, 2018. WAYU helps in reducing ambient air pollution levels ejected by vehicles at places, which have high concentration of pollutants. WAYU can reduce PM10, PM2.5, CO, VOCs, HC emitted in the atmosphere. The cost of device is Rs.60, 000 per device with a maintenance cost of Rs.1500 per month.



**Figure 13. WAYU (Wind Augmentation and purifying Unit) developed by NEERI under DST funded project.**

### 3.3 Natural Resources Data Management System (NRDMS)

Natural Resources Data Management System (NRDMS) Programme aims at promoting R&D in emerging areas of Geospatial technologies and applications for providing relevant inputs to solve area specific problems. Over the years, NRDMS has developed capability for handling resource management at State, District and Panchayat levels. Efforts have also been made to develop capability and capacity to absorb geospatial technologies with the aim to apply the same to provide solutions to deal with the specific issues. Thus, NRDMS have direct relevance for the societal development and converging with the digital India programmes.

The progress made under various sub-programmes of NRDMS is as under:

#### 3.3.1 Geospatial Oriented R&D Programmes:

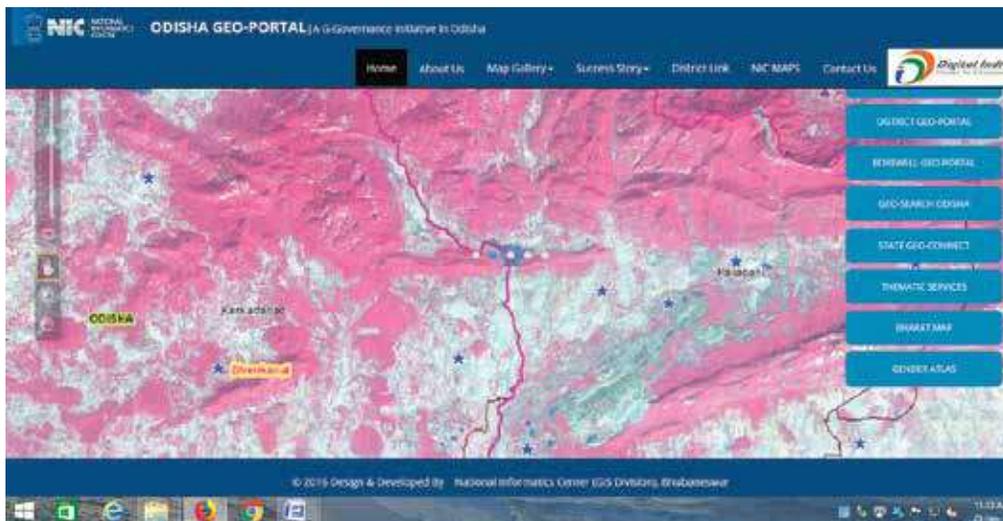
##### I. State Spatial Data Infrastructure (SSDIs):

In order to enhance the applications of Geospatial Technologies in implementing developmental schemes in the country at state and below levels, State Spatial Data Infrastructure (State SDI) initiated with the active participation of the state governments with the cost sharing basis. At present, State

Geo-portal in 10 states i.e. West Bengal, Haryana, Jammu & Kashmir, Uttarakhand, Karnataka, Odisha, Jharkhand, Madhya Pradesh, Nagaland, and Himachal Pradesh have been set-up. The geospatial portals are being proactively used by the state governments for attending various applications for good governance. The systematic web service of the odisha portal is given in Fig 1.

## II. Village Information System:

Village planning has been given the priority by the government over the years. Thus, Members of Parliament and other eminent people and institutions have been asked to adopt the villages for their development. To develop a scientific methodology for geospatial planning at village level, NRDMS has selected 10 R&D projects located in various geo-environmental conditions in the country. This was done to consider topographic and climatic variations. About 120 villages were selected to collect primary data on natural resources and other allied sectors and large-scale mapping on 1:10,000 scale was carried out. All the resources/assets of the village panchayat people were geo-tagged. This experiment provided scientific methodology for integrated village developmental planning.



**Fig 1: A screenshot of the Odisha State Geo-portal showing a Web Map Service**

## III. Revival of village ponds:

Village ponds in rural areas play a vital role for water conservations and ground water recharge at panchayat/local level. Over the years, it has been seen that most of the ponds either choked or encroached. This lead to scarcity of water level and increase run off. In order to utilize this opportunity for enhancing the recharge of ground water and increase the pond capacity, NRDMS has developed a sub-project on revival of village ponds. To demonstrate the efficacy of such experiment about 12 R&D projects have been supported. The locations of these ponds are spread over in entire country to see the climate and topographical variations and their impact on the recharge of ground water in ponds. Of late, Hon'ble Prime Minister of India emphasized the need for water conservations and utility of ponds at panchayat level. Therefore, it is considered important.

#### **IV. Coastal Hazard and Risk Assessment (CHRA):**

India is having a very long coast line of 7517 km, approximately including entire East and West Coast spread over several States. The problem of erosion and deposition of sediments leading to deterioration in coastal eco-system. Coastal land forms and shoreline are the result of geo-morphological processes such as erosion, sediment transport and deposition as well as sea level changes. In addition, lot of infrastructure like electric poles, houses, roads, school, hospital buildings are affected. Keeping in view of the above, a sub-programme was launched. 12 R&D projects addressing various aspects of the programme and research were undertaken in various R&D institutions. The outcome of the programme would address the local issues being encountered by the coastal states with the active participation with the other Government departments.

#### **V. Applications of State SDIs for Urban Governance:**

In order to demonstrate the concepts of Spatial Data Infrastructures (SDIs) in Urban Governance and core R&D areas focusing on emerging technologies related to city development using Geo-ICT, an expert committee has been constituted to guide the programme. During current financial year, the committee recommended 29 R&D projects for support.

##### *3.3.2 Disaster Mitigation Programmes*

#### **I. Landslide Hazard Mitigation (LHM):**

NRDMS is supporting R&D projects in the area of LHM to address issues like landslide hazards and risk assessment, monitoring of critical landslide zones, developing prognostic models for slope stability and design of suitable remedial measures. In the process, 50 R&D projects have been supported to develop scientific capability and handling the landslide problems with the active participation of the concerned Governments and academic institutions. The efforts made in these directions are as under:

##### **a) Landslide hazard mitigation for North-Eastern Region (NER)**

NER is important for strategic point of view for the country. Entire NER have landslide problems. In order to tackle such issues a network programme for this region was developed with the participation of the institutions/universities of these states. The focus is for identifying the active/unstable slopes and carrying out scientific analysis for developing suitable remedial measures.

##### **b) Large-scale Geological and Geotechnical mapping in Uttarakhand**

In the wake of Kedarnath Tragedy occurred in June, 2013, large-scale mapping was undertaken from Rishikesh to Kedarnath (about 150 km corridor). Relevant data on geological and geotechnical parameters were collected and integrated to categorize all the slopes with the magnitude of risk. All the study area has been demarcated with the probability of risk and factor of safety. In addition, the areas were also identified which are safe for reconstruction of infrastructure facilities.

**c) Tsunami/Flood Modelling**

This is a highly scientific programme that takes into account the historical climate and tsunami event for analysing the impact of tsunami to develop the inundation model. Institute of Remote Sensing, Anna University, Chennai have been given the responsibility for developing this with the ALTM data to improve the flood modelling.

**d) National Geotechnical Facility (NGF)**

In order to develop soil and rock mechanics, testing facilities, NGF has been set up in Survey of India, Dehradun. The advanced data acquisition instruments like ground penetrating radar, drone and other testing facilities to estimate the shear strength of the material were also developed. NGF is the state of art facility in geotechnical engineering.

*3.3.3 New Initiatives:*

**a) Gravity Recovery and Climate Experiment (GRACE)**

Gravity Recovery and Climate Experiment (GRACE) satellite gravity mission is one amongst latest technological development available to researchers to evaluate changes in the Earth's gravity field caused due to redistribution of mass inside on and around the Earth surface at regular intervals. In the view of contemporarily scientific importance of utilizing GRACE data in particular and other remote sensing data in general, it is important to develop Indian expertise in collaboration with global peers in this cutting edge scientific field. In view of the above, a National network project on 'Assessment of Regional Hydrological Systems using Space Borne Gravity Observations' has been developed. At present, 12 R&D projects have been sanctioned to various R&D institutions to undertake research work. The programme is being technically coordinated by National Geo Physical Research Institute (NGRI), Hyderabad. The major outcome of the programme would be to estimate the soil moisture upto the depth of 1.5 meter at basin level. This information would be very vital for developing the cropping pattern to enhance the productivity.

**b) National Programme on Geodesy**

It has been planned to set up a national centre on Geodesy in IIT, Kanpur with the objectives:

- Promotion of outreach activities: capacity building by educating on the use of Geodesy by imparting regular training programmes (long term and short term), dissemination of relevant information, development of courses and reference material in Geodesy.
- Promotion of the state-of-the-art research and development activities (academic research, sponsored/consulting) in Geodesy.
- Extension of all laboratory support (equipment, training, library, SW, etc.) for students and researchers from universities and institutions and advise state/central government departments on various issues related to Geodesy.

The centre will also take up and facilitate the relevant R&D to develop geoid model, Indian vertical datum and other relevant R&D in the field of geospatial science.

#### **D. Capacity Building on Geospatial Technologies**

Under NRDMS programme, number of R&D projects and sub programmes are being supported to develop tools and methodologies for promoting geospatial technologies. In the process, good amount of data bases have been developed to address area specific problems. To disseminate such outputs to the larger scientific community for adoption and replication, efforts are being made to support 32 training programmes on short terms (3 days) and long term (21 days: Level I and Level II) on the subject during current financial year. This will have a major impact to develop a trained manpower and build up a pool of experts. To facilitate this, a portal has been developed to standardize the course curriculum ([www.dst-iget.in](http://www.dst-iget.in)) for various training modules/ tutorials for targeting various stakeholders have been developed. It is envisaged that around 800 stakeholders across the Country will be exposed to the advances in the Geospatial Science and Technology, its application and hands on training.

### **3.4 National Science & Technology Entrepreneurship Development Board (NSTEDB)**

#### *3.4.1 National Science & Technology Entrepreneurship Development Board NIDHI- Technology Business Incubators (TBIs)*

DST has been pioneer in establishing a good network of Technology Business Incubators (TBI) and Science & Technology Entrepreneur's Parks (STEP) across the country. These startup incubators support and nurture knowledge driven innovative start-ups into successful enterprises. Several TBIs & STEPs have matured and developed competence to become state-of-art incubators. Technology based new enterprises are typically characterized as high risk and high growth ventures, and as such, enabling environment like TBI has helped to enhance the prospects of success of these ventures. The TBI cater to different technology sectors like nanotechnology, aerospace, biotechnology, ICT, agri-technology, medical devices, healthcare, manufacturing etc. The initiative has given Indian incubators very good credibility in the international arena.

During 2018-19, new Technology Business Incubators (TBI) under NIDHI program have been established at: Indian Institute of Horticulture Research (IIHR), Bangalore; Gujarat University, Ahmedabad; Indian Agricultural Research Institute (ICAR-IARI), PUSA, New Delhi; IKP -EDEN (ICICI Knowledge Park - Engineering Design and Entrepreneurship Network), Bangalore; Indian Red Cross Society (IRCS), Bangalore; Don Bosco College of Engineering, Goa; Nehru Group of Institutions, Coimbatore; Maharashtra Institute of Technology (MIT), Pune; Indian Institute of Management - Lucknow : NOIDA Campus; Symbiosis International University, Pune and Indraprastha Institute of Information Technology (IIIT) Delhi.

**i. Innovative Products developed by Start-ups at various TBIs**

- Startup “TURNPLUS” incubated at a first of its kind Technology Business Incubator nurturing startups with products focusing on disability i.e TBI- “ARTILAB FOUNDATION” at Indian Red Cross Society (IRCS) Bangalore, has developed a product called TURNPLUS. This is an affordable solution meant for disabled persons, is model agnostic( all imported solutions are car model specific) and can be fitted in the lower segment cars that are used as app-taxis.



**Fig : Innovative product TURNPLUS incubated at Artilab Foundation, Bangalore TURNPLUS**

- **VYAAN Purifiers**, incubated at IIT Roorkee, aims to bridge the gap between the rising problem of air pollution and lack of efficient and affordable air filtration products, using a unique combination of technology and design. Most air filtration masks available in the market put a lot of strain on the diaphragm making it very difficult for people to breathe through them.



**VYAAN is optimizing the air flow of the product using CFD that would create a high negative static pressure allowing consumers to breathe freely without straining themselves.**

- **Tapu Sustainable Solutions**, Startup at TBI- Zone Startup, Bombay Stock Exchange (BSE), Mumbai has developed EcoTrapIn technology. It is a retrofit design converting conventional urinal into touchfree, odorless and hygienic ergonomic waterless urinal. EcoTrapInPlus and EcoTrapInXtra is their current versions of waterless urinal technology.



**Fig : Waterless urinal Eco Trap incubated at Zone Startup , Mumbai**

- **FlytBase** (incubated at NIDHI TBI at College of Engineering, Pune) offers hardware-agnostic software solutions to automate and scale enterprise drone operations. FlytBase is on Internet of Drones Platform (IoD) platform and consists of reliable and secure components to assemble drone software solutions that can be easily scaled to production deployments of connected intelligent drone fleets, seamlessly integrated with business applications and workflows. Recently the startup was declared the grand champion in a global contest that saw participation of 401 startups from 18 countries.

- **Cretile**, incubated at TBI at Dayanand Sagar College of Engineering, Bangalore is easy to use modular electronics and electromechanical building blocks for students, makers and engineers. Cretile integrates Science, Technology, Engineering and Math (STEM) as one cohesive subject. It is set of modular building blocks of electronics, electro-mechanical, software and other technology components. It is innovative top-down learning tool where concepts are introduced first and details later. Projects can be created in electronics, automation, IOT and AI technology.



**Fig: Cretile - Modular electronics and electromechanical building blocks incubated at DSCoE , Bangalore**

- Startup –“**Tishitua company**“ at TBI- Malviya National Institute of Technology MNIT Innovation & Incubation Center (MIIC), Jaipur. MIIC has developed a novel idea of a water ionizer machine that can produce ionized and mineralized water similar to the natural composition of water found at high altitudes such as Himalayan forests. It is proven that regular consumption of alkaline water provides astounding health benefits such as anti-aging, colon cleansing, detoxification, skin health, cancer resistance, immune system support and many more.



**Fig : Water Ionizer incubated at TBI MNIT Jaipur**

- Construction & Operation Safety: **AlonAsset (Safety)** is incubated at TBI at JSS Academy of Technical Education, NOIDA. It is a real time detection monitoring and alert for PPE (Personal Protective Equipment) compliance and human action in various environments from CCTV footage. It can instantly scan CCTV footage for jobsite risks like missing safety gear, fire & smoke, fall protection, vehicle movement, safe & unsafe zones and worker action recognition. It generates auto log and alerts.



**Fig: AlonAsset: Real Time Monitoring of CCTV footage incubated at JSSATE, Noida**

- 5G New Radio (NR) Small cell base station, **WiSig 5G NR** solution is incubated at TBI at IIT Hyderabad. WiSig 5G NR solution cuts across Massive MIMO with 64x64 MIMO, mmWave and operates in the frequency range from below 1GHz to 100GHz with different deployments. Flexibility, ultra-lean design, and forward compatibility are the pillars on which the 5G NR physical layer technology components (modulation schemes, waveform, frame structure, reference signals, multi-antenna transmission and channel coding) are being designed and built.



**Fig :WiSig 5G NR solution , TBI IIT , Hyderabad**

- PuREnergy Pvt. Ltd incubated at TBI at IIT Hyderabad has developed long-range, high-performance electric two-wheelers specifically designed for Indian Conditions. The Unique points of the vehicles developed by PURE EV include light weight portable batteries designed to work under tough environmental conditions and deliver high discharge currents for fast pickup. The team has built expertise in the battery design by choosing ultra-performance cells and efficient battery management to enhance on road life and range of battery by up to 50 per cent. The company has obtained ARAI (Automotive Research Association of India) approvals for electric bikes and two-wheelers and is working actively for channel development for commercial deployment of the electric vehicles on Pan-India basis.



**Fig : Range of EV two wheelers by PuREnergy Pvt. Ltd, TBI-IIT-Hyderabad**

#### 3.4.2 NIDHI Centre of Excellence (NIDHI-CoE)

NIDHI-Centre of Excellence (NIDHI-CoE) provides an enabling environment to technology based new enterprises which are high risk and high growth ventures. The existing STEPs and TBIs act as a reservoir of knowledge in venture promotion and help NIDHI-CoE in aligning the linkages with both national as well as international partners. NIDHI-CoE strengthens existing capacities of STEP/TBIs and supports potential start-ups with different pursuits and practices in transferring technological innovations into marketable products and high-growth ventures. The new NIDHI-CoE (Centre of Excellence) established during the F.Y.2018-19 is at PSG-Science & Technology Entrepreneurial Park (PSG-STEP) at PSG-College of Technology, Coimbatore, in addition to four other CoEs already under implementation in TBIs at IIT-Bombay, IIM-Ahmedabad, Veltech Univ. and NCL-Pune.

Some of the startups supported by DST NIDHI CoE:

- Startup- **Oizom** at Centre of Excellence (CoE) -CIIE Ahmedabad has developed an environmental data infrastructure through real time monitoring of air and water pollution, and analyzing reasons and correlations among multiple environmental parameters to derive actionable insights. Oizom solutions went live in Saudi Arabia as a part of Riyadh Airport Data Modelling Project.



**Fig : Environmental AI based product Oizam at CoE, CIE-IIM Ahmedabad**

- Startup-Inceptor Technologies Pvt. Ltd at CoE-SINE, IIT Bombay is an Assistive devices company. They manufacture low cost read-write electronic braille device (BrailleMe) for converting digital information into braille format for the visually impaired. They have sold their devices across 20+ countries.



**Fig : Read-write electronic braille device (BrailleMe) at CoE, SINE- IIT Bombay**

### *3.4.3 National Award for Technology Business Incubators for the year 2017*

In order to recognize and reward the remarkable work done in the area of incubation and technology entrepreneurship through value added business support by specialized facilities such as Technology Business Incubators and Technology Parks, department has established National Award for Technology Business Incubators. The National Award for Technology Business Incubators for the year 2017 was presented to the 'KIIT-TBI (Kalinga Institute of Industrial Technology -Technology Business Incubator), Bhubaneswar on the Technology Day, 11th May 2018. For the year 2017, the National Award for Emerging Technology Business Incubator was presented to 'A-IDEA'- the TBI at NAARM(National Academy of Agricultural Research Management), Hyderabad.

#### 3.4.4 Seed Support System (SSS) for start-ups in Incubators

Under the program on Seed support System, the Department equips the Technology Business Incubators (TBIs) with the much needed early stage financial assistance to be provided timely to deserving start-ups under incubation. In F.Y. 2018-19, five Technology Business Incubator were approved for Seed support under “National Initiative for Developing and Harnessing Innovations- Seed Support System (NIDHI-SSS)” programme. These TBIs are Society for Siddharth International Incubation Centre, Chittoor (Dist), Indian Society of Agribusiness Professionals (ISAP), Mathura Road, Delhi, SIDBI Innovation & Incubation Centre(SIIC-IIT) Kanpur, Society for Innovation and Entrepreneurship SINE, IIT Bombay, BIL-Ryerson Technology Startup Incubator Foundation, (Zone Startup India), Bombay and NS Raghavan Centre for Entrepreneurial Learning(NSRCEL) and Indian Institute of Management(IIM ) Bangalore. In addition, nine other ongoing TBIs namely Coimbatore Institute of Engineering and Technology-TBI, Coimbatore, IIM Calcutta Innovation Park, Kolkata, Foundation for Sandbox Startups Initiatives (FSSI), Deshpande Foundation, Hubballi, Global Incubation Service Pvt. Ltd (GINSERVE) Bangalore, Vel-Tech Technology Incubator, Chennai, Science and Technology Park (STP), Pune, Centre for Incubation and Business Acceleration (Agnel Charities-CIBA), Verna, Association for Innovation Development of Entrepreneurship in Agriculture (a-Idea), Hyderabad and Indian Institute of Technology(IIT)-Madras Incubation Cell, Chennai were disbursed grant in F.Y. 2018-19. Over 100 Startups in Incubators get benefit through seed support annually which enables these start-ups to take their ventures to the next level.

#### 3.4.5 Accelerator Programme

Accelerator is a typically a 3-6 months’ fact track structured program implemented by TBIs helping ideas get accelerated to the next level through rigorous mentoring and investment preparedness. In F.Y. 2018-19, 18 Accelerator Program were organized by various Technology Business Incubators under which 438 ideas were provided mentoring support, 66 ideas got seed funding, 49 ideas were absorbed by TBI’s for further Incubation & 40 ideas raised external validation

#### 3.4.6 NIDHI PRAYAS (Promotion and Acceleration of Young and Aspiring innovators and Start-ups)

NIDHI PRAYAS program has been focusing to address the funding gap from idea to prototype and is positioned as pre-incubation initiative. Two cycles of program have been completed and total 20 centres across the country have been approved for implementing the PRAYAS program. Each PRAYAS Centre supports the innovator with a prototype grant up to Rs. 10 lakhs for converting their idea into a prototype. The centre also gets funding from DST to set up PRAYAS Shala (Fab Lab) to facilitate mechanical and digital fabrication besides providing physical infrastructure, technical guidance and business mentorship to the PRAYASEEs (innovators). Around 3000 applications were received by the centres in the span of around 3 years, from which 138 innovators from cycle 1 and 192 innovators from cycle 2 are being supported.



**Fig : Impact of Cycle 1 of PRAYAS Program**

#### 3.4.7 Entrepreneurs-in- Residence (EIR) Programme

Entrepreneurs-in- Residence (EIR) Programme under **National Initiative for Developing and Harnessing Innovations (NIDHI) of Department of Science and Technology** supports aspiring or budding entrepreneur of considerable potential for pursuing a promising technology business idea over a period of 12 to 18 months with a subsistence grant up to Rs 30000 per month. During current year, 100 fellowships were provided by 12 TBIs as Program Execution Partner. Entrepreneurship Development Center (Venture Center), CSIR- NCL, Pune, is the Program Implementation partner. During last one cycle of the program, 116 EIRs were supported (17% being women and 70% EIRs were under 30 years of age), resulting in formation of 50 new companies and generation of 31 IPs.

#### 3.4.8 New Generation Innovation and Entrepreneurship Development Centre (New-Gen IEDC)

The NewGen IEDC program is aiming to inculcate the spirit of innovation and entrepreneurship amongst the young S&T students, encourage and support start-up creation through guidance, mentorship and support. As an outcome of this initiative, NSTEDB, DST has supported 26 academic institutions so far. Some of the important institutions are; University of Science and Technology, Ri-Bhoi, Meghalaya, Dr. MGR Educational and Research Institute, Chennai, Tamil Nadu, University of Kashmir, Srinagar, J&K, Indian Institute of Technology (IIT), Guwahati, Assam, Chitkara University, Rajpura, Punjab, S. R. M. Institute of Science and Technology, Kattankulathur, Tamil Nadu and Indian Institute of Information Technology, Allahabad, Uttar Pradesh.

Progress made by the NewGen IEDCs includes 171 student projects supported, 30 Patents filed by students, 4 patents granted and 16 companies set up by these students.

#### 3.4.9 DST-Lockheed Martin-Tata Trusts India Innovation Growth Programme 2.0

The India Innovation Growth Programme 2.0 for the year 2018 was launched on 21st March, 2018 at the Rashtrapati Bhavan. India Innovation Growth Program (IIGP) is a unique public private partnership initiated in 2007 between Government of India's Department of Science and Technology and Lockheed Martin Corporation. Tata Trusts joined the newly revamped India Innovation Growth Programme 2.0.



**Fig : Launch of IIGP2.0 for the year 2018 at Rashtrapati Bhawan on March 21st, 2018**

After conducting fifteen pan India roadshows and other social media platforms, a total of 3125 applications were received under IIGP2.0 for the year 2018. For the top 50 Open Innovation Challenge teams, and 4 Univ challenge winners, a rigorous one week bootcamp was organized at the Indian Institute of Management, Ahmedabad during 16th– 21st July, 2018. Earlier to this, the down-select event for University Challenge Competition was organized at IIT-Bombay for both the industrial and social tracks. The Open Innovation Competition was held during 1st -2nd August, 2018 in Delhi where 47 startups pitched to an eminent jury panel. Subsequently, the top 15 winners from Univ challenge and top 16 teams under Open Innovation Teams were awarded. Each university team was awarded a cash award of Rs. 10 Lakhs and each open innovation team was awarded Rs. 25 Lakhs. The top 10 awardees of the Open Innovation Challenge were taken to the USA for a global learning visit from September 25th to 3rd Oct. 2018. A demo day for innovator Investor meet was organised on 21st Dec 2018 in Bengaluru, where 15 IIGP winners participated. A design thinking workshop was held for univ teams during 13-16th March 2018 in IIT Mumbai. Finally an industrial immersive day for 16 startups was facilitated by program partners at Tata Steel on 28th March 2019 in Jamshedpur.



**Fig : Awards Ceremony of IIGP2.0 organized on 2nd August , 2018 in New Delhi along with product launch of BrailleMe for the visually impaired by IIGP 2017 winner Inceptor Tech Pvt Ltd, Mumbai**

#### 3.4.10 DST-Texas Instruments “India Innovation Challenge 2018”

DST has partnered with the Texas Instruments to scout, motivate, validate and incubate Engineering students driven innovative design ideas with commercial potential under Make in India, anchored

by MyGov platform and implemented through Indian institute of Management, Bangalore. The top 10 teams selected through IICDC 2017 version were facilitated through physical incubation along with seed support of Rs. 20 lakhs each at NSRCEL, IIM Bangalore during F.Y. 2018-19. This year's edition of IICDC 2018 has seen an exponential growth in the participation by 26511 students from 1760 colleges submitting 10146 ideas who dream of paving future of India with engineering solutions and path breaking innovative ideas. The process of shortlisted for the further stage of the program for prototype building , field testing and validation are already underway.

#### *3.4.11 First hardware acceleration and incubation program: Plugin by DST-Intel India and SINE- IIT Bombay conducted in 2018-19*

For the second version of Plugin 2018, an year long program focussed on hardware and systems based startups, a total of 260 applications were received. Boot camps were conducted in Bangalore and Mumbai. During Jan. 2019, a cohort of 10 startups were taken for learning visit to Taiwan hardware ecosystem. Overall the program through focussed sessions and mentoring helped companies in patent filing, accelerate product development, customer validation and business model development and served a felt need for providing mentoring and market connect in product development for hardware.

#### *3.4.12 India Rwanda Innovation Growth Program (IRIGP)*

Aligning with visionary outreach to African nations – ‘India shares for it cares’, DST for the first time has partnered with FICCI to roll out India Rwanda Innovation Growth Program in the year 2018. The Program identifies and scouts for validated Indian technologies/innovations culled through a unique and rigorous evaluation process to create sustainable social joint projects/ ventures in Rwanda. The Program aims to deploy 20 demonstrated and validated Indian technologies and innovations over a period of two years. During the year 2018-19, a Business Accelerator and Capacity Building Workshop” under the India-Rwanda Innovation Growth Programme (IRIGP) successfully concluded last week (June11-15, 2018) at Kigali, Rwanda. Eleven Indian and Rwandan partners successfully signed Business Engagement Agreements for technology collaboration in key focus sectors of Agriculture, Health, IT, Renewable Energy and Leather. Having successfully demonstrated impact in India, these Indian technologies are now ready to be scaled and replicated in Rwanda in partnership with Rwandan enterprises. These technologies were also showcased to the key innovation ecosystem stakeholders from Rwanda at the technology expo organised on June 14, 2018 in Kigali.

#### *3.4.13 DST- ABI- IUSSTF supports Women Entrepreneurship Quest (WEQ) 2018*

WEQ is a unique program designed to promote and showcase early-stage technology ventures which are founded or led by women entrepreneurs in all technologies. The program is one of its kind to be organized in the country for tapping talented technical women. The program has been running successfully for 4 years and offers an excellence platform to tap and support women entrepreneurs in technology. It is anchored by AnitaB.org along with IUSSTF. WEQ 2017 winners were taken for a week long experiential learning visit to Silicon Valley in May 2018 which offers them good connects, knowledge on access to mentoring and exposure to Investor pitches for scaling up in new markets.

Over 250 applications for WEQ 2018 were received against the call, and vetted by a team of mentors and program partners. Top 10 winners will be 32 women Entrepreneurs are the alumni of this program, and 21 have grown their start-ups to next level. The WEQ 2018 finale was held on 14th November 2018 year during AnitaB.org's flagship conference in Bangalore, the Grace Hopper Celebration India 2018 (GHCI 18), one of the largest conferences for women technologists in the country. The Top 10 winners were selected from applications received from across India. The applicants were evaluated on strength of team, unique business proposition and market traction.



**Fig : Award Ceremony of WEQ 2017 held on 14.11.2018 at Bengaluru.**

#### *3.4.14 Women Accelerator programme “Powered ” by Zone Start-ups, Bombay Stock Exchange Institute , Mumbai*

The powered programme is a first of its kind entrepreneurship programme focused on twin Sustainable Development Goals of Energy and Diversity, designed exclusively for women entrepreneurs in energy sector. The program is a joint initiative of Shell Foundation and Zone Startups and jointly funded by DFID, UK and DST, Government of India. Post its launch in the Month of April, 2018, the accelerator program received an overwhelming response of over 130 applications from a multitude of women entrepreneurs across the country from varied backgrounds creating innovative solutions in the broader energy sector. Out of these, top 10 startups were selected for first cohort. As part of the program offering, the cohort was provided with a 6 week 12 days residential mentoring program and concluded on 6th September 2018 with a Demo Day held in Delhi.

#### *3.4.15 Mentorship Program: “Women Entrepreneurship and Empowerment (WEE)” to IIT Delhi and IIT Bombay*

WEE (Women entrepreneurship and empowerment) Mentorship program is 4 month program initiated by WEE Foundation to empower and encourage women entrepreneurs. It facilitates training women in

entrepreneurship skills, mentoring and enabling them to convert their idea(s) into a successful business models. During the year, two WEE programs were conducted at IIT Delhi and IIT Bombay. Top 10 out of the cohort of 70 were awarded upto Rs.5.00 lakh each.

### *3.4.16 i-STED (Innovation, Science and Technology led Entrepreneurship Development) Programme*

i-STED programme is aimed at inculcating strong entrepreneurial orientation in people to translate already developed innovative/S&T solutions in the market. Only the ongoing 15 projects at M.P., UP, Punjab, Assam, Maharashtra and Gujarat were supported during the F.Y. 2018-19, as the programme has been recommended for discontinuation by EFC from F.Y. 2017-18.

### *3.4.17 NSTEDB Training Programmes*

The Training programmes of NSTEDB are aimed to create trained human resources in entrepreneurship with requisite knowledge, skills and aptitude. Various modules of training i.e Entrepreneurship Awareness Camp (EAC), Entrepreneurship Development Program (EDP), Women Entrepreneurship Development Program (WEDP) and Faculty Development Program (FDP) are conducted all over the country. During the year, 2018-19, 1,63,754 students were sensitised towards entrepreneurship through EACs, 4,339 persons trained through EDPs, 4,716 no. of teachers/ trainers/ resource persons for promoting S&T entrepreneurship and 2,714 women were trained by associating 611 institutions. These programs had geographical coverage of nearly all the states and union territories across the country.

## **3.5 National Council for Science and Technology Communication (NCSTC)**

National Council for Science and Technology Communication (NCSTC) Division, Department of Science and Technology (DST), has been primarily created to fulfil the lofty national goal of scientific temper for all, which is enshrined in the Constitution of India as fundamental duty of our citizens. The programmes & schemes of NCSTC are largely aimed at communicating and popularizing science and technology (S&T) to masses and stimulate scientific temper amongst them. The scientific best practices and potential of science & technology need to be promoted to support people's S&T solution finding behaviour, informed choices, and also to meet the Constitutional obligation and national objective, 'Scientific Temper for All'.

The initiatives taken by NCSTC has been devoted towards dissemination of knowledge in interesting, informative and innovative formats & different media so as to enable delivery of messages even up to the remote corners of India and to less endowed or stressed regions and communities.

The programmes of NCSTC basically focus on outreach activities to popularize science; training in science communication; development, production & dissemination of S&T software; field based projects; research & international co-operation; ecological sciences communication and so on. The Division has also instituted awards & incentive to recognize the best efforts in these areas.

### 3.5.1 Science Channel

In keeping with the Government of India's overarching endeavour to make scientific education and rational knowledge accessible to all a dedicated Science Channel has been set up. This was initiated in accordance with the Hon'ble Prime Minister's vision to have a national science channel which has been launched on 15th January 2019 by Hon'ble Minister of S&T & Earth Sciences. This initiative is implemented by Vigyan Prasar (VP) in collaboration with Doordarshan, Prasar Bharati. The Science Channel is dedicated to Science, Technology & Innovation (STI) related knowledge dissemination by video contents and programmes for masses and providing media services, with a strong commitment to spreading scientific awareness especially with Indian perspectives, ethos and cultural milieu. This will also seed scientific concepts and inculcate an interest in science and rational thinking among students and the youth. The target audience of the channel will essentially comprise most of the demographic segments of the society.

This initiative is focused on communicating science to larger public using the Television and Internet TV as:

- DD Science: A Dedicated Science Channel on Doordarshan (National DD)
- India Science: A Digital 24x7 Science Channel (Using Internet TV Applications)

These channels will help people to appreciate the presence of Science & Technology (S&T) in their daily lives and to demystify scientific knowledge. It aims to generate and enhance scientific content on STI developments through DTH & Internet TV routes to make it easily accessible to varied audience at the national platform.

### 3.5.2 National Children Science Congress 2018

National Children Science Congress (NCSC) is a flagship programme of the Department of Science & Technology to initiate the young students of the age group of 10-17 years in the process of scientific thinking and satisfying their quest for scientific knowledge through doing projects which started in 1993 by National Council of Science and Technology Communication (NCSTC), NCSC encourages a child scientist to identify some societal problems and motivate to arrive at a possible solution through his research based solutions.

NCSC covers almost all the districts of the country with a participation of over 200,000 students. Emphasis is on hands-on science and presentation of the results and its analysis. Some teams also presented working prototype and models. Through a process of evaluation, best of promising ideas and projects were shortlisted for presentation at State level. The current edition of National Children's Science Congress is being convened with a theme of Science Technology and Innovation for Clean, Green and Healthy Nation.

About 650 projects were shortlisted for a presentation at national level. The whole process of NCSC was guided by an Activity Guide Book (AGB) which was prepared in consultation with experts. The final of NCSC was held during 27-31 December, 2018 at Siksha O Anusandhan (Deemed to be University), Bhubaneswar.

Eminent scientists from agencies like Bhabha Atomic Research Centre, Homi Bhabha Centre for Science and IISER Pune and Bangalore participated in NSCS and interacted with the participants and address their queries.

### 3.5.3 *Bharat Vigyan Darshan- STEMM India*

Science, Technology, Engineering, Mathematics and Medicine (STEMM) India' activities comprise of Science fairs, melas, expositions, mobile science exhibitions, lecture-demonstrations, interactive media, visits to S&T establishments like labs and industry, hands-on-STEM activities, and so on. These events, whether stationary or mobile, including mobile science exhibitions, serve to utilize the expertise of resource persons trained/being trained by NCSTC in various aspects of activities listed above. Different kinds of demonstrations on a variety of STEM themes and also on environment, health, medicine, etc. are held across the nation each year. Support is extended for scientific awareness and exposure on these realms including hands-on activities, science in toys & games, quizzes, solve a puzzle, mathematical games & activities, ask a good question, short design/redesign, spot-the-odd-one, draw a future, painting, presentations, etc., besides skits and street plays, on select themes.

Science exhibition is one of the most important activities to create and enhance scientific knowledge of children; teachers, parents, peoples representative and common man, and it also brings about change in their attitude. It is participatory in nature where audiences learn by participating. DST initiated static and mobile Science Exhibitions, S&T Fairs, Basic Science experiment workshops, Technology and innovative workshops, etc., besides lectures and Hands-on activities and demonstration of workmanship on different engineering process, technological development and innovative methods. About 60 static and mobile exhibitions were organized receiving 50,00,000 footfalls in Andaman & Nicobar Islands, Andhra Pradesh, Arunachal Pradesh Assam, Chhattisgarh,, Bihar, Delhi, Punjab, Madhya Pradesh, Jammu & Kashmir, Jharkhand, Haryana, Uttarakhand, Uttar Pradesh, West Bengal, Orissa, Rajasthan, Tripura, Kerala, Nagaland, Manipur, Maharashtra.



**India International Science Festival 2018:** With an endeavour to promote scientific attitude amongst masses including young students, NCSTC set up an activity corner in the DST pavilion during the India International Science Festival (IISF) 2018 from 5-8 October 2018 at Lucknow. The prime objective of the IISF is to instil scientific awareness amongst the masses and showcasing India's contribution in the field of science & technology over the years. It was inaugurated by Dr. Harsh Vardhan, Hon'ble Minister for S&T and ES and EFCC on 5 October 2018. Hon'ble President of India too inaugurated India International Science Festival 6 October 2018. Apart from routine activities, there were corners like Hydroponic, Vermin composting, fun with science, Low cost, Science behind Miracles. A puppet show was staged in the pavilion on the theme "Swachh Bharat, Swastha Bharat" (Clean India, Healthy India) to inculcate the habit of maintaining cleanliness at home and the surroundings.





**Perfect Health Mela:** 25th MTNL Perfect Health Mela was organized by Heart Care Foundation of India (HCFI), which is one of the most visited community health event held annually in Delhi since 1993. It covers all aspects of health, addressing all segments of society using the medium of low-cost replicable education modules like exhibitions, competitions, infotainment and free health check-ups under one roof. NCSTC participated in this event for science popularization & outreach activities for students & general public and organized exhibition with science activity corners from 23-27 October, 2018 at Talkatora Indoor Stadium, New Delhi.



#### Science Exhibitions on Wheels:

Under STEMM India program unique mobile exploratory labs on wheels ‘Joy of Science’ to reach out to schools in Gujarat and Punjab were supported through NCSTC to Vikram A Sarabhai Community Science Centre (VASCSC) and Pushpa Gujral Science City, Kapurthala respectively which is directly reaching out to more than 100 schools including the aspirational districts. This mobile science lab has charted an itinerary covering schools even in interior villages. The team aboard the Mobile Science Exhibition (MSE) conducted sessions on Cleanliness and Hygiene at 8 schools in Gujarat.

In Punjab the bus visited village Kadiawali. The on-board team of Science Communicators took up local community engagement activities wherever possible for developing awareness. These include activities like science behind superstitions, Swachhh Bharat, night sky-viewing, demonstrations, etc. to develop scientific temper.

The Mobile Science Exhibition (MSE) bus is equipped with 24 indoor and outdoor interactive exhibits and information panels, which gave students/visitors an opportunity to learn through the process of interaction and discovery at Punjab. The broad components of the exhibition were Health Education, Energy Education and awareness, Waste Management, Water Management and Environment Education. The bus was also equipped with Mobile planetarium and high powered telescopes to hold night sky watching sessions where visitors under a starry night sky enjoyed telescopic views of beautiful objects, including planets, nebulae, star clusters and the Moon. Demonstrations and special programmes were also taken up to educate the visiting public about renewable energy sources and water testing and clean water properties. The exhibition was organized in rural schools in close coordination with the education department where it remained for 2-3 days each. This Exhibition bus has extended its outreach in all 22 districts (more than 100 blocks and 1500 villages) of Punjab. More than two lakh students in the rural areas visited Exhibition bus. Pre and post visit Questionnaire based analysis of students to Mobile Science Exhibition has revealed 60% improvement in their scientific knowledge.



The introduction of Mobile Science Exploratory in Kerala was conceived to explain the uses of appropriate/ intermediate technologies to educate the masses on healthcare, first-aid, need of clean drinking water, swachh literacy, hazards of pollution, etc. Through the scientific equipment fitted in the Mobile Science Exploratory, student communities were motivated to do scientific experiments. Through posters, video films, demonstrations, farmers were given awareness on cultivation through organic farming, production and processing of value added products, etc.

In Andhra Pradesh activities were conducted by students through mobile Science Bus Swachhh Bharat program along with learning from science bus exhibition to ensure clean and green campus of their

own. It also conducted Swachh Bharat Awareness Talks with students by science on wheels exhibition bus visiting periods. Students received appreciation prizes for their Swachh Bharat talks from the Regional Joint Director of Education.

Similar initiatives have been taken up in Uttar Pradesh and Haryana as well.

### *3.5.4 Make Tomorrow for Innovation Generation*

Make Tomorrow for Innovation Generation, a PPP Initiative between Department of Science & Technology, Intel Technologies and Indo-US S&T Forum, was launched during September, 2018. It aims to create inclusive technology innovation amongst diverse underserved youth (14-17 years). They would be empowered with skills needed to survive, succeed and scale up in rapidly changing digital India and it can help solving some of the largest social challenges. It has ecosystem partners such as Government, Industry and NGOs must come together and play their respective roles. During this year, 8 sensitization camps were organised covering 18 states including all the states of north-east. 211 schools participated with 300 teachers and 2000 school children. 5 Rapid Prototyping Camps, one each in Himachal Pradesh, Odisha, Uttarakhand, Meghalaya and Jharkhand, were organised in which the children prepared their working prototypes. 415 project ideas were received online. All the eligible idea entries were judged in an online mode and top 50 highest scoring projects were shortlisted and students who submitted them were invited to attend the Make Tomorrow for Innovation Generation National Showcase in New Delhi on December 3 and 4, 2018, and exhibit prototypes of their ideas. Out of 50 shortlisted projects, 25 were team projects and 25 were individual projects including entries from 32 schools in 8 states. Top 10 projects were declared winners.



### *3.5.5 Initiative for Research and Innovation in Science (IRIS)*

Initiative for Research & Innovation in Science (IRIS) is a public-private partnership between DST, Government of India, Intel and Indo-US Science and Technology Forum (IUSSTF) for empowering

the next generation of innovators. IRIS aims to promote and nurture science and science research amongst young Indian innovators. It is research-based science fair for students, which aims to inspire budding scientists in India. Since its inception, IRIS promotes and nurtures science and scientific research amongst young Indian innovators. With the purpose to recognize and reward outstanding projects, IRIS provides a platform for these young and talented ones to represent India at global science competitions like Intel International Science and Engineering Fair (Intel-ISEF). Each year, IRIS, with the help of Senior Scientists, and through its online presence, reaches out to students, teachers and schools across the country and encourages them to come up with research based science projects. IRIS has touched over 3 million students. IRIS National Fair is conducted annually in India for school students, who compete in 17 subject categories. By August, the students send in their entries which are thoroughly scrutinized by the IRIS Scientific Review Committee (SRC). Only the best shortlisted projects are chosen for the IRIS National Fair which has been running for past 9 years. National IRIS Fair: National IRIS Fair was held in New Delhi during 2-4 December, 2018. Over 100 child scientists/ innovators participated in the Fair and presented their innovative research based projects. 20 Outstanding projects were selected for National IRIS awards. Team India participated in International Science & Engineering Fair held in USA in May 2019



### 3.5.6 INTEL International Science and Engineering Fair (ISEF)

Team India, comprising of 20 projects and 26 school students (IX-XII grade), who were selected as winner at Innovation for Research and Initiative in Science (IRIS) National Fair 2018, represented India at International Science and Engineering Fair (ISEF) held in Phoenix, Arizona, USA during 13-17 May, 2019. More than 1900 students from 80 countries participated. Indo-US Science and Technology Forum in partnership with DST facilitated the participants of Team India. In addition to ISEF, Team India also visited Maker Fair in San Francisco. Team India in ISEF 2018 has done nation pride by winning a total of 14 awards at ISEF 2019. In addition, 2 minor planets were named after these outstanding Indian students.

The final Awards won by Team India students at ISEF 2019 are as below:

**Special Awards :-**

1. Association for Computing Machinery-Fourth Award
2. American Psychological Association-Certificate of Honourable Mention
3. American Statistical Association-Certificate of Honourable Mention
4. Ashtavadhani Vidwan Ambati Subbaraya Chetty Foundation -Second Award
5. China Association for Science and Technology (CAST)
6. National Institute on Drug Abuse, National Institutes of Health & the Friends of NIDA- Honourable Mention
7. USAID Science for Development Third Place Award
8. ASU Rob and Melani Walton Sustainability Solutions Initiatives Awards

**Grand Awards:**

**4th Place :**

1. 1 Award in Behavioural Science
2. 1 Award in Robotics and Artificial Intelligence

**3rd Place :**

1. 1 Award in Biochemistry
2. 1 Award in Earth and Environment Science
3. 1 Award in Translational Medical Science

**2nd Place :**

1. 1 Award in Plant Science- Richard Joseph & Manya M Kumar

They also get 2 minor planets in their name.



### 3.5.7 *Rashtriya Kishore Vigyanik Sammelen and Science*

The Child Scientists from the best projects of NCSC 2018 also participated in Rashtriya Kishore Vigyanik Sammelan held at Lovely Professional University, Phagwara as a part of 107 Indian Science Congress during 4-6 January, 2019. The students got an opportunity to interact with the best of the Indian scientists who visited their exhibition during the Indian Science Congress. This provided the Child Scientists an opportunity to sharpen their scientific temperament and knowledge and learning from the best of the Indian scientist during the event.

### 3.5.8 *National Teachers' Science Congress (NTSC)*

The National Teachers' Science Congress (NTSC) was started by the National Council for Science & Technology Communication (NCSTC) in 2003. Since then it provides a platform to the science teachers to communicate their innovative ideas, share their newer experiments & research in science education & communication. NTSC has a broad mandate to provide an opportunity to science teachers to present their innovative approaches in science teaching; Allow teachers to pick up good ideas of other teachers and use them in their teaching practices, science communication, etc. Regional Orientation Workshops are organized before the national event, in order to motivate and orient the teachers to submit papers on the main theme of the congress. Teachers of upper primary, secondary and higher secondary levels. Educators of vocational/open schools, teacher educators, DIET faculty, science educators/communicators, B.Ed / M.Ed students, researchers and scientists participated.

9th NTSC was organized by NCSTC at Vikram Sarabhai Community Science Centre, Ahmedabad on 14-16 December 2018. It was inaugurated by former ISRO Chief Dr K Kasturirangan and had the focal theme, "Design Literacy for Effective Science Communication by Educators" having following Sub Themes —

1. New and emerging media for effective science learning
2. Transition to STEM education
3. Science communication for all
4. Science learning for sustainable development
5. Innovations in science communication

A total of 578 research papers were received out of which 270 were screened in and evaluated to select 212 Oral and 58 poster presentations. An exhibition and hands-on practicals were also organized on site.



**9th NTSC inaugurated by former ISRO Chief Dr K Kasturirangan**



**Participants of 9th NTSC**

### 3.5.9 *Sci-com Folk Media, Low Cost Teaching Aids, Science behind Miracles*

Science Communication initiatives of NCSTC also strives to reach the unreachable, through training, demonstrations, low cost teaching aids, folk media, puppetry, street plays or nukkad natak, folk songs, dances, etc., and to address societal misconceptions like blind beliefs, myths, so-called miracles, and other controversies which can be addressed using S&T and thus instil scientific temper amongst the gullible.

#### **Low cost teaching aids:**

Training workshops were supported in different states such as Andhra Pradesh, Goa, Madhya Pradesh, Punjab etc. with an aim to empower teachers in understanding the importance of learning through hand-on and/or through one's own personal experience and not simply based on what is written in text books. The participating teachers further encourage students and promote the concept of learning science by fun.

Four days training workshop was organized at Govt. Degree College Leh, Ladakh in which teachers from different educational institutions of this hilly area participated



Five North Regional Training Workshops were organised on Teaching Mathematics through Origami (technique of paper folding) to school mathematics teachers from the states of Haryana, Himachal Pradesh, Rajasthan, Punjab and Uttarakhand to popularize the teaching and learning of Mathematics. The workshops were conducted to popularize methods to teach geometrical and Mathematical theorems among teachers through the interesting and fun filled activity of Origami. 163 participants were trained to act as Resource Persons in their respective states



### Explaining Science behind Miracles:

Training workshops were supported to create local science communicators activists who can go to the field, expose prevalent blind beliefs and help inculcate scientific temper among the masses. Workshop were supported in different states such as Assam, Jharkhand, Uttar Pradesh Uttarakhand, Haryana, Madhya Pradesh etc. to create science communicators who can go to the field and expose prevalent blind beliefs and help inculcate scientific temper among the masses.



**“Vigyan Jagar” A campaign for scientific explanation of so-called miracles in two districts of Uttarakhand:** Workshops were organized to train resource persons in Hardwar and Almora districts of Uttarakhand. Vigyan Jagaris were trained as a torch-bearers to hold our flag of scientific temperament, and to help eradicate superstitions and so called miracles. Highlights of the initiatives are -

- 02 workshops and 160 demonstrative workshops during the Vigyan Jagar campaign
- Training 82 resource persons & science communicators
- Reaching out to 38 schools, 30 villages, around 15,254 students, and 6700 villagers



**Science communication through folk media:** The program envisages Science communication in local languages and involves training & demonstrations using folk media. field programmes training workshops. Awareness campaigns were supported in different states i.e. Jharkhand, Madhya Pradesh, Orissa, Karnataka, Punjab, Tamil Nadu, Uttarakhand etc. to promote S&T awareness and develop resource persons as science communicators through folk media.

Eradication of superstitions with the help of folk media among people of Ghansaur Tehsil, District Seoni (Madhya Pradesh)

The programme aims to inculcate scientific awareness among the rural people of tribal block Ghansaur district Seoni Madhya Pradesh and eradicate superstitions through folk media. About 2000 young women, men and students became aware about the science behind the Miracles. Indirectly family members, other villagers, teachers and other students of the schools get benefited. Among rural population folk media is proved successful medium and our messages grasped by them easily as folk media is deep-rooted in their culture. During the programme, collaborated with school principals, teachers, Sarpanch, Panch, apolitical people and administration of the villages and Tehsils and shared the concept with them. Now, they will spread the message to other people in villages. In each selected village, trained at least 05 adults and 05 students to continue the activities and spread the message among the villagers of selected villages. Quiz contests and other activities were hold for students in each village and were felicitated with medals and trophies.



School Students

**Science awareness campaign in Mewat district of Haryana:** The campaign was organised in 90 villages through Drama & Nukkad Natak on Science behind Miracles, Child Marriages, Education, Health and hygiene, and Nutrition.



Nukud team performing act

**Workshop for Science and Technology Communication through Folk Media (Puppetry):** The Government Polytechnic Kohima organized Workshops for Science and Technology Communication through Folk Media (Puppetry) in the 5 districts of Nagaland. 250 communicators at the grass root level were trained in usage of puppetry for science communication.

#### *3.5.10 Science and Tech Communication through Community Radio*

‘Science and Technology through Community Radio’ is an initiative of Department of Science and Technology to inculcate scientific temper among people in a participatory approach on issues pertaining to Health & Nutrition and Mathematical learning using community radio. DST funded 9 community radio stations for promoting easy to understand modes and methods of mathematical learning in their day to day life. These stations are currently creating content based on the need assessment of locals and broadcasting it. A workshop to discuss the programme with stakeholders was organized in December 2018 at New Delhi.

#### *3.5.11 Mission Eco Next*

The programmes aims to inspire and nurture the Eco Intelligent Youth and Young Change Makers. ‘Mission Eco NEXT’ initiatives focus upon promoting regional responsiveness for building regenerative ecological futures which are leveraged by eco-media, eco-design, eco-innovation. It is promoting integrated efforts for conservation of natural resources, specifically aimed at developing models in public guidance systems based on science communication. These may include location-specific innovative initiatives for actionable learning and building field capacity for adopting scientific best practices in knowledge critical domains. Science & Technology Communication Trainings and support are provided in project mode for knowledge-led motivation and capacity building of youth for leadership and improvement of quality-of-life of specific target groups, based on scientific approaches of ‘being-on-their-own’ and ‘collective response’ to challenges and location-specific issues

5th Meeting of TAC was organized on 02 June 2018 in Madurai with Madurai Kamraj University. The Committee considered 16 new & revised proposals and considered 15 proposals/ matters arising out of on-going/completed/ recommended projects, in addition to detailed consideration of Programme Policy matters. 09 completed projects were evaluated.

Regional Eco Next Media Lab on 3rd June 2018 2018in Madurai with Madurai Kamraj University with an aim to promote Science Communication studies related to Vaigai River Civilization & Indus Valley Civilization based on Archaeo-ecology for reconstructing the relationships between past societies and the environments they lived in and Model Heritage-Eco-Water System of Arittapatti. It also aimed at configuring the strategies to develop Scientific pathways for Eco-cultural modelling for a regenerative future, &Contributing a fresh approach to deciphering eco-intelligence for today & tomorrow & communicating related S&T. It was hugely successful in terms of content development and drew strong regional participation with invited and local resource persons.



*Mission Eco Next*  
 Regional Eco Media Lab,  
 Madurai Kamraj University, Madurai  
 June 3, 2018

## Young Eco Creatives' Madurai Declaration

"We the enlightened young creatives are ushering on the path of re-building eco faith by putting our trust in eco-talents all around us and fostering them with expressions of our genuine humanity.

As we evolve and rise with unrelenting creative, scientific and investigative eye, restorative mind and compassionate hearts, we firmly resolve to create every single moment in our diligent practice for ourselves and others for a resilient habitat and bright regenerative future for all.

As active eco creative practitioners we kindle hope and joy of meeting and surpassing sustainable development goals and creating enduring ecological value for humanity."

**Signatories:**  
 Participants & Resource Persons, Regional Eco Media Lab,  
 Mission Eco Next & MKU  
 Research Advisory Council, Eco Media School, MKU  
 Technical Advisory Committee, Mission Eco Next, D/O SAT, GOI

6th Meeting of TAC was organized on 30 November 2018in Bhuj, Gujarat with KSKV Kachchh University. The Committee considered 25 new & revised proposals and considered 06 proposals/matters arising out of on-going/completed/ recommended projects, in addition to detailed consideration of Programme Policy matters. 05 completed projects were evaluated.

Regional Eco Next Connect & Eco Media Lab were organized on 28th& 29th November 2018in Bhuj, Gujarat with KSKV Kachchh University with an aim to promote Science Communication studies related to Kachchh eco region for reconstructing the relationships between past societies and

the environments they lived in and current challenges. It was hugely successful in terms of hands on science & eco media activities and drew strong regional participation with invited and local resource persons.



Eco Eureka Workshops, Eco Studios for Eco Creatives with post-trainings engagements, and Water Clinics are a series of continuing initiatives whereby scores of young leaders have been trained. Stress has been placed on model interventions for remote, inaccessible, marginalized, and challenging areas & populations. Some projects completed with significant entry point trainings organized are -

- Eco Eureka on Youth Engagement Workshops on Nature and Labs by C.P.R. Environmental Education Centre, Chennai
- Eco Eureka trainings by Gangothri Charitable Cultural and Educational Trust, Nammara, Palakkad, Kerala
- Certificate Programme in Eco-WaSH Science Communication under Eco-WaSH Awareness and Literacy Programme of NCSTC by Kerala Educational Development and Employment Society (KEDES), Thiruvananthapuram

- Eco Studio Prashikshan Karyashalaon wa Vigyan Adharit Sahbhagita Poorna Vigyan Sanchar ke Madhyam se Gramin Anusuchit Jati wa Janjati ke liye Aajivika ke Eco samadhan Navachar wa Prakritik Sansadhan Prabandhan ke Uttam Abhyason ka Utpreeran by Girijan Swaichchik Sansthan, Jaipur, Rajasthan
- Sthaniya wa Kshetriya Gyan Vigyan, Vaigyanik wa Prakritik Samadhan dwara Prakriti punarjeevikaran tatha Eco Eureka Prashikshan Karyashalaon ke aayojan dwara Parasthitiya Punarjeevikaran by Ashoka Takneeki Evam Vyavasayik Prashikshan Sansthan, Cheepabarod, Baran (Rajasthan)
- Developing Rural Youth as Wash Creatives by Uttarakhand Bio Products and Technology Development Cooperative, Takula, Almora

**Highlights from significant Intensive, moderate range initiatives:**

- Health risk awareness with special reference to water hygiene and environmental conservation by development of web portal and awareness campaign in Uttarakhand, was implemented by Department of Zoology and Environmental Science, Gurukula Kangri University, Haridwar, Uttarakhand - Large numbers of students and locals living in and around industrial areas have participated. Works and camps were organized during project and demonstrated the actuality of health effects of industrial pollution. Demonstrations have been made through audio visual modes in schools and among the local and industrial labours to show how to be safe from the polluted water.
- Eco Eyes: Creating Youth Leadership Group for conserving the Water Ecologies & promoting WaSH in Southern Districts of Haryana: The initiative has built capacity of about 102 youth (96 Eco Eyes and 6 EcoWaSH Leads (interns) from target area on conservation of water bodies and promotion of WaSH. Evidence based training material has been developed using Geo Media. All the messages are backed up with the precise Geo Media (Geo tagged pictures, maps). Participatory Rural Appraisal and village data collection tools were developed for data collection in standardized format for all the target villages. Mixed methods approach has been utilized. Training program developed with class room lectures, discussions, field observation visits and participatory methods. Eye opener video films, case studies, geospatial maps and baseline data, guided & supervised field work was utilized. Geospatial media was developed and used for awareness generation and PRA and data collection especially from villages of Nuh and Palwal district in Haryana.

WaSH reassessment of villages by trainees provided good measurement of the environmental hazards and exposure in the rural areas. It included detailed mapping of solid and liquid waste in the village.



- Youth Engagement on Nature and Labs -C.P.R. Environmental Education Centre, Chennai conducted five Eco Eureka workshops of five day duration in the states of Tamil Nadu, Karnataka, Odisha and the Union Territories of Puducherry and Andaman & Nicobar Islands. The workshops were organised in collaboration with the concerned Education and Forest Departments. The workshops were organised at the proposed places targeting college students and 100% participation was achieved. College students accompanied by their lecturers benefitted from the workshops. They gained hands on experience understanding the nature and environment and on analysing water and soil samples. They actively monitored the noise levels too. The participants got an opportunity to learn about local ecology and environment and also identified the local flora and fauna. The students had an opportunity to visit naturally protected areas and interacted with natural resource managers, scientists, academicians, foresters and other field level staff.



**Students analyzing the water samples using CPREEC's water testing kit**



**Students at the Auroville Earth Institute, Auroville and observing the soil samples brought from across 190 countries**



**Water and soil analysis methods at the Analytical Laboratory of the Puducherry Pollution Control Committee**

- **Social Marketing of Water Saving Technologies to Mitigate the Effects of Climate Change** has been implemented by College of Home Science, Punjab Agricultural University, Ludhiana. The overall level of awareness of majority of the respondents regarding climate change was assessed at the beginning of the initiative. Accordingly, Water Literacy Kit was developed for creating awareness and imparting knowledge regarding water saving technologies at agricultural and household level. This can further be used for different extension activities conducted by different

departments. Awareness campaign was organized to create awareness among farm families and to popularize water saving technologies at agricultural and household level. Adoption of small water saving devices on trial basis was facilitated by distributing water literacy kit.

### Street plays in selected villages



Following other important initiatives have been concluded successfully:

Communicative Profiling, Monitoring & Analysis of water quality awareness vis- a - vis need for innovative field test methods for Chromium and Copper, Sriram Institute of Industrial Research, Delhi

Development of Water Entrepreneurs for Integrated Eco-WaSH Technology and Practices Literacy through Women Self Help Groups in Marginalized Areas- National Institute of Advanced Studies, Indian Institute of Science Campus, Bangalore

Pesticide risk reduction through Pesticide literate Model Villages in South Western Punjab-Regional Research Station, Faridkot (Punjab Agricultural University)

Capacity building of mountain farmers for promotion of climate resilient horticulture crop production under changing climatic situations in Himachal Pradesh -Dr. YS Parmar University of Horticulture & Forestry, Nauni, Distt. Solan (H.P.)

In addition, some of the latest field initiatives supported during the year are -

- Eco Routes Eco and Wash Dialogues for Eco Intelligent Rural Rejuvenation Field Capacity Enhancement for States of Uttar Pradesh, Uttarakhand - India Water Foundation, New Delhi
- NCSTC's Eco-Media Tool on Climate Change Potentially for Use by Science and Environment Communicators for Holding Awareness Building Programmes among People on Climate Change Issues - Alternative Futures, New Delhi
- Creating Awareness Among School Children of District Amritsar About Eco-Wash Techniques Through Participatory Media Approach- DAV College Amritsar, Punjab

- Haritam Sarvada: Science communication for eco innovation and green livelihoods- Aajeevika Sansthan Salumber, Udaipur, Rajasthan
- Eco Next Miles Chunauti: Champawat Jile Mein Vigyan Sanchar ke Madhyam se Yuvaon ka Kshamta Vardhan - Yogdan Yuva Janjagran Samiti, Almora, Uttarakhand
- Eco Leads Eco health science communication to promote young change makers-Kadam Samiti, Nainital, Uttarakhand

### *3.5.12 Mission Enlighten*

In order to strengthen Science Media, NCSTC aims to innovate, augment, synergize and harness research in keeping with emerging trends like transdisciplinary imaging science media. Support is considered for innovative Sci-Media research, including research on future of science literature, media magazines, Research Modules for existing/new popular science magazines/publication/ translations and pilot publication runs of the research-enriched versions so as to assess the impact, especially on youth, and defining the innovative models for replication/or scale up. The aim is to involve lead institutions so that path-breaking innovative concepts researches are nurtured and shared especially for young practitioners in science media. The successful models may be then considered for upgradation as Science Media Centres. Recommended thrust areas for such initiatives include Environmental Health Sciences, Public Health, Medicine Sciences, Food, Biosciences, Agricultural Sciences, Energy, S&T Information Sciences, Science Fiction, Computational Media, Animation, Gamification for Scientific Literacy & Temper among others.

“Science Media & Communication Research Initiative” was launched as Mission Enlighten from Jawaharlal Nehru University, New Delhi on June 14, 2018. 1st Meeting of Technical Advisory Committee and a Brainstorming Meet were organized on this occasion.

Vaigyanik Drishtikon- Shodh ki Parampara aur Vaigyanik Drishtikon, the Science Communication Monthly, has been relaunched from Jaipur in its present, recast version focussing upon scientific research having 16 nos pf pages and coloured visuals on four pages. The inaugural issue was unveiled by Hon’ble Minister of Science and Technology and Earth Sciences. The publication has come out with 19th issue on 1st December 2018.

Science Creatives & Media School for Scientists & Media, is the latest initiative supported to Vaigyanik Drishtikon Society, Jaipur, Rajasthan for promoting scientist, media & students connections through Transformatory Labs and Short Term Training course. A campaign for the creation of good quality science communicators has started. The first phase of this campaign was organized at Kota. In the three-day workshop researchers of various higher educational institutions and some professional sciences communicators participated. The second and third phase will be held at Jaipur and Udaipur respectively. 10 Selected researchers from these workshops shall undergo a two weeks school of advanced training.



Gamification of Science Topics as Role Plays is another initiative supported for engaging children with understanding of science.

### **Science Communicators' Meet**

Science Communicators' Meet is a two day event held every year during the Indian Science Congress. Maximum two persons (one for oral and one for poster) are selected from 28 different chapters of ISCA across the country by the selection committee and are nominated to participate in the "Science Communicators Meet" during Indian Science Congress. Science Communicators' Meet provides opportunity to selected science communicators to present their research papers and interact with wider section of the scientific participants all over the country.

12th Vigyan Sancharak Sammelan (Science Communicators' Meet) with an objective of communicating the basic concepts of science amongst the common people was held at Lovely Professional University, Punjab as a part of 106th Indian Science Congress on January 5-6, 2019.

- The meet was inaugurated by Hon'ble Minister, Shri Ravi Shankar Prasad, Union Minister for Electronics & Information Technology and for Law & Justice on January 5, 2019 and was attended by a huge gathering of more than 2500 scientists, science communicators, media personnel, faculty & students.
- Release of Souvenir: Abstract book of Science Communicators' Meet was released by the Hon'ble Minister and other dignitaries during the event.

32 Science Communicators made the presentations of their contemporary research work in four Technical Sessions spread over two days. 17 oral presentations, 15 poster presentations were held on contemporary issues in Science & Technology communication.



**CSE-2019 Children Science Congress-2019**

**Vigyan Sancharak Sammelan at ISC-2019**

### *3.5.13 Augmenting Writing Skills through Articulating Research (AWSAR)*

A new initiative Augmenting Writing Skills through Articulating Research (AWSAR) was launched to utilize the latent potential of PhD scholars and Post-doctoral fellows (PDFs) towards science communication in popular format and to promote scientific temper in the country. A National Level Competition was created where 100 best stories from PhD scholars will be awarded Rs 10,000/- along with a certificate of appreciation and three superlative popular stories were awarded Rs 1,00,000/- (First), Rs 50,000/- (Second) and Rs 25,000/- (Third). Under Post-doctoral category 20 stories were awarded Rs 10,000/- along with a certificate of appreciation and an outstanding story was awarded with Rs 1,00,000/- . Capacity building workshops on ‘Popular Science Writing’ were conducted at Dehradun, Kolkata, Chennai and Mohali in the month of September 2018. A total of 2629 stories were received under ‘Call for Entries’; 2269 stories were from PhD Scholars and 455 stories were submitted by PDFs. Winners were declared under PDF Scholar & Ph.D. Scholar categories, in addition to 20 best stories under PDF category and 100 best stories under the Ph.D. category. During National Science Day-2018 (NSD) the AWSAR Awards were conferred.

### *3.5.14 Celebration of the National Mathematics Day (NMD)*

To popularize Mathematics among students, women and general public NCSTC, DST is supporting programmes related to NMD, ranging from one day to a month or longer. The activities include debates, quizzes, exhibitions, lectures, training programmes, hands on activities, Math-lab activities and other innovative programmes etc. Programmes are implemented in schools, colleges, universities in various States through state S&T councils.

The National Mathematics Day is observed all over the country on December 22 to popularize Mathematics. In the states, this the day marked either the culmination or beginning of the activities related to Mathematics popularization. The States S&T councils supported for this important area, namely, are Nagaland, Mizoram, Manipur, Assam, Tripura, Arunachal Pradesh, Sikkim, Goa, Chhattisgarh, Himachal Pradesh, Maharashtra, Karnataka, Andhra Pradesh, West Bengal, Tamilnadu, Uttarakhand, Uttar Pradesh, Telangana, Kerala, Punjab and many other states.



Prize winners with Chief Guest, Guest of Honour and Organizers.

### 3.5.15 National Science Day

National Science Day Function was held at Jawaharlal Nehru University, New Delhi on 28 February 2019. The focal theme was “**Science for the People and the People for Science**”. **Padma Sri Prof. K. VijayRaghvan, FRS, Principal Scientific Advisor, GOI** delivered an insightful lecture on the theme. Prof Raghvan & Prof Ashutosh Sharma, Secretary, DST released publications, “**NCSTC at a Glance**” and “**Communicating Science & Technology-Achievements 2018-19**” on this occasion. Ten National Award for Outstanding Efforts in Science & Technology Communication were conferred on National Science Day in appreciation of work in Science Media & Journalism/Science Reporting. In addition, AWSAR Awards 2018 were also conferred for popular science writing to the four selected scholars.



National Science Day highlights need to connect science with community

Celebrating NSD by S&T Councils/ S&T Departments of States

Every year, 28 February is celebrated as the National Science Day (NSD). The programme was initiated to trigger science popularization activities throughout the country. NCSTC acts as a nodal agency to support and coordinate celebration of NSD by giving support to State ST Councils/ Departments for organization of lectures, quizzes, open houses, science week, etc. NCSTC, DST supports various programmes countrywide through State S&T Councils & Departments. State S&T Councils invite proposals from various scientific institutions, S&T based agencies and laboratories.

The National Science Day 2018 programme was supported all over the country through State S&T Councils/Departments, to name a few are Nagaland, Mizoram, Manipur, Assam, Tripura, Arunachal Pradesh, Sikkim, Goa, Chhattisgarh, Himachal Pradesh, Maharashtra, Karnataka, Andhra Pradesh, West Bengal, Tamilnadu, Uttarakhand, Uttar Pradesh, Telangana, Kerala, Punjab and many other states.



**Model making competition organise on the eve of NSD - 2019 Celebration**

### 3.5.16 UNESCO Kalinga Award for Science Popularization (Biennial)

The UNESCO Kalinga Prize for Popularization of Science is a prestigious award given by UNESCO for exceptional skill in presenting scientific ideas to lay people. It was created in 1951, following a donation from Shri Biju Patnaik, then Chief Minister of Orissa and Founder President of the Kalinga Foundation Trust. Now the Prize is co-funded by DST, Government of India, Kalinga Foundation Trust and DST, Government of Orissa. Some of the past prize winners have been Nobel Prize winners. It is administered by the Science Analysis and Policies Division of UNESCO. The purpose of the Prize is to reward efforts of a person who has had a distinguished career as a writer, editor, lecturer, radio/television programme director or film producer, which has enabled him/her to help interpret science, research and technology to public. Many past prize winners have been scientists, while others were trained in journalism or have been educators/writers. Each member State is entitled to nominate one candidate, through its National Commission for UNESCO, on recommendation of national associations for the advancement of science or other science associations, or national associations of science writers/journalists. Applications from individuals are not accepted. The laureate is selected by Director-General of UNESCO upon the recommendation of a five-member jury designated by her/him. The recipient receives US\$40,000 and a UNESCO Albert Einstein Silver Medal. The recipient is also awarded the Kalinga Chair, introduced by GoI in 2001. As holder of the Kalinga Chair, the winner travels to India for a period of 2-4 weeks as the guest of Government of India. The Chair also comprises a token honorarium of US\$5,000.



Prof. Prof Erik Jacquemyne from Belgium is the winner of UNESCO Kalinga Award for Science Popularization for 2017. Prof Jacquemyne became a science and technology advisor to the Minister-President of the Flemish Government. He has launched notable science communication initiatives, like the Flemish Science Week, the Science Festival and several science contests. He has been invited by Secretary, Department of Science and Technology to visit India as guest of Government of India for duration of 2-4 weeks to give lecture in various cities in India. Prof Jacquemyne shall also be awarded the Kalinga Chair, introduced by the Government of India in 2001 to mark the 50th anniversary of the Kalinga Prize.

### 3.6 Science for Equity for Empowerment and Development (SEED)

Science for Equity for Empowerment and Development (SEED) Division of DST has been implementing several field based schemes & programs with a view to apply Science & Technology (S&T) primarily to enhance livelihood opportunities and the quality-of-life of under-privileged section of the society, through adaptive research, capacity building and skill development at local level. Initiatives being taken through such technology driven field based interventions have also been contributing to address UN-Sustainable Developmental Goals (SDGs) 1-8,10-11, 13-15 & 17 as well as in National development programs like Unnat Bharat, Sugamya Bharat Abhiyan (Accessible India Campaign), Swachh Bharat Abhiyan and so on. Specific achievements made during the year under various schemes/programs are as under:

#### 3.6.1 *Technological Advancement for Rural Area (TARA): Long Term Core Support:*

SEED Division of DST extended long term Core Support under Technological Advancement for Rural Areas (TARA) scheme to 26 S&T based NGOs to enable them primarily to provide affordable technological solutions to challenges in rural as well as remote settings through adaptive R&D under field conditions. In this process, these Core Support Groups (CSGs), which are spread across the country, play crucial role in building capacities at the grassroots level and facilitate better livelihoods and skill development in adoption of appropriate technologies in farm as well as non-farm sector and also enhance quality of life ([www.dsttara.in](http://www.dsttara.in)). These groups have strong linkages with R&D labs/academic institutions for technical backup support besides in-house capabilities that are strengthened through budgetary support of DST which enables them to hand-hold the communities by engaging them in technology adoption for societal benefits.

Under Core support, these groups focus on technology innovations, incubation and delivery in respective geographical area to empower local community in utilizing field-based technologies and packages. In such an endeavour, a rural tech exhibition showcasing innovative technologies/products developed by these Core Groups for better livelihoods and services in rural settings was organized at FRI, Dehradun during 5-6th February, 2019. Prof. Ashutosh Sharma, Secretary, DST, inaugurated the exhibition and chaired a Brain-storming session on “**Technology Innovation and Up-Scaling for Rural Transformation: Challenges & Opportunities**” involving different stakeholders to discuss convergence possibilities in development & deployment of innovative technologies/tools/techniques & creation of social entrepreneurship particularly at the grassroots level involving Core Groups.

#### 3.6.2 *Specific Outcomes: Core Groups & Social Innovation*

Sardar Patel Renewable Energy Research Institute (SPRERI), Core Group based in Anand has developed PV integrated solar low tunnel dryer (Capacity: 35-40 kg/day). It has specific features like: 1) Low cost and modular 2) Grid independent operation 3) Uniform drying of the products 4) Retains nutrients and colour of dried product and 5) Hot air flow “through the product” for faster drying for agro-produce. The system is standalone & for use by small and marginal framers in remote rural areas/farm where electricity is scarce or unavailable. 10 Nos. of SPRERITECH PV integrated solar tunnel dryers have been installed in various part of India with payback period of 2.5 to 3.0 years.



**PV integrated solar dryer installed at Aromatic and Medicinal Research Centre, Anand**



**Secretary, DST inaugurated Rural Tech Exhibition (showcasing innovative technologies/products developed by Core Groups, SEED, DST) organized at FRI, Dehradun during 5-6th Feb., 2019. Released knowledge products developed under People & Protected Area Program, & interacted during Brainstorming Session organized on Technology Innovation and Up-Scaling for Rural Transformation: Challenges and Opportunities organized by SEED, DST.**

- a. Janata Solar ATM:** The Janata ATM is a Solar Powered ATM specially designed and developed by NB Institute of rural Technology (NBIRT), Tripura under Core support project for the rural masses

of the Country who cannot perform transactions on conventional ATMs due to unavailability of the same in Rural areas and their inability to understand the complex transaction procedure associated with them. This innovative technology will be able to provide safe, secure and easy transactions to the rural masses. It is exclusively powered by solar energy thus it can be used in the remotest of places. It incorporates an audio visual based transaction procedure which is very easy to understand. Additionally, the ATM uses fingerprint instead of PIN and NFC tech instead of Card to enhance security and to make the ATM transactions fail-proof. Fabricated using 2mm cold rolled, the ATM will be very difficult to break into.



**Janata Solar ATM developed by NBIRT, Tripura**

- b. Vigyan ashram (VA), Pune, a Core Group works in development and adoption of different rural technologies and disseminate them through formal (Introduction to basic technology- IBT) and non-formal (Vocational) education programs. It has been able to do technology transfer through micro-enterprise incubation particularly in tribal belt of Pune district through training youth, farmers, WSHG etc with focus on adoption of modern technologies in electronics, digital fabrication, waste management, renewable energy etc on ‘design thinking’ approach. Following are few highlight about the technology development work during last year:

SN	Particular	Status
1	New modified Rice- De-husking machine	<ul style="list-style-type: none"> <li>• Rice de-husking machine is fine-tuned &amp; standardized based on field trial feedbacks from farmers &amp; partner institutes in CORE support project area.</li> <li>• Technical specification of new version: Capacity- 15-20 Kg/Hr , Size- 1300*600*800 mm, Power- Single phase, 1 Hp (0.75 Amp)</li> <li>• Technology transferred to M/s. Climber Enviro solutions Pvt Ltd &amp; new version is adopted by 10 + beneficiaries.</li> </ul>

2	Drying technologies for vegetable / fruits / spices	<ul style="list-style-type: none"> <li>• New version of dome dryer with 25 Kg pomegranate arils loading capacity is under field trial for various inputs like onion, leafy vegetable, sprouts etc.</li> <li>• Dome dryer installed at 3 location as in CORE area for field study.</li> <li>• A drying apparatus developed to study drying behaviour of various inputs with respect to air-flow, humidity, temperature.</li> </ul>
3	Waste recycling	<ul style="list-style-type: none"> <li>• Composting technology of kitchen waste is standardized by developing auto-rotating composters for housing society &amp; individual household based requirements. A microbial culture adopted from BARC &amp; replicated in 50+ locations as individual households, housing societies &amp; municipal corporation under Swatch Bharat Mission.</li> </ul>
4	Fab Projects (Digital Fabrication)	<p>Various projects are made using digital fabrication technology as –</p> <ul style="list-style-type: none"> <li>• DC laser cutter &amp; wood router for Schools.</li> <li>• Low cost temperature, humidity &amp; soil moisture sensor for polyhouse.</li> </ul>



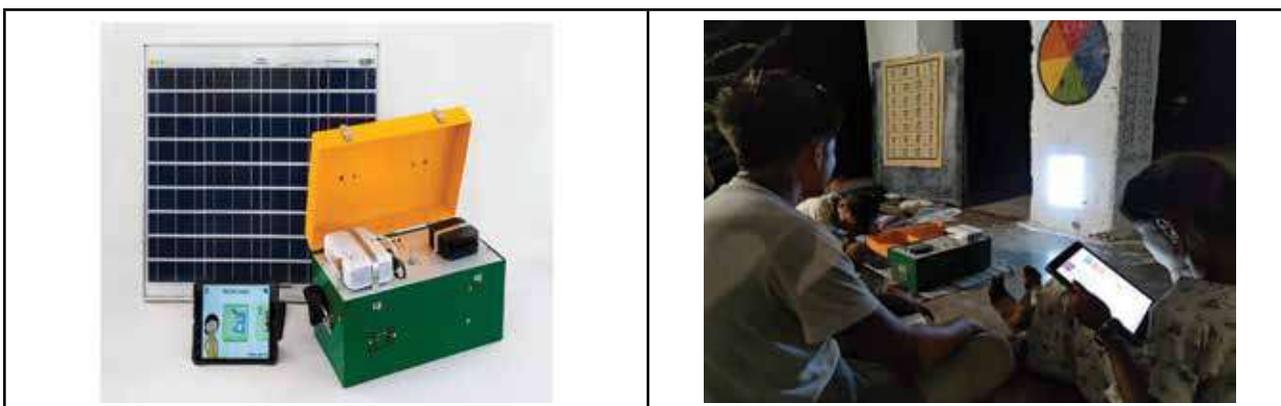
**Dome Dryer developed by Vigyan Ashram, Pune**

Technology Dissemination by Vigayn Ashram- Social Outreach:

- Number of youth employed – 43
- Total number of rural enterprise incubated – 6
- Soil analysis & soil health card given to farmers – 3432+ soil analysis for 14403 farmers under soil health card mission.
- 2000+ wiki articles are developed & published in local language.

- c. A **Solar powered Pico Projector** with offline server for classroom has been developed and practiced by Core Group- Barefoot College, Tilonia, Rajasthan. About 771 children who otherwise would not have gone to school were brought back to the educational system using digital night school (solar projector & offline server) out of which 57 per cent are girls who majority of them are less than 15 years of age in the last one year. Business was conducted in these schools using the technology product for 281,415 Hrs using (solar projector and offline server).

Solar powered Pico Projector with offline server for digital night school  
by Core Group- Barefoot College, Tilonia, Rajasthan



**Innovativeness / Novelty:**

- Easy-to-use tablet based digital projection to convert any classroom into a digital study room.
- The product has an open source data management tool to run “day to day” classes seamless with 4-hour battery backup.

- d. In agriculture sector, MSSRF another Core Group working in Wayanad, Kerala has been able to develop and deliver **Home Nutrition Garden Package under Livelihood Enhancement, Agriculture and Food Security (LEAFS)** activity. It includes vegetables, leafy greens, tubers, pulses and fruits, that is capable of meeting the daily requirement of nutritional factors of the community. The package also ensures the long- term conservation of traditional crop varieties with reduction in household’s food expenditure up to 50 per cent. While, another Core Group, Madhya Pradesh Vigyan Sabha (MPVS), Bhopal has been able to develop and deliver **Rural Nutri-Bakery technology package** utilizing local resources (Kondo, Kutki, Mahua flower, Bael and Aonla etc) to make value added nutri products with quality control by involving local communities. It has led to skill development at local level with creation of five social enterprises with increase in two-fold income for improving livelihood of economically weaker communities in Mandla, Dindori, Chhindwada and Sheopur Dist in MP and Kanker in Chattisgarh. Besides, MPVS has also developed multipurpose minor millet threshing cum dehusking Machine in order to reduce drudgery of tribal women involved in threshing and dehusking of minor millets such as Kondo and Kutki, Ragi. Dehusking may be done of all these minor millets from same machine. It has 2HP

single phase motor (designed for rural area) and having 120 kg per hrs capacity. While, in manual dehusking it requires at 2-3 hrs for 1 kg Kondo and Kutki. So far 10 Mobile dehusking units are being operated by 10 women SHGs of Tamia Block Chhindwada, MP as social enterprise with equal sharing of income benefits.



### **Multi-purpose minor millet threshing cum dehusking Machine**

In above technology led initiatives under TARA scheme, simple and affordable Solar Water and Space Heating Systems developed by Himalayan Research Group, Shimla for Mountain Areas has got recognition as HP State Innovation Award for 2018 which can be fabricated using local resources and material with less carbon footprint, indoor pollution and drudgery involved in collection of fuel wood.

#### *3.6.3 Scheme for Young Scientist and Technologists (SYST)*

Scheme for Young Scientists and Technologists (SYST), has evolved over the years and is currently focused towards encouraging, nurturing and mentoring young scientists associated with Academic Institutions, NGOs and Universities to harness their scientific knowledge towards addressing societal challenges through S&T based solutions. In 2018-19, about 52 projects have been recommended for support.

Specific Outcomes:

- a. An eco-friendly package of practice for cultivation of Phalaenopsis orchid has been standardized for growth media, nutrition, plant protection and cost management. This crop due to low volume and high value has great potential to double the farmers' income. Over 950 farmers of Kodagu and Hassan were sensitized through trainings in orchid growing.



- b. A Jute fabric based Synthetic Plaster cast for Orthopedic Immobilization has been developed at Shriram Institute for Industrial Research, Delhi. The developed plaster cast showed comparable properties with available synthetic plaster cast with respect to setting time, compression strength, elongation etc. Application trial has showed no in-vitro cytotoxicity, skin sensitization and skin irritation effect while performing preclinical studies. Synthetic plaster cast available in market is available at a rate of Rs 800-900/pkt, whereas the developed jute fabric based cast will be available at a rate of Rs 300-350/pkt.
- c. Red Spider Mite (RSM) is a major pest of tea in Assam. An Integrated Pest Management (IPM) strategy based on biochemical parameters xenobiotic enzymes to control RSM disease has been developed by Tocklai Tea Research Institute, Jorhat, Assam with less management cost to 15-25% as compared with conventional management programme. IPM package was demonstrated to 200 tea farmers through workshop in Assam and Tripura.

#### *3.6.4. Technological Interventions for Addressing Societal Needs (TIASN)*

Projects funded under TIASN programme involve technology development and adaptive R&D for the benefit of society. Grant-in-aid support is provided to R&D Institutions, Universities, and NGOs in the area of Agriculture, Health, Nutrition and activities related to Non-Farm sector. In 2018-19, 9 projects were supported under TIASN scheme.

Specific Outcomes:

- a. A portable device **Earth powered light** for generating electrical energy was designed and developed by Chandigarh University, Punjab especially for toilets in rural areas using earth's gravitational force to run a micro-generator. The device is generating clean and green energy and could be adopted under 'Swachh Bharat Abhiyan' to provide light and safety to toilet users. The

cost of this device currently is Rs.1000 and could be reduced further to Rs 500, if taken up for mass production. The device is being tested at village level in Gharual, **Mohali**.



**Earth powered light**

- b. In order to address the challenges related to refrigeration of end products, cost of transportation and storage faced by goat meat farmers, five shelf-stable retort processed products viz., retort processed goat meat curry, goat meat biryani, goat meat patties, goat meat kebab and goat meat nuggets were developed at ICAR – Central Institute for Research on Goats, Makhdoom, Mathura, Uttar Pradesh. Technology for the retorting was developed for both curry based animal products and non-curry based products. Developed products were found to have shelf life of more than six months at room temperature. The microbial counts were recorded in prescribed limits throughout the storage period of six months. The sensory panellists rated the products as good for overall acceptability. The technologies were demonstrated to progressive farmers, entrepreneurs and to the trainers involved in the transfer of technology

*3.6.5. Network Program: Technology Intervention for Mountain Ecosystems-Livelihood enhancement through Action Research & Networking (TIME-LEARN):*

This program has been initiated as Umbrella Program covering three Himalayan states (J&K, H.P. and UK) with 20 approved projects under execution since 2016-17 to improve socio-economic status and livelihood opportunities of mountain communities through intervention of need based technologies involving S&T knowledge institutions and field level agencies. Specific outcomes during the year are:

- a. Under a project, specific efforts have been made by Indian Agricultural Research Institute, Regional Station (CHC), Shimla to establish virus free elite mother block of apple in the tribal areas of Kinnaur and Lahaul Spiti in Himachal Pradesh to address the problem of low productivity and

income to farmers. Twenty virus-free elite variety of apple plants have been identified for planting, and further multiplication for the production of virus-free elite variety of apples is in progress involving farming community to fetch better income & livelihoods. The effort is to make the area virus free which will lead to 30 to 40 percent increase in virus free apple production. Further, to address the problem of low productivity in apple farming, the Bee-Keeping Mud Hive Technology in Wet Temperate Zone of H.P has been introduced by STD, Mandi covering cluster of 8 villages in the district Mandi, HP. This mud hive has characteristics of both wall hives (Natural Habitat) & modern wooden hives where bees can be managed scientifically for inspection, feeding, & extraction of honey. Introduction of 100 colonies of local bees (*Apis cerana*) by skilling framers in mud hives preparation and management has increased pollination leading to increase in apple productivity 25 per cent with total 30 per cent increase in income of apples growers covering 20 ha. Besides, farmers were able to have increase productivity of honey contributing to local livelihood security.

- b. In another project under TIME-LEARN program for enhancement of livelihood options based on locally available resources in disaster affected villages in Kedar valley of Uttarakhand, 92 farmers from 12 villages were trained in protected cultivation technologies, bio-prospecting of agro and wild bio-resources, including medicinal plants (MAPs) cultivation/conservation as a source of income, livelihood enhancement & biodiversity conservation.



Virus free apple grafts in poly-house conditions.



Apple grafts in open field conditions



On site interaction by DST's Expert Group at Kinnaur, HP



Cultivar: Golden delicious

- c. Due to lack of bridges and motor-able roads in many far-flung areas of Himachal Pradesh and Uttarakhand, local people have been using traditional river ropeway systems called 'Jhulla' for quite long. The main problem with the traditional river ropeway system is that it is cumbersome to pull it away from sag, it requires extra person on the other side than passengers using it to pull the rope and is accident prone as there is risk of overturning the trolley. To address such problems to commute across the river in rural and hilly terrain, a prototype of Improved Ropeway as a light weight carrier has been designed by Society for technology & Development, Mandi with technical support from IIT, Mandi. Prototype is being field-tested at Mandi, HP to address recurring problems of efficiency, safety and drudgery associated with conventional river rope way system. It will be easy and safe to operate by women, children and elderly people.



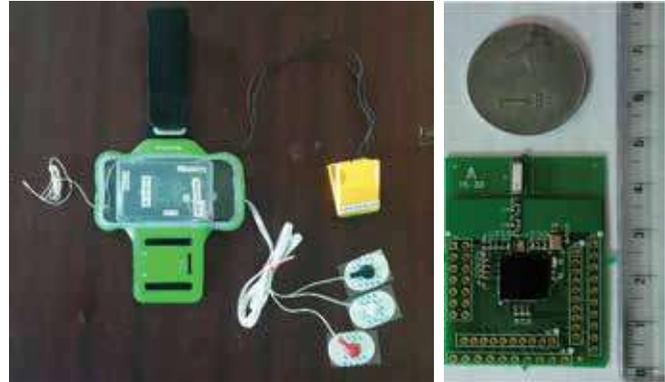
**Prototype of Improved River Ropeway**

### 3.6.6 Technology Intervention for Disabled & Elderly (TIDE) Program:

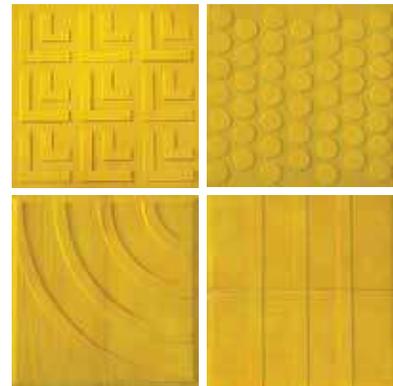
The Technology Interventions for Disabled and Elderly (TIDE) program has a mandate to promote applied research, development and dissemination of assistive technologies for empowerment of Elderly and Divyangjan in the country. The focus of the program is to develop customized & affordable, state-of-art assistive devices in Indian context. The Committee of Secretaries monitoring Accessible India Campaign (AIC) had identified the TIDE Program for promoting technological innovations for the benefit of Divyangjan. The program also complements the three verticals of AIC (Accessibility, Transportation and ICT ecosystem). The Department of Empowerment of Persons with Disabilities (DoEPwD) is exploring the possibilities of commercialization of technologies developed by DST under TIDE Programme. Some of the significant outcomes of the year 2018-2019 are as under:

- a. **A Wearable Physiological and activity Sensor node for Elderly** people and post-operative patients in home and hospital environment was developed by Electronic Sensor Research Lab &

Electronic System Design Lab, Velammal Engineering College, Chennai for monitoring physiological parameters, such as, body temperature, pulse, oxygen saturation rate (spO<sub>2</sub>) and body acceleration remotely. The system can be used with real time cloud interface using web server. The wearable sensor nodes developed indigenously are cost effective, easily reconfigurable, minimum in size, non-invasive, power efficient and wireless. Similar sensor nodes available in the market cost around 1000 USD. The system is Internet of Things (IoT) enabled and can operate home based electrical gadgets using user's body temperature (Actuator control)



- b. In another project, **Adhesive Tactile Walking Surface Indicators** were developed by SR Engineering College Warangal for Visually Challenged Persons. The prototype is a tactile tile which consists of different types of protrude designs that are easily recognized and remembered for navigation of visually impaired in different built environments. The existing tiles for navigation of visually challenged are ceramic based. The proposed tactile is made up of synthetic rubber, polylactic acid (PLA) and thermo plastic poly urethane (TPU) materials which are break free, corrosion free and non slippery. The tactile can be even pasted without modifying the existing structures/built environment and can be changed according to the environment. The tactile can also be used by elderly with low vision in home environment.



- c. Many digitized models of Amsler available in play stores, cannot objectively quantify the functional loss. The Manipal E© Amsler is interactive software that effectively connects patient and the clinicians. The **developed interactive Manipal E© Amsler software is a cost-effective application for Screening Sight-Threatening Eye (Macular) Diseases** which evaluates patterns of distortions and aids home-based monitoring of functional losses. The Product has interactive and objective Amsler software that can address the gaps in existing technology. The Manipal E© Amsler grid chart allows the user to make markings on the grid which gives a novel scoring to each marking made on the grid. The tool has a list of instructions for the end user to understand how to perform the test. It also saves the pattern made by the user and sends to the cloud whenever the users connect to the internet or saves in the device. Patient as an end user can use the tablet-based software in the home and the clinician extract the data from the cloud to



follow- up the prognosis.

- d. Speech algorithms automatically assess the patient speech and instant feedback is provided to the patient, to enable them rectify their articulation errors. Mobile Phone Assisted Remote Speech Therapy (MoPAREST) Platform has been developed by Ali Yavar Jung National Institute for Speech and Hearing Disabilities, Mumbai in collaboration with TCS Innovation Labs Mumbai is used to rehabilitate patients with speech disorders through mobile device. This platform virtually bridges the gap between SLPs and patients, especially for rural patients. Automatic assessment of pathological (misarticulated) speech using speech signal processing is an integral part of this smart system. A web interface is used by the speech language pathologist (SLP) which enables the SLP to digitize their interactions with their patients and monitor patient progress remotely at a convenient time. The patient enrolls on the platform based on recommendation of a SLP. The data can be stored on the web server and later can be assessed by SLP for assessment and corrections.



### 3.6.7 S&T for Women

This scheme aims to promote research, development and adaptation of technology to create gainful employment potential of women, reduce their drudgery, improve working conditions in local areas through inputs of S & T. It also look into challenges to improve the quality of life, health and nutrition of women through the application of S&T. It also supports setting up of Women Technology Parks as common facility center to involve and build capacities of women in new trades and skills with scientific knowledge as highlighted below:

- a. **Establishment of Rural Women Technology Park in CSIR-North East Institute of Science and Technology, Jorhat, Assam:** A project has been sanctioned to CSIR-NEIST with the objectives of developing a common platform for women entrepreneurship development through dissemination of suitable technologies, organizing awareness, training, skill development programs for rural women and for providing post training intervention through financial and market linkages. Training programs for technologies like Herbal mosquito repellent candle, Herbal Mosquito Repellent incense sticks, Low dust Chalk Pencil, Wax colored pencil, Banana Fibre Extraction processes, Handmade paper, weaving, etc. will be offered in the Women Technology Park, which aims to take up women beneficiaries from the Aspirational districts of Assam namely, Baksa, Darrang and Udalguri besides Jorhat district in North East.



### Rural Women Technology Park (RWTP) at Basani, Varanasi

- b. Another Rural Women Technology Park (RWTP) has been set by Digital India Corporation (formerly Media Lab Asia), New Delhi jointly with Sai Institute of Rural Development (SIRD-YGVS) Varanasi with the objectives of Skill enhancement training on food processing & preservation, digital art making Craft designing, and marketing as well. It will also spread health awareness and entrepreneurship among the target women. The place of establishment of RWTP is Basani, district Varanasi, Uttar Pradesh. More than 500 women artisans/students will be trained on Chick™ CAD software for Skill enhancement on khaka & craft design. Training on embroidery designing using Chic CAD software has created more than 100 designs.
- c. **Bolmoram Technology Resource Centre Cum Knowledge & Innovation Park, East Garo Hills, Meghalaya:** The Bolmoram Technology Resource Centre cum Technology Park has been sanctioned to the State Council for Science Technology & Environment, Meghalaya. The technology park will promote the use of green technologies through demonstration, hands on training and information sharing. It will be able to demonstrate eco-friendly technologies on housing components, sanitation, bamboo products and livestock, including value-addition of agriculture and horticulture products. Moreover, Technologies that can reduce women's drudgery will be promoted among the villagers.
- d. **Popularization of kharif onion production in Chamba district of Himachal Pradesh:** A project on Popularization of kharif onion production in Chamba district of Himachal Pradesh was sanctioned to the College of Horticulture, Y.S.Parmar University of Horticulture & Forestry, Hamirpur, H.P. Sensitization programs were organized at eleven locations and progressive farmers were selected for the same. The seed of onion variety Agrifound Dark Red (AFDR) was provided to the farmers for raising sets to produce Kharif onion. More than 150 farmers benefitted from this technique and harvested a winter crop of onion. Farmers earned substantial profit through the Kharif onion crop.



### 3.6.8 Scheduled Caste Sub Plan (SCSP):

Department of Science and Technology has been implementing a Scheme, viz Scheduled Castes Sub Plan with a view to empower SC population through the input S&T and to promote research, development & adaptation of S & T for improving quality of life of scheduled castes. Some of the significant outcomes of the year 2018-2019 are as under:

#### Specific Outcome:

- a. During the period of 2018-19, a total of 6 new projects with strong social component were supported under the scheme
- b. The **Coordinated program on Resource management and Development for the empowerment of scheduled caste** in different parts of the country has achieved the following output :
  - 48 NGO partners belonging to Andhra Pradesh, Bihar, Gujarat, Himachal Pradesh, Jammu & Kashmir, Karnataka, Kerala, Madhya Pradesh, Maharashtra, Odisha, Pondicherry, Rajasthan, Tamil Nadu, Telangana, Uttarakhand and West Bengal were involved in the project.
  - 15,000 beneficiaries belonging to 4557 Households in 93 villages were benefitted through the project.
  - reverse osmosis technology based water purification plants installed in 3 villages to solve drinking water problems
  - Around 350 toilets constructed. In addition 400 soakage pits were introduced in 30 villages to control water logging
  - 145 ASTRA model stoves introduced in 3 villages and 2 biogas plants were constructed

- Micro-enterprises like cement block making unit, tamarind deseeding and press block making unit, bio-pesticide making unit were established which makes an average monthly income of Rs. 3000 to 4000/- per month
  - 84 mini dairy units have been introduced in 4 villages, which fetch an average monthly income of Rs.3,000/- per family
  - 150 goat/sheep rearing units introduced in 15 villages (annual income of Rs. 10,000 from each unit) and 150 poultry units introduced in 15 villages (annual income of Rs. 500 per month from each unit)
  - About 1000 rural SC youth have been placed in various non-farm jobs at different villages/ towns. 2500 youth were trained in tailoring, bag making, pickling and related skills.
  - 45 awareness programmes were conducted in each village during last three years on health, hygiene, food and nutrition, safe drinking water, drug abuse etc
- c. Under the Coordinated Program on **“S &T interventions in Traditional Crafts”**, a set of six less-intervened crafts were identified for S&T interventions for improving the techniques and practices followed for improving the productivity, product and design diversifications etc. Some of the significant achievements in the program:
- Design and Development of export quality and cost efficient light weighted pin cylindrical locks with zero defect and zero effects
  - Design and development of low cost carding machine for Namdah weavers of Tonk, Rajasthan
  - Skill development programme to provide science and technology intervention through state of art and craft technology on bell metal casting for scheduled caste community in 3 villages of Kantilo gram panchayat of Nayagarh district Odisha.
  - Upgrading the attar value chain-development of improved production technology and standard specification for quality control in Kannauj, U.P.

		
<p>Leather bottles where residual water is dried from the final product</p>	<p>Bhormara or carving rings on the bowl Carving imprints on the bell metal ware</p>	<p>Perfume producers boiling attar at a factory</p>

- d. **A Science Technology and Innovation Hub** had been established at Vivekananda Institute of Biotechnology, Nimpith for SC population through scientific and sustainable natural resources livelihood management; and at Dr. Babasaheb Ambedkar Marathwada University, Aurangabad for skill development, training and capacity building of SC youth in various technologies for establishment of microenterprises.
- e. During the year, around 2000 SC beneficiaries were trained in various livelihood activities in farm and non-farm sectors where there has been an increase in monthly income ranging between Rs.5000-Rs.8000.

#### Social Impact:

- People are now aware of the self-hygiene and sustainable livelihood activities. Linkage with grassroots level youth clubs, PRI strengthened
- Safe drinking water is assured. Staff from the community has ensured ownership of the program
- Adoption of agricultural technologies has increased
- Communities are organized and involved in development initiatives through collective actions towards better livelihood
- Improvement in animal health and decline in mortality
- Awareness about sanitation among household members is on increase
- Quantity and variety of vegetables have increased in food basket of families
- Use of low cost water filter has become popular among the community
- Importance of scientific interventions is realized and technology absorption rate has increased
- School dropout rate has also decreased
- Use of energy-efficient devices has led to reduction in fuel-wood consumption to 45 per cent with less drudgery associated with collection of wood by women

#### *3.6.9 Technological Intervention for Tribal Empowerment (TITE) under Tribal Sub Plan (TSP):*

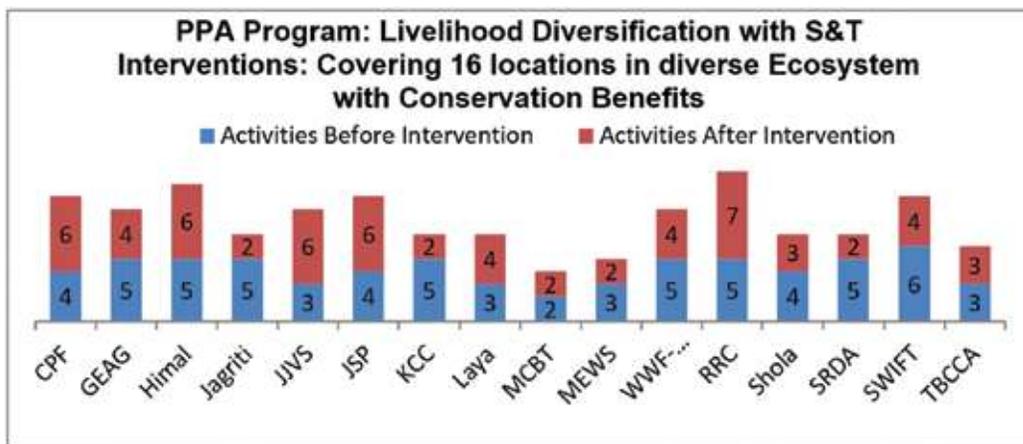
Department of Science and Technology has been implementing a Scheme, viz Tribal Sub Plan with a view to empower ST population through the input of S&T, and initiation of location specific S & T based program in major socio-economic sectors. It has focus to preserve traditional artisan skills, building on local innovation & local knowledge systems in designing local resource management strategies through participatory research approach, and to explore & promote alternative livelihood potential (wherever the present occupation is dwindling) on innovative community-based approaches and technological options to enhance field-level impact. Some of the significant outcomes of the year 2018-2019 are as under:

Specific Outcomes:

- During the period of 2018-19, a total of 24 new projects with strong social component were supported under the scheme
- Individual project were supported in the areas of agriculture, water, livestock, skill enhancement etc. leading to income generation, livelihood enhancement, drudgery reduction and overall improvement in quality of life.
- Network Programme entitled “**People and Protected Areas: Conservation and Sustainable Livelihoods in Partnership with local communities:** has completed its 2nd phase and will soon venture into its third phase. This program is unique as it provides support to local and grassroots NGOs to work towards enhancing sustainable livelihood opportunities through innovation and scalable technological solutions for local communities as well as for the conservation. Programme has also helped to demonstrate innovative approaches and mechanisms based on appropriate technological inputs that enhance sustainable livelihoods of people living around protected area. In the 2nd phase, the program was implemented in & around 16 protected areas leading to adoption of alternative livelihood options to decrease dependency on & sustainable utilization of natural forest resources. A total of 75 villages/hamlets located in tribal regions with a population of around 30,000 individuals have been covered under the program in second phase.

Social Impact:

- The issues and problems solved by a particular community have become a role model for replication by other stakeholders in similar conditions. This has resulted in large scale replication of successfully adopted technologies among the communities



- Confidence is clearly discernible within community, particularly in their behaviour, discussion and rights of their resources. They are frequently visiting Government agencies for developmental issues related to their villages.

- Technologies introduced in the field of rain water harvesting, ground water recharging, open well recharging, soak pit technology, water purification, sanitation technology including two pit and compost toilets and kitchen waste based bio-gas plants.
- Wise use of water from mini water tanks and sprinklers and “sharing of water” for irrigation among farmers is reducing water consumption in agriculture farms.
- Initiated local resources based livelihood activities/ micro-enterprises by forming beneficiary groups e.g., plant nursery unit, cattle feed development unit, fruit & vegetable production units.
- Establishments of saving and credit activities among women and earning enhancing their status in the society.
- Networked with local training centres and production/service units for market driven skill development and placement of local youth and semi-skilled/unskilled workers.

To up-scale above efforts, 3rd phase of the program is scheduled to be implemented involving 23 partner NGOs in collaboration with WWF-India as Coordinating agency and National Botanical Research Institute(NBRI), Lucknow as technology partner, by engaging tribal communities from buffer zones of 23 diverse Protected Areas(PAs) across the country. 3rd phase will focus on technology driven initiatives for energy saving, environment conservation, NTFP processing, nursery rising, farm and off farm based activities to address conservation and livelihoods issues with interface from technology knowledge hubs.

### 3.7 Drug & Pharmaceutical Research Programme (DPRP)

The Drugs and Pharmaceuticals Research Programme (DPRP) has being setup for promoting Industry – Institutional collaboration in the sector of drug and pharmaceuticals. This programme aims at enhancing capabilities of institutions and Industry towards development of New Drugs in all systems of medicine. The specific objectives of this scheme are:

- To synergize the strengths of publicly funded R&D institutions and Indian Pharmaceutical Industry in developing drugs in areas of national relevance;
- To create an enabling infrastructure, mechanisms and linkages to facilitate new drug development; and
- To stimulate skill development of human resources in R&D for drugs and pharmaceuticals.

Under this programme during the financial year 2018-19, a call for proposals was made, against which 159 proposals were received by the division. These project proposals were shortlisted through Internal Screening Committee and the screened-in proposals were evaluated by the Expert Committee of DPRP. The Expert Committee recommended 22 proposals for financial support.

For ongoing project, clinical trials are being conducted at the designated sites as per the approved protocol on “A clinical drug development programme to evaluate and compare safety and efficacy of new regimens of Lifecare’s Liposomal Amphotericin B (FUNGISOMETM) alone or in combination with Miltefosin compared with Single Dose Treatment Regimen of AmBisome® for Visceral Leishmaniasis in India” by Lifecare Innovations Pvt. Ltd., Gurgaon.

### 3.8 Good Laboratory Practice (GLP)

Good Laboratory Practice (GLP) is a quality system under which non-clinical health and environmental safety studies are conducted on various chemicals viz. Industrial Chemicals, Pharmaceuticals, Pesticides, Veterinary Drugs, Cosmetics, Food additives, Feed Additives etc. The National Good Laboratory Practice Compliance Monitoring Authority (NGCMA) was set up under the administrative control of Department of Science and Technology (DST) in August, 2002 to provide GLP certification to the test facilities, which are involved in conducting safety studies on such chemicals in accordance with Organization for Economic Co-operation and Development (OECD) Principles of GLP. India is a full adherent to OECD Council Acts related to Mutual Acceptance of Data (MAD) since March 3, 2011, which ensures that the data generated by the GLP certified Test facilities in India is acceptable in the 36 member-countries of the OECD and other countries, thus removing the technical barriers to trade. As on date, there are 50 GLP certified test facilities in the country.

Some of the major achievements of the Indian GLP programme during the financial year 2018-19 are given below:

I. Seven new test facilities were granted the GLP-compliance status. These include:

- JDM Scientific Research Organization Private Limited, Vadodara
- PRADO Private Limited, Pune
- Edara Research Foundation, Hyderabad
- Cadila Pharmaceuticals Ltd., Ahmedabad
- Diligence Bio Private Limited, Pondicherry
- Vipragen Biosciences Private Limited, Mysore
- Accutest Biologics Private Limited, Navi Mumbai

Periodic surveillance and re-certification of certified test facilities was done as per the laid down procedures of NGCMA.

II. Joint-inspection and Study Audits with United States Food and Drug Administration were conducted for the following test facilities as per Mutual Acceptance of Data Agreement of OECD Working Group on GLP:

- Aurigene Discovery Technologies Limited, Hyderabad
- Vimta Labs Limited, Hyderabad.

III. The following training courses were organized by NGCMA:

- Sensitization Workshop on GLP – May 17&18, 2018
- Training Course on GLP for Archivists of GLP Test Facilities – June 21&22, 2018
- Refresher Training Course for GLP Inspectors – July 16-18, 2018
- Training Course for QA Personnel of GLP Test Facilities – August 23&24, 2018
- National Workshop Series on GLP Sensitization for Faculty & Scientists – September 26, 2018, December 7, 2018, March 29, 2019 and May 20, 2019
- Training Course on GLP for Computerised Systems – October 30, 2018
- Train the Trainer Programme on GLP – May 16&17, 2019
- Sensitization Workshop on GLP – May 25&26, 2019
- Training Course for Study Directors of GLP Test Facilities – May 29-31, 2019
- Sensitization Workshop on GLP – June 10&11, 2019

On the OECD front, representative of NGCMA, India attended the 33rd meeting of OECD's Working Group on GLP held during March 5-7, 2019. Further, India participated in the conduct of On-site Evaluation (OSEs) of National GLP Programmes of Japan (Work Place chemicals) and Thailand during January, 2018 and September, 2018 respective.

### 3.9 Patent Facilitation Programme (PFP)

Department of Science & Technology (DST) has established Patent Facilitation Cell (PFC) in Technology Information, Forecasting and Assessment Council (TIFAC) in the year 1995. Subsequently, 24 Patent Information Centres (PICs) were established in various states under Patent Facilitation Programme (PFP) of the Department, for creating awareness and extend assistance on protecting Intellectual Property Rights (IPR) including patent, copyright, geographical indication etc. at state level. These PICs have also established Intellectual Property Cells in Universities (IPCU) of their respective states to enlarge the network. As of now 84 IPCU's have been created in different universities of the states. In addition, they are also liable to provide assistance to the inventors from Govt. organizations, State Universities, for patent searches to find out the potential and assessment of the invention.

### I. Summary of the activities carried out during the F. Y 2018-19:

- Financial support was provided to the 24 Patent Information Centers established at various State Councils to the tune of Rs. 6.5 Crore.
- Annual Review meeting of the Patent Information Centers established at various State Councils for S&T was organized at Assam State Council for Science & Technology, Guwahati during 31st Oct'2018 to 1st Nov 2018.
- A Standing Finance Committee (SFC) was constituted for the formulation of the SFC document of the Patent Facilitation Programme under the Chairmanship of Secretary, DST. The Committee recommended for the continuation of the programme for a period of 3 years from 01.04.2017 to 31.03.2020 with a total budget of 17.0 Crore.
- Various awareness programmes, sensitization workshops, regional workshops, national workshops organized to create awareness on national intellectual property right policy among the stake holders.

### II. Details on the activities being carried out under the programme during the F. Y 2018-19:

#### a) IP/Patent Facilitation

DST through Patent Facilitation Centre helps in filing and prosecuting patent and other IPR applications in India and in other countries on behalf of academic institutions and government R&D institutes. These patent and IP applications are drafted and filed through patent attorneys on the panel. The cost of filing these patents is borne by Department and patent/IP applications are filed in the name of inventing institute/s. Department conducted through patentability assessment in house for all the invention disclosure received by it.

##### i. Filing of Patent and Other IPR Applications

DST through Patent Facilitation Centre has assessed the patentability of about 114 new cases for filing of patents on behalf of academic and government R&D institutions. Out of which, 49 cases were found suitable and have been sent to attorneys for filing of new patent applications along with one National Phase application (in persuasion to PCT application filed earlier) and one copyright application. One case for National Phase Filing was considered following filing PCT application earlier. Three design registrations were also examined and found they were not subject matter of design registration, hence not proceeded further.

##### ii. Grant of Patents

During the period 16 Indian Patents have been granted to respective applicant and facilitated filing and prosecution of these patent

S. No.	Patent No.	Grant Date	Applicant	Title
1.	296215	26.04.2018	University of Hyderabad	A polymeric film embedded with silver nano particles and a method for preparing the same
2.	296175	26.04.2018	Sardar Patel University And Gujarat Council On Science & Technology (Gujcost)	Smectite clay from naturally occurring clay
3.	296326	27.04.2018	Sardar Patel University	Substituted carbazole based dyes for dye solar cells and other optoelectronic device
4.	298220	28.06.2018	Banaras Hindu University,	A composition for controlling pests infesting grains, comprising an effective amount of melaleuca leucadendron and carumcarvi
5.	298981	19.07.2018	Centre For Earth Science Studies	A low cost device for detecting neoplastic changes in tissue
6.	299760	07.08.2018	Mumbai University Institute of Chemical Technology	Novel pyrimidone compounds
7.	300279	24/08/2018	G.B. Pant University of Agriculture & Technology, Pantanagar, Uttrakhand	Decontaminant formulation for farm-gate vegetables and process for preparing the same
8.	300838	07/09/2018	Baba Banda Singh Bahadur Engineering College, Fatehgarh Sahib, Punjab	Erosion-Corrosion Resistant Coating for Power Plant Boilers
9.	302643	30/10/ 2018	Pondicherry University, Puducherry	The Inclined Parallel Stack Continuously Operable Vermireactor
10.	303292	20/11/2018	Indian Institute of Technology, Kharagpur	A spindle assembly for micro-electrochemical/micro-electro-discharge machining set up
11.	305383	04/01/2019	Baba Banda Singh Bahadur Engineering College, Fatehgarh Sahib, Punjab	Erosion corrosion resistant cold spray coatings for boilers Ni-20 Cr Ti C Re

12.	305849	18/01/2019	Indian Institute of Technology Delhi	A novel phase change material composition and a process for preparing same thereof
13.	306804	04/02/2019	Panjab University, Chandigarh, Punjab	A radioactive trimer complex for the detection of tumors
14.	308621	06/03/2019	Dayalbagh Educational Institute, Agra, UP	Continuous gas fired annealing furnace
15.	309209	14/03/2019	Visva-Bharati University, Bholpur, West Bengal	Improved method of extracting humic acids
16.	309461	19/03/2019	Guru Nanak Dev Engineering College, Ludhiana, Punjab	Cryogenic Treatment of Brass Wire for Improved Machining Characteristics

### b) Awareness and Training on IPR

Department through Patent Facilitation Centre conducted 3 IPR Awareness Workshops. In total, 400 plus scientist, technologist, academic and industrial participants attended these workshops.

A “**Two Weeks Training Programme on IPR and Patents**” for officials of Patent Information Centers (PICs) at State Councils of Science and Technology and University IPR Cell (IPCUs) was held from April 23, 2018 to May 2, 2018 at Chennai in association with PIC, Tamil Nadu State Council for Science & Technology. Mostly PICs and IPCUs from southern India attended this programme. The other two training programmes include: a two-day workshop on “**The Guides for Identifying and Using Inventions in the Public Domain**” held on December 3-4, 2018, conducted jointly by PFC, CIPAM, DIPP and **World Intellectual Property Organisation (WIPO)** and the other with DRDO and ICAR.

In addition, various awareness programmes were organized by the Patent Information Centre situated in the States

### 3.10 Technical Research Centre

This programme was launched as a follow-up of the budget announcement made by the Hon’ble Finance Minister of India in his Budget Speech in FY 2014-15. Five Technical Research Centres (TRCs) were established with a mission to provide techno-legal-commercial and financial support to scientists, entrepreneurs, and business fraternity to achieve translation of research into products and processes for greater economic and societal benefits in 5 DST institutions namely, Sree Chitra Tirunal Institute for Medical Sciences and Technology (SCTIMST), Trivandrum; International Advanced Research Centre for Powder Metallurgy and New Materials (ARCI), Hyderabad; Jawaharlal Nehru Centre for Advanced Scientific Research (JNCASR), Bengaluru; Indian Association for the Cultivation

of Science (IACS), Kolkata; and S.N. Bose National Centre for Basic Sciences, Kolkata during FY 2015-16.

### 3.10.1 SCTIMST, Trivandrum

During the current financial year, the following technologies were transferred to industry taking the total number of technology transfer from TRC to six.

S No	Technology Transfer	Industrial Partner
1.	Lint free absorbent dressing for surgical and highly exudating chronic wounds	M/s. Phraction Scientific Kochi
2.	An injectable hydrogel for repair of cartilage injury and growth plate defects	M/s. Phraction Scientific Kochi
3.	Paracorporeal Left Ventricular Assist device (LVAD)	M/s. Meril Lifesciences Pvt Ltd, Gujarat
4.	Diagnosis kit for TB screening	M/s. Agappe Diagnostics Pvt. Ltd, Kochi
5.	PT / INR diagnostic kit	M/s. Agappe Diagnostics Pvt. Ltd, Kochi

A new state of the art **3D Bioprinting facility** to deposit living cells based computer aided designs (CAD) has been installed and commissioned. The 3rd Technology Conclave & Industry Meet was organized on 24th & 25th March 2019 at the Institute. Dr VK Saraswat, President, Governing Body of the Institute presided over the event. Technology transfer of six new products and relicensing of five products also took place during the technology conclave.



**Dr. V K Saraswat, President SCTIMST inaugurating the Third Technology Conclave**

3.10.2 ARCI, Hyderabad

The aim of this TRC is to develop materials and systems for energy storage, energy conversion and energy conservation with partnership of industries which has been actively pursued during the year.

In the energy storage programme, Li ion battery manufacturing know-how and large scale synthesis of battery electrode materials and supercapacitor carbon electrode materials have been accomplished. Hindustan Petroleum Corporation Limited (HPCL) has shown interest to take up the LIB technology/ know-how to setup a LIB manufacturing plant of 170 MWh/year for which plans have been drawn for field testing of TRC-ARCI batteries by a two-wheeler company before know-how transfer is effected. Collaborations have been forged with HPCL-Bangalore, SPEL-Pune, IMMT-Bhubaneswar, Toyota Tsusho Corporation-Japan, Bromine compounds Ltd-Israel to collaborate in energy storage technologies.

In the energy conversion programme, Fe-P soft magnetic material have been scaled up for alternator application and five prototype modules have been developed in collaboration with Lucas-TVS. In addition, ARCI has signed collaborative agreements with ABB and Ashvini Magnets, Pune for technology collaboration leading to technology transfers.

In the alternative energy generation programme, solar thermal energy technology for low temperature industrial heating has been transferred to Greenera Energy Pvt. Ltd., Coimbatore. Technology for dust repellent coatings for solar PV panels have been successfully field tested in collaboration with NTPC and several companies are now showing interest in licensing this technology. PEM fuel cells of 5 and 10 kW power have been field demonstrated at places where hydrogen fuel is available.

On the research side, Perovskite solar cells with 16.6% efficiency under laboratory conditions were demonstrated. Encouraging results were obtained on development of CIGS solar cells based on non-vacuum techniques (electrodeposition and ink printing). Two test rigs for performance evaluation of thermoelectric devices and solar thermal receiver tubes have been established at ARCI.

Overall, the TRC accomplishments include one technology transfer, funding from one public sector company, forging of collaborations with more than 20 companies, filing of 8 Indian/International patents and 56 publications in reputed journals.



Energy Materials (left), devices (middle) and demonstration of devices for various applications (right).

### 3.10.3 JNCASR, Bengaluru

Under this TRC, necessary infrastructure and administrative structure for implementing this initiative has been setup by JNCASR. With a mandate to support technologies with high growth potential, TRC funded projects aim to overcome challenges in health, energy, transport, solar, supply of raw materials, resource efficiency and climate action, secured societies etc. In a nut shell, TRC aims to strengthen JNCASR's capacity to generate new knowledge that will feed back into the economy and society.

Since its commencement in 2016, TRC supported about 30 R&D projects – many of them have industrial partners at different levels, licensed more than a dozen technologies/IPs, built a pipeline of more than 10 technologies/IPs, spun-off three start-up companies, built a pipeline of two more start-ups, supported more than 20 patents, collaborated with more than 10 industrial partners, set-up a state-of-the-art R&D infrastructure that is being shared with broader research and business community, and built a wider network of R&D stakeholders with conducive innovation ecosystem.





**JNCASR in collaboration with Bangalore International Airport Limited is developing technologies for predicting onset radiation through micro-physical processes and modelling**

*3.10.4 IACS, Kolkata*

During the year of report, three industry-academia conclaves have been organized at IACS to initiate collaborative work between TRC scientists and suitable industry partners and the events have been successful.

An MOU has been signed with Environmental research group R&D, Tata Steel on removal of cyanide and chloride from steel industry waste water to mitigate the wastewater pollutants, reduce water consumption and maintain sustainable recycling process. The cage complex receptor (active ingredient) is capable of complexing 70-80% free cyanide in steel wastewater within 10 minutes. This active ingredient had been used to treat Tata Steel waste water, in lab process. This particular molecular capsule has been made in large scale and delivered to TATA Steel Ltd. for removal of toxic elements from water. A rubber based power source has been developed by at IACS for smart batteries of car industries. The triboelectric generator technology has been transferred to and patented with Continental Automotive GmbH, Germany for further development and commercialization.

*3.10.5 S.N. Bose National Centre for Basic Sciences, Kolkata*

A low-cost non-contact machine (AJO) for anemia detection is under large-scale clinical trial conducted by AIIMS and Public Health Foundation of India (PHFI) for potential induction in “Anemia Mukh Bharat”. The instrument is developed under the TRC project.



**Clinical trial of Non-contact Anemia Detection Machine in Kolkata**

### 3.11 Exhibitions and Fairs

Exhibition Cell of DST is vested with the responsibility of organising/participation of Department of Science & Technology (DST) in science exhibitions of national and international importance. It is also assigned with the responsibility of coordinating participation of organisations under control of DST in such exhibitions.

The aim of Exhibition Cell is organising exhibitions to bring awareness among students, scholars and general public concerning various government policies, schemes, scientific innovation and milestones in the field of Science & Technology.

During the year 2018-19, Exhibition Cell facilitated participation of DST, in association with its subordinate offices and aided institutions, in the following major events:-

- Global Exhibition on Services (GES), Mumbai from 15th to 18th May, 2018;
- World Environment Day, New Delhi from 1st to 5th June, 2018 organised by Ministry of Environment, Forest & Climate Change;
- India International Science Festival (IISF)–2018, Lucknow from 5th to 8th October 2018;
- Indian Science Congress (ISC) – 2018, Jalandhar, from 3rd to 7th January 2019;
- Technology Day exhibition at Vigyan Bhawan, New Delhi on 11th May, 2018

The Cell also coordinated participation of subordinate offices and autonomous institutions under DST in various exhibitions across the country.



**Exhibition Area - Department of Science & Technology at World Environment Day, New Delhi from 1st to 5th June, 2018**

## Chapter 4

## AUTONOMOUS INSTITUTES

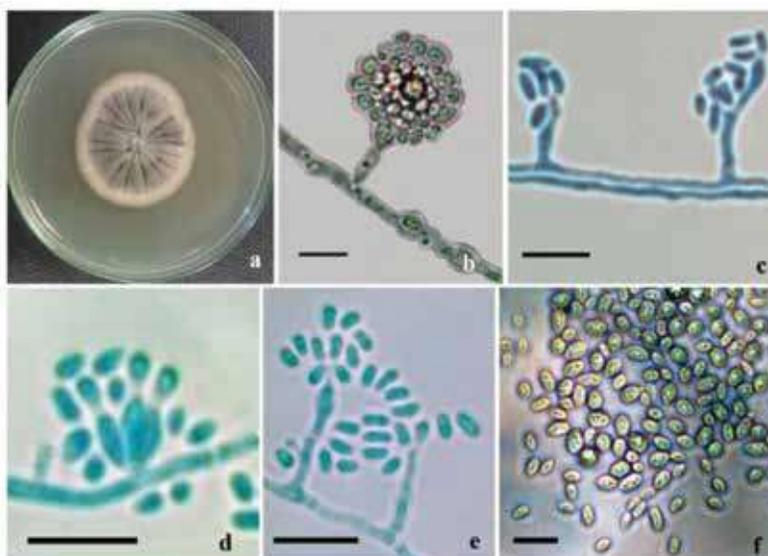
The Department of Science and Technology nurtures 25 Autonomous Bodies (ABs). These include 16 research institutions, 4 specialized knowledge institutions and S&T service organizations and 5 professional bodies. These institutions, with long and varied history and their variety of activities, occupy a very important place in the S&T eco-system of the country. Activities and achievements of autonomous institutes during the year under report are briefly described below:

## 4.1. Agharkar Research Institute (ARI), Pune

The institute focusses on Biodiversity and Palaeobiology, Bioenergy, Bioprospecting, Developmental Biology, Genetics and Plant Breeding and Nanobioscience.

## Some Major Accomplishments

**Biodiversity** - National Fungal Culture Collection of India (NFCCI), housed at ARI, is involved in identification, authentication and supply of fungal cultures to industry and academia. More than 600 fungal cultures were deposited in NFCCI by 120 different centres. A few novel fungal taxa which included *Coniochaeta simbalensis*, *Hyweljonesia indica* and *Talaromyces amyrossmaniae* and a novel yeast, namely *Blastobotrys bombycis* were identified, documented and reported.



***Coniochaeta simbalensis*.** **a** Colony morphology on PDA (front view). **b** Colony morphology on SDA ( front view). **c** colony morphology on PCA. **d** Hyphal wall septate, thickened, globulated, and showing anastomoses. **e** Terminal to intercalary chlamydospores. **f** phialides with gleosporic mass of conidia

**Palaeobiology:** The research in Palaeobiology group is dedicated to two broad areas: palaeoichnological studies, and a multi-disciplinary approach on the genetic diversity related to biogeography in extant Foraminifera to improve the resolution of palaeoceanographic proxies. Various bivalve ichnogenera exhibiting different ethological attributes, from the Jurassic of Jaisalmer Basin, have provided insight into bivalve ethology and paleoecology, environmental dynamics, and substrate consistency. Taxonomic identification using combined morphological and ribosomal DNA sequences revealed hidden diversity in monothalamous benthic Foraminifera.

**Bioenergy:** The bioenergy group is involved in exploration of microbial diversity for taxonomic novelty and industrial applications. As a part of this investigation, one novel genus and one novel species of methanotrophs were identified, documented and reported. FWC3, the representative of 'Methylobus aquaticus' gen. nov. sp. nov. showed unique features including genes encoding metabolic pathways, sugar transporters, etc. which are uncommon in methanotrophs. Strain KRF1, a representative strain of a novel Methylobacter species, representing the first tropical member of the most active and dominant clade of ubiquitous methanotrophs was isolated and documented.

**Bioprospecting:** Inflammation associated anemia (AI) is the second most prevalent anemia after iron deficiency anemia. Dietary habits, iron and inflammatory status of adolescent girls (n=85) were examined in order to determine whether food components contributed to any positive connection between iron status and inflammation. It was found that consumption of vitamin C-rich fruits such as amala, guava, tomato and lemon had a significant effect on iron status and thus they should be an imperative part in diets of adolescent girls for reducing inflammation, thereby improving their iron status.

**Developmental Biology:** The focus of research of developmental biology group has been on regulation of processes that contribute to animal development using three model systems, namely, hydra, drosophila and zebra fish.

**Hydra:** Two helicases involved in DNA repair namely XPB and XPD were identified for the first time. Both exhibited significant structural similarities with their vertebrate counterparts and were capable of unwinding DNA suggesting that hydra could be used to study evolution of DNA repair mechanisms in metazoans.

**Drosophila:** Three germline-specific transgenic lines, mcherry-Atg8a, GFP-Ref(2)P and mito-roGFP2-Orp1 were generated to monitor autophagy and mitochondrial ROS production in Drosophila, which revealed that under basal and stress-induced conditions, autophagy and mROS levels were low, suggesting that germline stem cells were protected from effects of stress-induced autophagy. Involvement of the endo-lysosomal pathway regulated by Mon-Rab7 axis in transsynaptic control of glutamate receptor levels at the neuromuscular junction was demonstrated.

**Zebrafish:** An extracellular matrix protein nephronectin (Npnt) as a proangiogenic molecule was identified. It was demonstrated that Npnt depletion in zebrafish resulted in diminished

axial vein sprouting and endothelial cell proliferation while Npnt supplementation in culture medium induced angiogenic sprouting and stabilization. Further, it was shown that Npnt was necessary for caudal vein plexus formation and could promote angiogenesis in association with integrin  $\alpha V/\beta 3$  heterodimer.

**Genetics and Plant Breeding:** The primary focus of research in Genetics & Plant Breeding is on enhancing the productivity of crops on sustainable basis. The target crops include soybean, wheat and grapes.

**Soybean:** Variety MACS 1520, maturing in 100 days, showed high and stable yield in Central Zone. It was identified for release in Central Zone (Madhya Pradesh, Bundelkhand region of UP, Rajasthan, Gujarat and Marathwada and Vidarbha regions of Maharashtra) by the Varietal Identification Committee. This variety has a maximum yield potential of 29 q/ha and is resistant to major viral, bacterial and fungal diseases of Central Zone and suitable for mechanical harvesting and has non-shattering pod habit. During kharif 2018, 321 quintals of soybean breeder seed of improved high yielding varieties was supplied to public and private seed multiplying agencies and farmers.



**Wheat:** Variety MACS 4028 (T. durum) with superior and stable yielding ability (19.3 q/ha) was notified (S.O.1379 (E)) for rainfed-timely sown conditions of Peninsular Zone. Twenty Wheat Choupal Pradarshan Khets (10 each of MACS 6222 and MACS 6478) were conducted in Amravati hub of Maharashtra under public-private partnership with ITC. Both the varieties showed 74 % yield advantage over the popular check Lok1. During 2018 rabi season, about 239 quintals of wheat breeder seed was sold to different seed multiplying agencies and farmers.

**Grape:** 5500 cuttings grape of the variety ARI-516 were supplied to different grape growers in Maharashtra for cultivation.

**MAB:** Using marker assisted breeding approach, lines with improved grain quality traits like protein content, gluten strength and yellow pigment content have been developed in the background of bread wheat cultivars MACS 2496 and NI 5439 as well as durum wheat cultivars MACS 3125 and HI 8498.

**Nanobioscience:** The focus of research in Nanobioscience area has been on development of technology in medicine, agriculture and environment.

**Chitosan nanoparticles:** The increase in fertilizer use efficiency and Zn enrichment in wheat using Zinc complexed chitosan nanoparticles as nanocarrier was demonstrated in field-level studies.

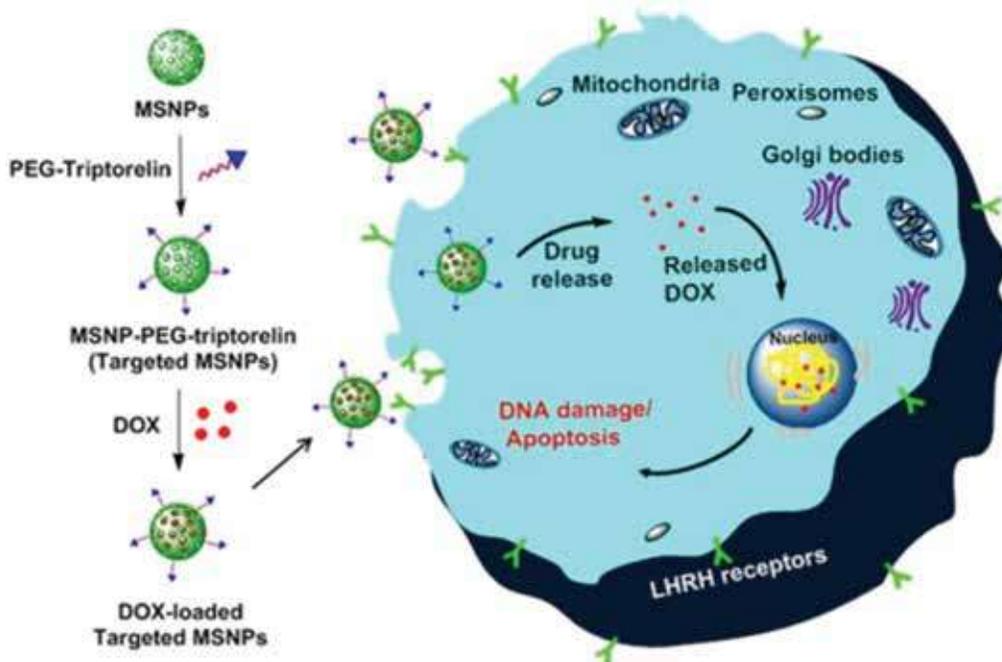
**Silver nanoparticles:** Silver nanoparticles specific effects versus silver-ion specific effects on functional genes in Staphylococcus aureus biofilms were elucidated.

**Hepatitis E virus:** It was established for the first time that the activities of Thrombin and Factor Xa (clotting factors) are essential for replication of Hepatitis E virus and are possibly implicated in ORF1 polyprotein processing. A distinct pro-viral role of Hepatitis E Virus (HEV) RNA dependent RNA

polymerase which is crucial for successful infection in the host was proposed.

**Nanocarrier:** A robust pH-sensitive unimolecular dendritic nanocarrier that enables targeted anti-cancer drug delivery via GLUT transporters was developed.

**Targeted nanoparticles:** Decapeptide functionalized targeted mesoporous silica nanoparticles with doxorubicin exhibited enhanced apoptotic effect in breast and prostate cancer cells..



**Schematic Presentation of cellular uptake of nanoparticles in MDA-MB-231**

#### 4.2 Aryabhata Research Institute of Observational Sciences (ARIES), Nainital

The Institute focuses on research in the areas of Astronomy, Astrophysics and Atmospheric Sciences. The Institute operates a suite of optical telescopes and advanced instruments to study the Earth's atmosphere, Sun, Planets, Stars and Galaxies.

##### Major Accomplishments:

- Routine observations and tests from 3.6m Devasthal Optical Telescope (DOT) as a National facility.
- ARIES ST Radar is operated with 12 clusters and the wind data recorded are in reasonable agreement with balloon-borne wind observations. Extensive balloon-borne observations over Nainital show very high wind speed near the subtropical jet and highlight the discrepancy in temperature profile from space-borne sensors.

- Postulated a new method to remove degeneracy in two-temperature accretion solutions around black holes.
- Studied the effect of plasma composition of accretion flows onto neutron stars.
- Anomalous variations observed in VLF subionospheric signal and Mesospheric Ozone prior to one of the most disastrous 2015 Gorkha Nepal Earthquake over Himalayan region.

### Important Highlights of few major programmes:

#### (i) 3.6m Devasthal Optical Telescope (DOT):

One of the major achievements of ARIES during the financial year is successful coating of the primary mirror of the 3.6m DOT. This is India's largest optical/IR telescope for conducting observations of celestial objects in Astronomy and Astrophysics.



**TIFR- ARIES Near Infrared Spectrometer (TANSPEC) at 3.6m telescope building at Devasthal, Nainital.**

**(ii) ST Radar:** The ARIES Stratosphere Troposphere Radar (ASTRAD) has been operated for about 570 Hrs and captured wind data up to height  $\sim 18$  Km. During this period, extensive comparisons between radar winds and winds from GPS radiosonde were made. The observations from ASTRAD are also used to determine temperature profiles, which showed a good agreement with the radiosonde observations. These data are also being used for the determination of turbulence parameters in the lower atmosphere above complex Himalayan terrains.

**(iii) Trace gases and aerosols:** For the first time, observations of light non-methane hydrocarbons (NMHCs) are made using a Gas Chromatograph equipped with Flame Ionization Detector (GC-

FID). Modelling study of one of the important greenhouse gas, CO<sub>2</sub>, showed that ocean flux has least contribution (<10%), while dominance of biospheric flux is seen over fossil (>80%) in the study region of Asia. A significant enhancement is also observed in trace gases and aerosols during the biomass burning period.

### Important Output Indicators

S.No.	Parameters	Output
1.	Papers in refereed journals	41
2.	Book	01
3.	Papers in Conferences	17
4.	Number of Ph.Ds. produced	Awarded - 01, Submitted - 03

### 4.3 Birbal Sahni Institute of Palaeosciences (BSIP), Lucknow

A premier research center of the country, is dedicated to trace the antiquity and evolution of plant life on earth through geological history. BSIP studies involve both fundamental & applied aspects of palaeoscience research, from different Geological Eras spanning over last 3600 million years to present day.

#### Major Accomplishments:

541 million years old sedimentary succession of the Rajasthan, known as Bilara Group, Marwar Supergroup, revealed the high amplitude negative excursions of carbon and oxygen isotopes denoting large-scale changes in atmosphere and hydrosphere during 635–541 Ma. These perturbations initiated the radiation of animal life for the first time on the earth. Similar pattern in  $\delta^{13}\text{C}$ -carb pattern has also been noted in the time equivalent Yangtze Gorges platform, South China area (Precambrian Research, 308: 75-91). In recent years, BSIP has initiated studies in the field of Astrobiology. In this connection a theoretical assessment about chances of life beyond the Earth are being explored. The habitability of Venus' clouds has been a subject of discussion since long. The lower cloud layer of Venus (47.5–50.5 km) is an exceptional target for exploration due to the favorable conditions for microbial life, including moderate temperatures and pressures (~60°C and 1 atm.), and the presence of micron-sized sulfuric acid aerosols. A hypothesis has been propounded regarding the potential for microorganisms to survive in Venus' lower clouds and contribute to the observed bulk spectra (Astrobiology 18(10): 1-18).

Indian coal deposits are found in Gondwana successions of the country. In Jammu Kashmir State, near the Gund village in the Banihal area, where Fenestella Shales are exposed, provided new insights into the floristic evolution of Gondwana during Carboniferous-Permian Period. The first report of pollen and spore assemblage obtained on these rocks, along with detrital zircon U-Pb age, suggest the age of these rocks as  $329 \pm 16$  million years old. Based on the affinities of the palynofloral assemblage and earlier palaeontological records, a warm, temperate and arid climate has predicted for this period. (Journal of Asian Earth Sciences, 157: 348-359).

In the geological past, the Earth has experienced several episodes of mass extinction. Approximately 252 million years ago, the earth faced most severe mass extinction that is known as great dying or the Permian and Triassic Boundary (PTB) Mass Extinction in which 96% of the marine and 70% of terrestrial biota got extinct. However, new studies on the megafossil assemblages recovered from the sedimentary successions of Tatapani–Ramkola Coalfield of India (Barakar, Raniganj, and Panchet Formations) suggest that the extinction at PTB on land was not that drastic as believed rather a trend of gradual floral transition is observed than the sudden demise of flora along the boundary (Geological Journal, <https://doi.org/10.1002/gj.3307>). The Cretaceous greenhouse climate accompanied major changes in Earth's hydrological cycle, but hydroclimatic reconstructions for this anomalously warm period are rare. The  $\delta^{18}\text{O}$  and  $\text{CO}_2$  clumped isotope  $\Delta 47$  of the extant mollusk *Villoritacyprinoids* (Black Clam) was applied to fossil mollusk *Phygraeavesicularis* from the Kallankuruchchi Formation of Early Maastrichtian of Cauvery Basin of southern India. The study showed that, unlike present-day India, where summer rainfall predominates, most rainfall in Cretaceous India occurred in winter. A match of the Cretaceous climate and present-day climate at  $\sim 30^\circ\text{S}$  suggests that the large-scale atmospheric circulation and seasonal hydroclimate patterns were similar to, possibly more intense than those at present. (Nature Scientific Reports, 8: 8482).

Root crop family Convolvulaceae is the world's second most important plant group which is extensively used as staple food by a large human population. Despite a large number of species having world-wide distribution, its fossil records are rare. *Ipomoea* leaves from the late Paleocene (58.7–55.8 million years ago) from east Garo Hills, Meghalaya revealed the earliest fossil record of family Convolvulaceae and the order Solanales, suggesting that the sister families of Convolvulaceae and Solanaceae diverged before the Eocene (56 to 33.9 million years ago) in Gondwana derived continents. The evidence supported the conclusions drawn from molecular phylogenetic analysis of an East Gondwana origin of Convolvulaceae (PNAS, 115:6028–6033).

Occurrence of carbonate rocks in paleosol profiles from the Dagshai Formation of Himachal Pradesh suggested presence of monsoonal circulation of modern strength in Himalayan foreland at 20 million years ago. (The Journal of Geology, 126:1–24). For the first time, the event of Miocene Climate Optimum (MCO) was documented based on the analyses of multiple microfossils (diatoms, calcareous nanofossils and radiolarians) from the outcrop of Havelock Island (Andaman and Nicobar Islands) of Northern Indian Ocean (Palaeobiodiversity and Palaeoenvironments <https://doi.org/10.1007/s12549-018-0342-3>).

Indian Summer Monsoon (ISM), a characteristic feature of the Indian subcontinent, is understood through various parameters. At BSIP, scientists have used  $\delta^{13}\text{C}$ , total organic carbon (TOC), sediment texture and environmental magnetic data of the samples from a  $\sim 3$  m deep glacial outwash sedimentary profile from the Sikkim Himalaya to obtain decadal to centennial scale records of ISM. The most prominent abrupt negative ISM shift was observed during the termination of the Younger Dryas (YD) between  $\sim 11700$  and 11400 years Before Present (BP). While, ISM was stable between  $\sim 11000$  and 6000 years BP, and declined prominently between 6000 and 3000 years BP. Surprisingly, during both the Medieval Warm Period and Little Ice Age spans, ISM was strong in this part of the Himalaya.

The rainfall reconstructions are broadly in agreement with local, regional reconstructions and PMIP3, CSIRO-MK3L model simulations (Nature Scientific Reports 8: 9287). Similarly the results of sediment texture,  $\delta^{13}\text{C}$  values, TOC, TN, TOC/TN, and magnetic susceptibility ( $\chi_{lf}$ ) of a 1.54-m deep sediment trench recovered from the Core Monsoon Zone of central India, to understand the palaeovegetational history and ISM variability during the Holocene. The study suggested enhanced ISM intensity during ~11400 to 9500 years BP and gradual weakening of ISM in pulses during ~8100 and 6300 years BP, ~6300 to 4700 years BP, and ~3000 to 2000 years BP. The weakest phase of ISM in this area was recorded at ~2000 years BP. Subsequently, three stages of enhanced ISM were recorded between ~1600 and 930 years BP, ~760 and 420 years BP, and ~280 years BP to present (The Holocene, DOI: 10.1177/0959683618804641).

Various proxies are used to understand the diet, habitat, and ecology of extant and extinct megaherbivores found in the Higher Himalaya. The micro- and macro-botanical remains found in the wild Yak dung provided evidence their food habit. The study showed that grasses were the primary diet of the yak as indicated by the abundance of grass pollen and phytoliths in their dung. Other associated non-arboreal and arboreal taxa namely, Cyperaceae, Rosaceae, Chenopodiaceae, Artemisia, Prunus, and Rhododendron are also important dietary plants for their living (Plos One, <https://doi.org/10.1371/journal.pone.0202723>).

The rugged topography of the mighty Himalayan region has hindered large-scale human migrations, population admixture and assimilation. Such complexity in geographical structure might have facilitated the existence of several small isolated communities in this region genotyped about 850,000 autosomal markers among 35 individuals belonging to the four major populations inhabiting the Himalaya and adjoining regions. In addition, 794 individuals belonging to 16 ethnic groups from the same region were genotyped for uniparental (mitochondrial and Y chromosomal DNA) markers. Analyses suggested a closer link of the Himalayan and adjoining populations to East Asia than their immediate geographical neighbors in South Asia. The admixture time estimate suggests a recent westward migration of populations living to the East of the Himalaya. Uniparental marker analysis among the Himalayan and adjoining populations also revealed the presence of East, Southeast and South Asian genetic signatures (Hum Genet, 137: 129).

Important Output Indicators

S.No.	Parameters	Output
1	Papers in refereed journals	124
2	Books	2
3	Chapters in Books	6
4	Papers in Conferences	69
5	Number of Ph.Ds. produced	4
6	Research Manpower trained (other than Ph.D.s)	11
7	Technical Manpower trained	2
8	M.Tech/M.Sc./M.Phil projects guided	2

#### 4.4 Bose Institute (BI), Kolkata

Bose Institute pursues research for augmentation of fundamental knowledge-base and developing solutions to national problems in the areas of healthcare, food security, environmental pollution and climate change. Research is pursued in areas such as understanding stress response and disease biology, anthropogenic activity-induced environmental changes, bioremediation of environmental pollutants and geomicrobiology, fundamental understanding of subatomic particles, development of detectors/sensors- from cosmic rays to biomolecules and the dynamics of atmospheric pollutants, especially in the Himalayan region.

The efforts of institute's researchers have yielded several exciting results, which are as follows:

- Unveiling of the immune landscape of tumor micro-environment towards understanding the failure of immunotherapy and development of the next generation immunotherapy
- Establishment of cancer as a 'stem cell disease' and repurposing FDA-approved drugs for sensitizing highly resistant cancer stem cells
- New strategy for nanoparticle-mediated drug & gene delivery developed
- Design and synthesis of glycoconjugates for development of antibacterial vaccine candidates
- Deciphering how Mycobacterium tuberculosis regulates host innate immunity using transcriptional and post-transcriptional mechanisms
- A recombinant reporter assay in E. coli has been developed to identify the interaction of RNA polymerase or transcription factors with promoters of Mycobacterium tuberculosis.
- Understanding how anthropogenic influence shapes the distribution and dissemination of antibiotic resistance in natural environment
- Structural determinants that preserve function and stability of a global staphylococcal virulence regulator, SarA, have been identified
- Pilot study on human plasma proteomics of asthmatics identifies Apo E and IL-33 as asthma markers
- Epigenetic marks responsible for change in chromatin structure associated with transcriptional regulation of stress responsive genes in rice has been identified
- Nontoxic short peptides were designed that specifically target c-Myc oncogene to repress its transcriptional / translational expression in breast cancer
- Local epigenetic landscape of the promoter element of an oncogenic transcription factor is instrumental in maintaining its elevated status has been established
- First Indian experiment entitled 'Search for higher excited states of  $^8\text{Be}^*$  to study the cosmological

7Li problem' at CERN-HIE-ISOLDE, Geneva, Switzerland successfully carried out in November 2018

- Au -MoS<sub>2</sub> shown to be an efficient molecule sensor and it is sensitive enough to detect free bilirubin in human serum even in the presence of crucial interferences
- Active detectors for Cosmic Ray measurements commissioned and running successfully at Darjeeling
- The first ever study on the trend of atmospheric aerosols and black carbon over eastern Himalaya has been conducted revealing decreasing trend associated with biomass burning over Indo-Gangetic plains
- Study of below cloud scavenging of aerosols of different size and pollution level by the rain of different physical properties over eastern Himalaya has been conducted for the first time
- Coupling of organic carbon sequestration and greater bioavailability intensify the carbon-sulfur cycle in the oxygen minimum zone sediments along the Arabian Sea coast of India

**Outreach activities:** Participation in the Mega Science, Technology and Industry Expo at the India International Science Festival 2018 at Lucknow; conference entitled "Rural biotechnology programme and economic development of scheduled tribe people: present status and future" was organized

### Important Output Indicators

S.No.	Parameters	Output
1.	Papers in refereed journals	236
2.	Books	20
3.	Number of Ph.Ds. produced	39
4.	Research Manpower trained (other than Ph.Ds)	154
5.	Technical Manpower trained	23
6.	M.Tech/M.Sc./M.Phil projects guided	81

### 4.5 Centre for Nano and Soft Matter Sciences (CENS), Bengaluru

The centre focusses its R&D activity in the areas of Nano Science and Nanotechnology; Nano-Soft composites; Soft matters such as liquid crystals, polymers, gels, membranes etc.

#### Major Accomplishments:

**An anisotropic fluorescent magneto-gel:** A soft photoluminescent composite, prepared using a nematic liquid crystal and a fluorescent gelator, exhibits a nearly two orders of magnitude increase in fluorescence on addition of superparamagnetic nanoparticles.

Refractive index sensor based on self-assembled non-close packed colloidal spheres: Gold nanohole

arrays of various hole sizes with fixed thickness are fabricated using colloidal lithography which exhibit coupling of LSPR and surface plasmon polaritons and used for refractive index sensing.

Tunable structural colour in TiO<sub>2</sub>/Ti films: Structural colours, generated by combining TiO<sub>2</sub> vertical nanorods deposited on Ti thin films fabricated by glancing angle deposition technique, can be tuned by controlling the height of the nanorods.

**Humidity Sensing Applications:** TiO<sub>2</sub> slanted nanorods deposited by e-beam evaporation with glancing angle is the working material for humidity sensing. The humidity sensing results show a good improvement on annealed sample compared to as prepared.

**Porous MoO<sub>2</sub>:** MoO<sub>2</sub> nanomaterials due to its metallic as well semiconducting nature have been explored for electrocatalysis and as co-catalyst in photo-catalysis applications in literature. In the present work, porous metallic MoO<sub>2</sub> nanostructures are synthesized in a very short time scale of 30 minutes employing a green synthetic approach involving inexpensive precursors in an aqueous medium catalysed by the substrate.

**Metal-organic framework (MOF) derived Pd nanoparticles for water splitting:** Pd nanoparticles embedded in MOF (Pd@Pd(II)BTA-rGO) exhibited high stability in acidic media at 85 mA/cm<sup>2</sup> current density up to 10000 cycles for hydrogen evolution reaction.

**Prototype gas sensors based on colorimetry:** Detection of hazardous gases like NO<sub>x</sub>, SO<sub>x</sub> and etc. which are harmful to human health and environment. Development of a simple visual gas sensor using luminescence materials, is a very appealing and easy way to detect harmful gases.

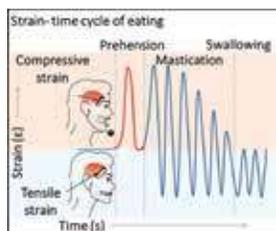
**Determination of chemical nature of the Sb doped SnTe for thermoelectric materials:** Increase in chemical stability of the perovskite material for photovoltaics will improve the solar cell lifetime.

**Influence of zinc oxide nanorods on an orientationally ordered fluid comprising soft-bent dimers**

Thermal, dielectric and elastic properties of a host LC system consisting of a soft-bent component and a calamitic one, in its pure form and upon addition of ZnO nanorods (NRs) indicate that the NRs bring about the power of tunability to the associated parameters.

**Nanophase segregation in a CNT doped nematic liquid crystal:** Induction of smectic A and nematic–smectic–nematic re-entrant phase sequence in “nematicmesophase-only” material is seen by the addition of small amount of CNT.

**Cosmetically adaptable transparent strain sensor for sensitively delineating patterns in small**



**movements of vital human organs:** A wearable strain sensor made of gold micromesh partially embedded in polydimethylsiloxane substrate is fabricated for monitoring live movements of human body parts. The sensor exhibits a high optical transmittance (85%) with an effective strain range for stretching of 0.02%–4.5% for a gauge factor of over 108. The nanometric break junctions that form throughout the wire network increase with increasing strain resulting

in a large change in the sheet resistance. The semi-embedded nature of the gold microwires allows the broken junctions to retract to the original positions, thus closing the nanogaps and regaining the original low resistance state. The high repeatability and cyclic stability is established using live demonstrations involving human body activity.

#### Major and Unique National Facilities created:

High Resolution Transmission Electron Microscope, Environmental Testing Chamber, Gas Testing Laboratory and Probe ultra -sonic Processor

#### Important Output Indicators

S.No.	Parameters	Output
1.	Papers in refereed journals	72 (Average IF: 3.57/paper)
2.	Patents filed / granted	6
3.	Books/Chapters in Books	1
4.	Papers in Conferences	6
5.	Number of Ph.Ds. produced	5
6.	Number of Technology leads awaiting transfer	2
7.	Research Manpower trained (other than Ph.Ds)	57
8.	Other Products/ Indicators (* Lectures given at schools/colleges under popularization of science / V4 Programme)	Under V4 Programme and ROIS Programme of CeNS, overall, 2851 students of different school/colleges of the Country have been benefitted during the period of the report.

#### 4.6 Indian Association for the Cultivation of Science (IACS), Kolkata

Applied and Interdisciplinary Sciences, Biological Sciences, Chemical Sciences, Materials Sciences, Mathematical and Computational Sciences and Physical Sciences are some of the major areas of R&D at the IACS.

#### Major Accomplishments:

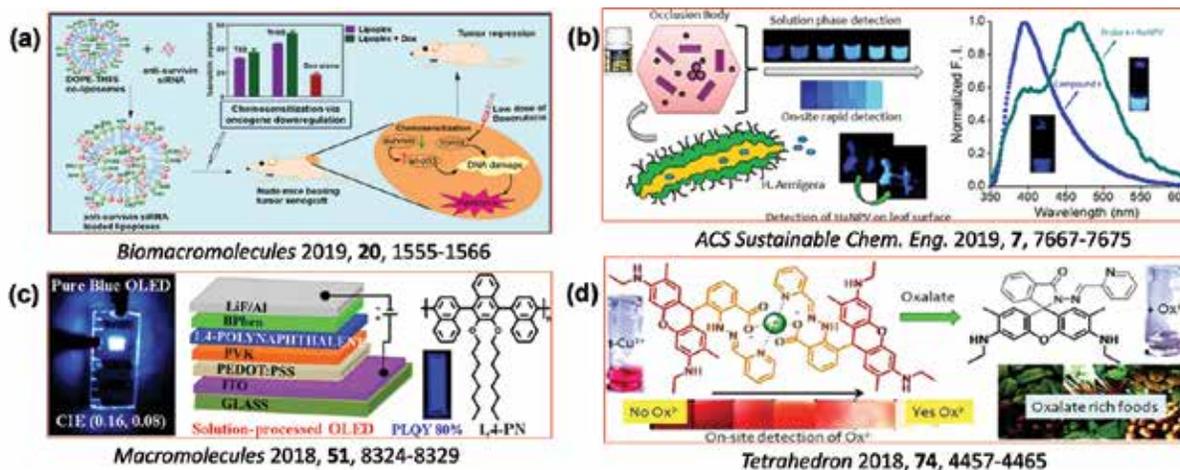
During 2018-19, one faculty member was awarded CHEMCON Distinguished Speaker Award, 2018 by Indian Institute of Chemical Engineers; one faculty member of the Institute was elected Fellow of TWAS; one faculty member was awarded the Micro Fellow, ITMO University, St. Petersburg, Russia and invited to be a member of the Editorial Advisory Board, ChemPhysChem, Wiley; one faculty member was awarded PCCP Emerging Investigator Lectureship, Royal Society of Chemistry and was invited to be a member of the Editorial Board, Electronic Structure, IOP Science; one faculty member was invited as Associate Editor, ACS Applied Nano Materials, American Chemical Society;

### Important Highlights of few Major Programmes :

An illustrative list of major R&D projects is given below in the following thematic areas:

- **Applied and Interdisciplinary Sciences :** Current research activities at SAIS span over wide-ranging emerging interdisciplinary topics of Science and Technology including Soft Matter, Polymer and Supramolecular Science, Colloidal Science, Electronics and Photonics, Liquid Crystals, Drug Delivery, Chemical Biology, Science of Sustainability, Environmental Science, climate change and others.
- **Biological Sciences:** Approaches towards the development of molecules, active principles and various methods to address several issues in biological sciences have been undertaken. This area spans over cancer biology, cellular and developmental biology, coagulation biology, cell to cell communication and chemical biology involving supramolecular chemistry and nanoscience& nanotechnology in health care, nanoscale biosensor and bioengineering.
- **Chemical Sciences:** Development and Applications of Many-Body Theories for Electronic Structure; Studies on Nonlinear dynamics, Statistical Mechanics; LIF spectroscopy of cold molecules and complexes, mass spectrometry and ion mobility spectroscopy, matrix isolation infrared spectroscopy, gas phase photochemistry and atmospheric chemistry; Theoretical and methodological developments on beyond Born-Oppenheimer treatment of Dynamics of triatomic systems, molecule surface scattering and laser induced molecular scissoring, Theoretical studies on hydrogen storage, catalysis and photochemical processes, etc.
- **Materials Sciences:** Nanomaterials based light harvesting systems and understanding their fundamental photophysical processes; perovskites nanocrystals in energy harvesting; designing microporous and mesomaterials for environmental application; polymer nanocomposites for energy applications; designed nanobiocojugates for controlling intracellular processes; designed thin film nanostructures for solar cells application; understanding the role of spin-orbit coupling in magnetic and electronic states of transition metal oxides; low temperature physics of semiconducting nanostructures and magnetic materials; fabrication of energy harvesting devices (LEDs, Solar Cells, and Photoelectrodes) and sensors.
- **Mathematical and Computational Sciences:** Current research activities at SMCS cover a broad range which includes Computational study of Electronic Structure, Catalysis, Statistical mechanics & dynamics of biosystems, Machine learning in physics and chemistry, Method development in quantum, classical, hybrid QM/MM and coarse graining simulations, Study of Complex variables, Complex dynamics, Computer Science problems like Approximate Computing, Cyber Physical Systems, Data Mining and Analytics, Formal Methods, IoT, AI and Machine Learning, Mobile Computing, Parallel Computing, Recommendation Systems, Security and Privacy, Social and Complex Networks.
- **Physical Sciences :** Charge carrier dynamics in glasses; Organic electronics; Solar cells based on hybrid perovskites and inorganic semiconductors; Scanning Tunneling Spectroscopy of 2D

transition metal dichalogenides and their hetero structures; Doping mechanism and electrical transport; nanostructures and nanocomposites for applications in transparent conducting oxides; and Ground state magnetic properties of transition metal oxides with novel low dimensional crystal structure and geometrically frustrated systems.



(a) Tumor chemosensitization through oncogene knockdown mediated by unique  $\alpha$ -tocopherylated cationic geminis; (b) On-field detection of *Helicoverpa armigera* nuclear polyhedrosis virus using luminescent amphiphilic probe; (c) development of high molecular weight 1,4-polynaphthalene for solution-processed true color blue light emitting diode; and (d) smart optical probe for 'equipment-free' detection of oxalate in biological fluids and plant-derived food items.

### Important Output Indicators

Sl. No.	Parameters	Output
1.	Papers in refereed journals	462
2.	Chapters in Books	06
3.	Papers in Conferences	33
4.	Number of Ph.Ds. produced	52
5.	Foreign Patents filed	01
	Foreign Patents granted	01
6.	Indian Patents Filed	09
7.	Research Manpower trained (other than Ph.Ds)	29

#### 4.7 Indian Institute of Astrophysics (IIA), Bengaluru

IIA focusses its R&D on Astronomy and Astrophysics.

##### Major Accomplishments:

- First science observation using the 0.7-m GROWTH-India telescope at the Indian Astronomical Observatory, Hanle is carried out. The object was a recurrent nova outburst (M31N-2008) in the nearby galaxy M31. During GROWTH winter school organized at IIT Mumbai, remote observations of GRB 1812A was carried out and the results are reported in the form of GCN circular.
- Digitized and calibrated white-light data obtained from Kodaikanal Solar Observatory for a period of 90 years is used to investigate long-term variation of sunspot penumbra to umbra area ratio. Observational evidence of the braiding of magnetic field lines has been reported. The radio signatures that occur in the solar corona were studied using the radio data obtained from the Gauribidanur Radio Observatory (IIA).
- As a part of international campaign AT2018COW was extensively monitored with the 2-m HCT. This turned out to be a fast-luminous optical transient, which represents a new class of astrophysical event and needs innovative exotic models to explain it.
- Contemporaneous multiwavelength observations of the planets hosting star HD219134 were carried out. Results reveal a weak poloidal magnetic, rotation period, evidence for differential rotation etc.
- Star formation studies in the nearby spiral galaxy NGC 2336 were carried out in far-ultraviolet (FUV) and near-ultraviolet (NUV) region using data from the Ultraviolet Imaging Telescope (UVIT) on-board AstroSat. A total of 78 star-forming complexes are identified; their positions, luminosities, sizes, star formation rates (SFRs), colours, and ages are also estimated.
- Even after seven decades of the discovery of active galactic nuclei (AGN), technology does not exist to resolve the central regions of these source via direct imaging. However, indirectly it is possible to probe the central regions of these objects. Based on optical and near-infrared observations carried out by using the HCT, the size of the dust torus in the AGN H0507+164 has been estimated as  $\sim 30$  days. This is the first time measurement on this source.

##### Important Highlights of some of the major Programmes:

- India TMT successfully delivered 20 nos. of M1 control systems Actuators. They met performance tests at TMT laboratory in Pasadena, USA. The construction of Optics Fabrication Facility at IIA, CREST, Hoskote has been completed and will be commissioned shortly telescope and its subsystems.
- For the establishment of National Large Solar Telescope (NLST) at the incursion site of Pongong Tso lake in the Changthang Cold Desert Wildlife Sanctuary at Merak in the Ladakh region, Indian

Institute of Astrophysics paid the cost of the land to J & K Government for use of 7.6 Ha of land in March 2019. At present, in the site there is 20-cm H-alpha telescope is operating and it continues to take the images of the Sun in 656.3 nm wavelength region whenever sky conditions permit. Figure 2 shows active region NOAA 12723 obtained with H-alpha telescope installed at Merak. The image is obtained on October 1, 2018 at 03:18:52 UT.

#### 4.8 Indian Institute of Geomagnetism (IIG), New Mumbai

Areas of Focus: Geomagnetism and Allied Fields

##### Major Accomplishments:

- The occurrence of Electromagnetic Ion Cyclotron (EMIC) waves observed on the ground at Antarctic station, Maitri (geographic 70.7S, 11.8 E, L 5) was examined during quiet and disturbed days of 2011-2017. The data spans both ascending and descending phases of the solar cycle 24, which has witnessed extremely low activity. Overall the EMIC waves are observed on 1020 days (39.9%) out of 2557 days. Dependence of EMIC wave occurrence on solar flux is evident with significant contribution from the descending phase (25.4%) as compared to ascending phase (14.5%) of the solar cycle, which suggests nearly a two-fold increase in their occurrence.
- A novel framework has been developed for delineating groundwater potential zones (GWPZ) using fuzzy datasets and the analytical hierarchical process (AHP) integrated with hydrogeological, geophysical and geospatial data for a hard-rock trap-covered terrain in Maharashtra, India. This approach is based on the consideration of ten factors that influence groundwater potential: aquifer resistivity, aquifer thickness, transverse resistance, electrical anisotropy, drainage density, lineament density, rainfall, slope, geology and land use/land cover. The ranks and weights were obtained by fuzzy and AHP techniques and assigned to these layers and their feature class. The reclassified layers were integrated in a geographical information system environment to delineate the GWPZ of the study basin. The findings reveal that the areas of very high groundwater potential are located in the plateau region and plains of the basin that occupy about 11.5% of the total study area. The study highlights that such an integrated approach is reliable and can be applied in other semi-arid regions of the world to help hydrogeologists manage groundwater resources.
- Forecasting of the solar cycle characteristics is vital in understanding the space weather. Addressing this issue, two different models have been developed to predict peak of solar cycle (SC), and length of solar cycle. Employing Shannon Entropy estimates, the inherent randomness in the SC is found to vary with the phase as it progresses. The prediction has revealed a superior correlation coefficient of 0.94, suggesting that the upcoming SC 25 would be significantly weaker.
- Simulation of one-dimensional Particle-in-Cell simulation of the head-on collision of multiple counter-propagating ion acoustic coherent phase space structures in the space plasma is performed and a new mechanism of electron acceleration via interaction of multiple coherent waves has been proposed. Such local electron acceleration may be relevant to the energetic electrons observed in the planetary magnetospheric plasmas.

- A new approach is proposed to estimate geomagnetic indices equivalent to Dst and AsyH during geomagnetic storms, making use of the increased observations from spacebased instruments in recent times and demonstrates their utility in quantifying the geomagnetic environment. The important advantage of multispacecraft Swarm mission is that it provides an opportunity to investigate the spatial gradients in the stormtime magnetic fields. It is found that strong azimuthal gradients in the magnetic field, near the equatorial sector are associated with particle injection from the magnetotail. The utility of spacebased measurements in understanding the geomagnetic environment is also demonstrated.

### Important Output Indicators

S.No.	Parameters	Output
1.	Papers in refereed journals	79
2.	Papers in Conferences	121
3.	Number of Ph.Ds. produced	3
4.	Indian Patents filed	1
5.	M.Tech/M.Sc./M.Phil projects guided	45
6.	Scientific Outreach Programmes organized	22
7.	Popular Science Articles published	20
8.	Number of persons who attended various science outreach programmes/conferences etc.	1200
9.	Scientific Lectures/Training Programmes organized	45
10.	Number of students trained	60
11.	Number of school/college/university teachers trained	52

### 4.9 Institute of Advanced Study in Science and Technology (IASST), Guwahati

**Areas of Focus:** Basic and applied plasma physics, advanced material sciences, mathematical and computational sciences, biodiversity and ecosystem research and traditional knowledge based drug development and delivery.

#### Major Accomplishments:

- Proposed an alternative diagnostics technique to measure plasma space potential.
- Carbon nanoparticles generated in simple glass chamber using radio frequency discharge with argon and acetylene gas mixture.
- Developed a new method to classify large scale sequence data in terms of protein or nucleotide in a short time. The algorithm outperforms the contemporary methods while preserving accuracy.
- An efficient antibacterial hybrid fabricated through surface functionalization of lysozyme capped gold nanoclusters (AUNC-L) with  $\beta$ -lactam antibiotic ampicillin (AUNC-L-Amp) that not only

reverted the MRSA resistance towards ampicillin but also demonstrated enhanced antibacterial activity against non-resistant bacterial strains.

- Developed a Cholesterol-aminoacid conjugates treated filter paper-based photoluminescence sensor for nitroaromatic.
- Polyethylene Glycol-Encapsulated Histone Deacetylase Inhibitor Drug-Composite Nanoparticles developed for Combination Therapy with Artesunate.
- Sediment characterization and spatial distribution of heavy metals in the sediment of a tropical freshwater wetland of Indo-Burmese province carried out.
- Studied the Biosurfactant production by a rhizosphere bacteria *Bacillus altitudinis* MS16 and its promising emulsification and antifungal activity
- Explored the microbiota and metabolites of traditional rice beer varieties of Assam and their functionalities.
- Hybrid Oleic Acid-Graphene Quantum Dot Vesicles developed for Drug Delivery
- A comparison study undertaken of various deep convolution neural network (CNN) based fine-tuned transfer learned classification approach for the diagnosis of breast Fine needle aspiration cytology (FNAC) images.
- A computational study on New types of organic semiconductors based on diketopyrrolopyrroles and 2,1,3-benzochalcogenadiazoles undertaken
- Plasma Based Synthesis of Nanomaterials for Development of Plasmon Enhanced Infrared Responsive Optoelectronic Devices
- Authenticated ayurveda literature listed *Premna herbacea* as a potential herbal drug to prevent and cure Type 2 Diabetes Mellitus.

### Important Output Indicators

S.No.	Parameters	Output
1.	Papers in refereed journals	55
2.	Chapters in Books	22
3.	Papers in Conferences	54
4.	Number of Ph.Ds. produced	09
5.	Indian Patents filed	06
	Indian Patents granted	01
6.	Number of Technologies/Designs and other intellectual products commercialized	01

7.	Number of Technology leads awaiting transfer	04
8.	Research Manpower trained (other than Ph.Ds)	42
9.	B.Tech/ UG projects guided	17
10.	M.Tech/M.Sc./M.Phil projects guided	27
11.	Extramural projects	07

#### 4.10 Institute of Nano Science and Technology (INST), Mohali

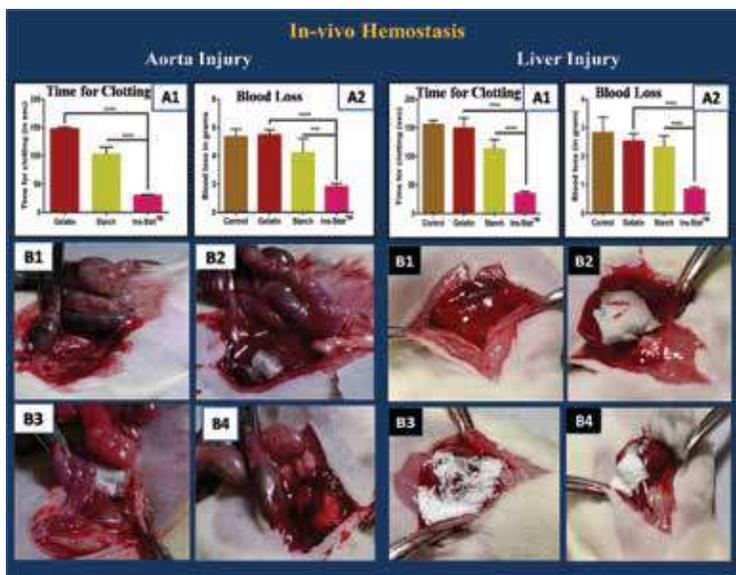
**Area of Focus :** Various areas of nano science and technology with major thrust on the following areas: Electrochemical devices for Energy Conversion and Storage, Smart materials for packaging, Terahertz Spectroscopy Imaging and its Applications, etc.

##### Major Accomplishments:

- Researchers at INST have developed a new route for the scalable preparation of large area few-layer graphene from waste biomass (nutshells) for developing supercapacitors.
- A research team of INST have experimentally probed the existence of radiation pressure of light on solid-air interface which was a long standing controversial problem of Physics.
- INST researchers have successfully developed a prototype air purifier with advanced ammonia sequestering nano-filtration unit specially designed for effective in-door air filtration.
- INST has made low-cost Cartridges for purification of industrial and domestic waste water. INST has plans to test this modified adsorbent on real waste water contaminated with arsenic collected from rural area.



- A novel low cost hemostatic device has been developed to address moderate-heavy bleeding. The patented process has been tested in pre-clinical studies.



- Under INST-Industry collaborative programme: A) a project with SRF limited has been initiated where INST is developing chemical free formulation for adhesion of fabric with rubber; B) a project with NTPC Energy Technology Research Alliance was initiated on conversion of gaseous effluents released from power plants to materials with high commercial value ; C) Another project titled “Method Development for measurement of thermal conductivity for Heat Transfer Fluids (HFTs)” with Indian Oil Corporation Limited, Research and Development Centre, Faridabad has been initiated; D) An MoU with Titan Industries, Tamilnadu has been initiated for developing Next Generation Jewellery; E) Talks have been also initiated with Tata Steel for synthesis of fine chemicals from Industrial effluents.
- INST has taken a step forward by introducing an Outreach program in May 2014 especially for rural and remote areas schools as they typically have a limited budget and scarcity of resources. INST Scientists have interacted with students of nearly 350 schools in rural/remote areas by covering length and breadth of India to the states/UT like Uttarakhand, Punjab, Haryana, Himachal Pradesh, Uttar Pradesh, Chandigarh, Tamil Nadu, Madhya Pradesh, Andhra Pradesh, Rajasthan, Orissa, West Bengal, North Bengal, Kerala, Assam, Nagaland, Meghalaya and Manipur. Out of 2500 students covered under the outreach lectures, about 1500 students belonging to the ST community.

**Important Output Indicators ;**

S No.	Parameters	Output
1.	Papers in refereed journals	83
2.	Chapters in Books	18
3.	Indian Patents filed/Indian patents granted	Patents Filed - 4
4.	Number of Technology leads awaiting transfer	3
5.	Research Manpower trained (other than Ph.Ds.) through workshops/conferences, training programmes etc	150
6.	B. Tech/ UG projects guided	15
7.	M. Tech/ M.Sc./ M. Phil projects guided	06
8.	Number of Fellows Pursuing Ph.D	125

**4.11 International Advanced Research Centre for Powder Metallurgy and New Materials (ARCI), Hyderabad**

**Areas of Focus:** Nanomaterials, Engineered Coatings, Ceramic Processing, Laser Processing of Materials, Sol-Gel Technology, Carbon Materials, Fuel Cells, Solar Energy Materials, Automotive Energy Materials.

**Major Accomplishments:**

- ARCI in collaboration with NEERI Nagpur transferred the technology to an industry for making eco-friendly incinerators for disposal of sanitary napkins. The company has launched the product under brand name 'Green Dispo'.
- Facility for large scale production of Tungsten disulphide (WS<sub>2</sub>) and Molybdenum disulphide (MoS<sub>2</sub>) nano sheets (250 g/ batch) has been established and 2kgs of MoS<sub>2</sub> nano sheets have been produced and supplied for field trials to Industry.
- Academic version of Micro Arc Oxidation technology has been designed, custom-built, supplied, installed and commissioned at NIT-Tiruchirappalli.
- Agreement signed for demonstration and transfer of know-how for medium temperature solar selective absorber coating for industrial heating.
- Easy-to-clean coatings on solar PV panels were field-tested at NETRA, NTPC, Delhi and found to be effective in reducing cleaning requirements.
- Developed smart carbon based TiO<sub>2</sub> nanostructure materials for visible light self cleaning applications.
- Successfully completed field trials of sol-gel based protective coatings on retroreflective road markers.

- Ultrafast laser micromachined control and shadow grids were supplied for pulsed microwave applications.
- Developed Spiral grooving process for journal and thrust bearings of rotating X-ray tube components.
- Developed an Analytical tool to determine the property of constituent phases for a multi-phased material using high speed nano-indentation
- Developed and demonstrated Cold sprayed refractory coatings for electromagnetic rail guns
- Developed and demonstrated Erosion resistant coatings for helicopter engine compressor blades.

**New Initiatives:**

- In order to exploit the application potential in aerospace sector, an ARCI-Industry Joint Special Coatings Centre has been established in Public-Private Partnership (PPP) mode.
- Activities on establishment of ‘National Centre for Development of Advanced Materials and Manufacturing Processes for Clean Coal Technologies for Power Applications’ have been initiated with several partners from R&D, academia and industry.

**Important Highlights of Major Programmes:**

- Solar energy materials: Developed prototype perovskite solar module (50mm x 50mm) with 5.2 % power conversion efficiency and 80 mW continuous power output; Demonstrated 8.2% efficiency on cell and 5% on 50 mm x50 mm module CIGS thin film solar cell by atmospheric process selenization.
- Energy storage materials: Developed porous carbon materials for supercapacitor applications from cloth and petcoke.Lithium ion battery pack/ modules (48V-1KWh) were indigenously fabricated and field tested on two-wheeler.
- Fuel Cells: Two units of fully integrated 5.0 kW PEMFC system were developed for stationary applications based on hydrogen availability. Developed modular type 2.5 Nm<sup>3</sup>/hr PEM based water electrolyser and tested for hydrogen generation.

**Important Output Indicators**

S No.	Parameters	Output
1.	Papers in refereed (SCI) publications	122
2.	Books & Chapters in Books	12
3.	Papers in Conferences (with or without proceeding)	98
4.	Number of Ph.Ds. produced (including employees and Fellows)	02

5.	Indian Patents filed	9
	Indian Patents granted	9
6.	Number of Technologies Transferred/applications developed/products supplied	26
7.	Number of Technology leads awaiting transfer	23
8.	Research Manpower trained (other than Ph.Ds)	19
9.	Technical Manpower trained	68
10.	B.Tech/ M.Sc projects guided	96
11.	M.Tech projects guided	37
12.	Number of Fellows Pursuing Ph.D	46

#### 4.12 Jawaharlal Nehru Centre for Advanced Scientific Research(JNCASR), Bengaluru

**Areas of Focus:** Chemistry and Physics of Materials, Engineering Mechanics, Evolutionary and Integrative Biology, Geodynamics, Molecular Biology and Genetics, Neurosciences, Theoretical Sciences and New Chemistry.

**Institutional recognitions:** UGC on 24th May 2018, graded JNCASR as Category-I Deemed to be University as per the provisions of the UGC regulations. JNCASR was also rated as the best institution for research Productivity, based on performance (per capita) of different Indian Institutions (Current Science 10 June 2018). Further JNCASR received the Clarivate Analytics India Innovation Award for 2018 in the academic institutions' category. In NIRF ranking 2018, JNCASR ranked as Special Mention Institutions.

#### Major accomplishments:

JNCASR made major progress in research, which were published in the some of the high-impact science journals. Few of these are listed below:

- Novel molecules were discovered that target a cell's ability to eliminate waste (termed auto phaggy) which may help develop therapeutics for neurodegenerative diseases.
- Cause of faster replication of HIV-1C subtype has been found.
- Scientists developed electrochemical sensor which detects levels of dopamine and paracetamol, in combination, in spiked human urine and serum samples.
- Using a small molecule that activates two enzymes (CBP/p300 histone acetyltransferases), researchers from the Centre could recover long-term memory in mice with Alzheimer's disease.

#### Academic Programmes:

- Students Strength- During the January admission of 2018-19, 6 students joined the Ph. D programme and 01 student joined the M.S.-Ph. D programme of the Centre. During August 2018 57 students joined different degree and diploma programmes. The current student strength at the Centre is 325.

- Fellowship and Outreach activities-Under Summer Research Fellowship Programme (SRFP) 2018, 63 students availed the fellowship. Student Buddy Programme, which is an outreach programme of the Centre that brings school children to JNCASR was a success. Further a number of lectures and demonstrations on science were conducted at the Centre and the faculty from JNCASR delivered lectures and interacted with a large number of students belonging to rural areas like Laxmeshwar (Karnataka), Gangolihat (Uttarakhand) etc.

**Intellectual property:** Seven Patents were granted during 2018. Seven technological products originated from the Centre have been commercially launched in the market. Start Up companies established by few of the faculty of the Centre have commenced their operation successfully.

### Important Output Indicators

S No.	Parameters	Output
1.	Papers in refereed journals	268
2.	Books	02
3.	Chapters in Books	02
4.	Papers in Conferences	03
5.	Number of Ph.Ds. produced	43
6.	Foreign Patents filed	7
	Foreign Patents granted	5
7.	Indian Patents filed	5
	Indian Patents granted	2
8.	Number of Technologies/Designs and other intellectual products commercialized	2
9.	Number of Technology leads awaiting transfer	15
10.	Research Manpower trained (other than Ph.Ds) (Information from Admin)	80
11.	Technical Manpower trained (Information from Admin)	07
12.	B.Tech/ UG projects guided (Information from Admin)	88

### 4.13 Raman Research Institute (RRI), Bengaluru

Areas of Focus: Astronomy & Astrophysics, Light & Matter Physics, Soft Condensed Matter and Theoretical Physics.

#### Major Accomplishments:

- In 2018, Astrophysicists at RRI solved the long-standing problem of why the orbits of globular clusters (GCs) appear to ‘stall’ in the cores of dwarf galaxies, which is in contradiction with the predictions of Chandrasekhar’s dynamical friction formula. They found that due to the progressive loss of strong resonances at small radii, the net torque was suppressed by factors of 100 to 10,000

when compared with the Chandrasekhar torque, which resulted in the appearance of stalling at an orbital radius between 200 and 300 parsecs. This work was published in The Astrophysical Journal.

- RRI theorists studied the relation between qubit entanglement and Lorentzian geometry and proposed a test for detecting two-qubit entanglement. The entanglement criterion is based on Partial Lorentz Transformations (PLT) on individual qubits. Apart from testing for entanglement, the approach also leads to the construction of a separable form for the density matrix in those cases where it exists. The approach leads to a simple graphical three-dimensional representation of the state space, which shows the entangled states within the set of all states. In another study, the Brownian motion of a charged particle in a magnetic field revealed a qualitatively interesting transition from a monotonic to an oscillatory behaviour of the mean square displacement with increase in magnetic field strength. The predictions stemming from this study can be tested against experiments in trapped cold ions.
- This year RRI experimentalists measured spin properties of atomic systems in and out of equilibrium via noise spectroscopy leading to extremely sensitive detection of magnetic fields (on the order of few nano-Tesla). Devices made using this technology have potential applications in diverse fields such as quantum metrology, gravimetry and quantum information processing.
- In X-ray astronomy research, first ASTROSAT results of cyclotron resonance scattering feature in an accreting pulsar, and its pulse phase resolved characteristics, have been published from RRI. A rare triplet of thermonuclear X-ray bursts in rapid succession has been discovered from another ASTROSAT observation. Detection of a Compton shoulder has been reported from a Chandra high resolution spectrum, making it only the second X-ray binary with this rare spectral feature and indicating dense stellar wind around a neutron star.

### Important Highlights of Major Programmes:

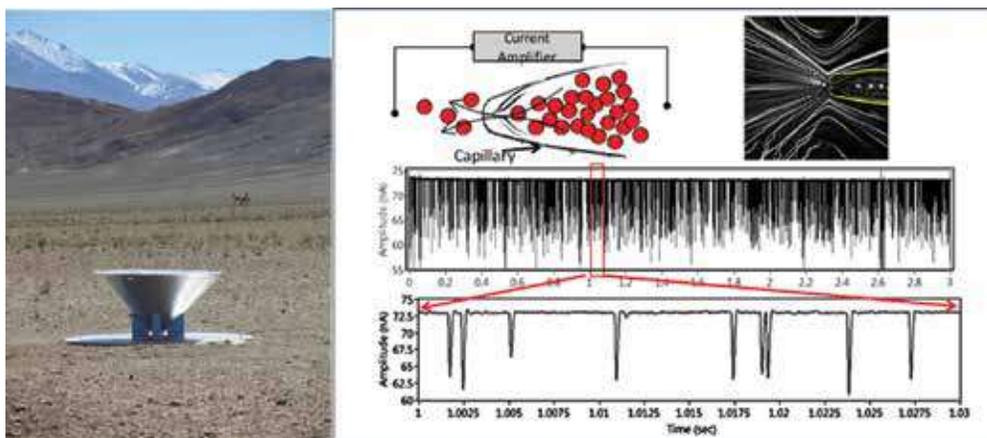
- An **X-ray polarimeter, POLIX**, made at RRI will be key payload on a dedicated satellite of ISRO named XPoSat. Two preliminary design reviews, one of the POLIX payload and another of the overall XPoSat satellite along with POLIX were successfully conducted in the year. All design and analysis aspects of POLIX have been finalised and tested. Fabrication of the qualification model of POLIX is in final stages and fabrication of some of the flight components have been initiated. Test and calibration facilities for POLIX have been built at RRI and are currently operational.
- In the programme towards detecting **Spectral Distortions in the Cosmic Microwave Background**, data from deployment of the precision radiometer **SARAS 2**, designed and built at RRI, was used to infer that during Cosmic Dawn, when the first stars formed in the universe, the first objects were effective X-ray sources that significantly heated the primordial intergalactic gas, and that the reionization did not happen rapidly with high efficiency; the work appeared in publications in The Astrophysical Journal and its Letters. The success led to new design and construction of a scaled radiometer called **SARAS 3** at longer wavelengths, to probe the earlier thermal history

of the universe at the end of the Dark Ages. First deployment was done in 2018 at the Indian Astronomical Observatory, Hanle, Ladakh, and science deployments are planned for 2019.

- The **Nano-biophysics laboratory** has (a) applied the home-built nano-devices to understand shapes-at-nanoscale by measuring signatures of disc-shaped clay nanoparticles (b) built an electro-fluidic device capable of measuring small changes in the mechanical state of the blood cells caused by different disease.
- The **Quantum Information and Computing laboratory** at RRI has embarked on its project on “Quantum Experiments using Satellite Technology” in collaboration with ISRO. During 2018, the lab also demonstrated free space QKD within the lab with competitive bit rates and error rates using indigenous photon sources, which have been pioneered by this lab in India.

**Important Output Indicators**

S No.	Parameters	Output
1.	Papers in refereed journals	122
2.	Papers in Conferences	7
3.	Number of Ph.Ds. produced	8
4.	Number of Technology leads awaiting transfer	2
5.	Research Manpower trained (other than Ph.Ds)	126
6.	Technical Manpower trained	32



(Left) Precision Radiometer SARAS 3 deployed at IAO, Hanle, a site operated by the Indian Institute of Astrophysics. (Right) Electro-fluidic device for measuring cellular morphology changes as early biomarkers of disease. Top panel shows time integrated image of fluidic field lines of model cells translocating through the micro-orifice. Bottom panel shows the corresponding electrical signature that is used to relate the cell morphology to the cell state.

#### 4.14 Sree Chitra Tirunal Institute for Medical Sciences and Technology (SCTIMST), Trivandrum

**Areas of Focus:** Biomaterials Research and Development, Biomedical Product Development, Technology Transfer and Industrial Linkages, Quality Management Systems, Testing and Technical Services, Research in cardiac and neurosciences, and Patient Care and Public Health.

##### Major Accomplishments:

- **New super-speciality block:** On 23rd June, 2018 the Hon`ble Union Minister of S&T, Dr Harsh Vardhan formally launched the following four major initiatives of the Institute: -
  - (1) The Swasthya Suraksha Hospital block under the Pradhan Mantri Swathya Surakha Yojana
  - (2) The Combinational Devices Block of Biomedical Technology Wing
  - (3) The Regional Technical Resources Centre for Health Technology Assessment
  - (4) The Data Centre



**Union Minister of S&T, Dr Harsh Vardhan launching the  
new initiatives on 23rd June 2018**

##### Major and unique national facilities created, and highlights of major programmes:

- The Nucleic Acid Amplification Testing (NAT) Laboratory in the Department of Transfusion Medicine, SCTIMST is started from from 4th January 2019.
- International Launch of the Vein Viewer product transferred by the Institute to M/s Agappe Diagnostics Pvt Ltd at “Medica 2018” Expo held at Dusseldorf, Germany on 15th November, 2018.



**Launch of Vain Viewer product at Dusseldorf,  
Germany on 15th November 2018**

- **3D Bioprinting facility:** A state-of-the-art 3D with capacity to deposit living cells based computer aided designs (CAD) has been installed to augment the basic capabilities available at the Institute.
- Animal implantation started in the DBT Center of Excellence Project “Programme Support on Translational Research on Biomaterials for Orthopaedic and Dental Applications”

#### Important Output Indicators

S No.	Parameters	Output
1.	Papers in refereed journals	213
2.	Books/Chapters in Books	17
3.	Scientific presentation in Conferences	193
4.	Indian Patents filed	28
	Indian Patents granted	1
5.	Number of Technologies/designs and other intellectual products commercialized	9
6.	Number of Technology leads awaiting transfer	8
7.	Number of PhDs produced	14
8.	Research/Technical Manpower trained (other than PhDs)	552
9.	Manpower trained against affiliated programmes (CMC-Vellore, NIE-Chennai, IIPH-Delhi), IITM-K, Trivandrum)	141
10.	M.Tech/M.Phil/MPH projects guided	25

#### 4.15 S N Bose National Centre for Basic Sciences (SNBNCBS), Kolkata

**Areas of Focus:** Physics of nanomaterials including application-specific materials and nano devices; Advanced computational materials science including soft condensed matter, ionic liquids and biomolecules; Interface of biology and condensed matter physics; DNA-protein and nanomaterials interactions; biomolecular recognition; etc.

#### Important Highlights of Major Programmes:

- The Centre has done its first Technology transfer under TRC project through NRDC to a start-up company for 'Non-invasive Quantitative Estimation of Haemoglobin in Blood'.



Celebration of the 125th Birth Anniversary of Prof. Satyendra Nath Bose



Public Lecture by Dr. Srikumar Banerjee, Outreach Programmes at Jagachha High School, Howrah, W.B. and Bangiya Bijnana Parishad, Kolkata (from left to right).

### Technical Research Centre

Innovation/Deliverable	Sector
1. A simple diagnostic methodology for non-invasive detection of infection in real-time using human breath analysis.	Health care
2. Pico-calorimeter for biochemical and small volume analyzer for DSC/microscope attachment	Value added product to an existing sector of economy
3. Prototyping thin film devices using functional oxide patterned films.	Value added product for an existing sector of economy
4. Development of light operated micro-actuator using photomechanical actuation of ferromagnetic shape memory alloys	Health care: Engineering Applications
5. (a) Hybrid Nanocomposites and (b) porous metal-organic framework compounds for CO <sub>2</sub> and toxic gases removal	Environment
6. Enzyme Catalyzed Biodegradation of Xenobiotic Compounds: Treatment of Industrial Effluents.	Environment
7. NIR Optical instrumentation for application.	Value added product

### Important Output Indicators

S No.	Parameters	Output
1.	Papers in refereed journals	187
2.	Papers in Conferences	2
3.	Number of Ph.Ds. produced	23
4.	Indian Patents filed	5
	Indian Patents granted	2
5.	Research Manpower trained (other than Ph.Ds) PDRA	29
6.	B.Tech/ UG projects guided	2
7.	M.Tech/M.Sc./M.Phil projects guided	29
8.	Summer Project at PG level	26
9.	Completed M.Sc. under IPHD	8

#### 4.16 Wadia Institute of Himalayan Geology (WIHG), Dehradun

**Areas of Focus:** The Institute's main focus is to study Himalayan river systems, glaciers, earthquake precursors, landslides, biodiversity and climate-tectonic interaction with major emphasis on the geodynamic studies of the Himalaya.

**Major Accomplishments:**

- Institute completed 50 glorious years of existence on June 29, 2018. On its Golden Jubilee celebration, compendium highlighting the milestone of the Institute research contribution was released.
- A glacier lake inventory of Himachal Pradesh was generated using high resolution Resources at 2 LISS IV satellite images. A total of 958 glacier lakes (size > 500 m<sup>2</sup>) covering an area of 9.6±0.3 km<sup>2</sup> have been mapped.
- Active fault database including its length, number and other parameters are made and is available at the Institute server for free access to the planners and administrators for making seismic hazard assessment.

**Important Highlights of Major Programmes:**

- Geomorphological assessment of the Kosi river valley suggests that the development of landforms along its path have greater imprints of tectonic activity. The extension tectonics has created subsided zones where maximum thicknesses of debris have been deposited.
- Based on the WIHG seismic network data from 2007 to 2015, peak ground acceleration contour map was drawn for the Central Seismic Gap region
- The clay mineralogy and Sr-Nd isotopic compositions of sediments from IODP Site U1457 located in the Laxmi basin, eastern Arabian Sea were analysed to reconstruct a high-resolution record of sediment export to the Indus deep-sea fan over the past 600 kyr. The <sup>87</sup>Sr/<sup>86</sup>Sr ratio and εNd imply a mixing of sediments derived from not only the Indus River but also the rivers draining the Deccan Traps.
- The study of Late Eocene- Oligocene trace fossil in the Naga Hills of Indo-Burma range supports the presence of a proximal part of the hyperpycnal lobes of delta-fed marine coarse-grained turbidite system for the depositional environment of the Laisong Formation.
- The anisotropy strength for the Sikkim region varies from 0.6 s to 3.0 s. This observed anisotropy with orthogonal polarization highlights the presence of a two layer anisotropic model. The fast axis and strength at the bottom layer shows pristine nature of upper mantle deformation. The top layer indicates the tectonic deformation of upper mantle within the lithosphere
- The contribution of high ratios of (Ca + Mg)/(Na + K), Ca/Na, Mg/Na, HCO<sup>-</sup>/Na and low ratio of (Na + K)/TZ in the melt water of Dokriani Glacier for pre-monsoon and post monsoon seasons suggests the predominance of weathering of carbonate minerals which is the major source of dissolved solutes followed by silicate weathering.
- Study of the Himalayan Foreland faunas suggest that it has a significant relation with the uplift history of the Himalaya and the Himalayan Foreland Basin even extended to south of Potwar Plateau, Pakistan and south of Himalayan ranges in India.

- Prolonged weakening of the Indian summer monsoon has been reported between 4.35 and 3.45 cal. kyr BP that induced the eastward population migration in the Indus civilization. Further the establishment, expansion and deurbanization of the Indus civilization was largely modulated by the changing climatic conditions in the Indian subcontinent
- The close mimicking of a shallow crustal exhumation pattern with the synformal structure in the central Arunachal Himalaya suggests a strong control of the development of the synform on the exhumation path of the rocks and hence a tectonics–exhumation linkage
- The formation of modern ravines in the Marginal Ganga Plain (MGP) postdates 14 ka and the Specific Sediment Yield (SSY) in the ravines of MGP range from 600–1600 t/km<sup>2</sup>/yr.
- Studies on the magmatic enclaves, pelitic xenoliths and host Jaspa granite pluton outcropped in the Lahaul area, NW Himalaya illustrate that the rocks have undergone garnet-grade metamorphism. The P–T pseudosection modelling shows that the metamorphic mineral assemblage is stable in the P–T range ~4.5–7.3 kbar and ~440–500 °C, matching quite well with the results obtained from the conventional geo- thermobarometers (5.7–8.6 kbar and 409–531 °C).

#### Important Output Indicators

S No.	Parameters	Output
1.	Papers in refereed journals	54
2.	Number of Ph.Ds. produced (5 awarded and 5 submitted)	10
3.	Research Manpower trained (other than Ph.Ds)	102
4.	M.Tech/M.Sc./M.Phil projects guided	20

#### 4.17 National Innovation Foundation (NIF), Ahmedabad

The National Innovation Foundation – India (NIF) is India’s national initiative to strengthen the grassroots technological innovations and outstanding traditional knowledge. Its mission is to help India become a creative and knowledge - based society by expanding policy and institutional space for grassroots technological innovators. It is helping India become global leader in sustainable technologies with a major thrust on end to end incubation.

Over 8,000 innovations and traditional knowledge practices from grassroots innovators and knowledge holders were received by NIF during the year. The support was extended to innovators for developing improved prototypes for more than 50 technologies. NIF also setup 8 new community workshops in 3 States, the total number of workshops now being 59 in 23 states. The major technologies developed includes - tractor operated paddy transplanter, intelligent sun glasses for blind, six axis printer for golden embossing, tractor powered sprayer, small animal restraining cum operation table, tractor powered combi tillage implement, toilet attached cot with auto cleaning, multipurpose agric equipment with mechanical sensor etc.

In terms of Dissemination and Social Diffusion, low cost innovative technologies like manual hand operated water lifting pump, head load reducing device, multipurpose tools, paddy husk stove and others were disseminated in parts of Jammu and Kashmir; socially useful innovations like sanitary napkin making machine were implemented in North Eastern part of the country particularly Odisha, Assam and Meghalaya.

NIF had standardized a technical knowhow to combat tick infestation, a common problem among livestock and has taken a constant endeavour to popularize it across different regions of country. Veterinary universities viz., Chhattisgarh Kamdhenu Vishwavidyalaya (CGKV) Raipur, Uttar Pradesh Pandit Deen Dayal Upadhyaya Pashu Chikitsa Vigyan Vishwavidyalaya Evam Go Anusandhan Sansthan (DUVASU), Mathura and DGCN College of Veterinary and Animal Sciences, Palampur had adopted this NIF's acaricide technology and disseminated in their respective areas.

The field trials of validation of innovator's claims for 41 farmers' crop varieties of paddy, wheat, cauliflower, pea, pumpkin, chilli, cucumber, hyacinth bean pigeon-pea, sorghum, nutmeg, were conducted at 12 locations in collaboration with research institutes and Agricultural Universities.

During the year, 92 patents were filed and 10 applications for plant varieties were submitted to Protection of Plant Varieties & Farmers' Rights Authority (PPVFRA). Total 21 patents and 3 registrations under PPVFRA are granted.

Amongst major commercialization accomplishments, the technologies transferred were as treatment of anestrus, mastitis and endoparasite infestation Anti-tick in animals, walker with adjustable legs, multipurpose Room Heating appliance, walnut Peeler, timer based Auto switch etc. Commercialization was also achieved through Correctional Homes in Dasna, Gurugram, Dharamshala, Nagpur and Gandhinagar. Two new grassroots innovation based enterprises were incorporated and three distinct enterprises (which were incorporated in previous years) were recognized as Start-Up by Department for Promotion of Industry and Internal Trade (DPIIT).

NIF hosted the Festival of Innovation and Entrepreneurship (FINE), an initiative to recognise, respect, showcase, reward innovations and to foster a supportive ecosystem for innovators along with the President's Secretariat and Department of Science and Technology (DST) from March 15th to 18th, 2019 at the Gandhinagar, Gujarat. Hon'ble President of India Shri Ram Nath Kovind inaugurated the festival and conferred the 10th Biennial National Grassroots Innovation and Outstanding Traditional Knowledge Awards. An exhibition of innovative technologies and 6th batch of Innovation Scholar In-Residence Program was also invited apart from roundtables on various themes of contemporary importance.



**Hon'ble President of India Shri Ram Nath Kovind visiting the innovation exhibition during the Festival of Innovation and Entrepreneurship (FINE) 2019 and interacting with the INSPIRE - MANAK awardees**

Organized by NIF since 2008, Dr APJ Abdul Kalam IGNITE Awards 2018 were conferred to 31 students from 11 States for their 21 ideas / innovations on 17th November, 2018 by Shri Pranab Mukherjee, the former President of India.

As a part of the INSPIRE Awards - MANAK (Million Minds Augmenting National Aspiration and Knowledge), a programme jointly executed by NIF and DST, 2.87 lakh ideas and innovations were scouted in few months from all States and UT's of the country. In terms of establishing linkages with innovative students, be it through exhibitions or workshops or through various other outreach mechanisms, the districts across the country were sensitized. In line with the underlying theme of MANAK and so as to empower students who have demonstrated merit at the district level, a series of mentoring workshops were organized at premier institutions of the country with the objective of giving students the right exposure at an early stage. Apart from hundreds of District level exhibitions and several State wise exhibitions, a National Level Exhibition and Project Competition (NLEPC) was organized at IIT, Delhi where 776 student innovators from all over the country participated and top 60 received an award.

The ASEAN India Innovation Platform (AIIP), ([www.indiaaseaninnovation.com](http://www.indiaaseaninnovation.com)), a scheme under ASEAN-India Science and Technology Development Fund (AISTDF) executed by NIF for the Social Innovations by way of developing a web platform (Innovation Bank) went live. An international Innovation Competition in two categories viz. Grassroots Innovation and Children creativity was organized in association with Center for Research Science and Technology Indonesian National Science & Technology Park (PUSPIPTEK).



**Mastirak - a herbal medication in treatment of subclinical and clinical mastitis among animals, incubated and commercialised by NIF**

**Important Output Indicators**

S No.	Parameters	Output
1.	Papers in refereed journals	4
2.	Books/Monographs/booklets	5
3.	Chapters in Books	1
4.	Papers / Presentations in Conferences	25
5.	International Conferences Organized	2
6.	Indian Patents filed	92
7.	Indian patents granted	21
8.	Applications filed under PPV&FR Act 2001	10
9.	Applications granted under PPV&FR Act 2001	3
10.	Trademarks registered	2
11.	Number of Technologies / Designs and other intellectual products commercialized / technologies transferred	7
12.	Number of Technology leads awaiting transfer	50
13.	Number of GRIs based companies incorporated	2
14.	Number of companies registered as Start Ups	3
15.	Number of innovators supported under Micro Venture Innovation Fund (MVIF)	11

#### 4.18 Technology Information Forecasting and Assessment Council (TIFAC), New Delhi

**Area of Focus:** Technology foresight exercises, vision 2035, nurturing innovation, supporting MSME cluster, capacity building, electric mobility, collaborative linkages etc.

##### **Major Accomplishments:**

- Technology Vision 2035: Various dissemination events/ lectures were conducted as a post follow-up activity of TV 2035 Programme during the reporting period..
- During the reporting period, the sectoral reports of both Global Technology Watch Group (GTWG) and Technology Needs Assessment (TNA) projects have reached finalization under Climate Change Programme.
- TIFAC submitted the technology needs assessment inputs for the final version of Chapter 5 on 'Finance, Technology and Capacity Building Needs and Support Received' of BUR II in end October 2018 to MOEF&CC which was submitted to UNFCCC in December 2018.
- Further, an executive summary report of GTWG was released in COP24 at Katowice, Poland on 3rd Dec., 2018, by Dr. Harsh Vardhan, Hon'ble Minister for Science & Technology and Earth Sciences, Ministry of Environment Forest & Climate Change. TIFAC made a presentation on energy-efficient technologies identified under the TNA and GTWG projects in the panel discussion (Side Events) at the India Pavilion in COP 24.
- Four innovative products successfully commercialized during the financial year viz. Low Lactose Milk in aseptic pouch, Waste heat recovery from industrial compressors, Sewage treatment plant based on UF Membrane of PAN and Hydraulic directional control valve under Srijan Programme.
- During the period 16 Indian Patents have been granted to respective applicants. PFC facilitated filing and processing of these patent
- PFC conducted 3 IPR Awareness Workshops. First workshop was held at LMS Govt PG College, Pithoragarh on April 18, 2018 in association with Uttarakhand State Council for Science & Technology. For the second and third workshop PFC extended technical support in Organising these workshops on IPR one each Maulana Abdul Kalam Azad University Technology (MAKAUT), Kolkata on March 15, 2019. Completion of one year training on IPR by 103 KIRAN-IPR trainees in 9th batch.
- More than two hundred and eighty (280 nos.) students have completed technical internships in MSME industries and around 60 students have completed their internships in MSME enterprises this year only.
- Development of nine (9) technologies have been completed and demonstrated and further thirty six (36) project proposals have been assessed for consideration of support Scheme is replicated through Rajiv Gandhi Science and Technology Commission, Govt. of Maharashtra.

- Technology assessment study titled ‘Estimating generation and surplus amounts of crop residues in India’ in association with IARI was published and released on October 31, 2018 under Bioprocess and Bioproducts Program by Dr V K Saraswat, Member-NITI Aayog. The study provides district scale season-wise, crop wise, dry biomass, surplus biomass and their bioethanol production potential in India (state-wise). The study report titled ‘Spatial Information System on Biomass Potential from crop residues over India using geospatial techniques’ with National Remote Sensing Centre, Hyderabad is nearing completion.
- Technology Assessment reports on ‘Castor - Status, Challenges, Opportunities and Road Ahead’, ‘Bauxite – Status, Challenges, Opportunities and Road Ahead’ and ‘Seaweeds Cultivation and Utilisation- Prospects in India’ were published and released in October, 2018 . The reports focus on available and potential technologies which need to be developed / adopted / acquired by the industries to meet the global market requirements
- Under India-IIASA Programme, three studies namely Development of Methodology and DSS for water-scare Bundelkhand Region in India with NIH Roorkee, Evaluation of Soil Nutrients in humid tropics of Kerala with CWRDM, Kozhikode and climate Change Adaption Approach for Sustaining and Improving Rural Livelihoods – IRMA, Anand have been completed. These reports were published on TIFAC Foundation Day on February 12, 2019.

### Important Output Indicators

S No.	Parameters	Output
1.	State-of-the-art-Reports Published	10
2.	Original Science Communication Content Designed	2
3.	Scientific Lectures/Training Programmes organized	6
4.	Number of students trained	59
5.	Foresight Reports and Analyses Prepared	7

### 4.19 North East Centre For Technology Application and Reach (NECTAR), Shillong

NECTAR focusses on providing last mile guidance and support to north-eastern States in technology applications for socio-economic activities.

#### Important Highlights of Major Programmes:

- The project ‘High-resolution GIS Weather Data Mapping of Watershed in Meghalaya’, had been launched where indigenous development and supply of automatic weather stations for AWS Network and its applications in North East. 30 number weather stations are ready to be installed at various locations in the North East Region on requirement basis and instant data update facility is the highlight of these equipments.



#### Low Cost Weather Station

- NECTAR has supported the project to North East Network (NEN)/Chizami Weaves in Chizami village at Phek district, Nagaland. Chizami weaves has engaged 300 back-strap loom weavers and made products of 4500kgs yarn- home furnishing, garments and accessories catering to both rural and urban consumers. Management team and weavers were trained for skill upgradation. Society has already repaid the supported assistance.
- In continuation of the support for livelihood, skill development and assisting market linkages for North Eastern products, NECTAR has supported for beekeeping in Kiding village, Tuensang Nagaland, towards expansion of Honey growers of Tuensang. 135 honey growers are facilitated by providing with 675 improved bee harvesting boxes and accessories etc. Society is making regular repayments of supported assistance.
- Eleutheros Christian Society (a NGO based in Tuensang) has been supported by NECTAR. Around 1700 bee boxes were distributed among the 170 beekeepers under this project. With the intervention of NECTAR for expansion of bee boxes there is an increase in the output of honey production which in turn increased income generation of every farmer. Bee rearing boxes were manufactured in Nagaland with the local wood. In the said project, interior villages of district Tuensang were covered viz Chendang, Konya, Longtang and Chingmei. Society is making regular repayments of supported assistance.
- Roots Agri Producer & Marketing Cooperative Society Ltd., Dimapur, Nagaland has been supported by NECTAR for expansion of operation in fruit and vegetable processing. The society is created with an objective to provide and add value to all indigenous agro and forest products in Nagaland. NECTAR has supported machinery and working capital. Society is manufacturing Naga Chilli sauce and marketing in most of North eastern states.



**Ready Naga Chili Sauce bottles**

- NECTAR has supported zero energy storage facilities to 400 farmers of Chang tribe in Tuensang districts for improvising the agriculture produce. The concept of storing is based on zero energy which is an indigenous and a low cost technology. Indian Council of Agriculture & Research (ICAR) has developed this design & technology and has given the training to local people for constructing these storages.



**Zero Energy Cold Storage**

- After successful completion of wireless CCTV project in Shillong and Tura, District Administration (Planning and Development department of Meghalaya), requested NECTAR to install of such wireless CCTV system for 27 more locations (in addition to previous locations) for extension of the earlier project. On the basis of survey and LoS (Line of sight) analysis, 12 locations were finalized. The project proposal of NECTAR has been accepted by the Meghalaya Govt. Selection of suitable vendors for civil work has been done. After the civil work (erection of towers and other infrastructure), NECTAR will set up the extended CCTV Network in next phase.
- After completion of two pilot projects on establishing connectivity between unconnected police station under CCTNS project, NECTAR has extended support on technical feasibility analysis, for five North Eastern states viz. Nagaland, Arunachal Pradesh, Mizoram, Manipur and Tripura. Survey and feasibility report is under review by these states.

### 4.20 Vigyan Prasar (VP), Noida

**Areas of Focus:** Science and Technology Communication and Popularization.

#### **Major Accomplishments:**

- VigyanPrasar uses multiple approaches to deliver value-added scientific and technological information/learning meant for a wide array of stakeholders. These include audio-visual, print, training, hands-on, and other internet-based tools and techniques. The cross-cutting approach is employed to develop and deliver these knowledge products to be deployed and used with ease by the local populace. The central theme is to engage stakeholders, particularly the youth, to stimulate and inspire scientific temperament. The activities of VigyanPrasar are executed and carried out primarily through scientific divisions namely publication planning, audio/video programmes, astronomy popularisation, VigyanPrasar network of science clubs, science communication and training, gender and technology communication, EduSat network and Ham radio communication. Planning Division of Vigyan Prasar deals with Publication of popular science books/ resource materials and monthly science magazine Dream 2047. The Audio/Video Division develops Audio and Video Programmes for radio and television. The Gender and Technology Communication Division deals with gender parity; technology communication. Vigyan Prasar web portal is a repository of science communication content. Vigyan Prasar in furtherance S&T intervention for Tribal Population collaborates with state S&T councils, department and S&T based agencies.
- Science and Technology based video (158 episodes) and Radio Programmes (1250Nos) were produced and broadcast. The Indian Science Wire (Indian Science News Feature Service) released 483 stories. The product had more than 15,800 tweet impression and 10474facebook followers.
- Eight Nature activity camps for children of mobile schools of J&K were organized. More than fifty Vigyan Melas were organized in different states for Tribal Children. The 6th addition of VidyarthiVigyanManthan was organized jointly with the National Council of Educational Research & Training and VijnanBharti (VIBHA).

- Vigyan Prasar launched two national level initiatives in the field of science communication, i.e. DD Science and India Science on 15th January 2019.
- India Science Film Festival was held at Goa from 16 to 19th January, 2019 with the collaboration of other Institutes.
- 9th National Science Film Festival was organized during 27-31 January 2019 in collaboration with Chandigarh University, Mohali. Vigyan Prasar was a major partner in India Science Film Festival held at Goa from 16 to 19th January 2019.

### Important Highlights of Major Programmes:

- A new programme Sci-Connect - Nurturing Young Talents of North-East on Science was launched especially for North-Eastern states. The programme has an integration of science film screening, Hands-on training on Science and Studio based quiz competition. Total of 6000 students participated, and nine students were selected for the award.
- Capacity Building Workshops on Adolescent Health for Tribal Girls in five states of India. Film on Drug Reduction on Women Friendly Tools and Technologies.
- New Radio serial on theme Climate Change and Global Warming in 19 languages being broadcast from 121 stations of All India Radio ( 14 FM and 107 Medium Wave Stations )
- India Science & Technology Innovation (ISTI) Portal, science channel/.internet based science and technology channel, India Science News Feature Service (ISNFS) and Web Presence of India.

### Important Output Indicators

S No.	Parameters	Output
1.	Papers in refereed journals	09
2.	Books/Monographs	08
3.	Chapters in Books	06
4.	Papers in Conferences	15
5.	Popular Science Books/Newsletters	08
6.	Scientific Lectures/Training Programmes organized	40
7.	Number of students trained	10000
8.	Number of school/college/university teachers trained	700
9.	Number of Innovations Registered	09
10.	Data Bases Compiled	02

### 4.21 Indian National Academy of Engineering (INAE), Gurugram

A brief overview of the major activities/achievements of Indian National Academy of Engineering (INAE) for the year 2018-19 is as under:

**(i) Engineers Conclave 2018**

The sixth Engineers Conclave 2018 (EC-2018) was organized jointly with Larsen & Toubro (L&T) on Oct 4-6, 2018 at L&T LDA, Lonavala. The objective of the Engineers Conclave is to provide a platform for engineers from allied fields to meet, deliberate and recommend right engineering solutions to some of the pertinent issues of national importance. The two themes for EC-2018 were “**Defence Manufacturing in Industry**” and “**Engineering Challenges in Urban Infrastructure**”.



**Dr. Subhash Bhamare, Hon'ble Rajya Raksha Mantri delivering Address during the Inaugural Function of EC-2018 on Oct 4, 2018**

Actionable recommendations based on the deliberations of the two themes were compiled which are being progressed with the concerned Government Departments/Agencies for consideration.

**(ii) International Seminar on “Civil Aviation - Regional Air Connectivity”**

INAE in association with the Ministry of Defence Production and Ministry of Civil Aviation organized a one-day International Seminar on “Civil Aviation - Regional Air Connectivity” as a part of “Aero India 2019” on 21st February, 2019 at Bangalore. The genesis of planning of the event was that Dr Ajay Kumar, Secretary, Department of Defence Production in his address during the Inaugural Session of Engineers Conclave 2018 desired that INAE organize a one-day International Conference on Aerospace Technologies in the Aero India Show planned in February 2019 at Bangalore. This initiative was also in line with the earlier efforts of INAE wherein the recommendations emanating from Engineers Conclave 2017 regarding “Development and Production of Regional Civil Aircraft in India” were submitted to Niti Aayog; who had taken up the case for instituting a Special Purpose Vehicle (SPV) as recommended by INAE for approval of the PMO. The approval has since been

accorded and the Ministry of Civil Aviation directed to process the case to form a SPV to head the initiative. The emphasis of the INAE seminar was on next generation regional turbo prop aircraft since India has emerged as a huge market for regional turbo props. Global leaders from industry, major R&D labs, Academia, Indian aircraft industry, airline operators and government leadership participated in this seminar. The event concluded with the Panel Discussion on ‘Ecosystem of Manufacturing of Civil Aircraft in India’ chaired by Prof. K. Vijay Raghavan, Principal Scientific Adviser to the Government of India wherein the suggestions from eminent panelists and participants were summarized. The seminar provided an excellent platform for globally recognized engineering luminaries to interact with the national domain experts and bring out actionable recommendations for the way forward.



### **(iii) Abdul Kalam Technology Innovation National Fellowship**

INAE and Science and Engineering Research Board (SERB), Department of Science and Technology (DST) launched the Abdul Kalam Technology Innovation National Fellowship in the year 2017 to recognize, encourage and support translational research by Indian Nationals working in various capacities of engineering profession, in public funded institutions in the country. The Fellowship is applicable to persons engaged in the engineering profession only. The expected outcome of the research work carried out is to develop Commercialized or deployable technology; pilot scale or field trial worthy technology; patent (filed/ sold/ commercialized) working model or prototype for demonstration and trial. Eight nominees were selected for conferment of the Fellowship in the year 2018-19. The Technology Day was celebrated by DST at Vigyan Bhawan, New Delhi on May 11, 2018 and the Function was graced by Hon'ble President of India Shri Ram Nath Kovind. During the function the six Abdul Kalam Awardees selected during the year 2017-18 were felicitated by Dr Harsh Vardhan, Hon'ble Minister of Science & Technology, Minister of Environment, Forest and Climate Change and Minister of Earth Sciences.

### (i) INAE Youth Conclave 2018

An **INAE Youth Forum** has been instituted in the year 2017 with the objective of encouraging the engagement of Indian youth in engineering activities at national level. It is envisaged that the Youth Forum shall serve as a platform for encouraging youth to participate in engineering activities at the national level. The second INAE Youth Conclave was organized at Indian Institute of Technology, Kharagpur on Aug 11-12, 2018. The Conclave was attended by more than 230 engineering students from all over the country, and about 40 INAE Fellows participated in the deliberations. The INAE Youth Conclave 2018 was organized in two phases wherein the first stage involved a Pre-Conclave activity where students from different engineering colleges and institutions at graduate level presented their ideas on six identified problem statements namely **(a) Academic Planning (b) Town Planning (c) Optimizing Food Chain (d) Health Care App (e) Digitization of Agriculture sector and (f) Swachh Bharat**. All the shortlisted student groups were invited in the final conclave to present projects based on their problem statements and the presentations were judged by a panel of judges comprising of experts from academia and industry. INAE had also organized a Second Online National Essay Competition on the topic “National Challenge and the Engineering Solution”. The Conclave concluded with the award ceremony for the awardees of the Second Online National Essay Competition and other competitions held under the aegis of the Conclave.

### (ii) National Frontiers of Engineering Symposium (12NatFoE)

The National Frontiers of Engineering Symposium is an annual flagship event. It brings together 30-40 outstanding engineers between 30 and 45 years of age, from industry, Academia and R&D Labs to discuss leading-edge research and technical work across a range of engineering fields. Each year a few disciplines are chosen as focus areas. The Twelfth National Frontiers of Engineering (12NatFoE) Symposium was held from Sept 17-18, 2018 at IIT Guwahati. The Symposium had four thematic areas: **Remote Sensing and Image Processing; Cyber Security; Additive Manufacturing and Medical Diagnostics and Therapeutics**. Forty professionals from various institutes and R&D labs, industries and start-ups participated in the event and shared their contributions. They presented their views on the four themes, so as to generate novel ideas that may culminate in new generation technologies. A Panel Discussion was held with four overview talks on the topic “**Technology as the Bridge Between Science and Society**”. The networking between the participants gave them a flavour of the research work happening in various parts of the country.

### 4.22 Indian National Science Academy (INSA), New Delhi

Indian National Science Academy (INSA) is a National body of Indian Science devoted to the pursuit of identifying, nurturing excellence in Science; assisting the government with aspect of policies on science. INSA has been mandated by the Government of India to represent it in all International science fora. The Academy recognizes Indian scientists excelling in their work by electing them as Fellows covering all sciences, engineering, medicine, agriculture, and interdisciplinary research. During 2018, 30 Fellows and 5 Foreign Fellows were elected to the Fellowship making a total of 96 Fellows. The INSA Medal for Young Scientists was given to 31 young researchers. This included a

medal for exceptional research in the History of Science. INSA also recognized, 12 outstanding and creative teachers with INSA Teachers Award.

INSA conducts the entire selection process of INSPIRE (Innovation in Science Pursuit for Inspired Research) Faculty Fellowship Award, for DST. During 2018, 174 young scientists from 2526 applicants, were selected as INSPIRE fellows.

INSA pursues several programmes to **promote international relations**. These can be broadly placed in two categories, viz., i) activities in pursuance to adherence to ICSU now renamed as International Science Council (ISC) and, ii) bilateral exchange/collaboration programmes with academies of other countries. INSA thus represents India in all scientific unions affiliated to ISC and deals with all the logistics of Indian adherence, through pan-Indian advisory committees for each union, As a part of bilateral exchanges, during 2018 due to INSA's efforts, four Indian scientists were elected in various executive positions of ISC and unions affiliated to it; 26 scientists /researchers were supported to attend various ICSU/non-ICSU sponsored international conferences; 37 scientists were supported to work in laboratories overseas; 10 Indian scientists were selected for DST-JSPS Fellowship and 7 scientists from other countries, worked in India. INSA actively participated in the programs of Inter Academy panel (IAP), Association of Academies, and Societies of Sciences in Asia (AASSA) and participated in several meeting on Sustainable Development Goals and Science, worked with Commonwealth and other Academies on statements on Climate Change, Ocean Health and like.

Under the **Science Promotion Programme**, INSA Research Professorial Chairs were merged with the newly initiated scheme of INSA Distinguished Professors. The INSA Distinguished Professors are expected to participate in outreach programmes for school and college students. The Academy supports Senior Scientists, Honorary Scientists, and Young Scientists Awardees for advanced research in their specialized disciplines. During the year, two scientists were offered with INSA Distinguished Professor, 10 scientists were offered with INSA Senior Scientist position and six scientists were offered with INSA Honorary Scientist position. This number had to be limited due to funding limitation and several eminent scientists remained in the waiting list. INSA provided partial support to 51 Conferences/ Symposia/ Workshops.

INSA through its **History of Science programme** supports the development of monographs, discussion meetings and publishes the Indian Journal of History of Science (IJHS). The program under the guidance of the Indian National Commission for History of Science supported 11 new projects and reviewed 21 ongoing studies.

Under **Science and Society Programme**, INSA support the Academy sponsors lecture-cum-interaction meeting by the INSA Fellows / Young scientist awardees/ Teacher awardees / INYAS members at schools/colleges in remote and during 2018, 35lectures were held. In addition, 11 award lectures were delivered at local chapters.

**Some Important Output Indicators**

S No.	Parameters	Output
1.	Books (Indian National Science Academy's Inspirational journey in 75 years)	6 books Published
2.	Journals Published	03
3.	Refresher Course	40
4.	Lecture workshop	120
5.	Research Projects in History of Science	25
6.	International Conferences Organized	2
7.	National Conferences Organized	54
8.	Number of persons who attended various science outreach programmes/conferences etc.	625
9.	Scientific Outreach Programmes organized	8
10.	Scientific Lectures/Training Programmes organized	46
11.	Number of students trained	2161
12.	Number of school/college/Univ teachers trained	170

**4.23 The Indian Science Congress Association (ISCA), Kolkata**

Major activities of ISCA during the year under report are as following:

- Holding of 106th Indian Science Congress Session at Lovely Professional University, Jalandhar.
- Publications including ISCA bi-monthly journal Everyman's Science.
- Augmentation of 26ISCA Chapter Activities.
- Organising Seminars, Symposia, Discussions, Workshop etc.
- Young Scientists' Award Programme
- Best Poster Presentation Award Programme
- Science Awareness Programme for Popularisation of Science in Chapters
- Awards to eminent scientists
- Asutosh Mookherjee Fellowship to senior scientists
- ISCA Fellowship (FISCA) to members
- Advancement and Promotion of Science and Technology through National/International Symposia, Follow-up of Recommendation(s) Involving Young Scientists

- International Collaboration on Exchange Programme
- Infrastructure Development

### **Important Highlights of Major Programmes**

Holding of 106th Indian Science Congress at Lovely Professional University, Jalandhar under the General Presidentship of Dr M K Chakrabarti. Shri Narendra Modi, Hon'ble Prime Minister of India, inaugurated the Congress on 3rd January in the presence of Shri V. P. Singh Badnore, Hon'ble Governor of Punjab and Dr. Harsh Vardhan, Union Minister of Science and Technology,



**Hon'ble Prime Minister delivering the inaugural address at 106th Indian Science Congress**

The Indian Science Congress Association (ISCA) has instituted several new Awards to honour and encourage scientists in India – mainly through special endowments received from individuals and groups and also from its own funds.

The Association envisaged constructive work for the popularisation and advancement of science by organising national seminars on focal theme, symposia, discussions, popular lectures, quiz contest, etc. thorough out the year under twenty six ISCA Chapters. The Association through its Chapters observed the science day, environment day, doctor's day, yoga day, engineer's day, technology day, and also organized joint collaborative programmes with other organizations .

The Journal of the Association "Everyman's Science" which is circulated to all members free of costs has been published regularly.

#### **4.24 The National Academy of Sciences (NASI), Allahabad**

The Academy continued to promote Science & Technology by regularly organizing several activities with the help and support of its Fellows and Members. During the year of the report, the following activities were undertaken -

## Publications

- a) NASI published the Proceedings of NASI, Sec. A & B, each in IV parts and National Academy Science Letters in VI parts, in collaboration with the Springer India Pvt. Ltd.
  - National Academy Science Letters received Impact Factor (IF) as 0.519 in 2017 from Thomson Reuters; about 250 papers were received from twenty five countries.
  - PNASI, Sec. A received Impact Factor (IF) as 0.754 in 2017 from Thomson Reuters; about 200 papers were received from thirteen countries.
  - The PNASI, Sec. B received Cite Score as 0.62 in 2017 from Scopus; about 400 papers were received from nineteen countries.
  - Special Issue of PNASI, Sec. A on “Lasers for biomedical and material processing applications” was published in 2018.
- b) Indian Science, its Competitive Strength and its Relevance to National Needs (a report by the NASI Study Group), was published and sent to different agencies.
- c) ‘Proceedings of the Mega-event including significant recommendations’ was also published; and being sent to all concerned.
- d) The 9 volumes on the History of Science in India were distributed to the concerned government and non-government agencies for dissemination of knowledge; the ‘Vision Document’ on Women in Science was also distributed.
- e) Three reports on Nutritional Survey & Analysis (in collaboration with ICMR-NIN, Hyderabad) on the rural/semi-urban population of Allahabad, Hyderabad and Vadodara, were published after extensive work in these regions in last three years.

## Science Communication Activities

- The highlights of these activities were Children Science Meet, Summer & Winter Schools, Vocational Training Programmes, Teachers’ Training Workshops, Scientific Writing Contest, Vigyan, Jal & Health Chaupals, Seminars, and celebration of the National Technology Day, the National Science Day, the National Mathematics Day and the World Environment Day etc. The Academy also encouraged the teachers for out-of-the-class science activities by recognizing their talent and giving away NASI-Science Teacher’s Awards to them.
- NASI’s 20 Chapters spread across India, organized hundreds of science communication activities in and around their respective regions throughout the year. More than 20,000 students and teachers benefitted from these activities.
- One Science Awareness Programmes (relating to health issues) was organized for the Army personnel at Guwahati.



**A view of the participants of the Winter School at RSC, Lucknow Dec.30, 2018**

### **Activities under Scheduled Tribe Sub-Plan Programmes**

An innovative programme launched under this head during the year 2017-18 for improving the socio-economic status of the Scheduled Tribes, has now spread in 20 regions of our country, under Prof. Manju Sharma, Chairperson, NASI-New Initiatives.

### **Sensitization Programmes for Women Researchers/Scientists**

After organising **25 workshops on Technological Empowerment of Women** in different parts of the country during the last 5 years, the Academy organised a **Mega Event** under the leadership of **Prof. Manju Sharma**, Past President, NASI, on **March 8-9, 2018** with **Dr Harsh Vardhan, Hon'ble Minister for Science & Technology, Govt. of India**, as the Chief Guest, and about 1000 women scientists as participants; the 'Proceedings of the Mega-event including significant recommendations' has also been published and sent to all concerned. Recently, other workshops with more than 350 women scientists were organized at AIIMS, Rishikesh and NASI, Prayagraj, respectively on May 25-26, 2018 and **March 8-9, 2019**. Prof. G. Padmanaban, Prof. Satya Deo, Prof. Rakesh Bhatnagar, Prof. Sneha Bhargava, Prof. Kasturi Datta, Prof. Paramjit Khurana, Prof. Smita Mahale, Prof. Veena Tandon, Prof. Bina Ravi, Prof. Suchitra Banerjee and several other distinguished scientists/speakers graced the occasion on March 8-9, 2019.

### **Handing-over of Brahmaputra Gallery to the Govt. of Assam at Guwahati, Assam; and establishment of Cauvery Gallery at Mysuru**

- Following the establishment of Ganga Gallery in the year 2011 at NASI Headquarters, Allahabad, the Academy established another river gallery on **Brahmaputra River** in Guwahati, Assam in 2015; which is now being handed over to the Govt. of Assam; but it will remain as the joint property of NASI and Assam Govt.

- The work on the third gallery on **River Cauvery** has also been completed at Mysuru, Karnataka with the major support from the Government of Karnataka.
- Recently, a prototype of the ‘Ganga-gallery’ was created at ‘Pravasi Bharatiya Divas’, held on Jan. 21-23, 2019 at Varanasi; appreciated by several NRIs.

### 4.25 Indian Academy of Sciences (IASc), Bengaluru

The Academy was founded in 1934 by Nobel laureate Sir Prof C V Raman. The Academy strives to meet its objectives through promotion of original research and dissemination of scientific knowledge to the community via a variety of activities that include scientific meetings, discussions, seminars, symposia and science education courses and workshops.

The Academy publishes reputed international scientific journals that contain high quality papers and articles by scientists from India and abroad. The number of journals currently published by the Academy is 13 (including one online only journal), covering all major disciplines in science & engineering. The Academy during the year published over 1700 peer-reviewed articles with 19,799 pages in 12 thematic journals and the entire contents are available in a free access platform (<http://www.ias.ac.in/journals/overview>). Freely accessible journals during the year had over annual average of 17 lakhs downloads of refereed articles. 16 special publications of topical interest and 6 books were published. Over 30,000 print versions of these journals were circulated to individuals/universities/institutions. Worldwide visibility to Academy journals increased with more submission of articles. 10 journals of the Academy are being co-published with Springer and Springer Nature provides access to the journals’ content worldwide on its journal platform SpringerLink.

The Current Science Association works with the Academy in bringing out the frowningly multidisciplinary journal Current Science. During the year, Current Science published 1066 articles with 6216 pages. The total number of downloads was 335471.

The academy annually elects distinguished scientists of the country to its Fellowship: it also elects persons distinguished for contributions to science or engineering, whose place of work is outside India, as Honorary Fellows. The stringent annual exercise begins with nominations by Fellows, and goes through evaluation and shortlisting by Sectional Committees for the Council, and ends with ballot open to all Fellows in December every year. 23 outstanding scientists from India and one foreign scientist were inducted into the Academy Fellowship and Honorary Fellowship respectively (with effect from 1 January 2019). As on 31 March 2019, the number of Fellows on roll was 1085, and Honorary Fellows 53.

Associateship programme was introduced in 1983 to identify and encourage promising young scientists. The programme was assessed for its impact in 2018 by a committee constituted by the Council. Based on the recommendations of the committee the programme was reformed to provide opportunity to young scientists from diverse institutions and backgrounds to pursue scientific excellence. As per the revised guidelines, the upper age limit is now 38 years. The Associateship is tenable for a minimum

period of 3 years or a maximum period of 6 years. During July 2018, 23 promising young scientists were selected. As on 31 March 2019, the number of Associates on roll was 67.

Towards attempts to improve the state of higher education and teaching of science in the country, major activities are implemented. Under the Summer Research Fellowship and FAST–SF programmes, 1686 students and teachers undertook 2 months' Fellowship and worked with Fellows and other mentors spread across 215 research institutions in the country. The Academy, annually supports educational institutions in the country to hold lecture workshops and refresher courses in all major disciplines of sciences. 198 lecture workshops and 49 refresher courses were held.

The Academy annually holds scientific meetings, symposia and public lectures and encourages other similar activities to provide means of exchange of scientific knowledge among scientists and to bring new knowledge to the attention of whole scientific community. During the year, the academy held two annual meetings; 29th Mid-Year Meeting was held at the Infosys Leadership Institute, Mysore Development Centre, Mysuru and 84th Annual Meeting at the Banaras Hindu University, Varanasi. Four discussion meetings on various scientific themes and seven public lectures were organized during the year.

Under visiting Chair Professorship programme, Janaki Ammal Chair Professor Prof Nina Fedoroff from Penn State University, a molecular biologist known for her research in life sciences and biotechnology, especially transposable elements or jumping genes, and plant stress response, visited India during November. During her visit, Prof. Fedoroff visited NIPGR-Delhi, Mahyco-Aurangabad and UAS, NCBS-Bengaluru.

Prof. David Baker, Department of Biochemistry, University of Washington, a biochemist and computational biologist who has pioneered methods to predict and design the three-dimensional structures of proteins, visited India during December as Raman Chair Professor. Prof. Baker visited various institutions across India to deliver scientific lectures to the science community. He visited NII-Delhi, IIT-Madras and IISc-Bengaluru during his tenure.

Nobel Laureate Prof. Bernard Lucas Feringa (Ben Feringa), Jacobus van't Hoff Distinguished Professor of Molecular Sciences, Stratingh Institute, University of Groningen, The Netherlands, is the Raman Chair Professor. His research interest includes stereochemistry, organic synthesis, asymmetric catalysis, molecular switches and motors, self-assembly, molecular Nano-systems and photo-pharmacology. Professor Feringa visited India during March 2019. Prof. Feringa visited various Science and Technology Institutions in India and delivered scientific talks and interacted with scientific fraternity. Prof. Feringa visited Jawaharlal Nehru Centre for Advanced Scientific Research, Indian Institute of Science, Panjab University, IMTECH, IISER-Mohali, IGIB, IIT-Kharagpur and IACS-Kolkata during his tenure.

Under Repository of Publications of Fellows, an initiative of the Academy, is intended to make available research and review papers published by Fellows in peer-reviewed journals. 2220 new records were added, with a total of 106328 articles.

## SCIENCE AND ENGINEERING RESEARCH BOARD (SERB)

The Science and Engineering Research Board has come up with several innovative programmes and schemes to identify potential scientists and support them for undertaking R&D in frontier areas of Science and Engineering. The Board interventions are primarily focused to expand the research base in the country without compromising the quality of research. Special attention has been given to invest in young minds; and, to strengthen new areas of science.

The Board, chaired by Secretary, Department of Science and Technology (DST), comprised of 16 members including six Secretaries to the Government of India, met four times in the reporting period and has taken significant decision concerning R&D in the country. Some of the decisions taken by the Board are given below:

- In order to effectively utilize the R&D infrastructure and expertise of SERB grantee to benefit other S&T stakeholders and the society and also to embed a participatory, inclusive and sustainable culture of social responsibility among SERB grantee, the SERB Board has adopted a Scientific Social Responsibility (SSR) policy as an integral part in SERB Programmes.
- Introduced a new scheme titled ‘SERB Research Scientist (SRS)’ for the awardees of INSPIRE Faculty and Ramanujan Fellowships, who fail to secure regular positions after completion of the regular tenure of five years in the respective schemes.
- SERB connects the S&T system through 34 Schemes and Programmes catering to different segments of S&T ecosystem. The Board revisited the portfolios and phased out 10 Programs and restructured 9 Programs. These course corrections make SERB programmes more effective and meaningful.
- In a significant move, for the first time in the country, the Board has introduced quantitative social science as one of the subjects from social science / humanities disciplines for support. The Board approved the expansion of the Mathematical Research Impact Centric Support (MATRICS) Scheme to include theoretical sciences including economics & other social sciences involving quantitative analysis, mathematical modelling & use of physico - chemical or mathematical sciences.
- The Board adopted the payment of fellowship as given in DST Office Memorandum No. SR/S9/Z-08/2018 dated 30.01.2019 in SERB sponsored R&D Programmes for JRF/SRF/RA categories of researchers with effect from 1st January 2019.
- Budgetary revision in National Postdoctoral Fellowship Scheme: National Postdoctoral Research Fellows under the SERB – NPDF Scheme has been provided a research grant of Rs. 2.0 lakh per annum in addition to a fellowship of Rs. 55,000/- pm (Rs. 35,000/ p.m for candidates who have submitted the thesis, but degree not awarded). Overhead amounting to Rs. 1.0 lakh per annum is provided to host institute to provide necessary administrative and infrastructural support to the

fellow. The SERB Board has approved a provision to extend House Rent Allowance (HRA) to NPDF fellows as per prescribed rates applicable to central government employees with effect from 1st April, 2019. The additional financial provision will benefit more than 2000 fellows in the country.

## I. Schemes and Programmes

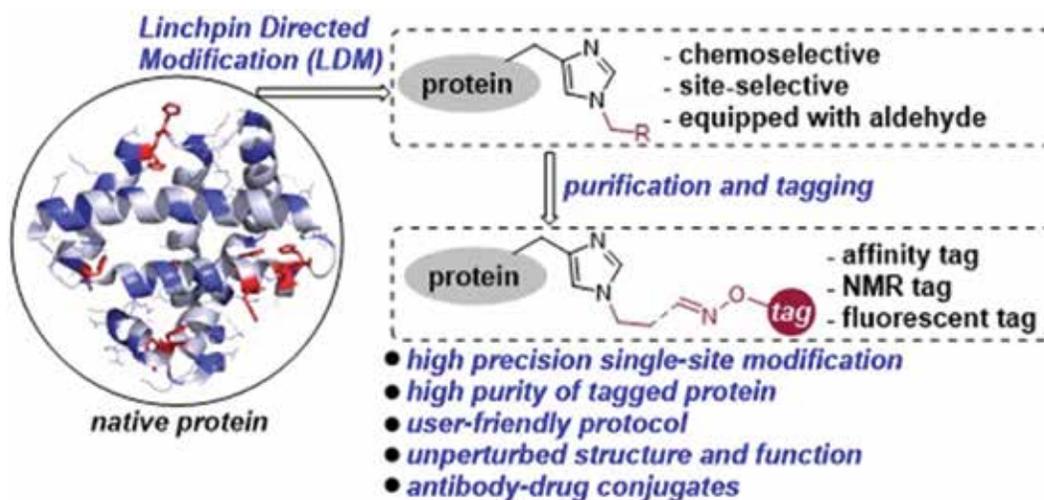
Several scientists from across academic and research institutions were supported through a wide variety of ongoing schemes/programmes in the reporting period. Some of the notable ones are:

- a. Ramanujan Fellowship is for brilliant scientists and engineers from all over the world to take up scientific research positions in India. This fellowship is open to scientists and engineers below the age of 45 years. Forty six scientists from abroad received Ramanujan Fellowship. The J.C. Bose National Fellowship is meant to recognize active, performing scientists and engineers for their outstanding performance and contribution. Sixty scientists received JC Bose Fellowship.
- b. Visiting Advanced Joint Research (VAJRA) Faculty Scheme aims to tap the expertise of Overseas scientists including Non-resident Indians (NRIs) & OCIs. It offers adjunct / visiting faculty positions to overseas scientists / R&D professional to undertake high quality collaborative research in public funded academic and research Institutions in India. The Scheme facilitate collaborative research in frontier areas of S&T including the interdisciplinary areas of national priorities such as energy, water, environment, health, security, nutrition, waste processing, advanced materials, high performance computing, cyber-physical systems, smart machines and manufacturing, etc. and stimulate the latent potential of our academic and research sector. In the reporting period, 32 accomplished scientists from abroad had undertaken collaborative research visit to identified Indian academic and research institutions.
- c. IMPRINT (Impacting Research Innovation and Technology), is a program piloted by the Ministry of Human Resource Development (MHRD) aims to address and provide solutions to the most relevant engineering challenges faced by our nation by translating knowledge into viable technology (product and processes) in selected technology domains. IMPRINT 2, a new and revised edition of IMPRINT Programme, has been launched to streamline and simplify the processes and sharpen the focus on translational research and also to attract wider participation of stakeholders including industry. IMPRINT – 2 is sourced on a corpus set up jointly by the Ministry of Human Resource Development (MHRD) and DST and it also intends to derive contribution from various participating Ministries. SERB has been entrusted for the implementation of IMPRINT projects. A total of 118 projects of translational potential costing Rs. 99 crore was sanctioned in the reporting period.
- d. A total of 233 scientists were supported through projects worth Rs. 82.8 crore in the “Empowerment and Equity Opportunities for Excellence in Science” Scheme. The scheme provides research support to scientists belonging to SC/ST categories and it received overwhelming response.
- e. Programme Advisory Committees continue to play a decisive role in providing core research support to scientists. 1216 projects worth Rs. 463.03 crore were supported through this scheme. Some of the significant results emanated from the projects were:

- f. Protein-based therapeutics is experiencing rapid global growth. Its capability to render target-specific treatment of chronic diseases, especially cancer has invited considerable attention. In this perspective, the chemical toolbox for precise engineering of proteins is essential. Unfortunately, the limited understanding in the area has been the major roadblock and kept the community away from success. In this perspective, precision protein engineering technology has been developed in a project being implemented in IISER Bhopal. The knowledge acquired over the first couple of years of the project led to the disruptive innovation of linchpin directed modification, the first ever modular platform for single-site engineering of native proteins.

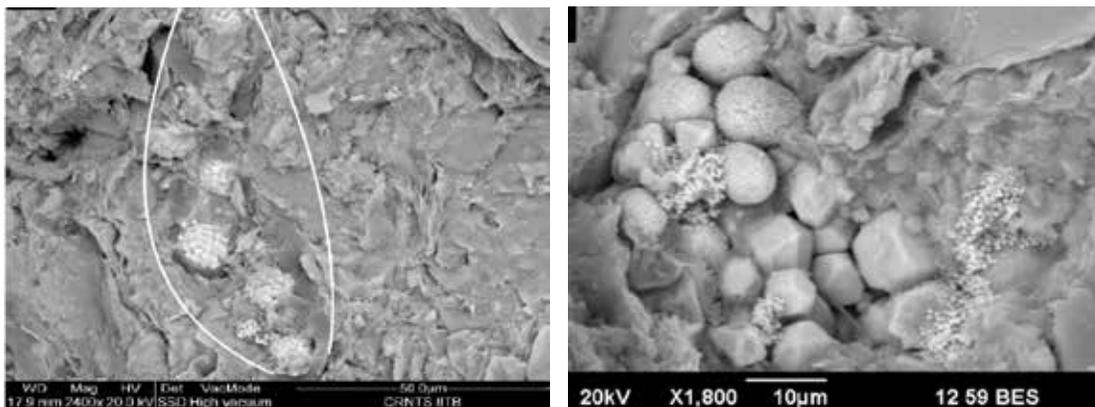
## II. Highlights of the Schemes and Programmes

- a. The protein engineering technology has opened the gateway for understanding and steering the properties of proteins in biological systems. It operates under very mild conditions and ensures that the structure and function of modified proteins are not affected adversely. The studies will help the community in the development of drugs for the aggressive type of breast cancer that is HER2-positive. Apart from quality publications, one patent has emerged out of this project.

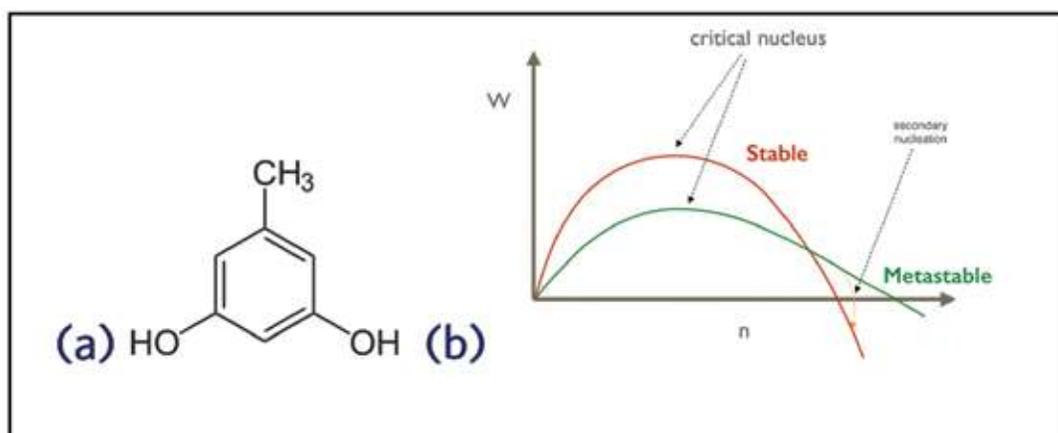


**Image: Precision technology for protein engineering**

- b. One of the projects is being implemented at Indian Institute of Technology Bombay investigates black shale of Jhuran Formation in Kutch for shallow marine anoxia in Jurassic. The project aims at understanding oceanographic conditions during the Mesozoic greenhouse climate on the basis of study of organic carbon-rich rocks in Kutch. Excess bioproductivity during the greenhouse climate caused the expansion of oxygen minimum zone up to the middle of continental shelf. The reduced oxygen level in shallow sea is characteristic of greenhouse climate. Frequent storm actions disrupt the stratification in the seawater and create oxygenated water. Figures below show tiny pyrite framboids within Mesozoic rocks in Kutch, bearing evidences of oxygen depleted seawater conditions. Figure in left show several framboids encircled by white curves; figure in right indicates detailed view of one of the pyrite framboids.

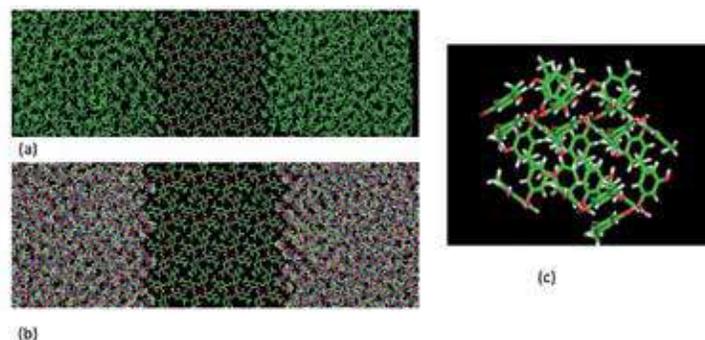


- c. In another project is being implemented at Indian Institute of Science, Bangalore, the Investigators look at developing techniques to study homogeneous nucleation of a molecular solid, Orcinol, from a solution. In particular, the project focussed on developing strategies/methods to selectivity of crystal polymorphs in a particular solvent during crystal nucleation.

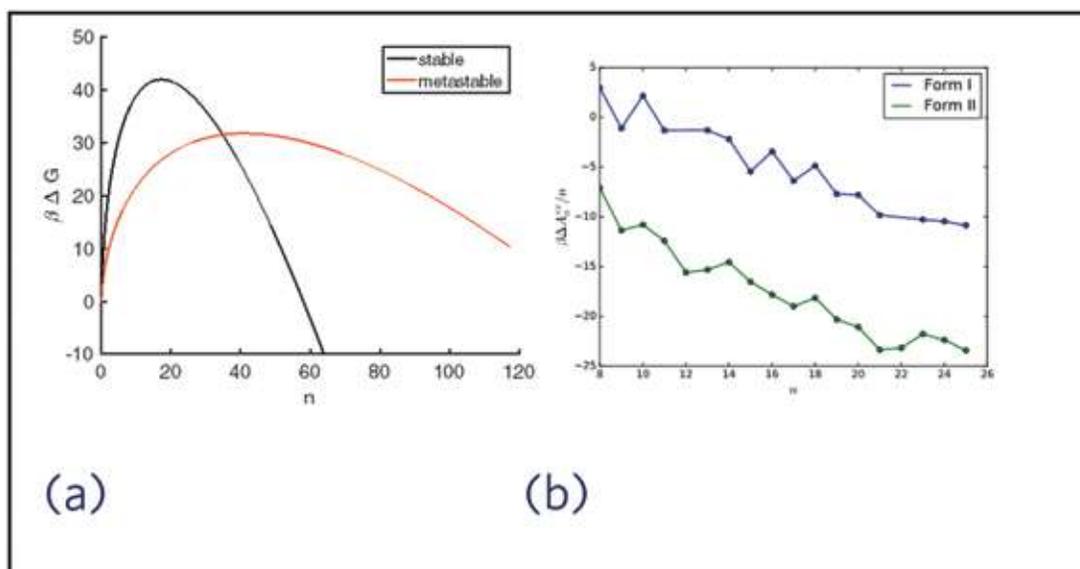


**Figure 1(a) Molecular structure of Orcinol (b) Profile for free-energy of formation of nuclei of a stable and a metastable crystal polymorphs during crystal nucleation from a solvent**

The investigators predicted polymorph selectivity during crystal nucleation of Orcinol from solutions which are in agreement with published experimental data. Results have led to good publications.



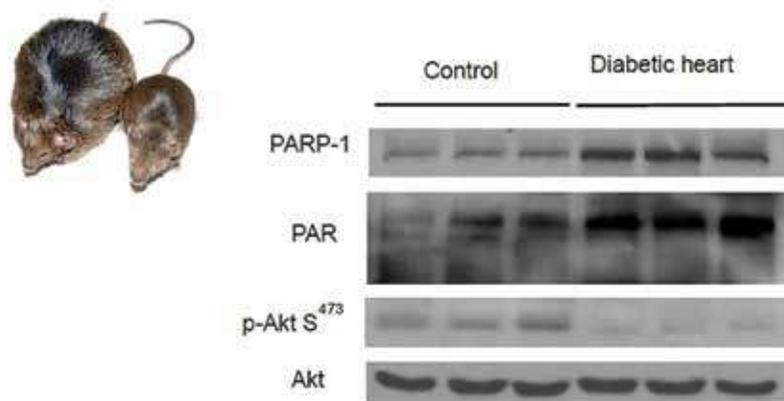
**Figure 2** (a) Slab of Orcinol crystal immersed in chloroform. Setup used to compute Orcinol-Chloroform interfacial tension (b) Slab of Orcinol crystal immersed in nitromethane. Setup used to compute Orcinol-Nitromethane interfacial tension (c) Crystalline cluster of Orcinol in vacuum. Setup used to compute free-energy of the cluster



**Figure 3** (a) Variation of free-energy of cluster of Orcinol for two different polymorphs in nitromethane. The figure shows that the metastable form has lower free-energy barrier to nucleation and hence is preferentially formed upon crystallization. (b) Free-energy of isolated clusters of Orcinol of various sizes for two different polymorphs

- d. As per the WHO in India, nearly 69 million people are affected by the diabetes. Diabetes is chronic disease characterized by decreased glucose clearance from the circulation either due to decreased insulin sensitivity or increased insulin resistance. The direct and indirect effects of excess glucose in the circulation effects peripheral organs like liver, kidney, brain and heart. Defective Akt kinase, serine-threonine specific protein kinase is believed to be the major cause for development of

diabetic cardiomyopathy (DCM). In the current project investigator hypothesize that PARylation of Akt may be one of the biochemical events that plays a major role towards pathogenesis of cardiac dysfunction during diabetic condition. In a project on poly ADP-ribosylation of AKT: Implications in the development of DCM, the investigator hypothesize that PARylation of Akt may be one of the biochemical events that plays a major role towards pathogenesis of cardiac dysfunction during diabetic condition.



In the figure 1 the investigator established that PARylation as a novel post-translational modification that regulates Akt kinase. It is the first time in field of research the investigator showed that Akt translocation to membrane is regulated by PARylation (figure 2).

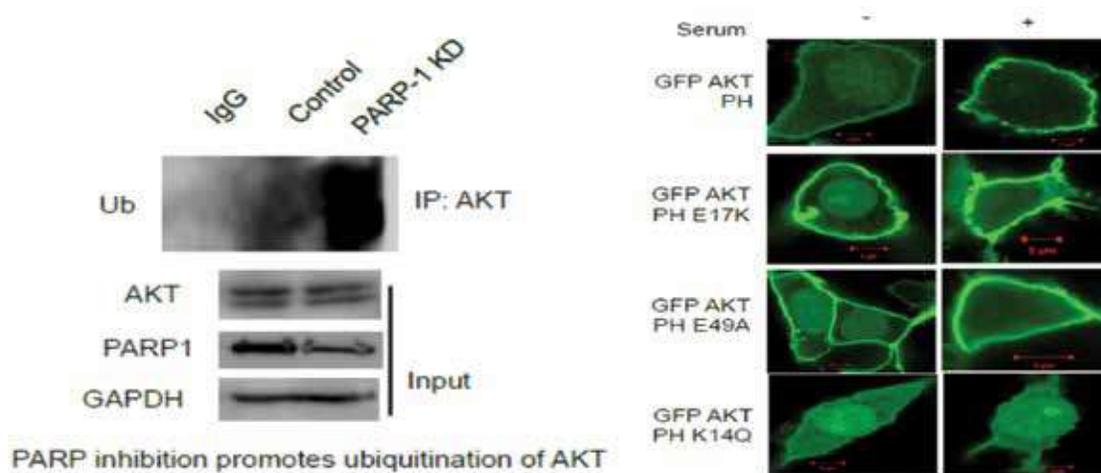


Figure 2

Also investigator established that increased Akt ubiquitination levels in PARP-1 depleted cells indicates that increased ubiquitination might be responsible for increased membrane recruitment, phosphorylation and activation of Akt in PARP-1 depleted cells. The observation of the current study might be therapeutically beneficial for diabetic patients affected with valvular disease.

- e. In a project on Interaction of water waves with floating and submerged bodies, two-dimensional scattering of linear water wave by thin vertical permeable plate in a two-layer fluid with free surface has been investigated. The permeable barrier is completely submerged in the upper layer of finite depth over a layer whose depth is either infinite or finite. Green's integral theorem is employed to formulate the problem in terms of a hypersingular integral equation in the discontinuity of the potential across the plate. A collocation method using a finite series of Chebyshev polynomials of second kind have been introduced to get the unknown difference potential numerically. The reflection and transmission coefficients for surface and internal modes are computed as integrals involving difference potentials. The proportion of reflected and transmitted energies of both the wave numbers are calculated.
- f. In a project being implemented at Jawaharlal Nehru Centre for Advanced Scientific Research, the investigators have discovered a new family of linear magnetoelectric materials based on A-site magnetic spinel oxides. The materials,  $\text{MnB}_2\text{O}_4$  ( $\text{B}=\text{Al}$  and  $\text{Ga}$ ) and  $\text{Co}_3\text{O}_4$  with  $\text{Fd-}3\text{m}$  space group exhibit magnetoelectric effect because of local non centrosymmetry at the magnetic sites ( $\text{Mn}^{2+}$  and  $\text{Co}^{2+}$ ). In order to confirm the intrinsic nature of the magnetoelectric effect, single crystal of  $\text{MnGa}_2\text{O}_4$  was grown by floating zone method. A family of A-site ordered chromate spinels  $\text{LiMCr}_4\text{O}_8$  ( $\text{M}=\text{Ga}$ ,  $\text{In}$  and  $\text{Fe}$ ) exhibiting breathing pyrochlore lattice have been investigated for magnetodielectric effect. These materials due to the breathing pyrochlore lattice exhibit spin gap features which are unique to these materials. A number of publications have emerged out the project.

### III. Early Career Research Award

This is one of the flagship programmes of SERB. The scheme aims to provide research support to the researchers who are in their early career for pursuing exciting and innovative research in frontier areas of science and engineering. A total of 622 research projects worth Rs. 217.0 crore were sanctioned to young scientists from across various institutions from the country. A significant number of high impact SCI publications have emanated from several projects. Some of the key findings from the projects that were supported under the ECRA scheme are given below:

- a. Catalysis is a key technology for making molecules for pharmaceutical and chemical industries. The advancement of organometallic catalysis is mainly pursued using noble 4d and 5d transition metals. However, use of these metals is not sustainable, especially in homogeneous catalysis, for a large number of reasons. Considering these and global emphasis on sustainable development of chemical synthesis, it is highly desirable to replace the 4th- and 5th-row-transition-metals with 3rd-row metals which are abundant, cheap, and less toxic. The Investigator's group from IISER – Kolkata in an ECRA project has developed catalysts with Earth's abundant first-row-transition metals such as Manganese, Iron, Cobalt, Nickel, etc. and applied them for reductive functionalization reactions. Emphasis was given on the possibility that in contrast to their heavier congeners, the first-row-transition metal catalysts can provide novel reactivity and selectivity and enable the development of new processes. The catalysts developed with 3rd-row-transitional metals were found to be highly efficient for catalyzing many reductive-functionalization reactions

under milder reaction condition with high selectivity. The products are interesting in terms of biological as well as material applications. The developed protocols are sustainable and highly environmentally benign. Most often by-products are water and hydrogen. The produced hydrogen can potentially be utilized.

- b. Two-dimensional arrays of plasmonic nanoparticles at interfaces are promising candidates for novel optical metamaterials. In a project on Tailorable Plasmonic Metamaterial Substrates: Gold and Beyond! estimation of plasmonic response of materials Au, Al, Cu, and Ag forms were successfully carried out using MATLAB and COMSOL programming. The extinction, scattering and absorption coefficient of different spherical structures of varying sizes from 150 nm to 250 nm were analyzed to give the best response in UV or VIS or NIR regime. Different synthesis methods have been employed for the fabrication of plasmon active and structured and non-structured thin films. De-alloying has been carried out using Au/Ag alloys shows the SEM image of the same. The oxides of Cu and Ti have being further fabricated using oxidation method in a muffle furnace. Au thin films have been synthesized by thermal evaporation on glass and silicon substrates. Work is been carried out to optimize on plastic melamine films. Many other methods and techniques are being tried to fabricate many different substrates. Different sizes and synthesis methods have to be employed for the fabrication of plasmon active nanoparticles and antennas. X-shaped antennas were simulated and their electromagnetic spectra is experimentally tested to work as sensors (receivers) in the X-band EM region. An environmentally friendly method for making stable and sturdy metal nanoparticle-gel composite has been demonstrated.

#### **IV. National Postdoctoral Fellowship**

In the reporting period 570 young researchers have been awarded National Postdoctoral Fellowship. The NPDF Scheme is aimed to identify motivated young researchers and provide them support for doing research in frontier areas of science and engineering. The fellows are to work under a mentor, and this training is to provide them a platform to develop as an independent researcher.

A NPDF Conclave was hold on 25th July 2018 at National Institute of Plant Genome Research, New Delhi to evaluate and monitor the Scheme. Forty-one shortlisted fellows of the online poster competition were made the presentation in the three parallel sessions viz. Chemical sciences, Engineering Sciences, Earth & Atmospheric Sciences, Physical & Mathematical sciences and Life Sciences. Prof. Ashutosh Sharma, Secretary, DST distributed the merit certificate to the NPDF fellows and delivered the special address.



**Participants of the first NPDF conclave**

#### **V. Mathematical Research Impact Centric Support (MATRICS) Scheme.**

302 projects to mathematicians were sanctioned under the Mathematical Research Impact Centric Support (MATRICS) Scheme.

#### **VI. International Travel Support (ITS) scheme**

More than 1700 scientists were supported under the International Travel Support (ITS) scheme which is designed to provide financial assistance for presenting a research paper or chairing a session or delivering a keynote address in an international scientific event (conference/seminar/symposium/workshop etc.) held abroad.

#### **VII. Assistance to Professional Bodies & Seminar / Symposia Scheme**

This Scheme extends partial support on a selective basis, for organizing seminar / symposia/ training programmes / workshops / conferences at national as well as international level. More than 500 events were supported.

#### **VIII. Online Portal**

The online portal [www.serbonline.in](http://www.serbonline.in) has been made operational for most of major schemes of SERB.

## Chapter 6

**TECHNOLOGY DEVELOPMENT BOARD**

The Government of India constituted the Technology Development Board (TDB) in September 1996, under the provisions of the Technology Development Board Act, 1995. The mandate of TDB is to provide financial assistance to the industrial concerns and other agencies attempting development and commercial application of indigenous technology or adapting imported technology for wider domestic application. TDB provides financial assistance by way of loan (upto 50% of total project cost @ 5% simple interest), equity (upto 25% of the total project cost) or grant (in exceptional cases).

During the year 2018-19, TDB has disbursed an amount of Rs. 168.00 crore towards on-going & new projects and other schemes. This included Rs. 163.72 crore as loan and Rs. 4.28 crore to Venture Capital Funds (VCFs) for investment.

**6.1 Major highlights of the year are given below:**

- During the year 2018-19, TDB has signed seven (7) agreements with a total project cost of Rs. 175.60 crore with TDB's sanctioned financial assistance of Rs. 45.77 crore. The commitment for the FY 2018-19 is about Rs 200 crore. TDB's support covers various sectors such as Defence, Medical Devices, Healthcare, Engineering, Agriculture, Energy & Waste Utilization, Telecommunication and Information Technology.
- The highlight of this year has been TDB's foray into the cyber security area by way of two loan agreements with M/s SecurelyShare Software (loan assistance of Rs. 7.50 crores out of total project cost of Rs. 18.86 crores) and M/s AKS Information Technology Services ( loan assistance of Rs. 6.00 crores out of total project cost of Rs. 14.52 crores). These companies are developing innovative and technologically advanced products for combating the ever-increasing cyber threats.
- Another highlight is the project with M/s Epygen Biotech (loan assistance of Rs. 9.95 crores out of total project cost of Rs. 68.62 crores) regarding the lifesaving thrombolytic recombinant Streptokinase which has been indigenously developed by CSIR-IMTECH and licensed to Epygen. Under this project, the company will produce 3-4 lakh vials a year and address a vital unmet medical need of the country.
- Further, the proposed project by M/s Biogen Fertilizers India Private Limited (loan assistance of Rs.4.60 crores out of total project cost of Rs. 10.27 crores ) aims to combine the goodness of organic manure and biomolecules (bio-fertilizers/bio-pesticides, probiotic microbes/ enzymes/ immune modulators etc.) through the process of granulation coating and encapsulation.

**6.2 The details of remaining financial assistance provided by TDB in the FY 18-19:**

- An agreement with M/s SureWaves Mediatech Pvt. Ltd., Bangalore for loan assistance of Rs. 9.80 crores out of total project cost of Rs. 47.09 crores for implementation of their project titled

“Development and Commercialization of SkyNet Programmatic TV Platform”.

- An agreement with M/s Perfect Infraengineers Ltd., Mumbai for their project titled “Development and Commercialization of Hybrid Thermal System” with financial assistance of Rs. 7.50 crores out of total project cost of Rs. 15.06 crores.
- An agreement with M/s Sickle Innovations Private Limited, Ahmedabad for their project titled “Grading and sorting machine for fruits and vegetables” with financial assistance of Rs. 0.42 crore out of total project cost of Rs. 1.18 crores.

### 6.3 Technology Day Function - 2018

The Technology Day 2018 was celebrated on 11th May 2018 at Vigyan Bhawan, New Delhi. Hon’ble President of India, Shri Ram Nath Kovind graced the occasion as Chief Guest alongwith Hon’ble Minister for Science & Technology and Earth Sciences, Dr. Harsh Vardhan who presided over the function. The theme of the function was “Commercializing Indigenous Technologies: Journey from Benchside to Business Programme”.



### 6.4 Awards were presented by the Hon’ble President of India under following three categories:

(a) National Award-2018 to an industrial concern who successfully developed & commercialized an indigenous technology was given to:



(i) M/s Agappe Diagnostics Limited Ernakulam, Kerala, for 'Mispa-i3', an indigenous automated cartridge based specific protein analyser;



(ii) M/s Bharat Biotech International Limited for 'Rotavirus Vaccine ROTVAC'.

**b) Awards for MSME 2018 was given to:**

- M/s Synkromax Biotech Private Limited, Chennai for Synkroscaff, a bovine scaffold for tissue engineering.
- M/s ANTS Ceramics Private Limited, Vasai East Maharashtra for High-end Zirconia ceramic products & carbon sulphur analysis crucible.
- M/s 3B Blackbio Biotech India Limited, Bhopal for TRUPCR:Two Step real-time BCR ABL1 Quantitative Kit
- M/s Envision Scientific Pvt. Ltd. Surat for ALBUMINUS DES+ Drug Eluting Stent for Diabetic Patients
- M/s Hind High Vacuum Company Private Limited, Bangalore for 3-Layer metallization on alumina substrate.

**c) National Technology Start-up Award for promising new technology with potential for commercialization. These Start-up Awards were accorded, one each to:**

- M/s Astrome Technologies Pvt. Ltd. SID, IISC, Bangalore for GigaMesh
- M/s Cyca Onco Solutions Pvt. Ltd., KIIT TBI, Bhubaneswar for Cyca and CyGlo
- M/s Xcellence in Bio Innovation and Technologies (xBITS) Pvt. Ltd for Right Biotic.

### 6.5 Product Launch during National Technology Day – 2018

Dr. Harsh Vardhan, Hon'ble Minister for Science & Technology and Earth Sciences launched the product “Charger for the Lithium-Ion Battery” developed by M/s Ampere Vehicles Private Limited, Coimbatore under TDB's financial assistance, on the Technology Day.



### 6.6 Outreach Activities

#### (a) B2B Summit for the Aeronautics & Aerospace Sector.

The Technology Development Board organized B2B Summit for the Aeronautics & Aerospace Sector on September 14th, 2018 in the South India city of Bengaluru. The summit was organized in partnership with FICCI, CEFIPRA and IFCCI to sensitize companies operating in aerospace and aeronautics sector towards investment opportunities from TDB. The summit was attended by 90 French, US and Indian companies. The B-2-B networking brought early stage and mature companies on a single platform as they discussed partnership opportunities and issues pertinent to the growth of the sector.



#### 6.7 Interactive Session with Industries -Defense and Homeland Security.

In continuation to MoU signed between TDB and PHD Chambers of Commerce and Industry (PHDCCI) to scout for emerging technologies/ technological areas of National Importance, an interactive session in order to share the objectives and policies of TDB, for the Defence and Homeland Security Industry, was organized at PHD House (Shriram Hall), August Kranti Marg, New Delhi on 07th Aug 2018. It is expected that in lines of TDB's funding to TATA SED for up-scaling and commercialization of DRDO-developed prototype defence technologies, TDB will be able to scout and work collaboratively with other private sector players to meet increasing demands of defense products.

## STRENGTHENING SURVEY AND MAPPING CAPACITY

### 7.1 Survey of India (SoI)

Survey of India (SoI), the National Survey and Mapping Organisation of the country, under the Department of Science & Technology has the unique responsibility to provide timely, updated, cost effective and accurate Topographical Data Base for expeditious and integrated development of the country. This foundation data is very important to ensure that all resources contribute their full measure to the progress, prosperity and security of our country. SoI works to ensure that the country's domain is explored and mapped suitably to meet the emerging needs of the user community.

SoI is also responsible for geodetic data generation & supply viz Precision Ground Control Points (GCPs) and Bench-marks (BMs) for Primary Horizontal Control and Vertical Control points. SoI also undertakes Geo-Physical & Geo-Magnetic surveys, Production of Aeronautical Charts; IAF Maps and flip Books; Special purpose Airport/Airfield Surveys for IAF/AAI/NAVY etc; Specialised surveys for National level developmental Projects, Demarcation/Relocation of the external boundaries of India; Correct depiction of International Boundaries on maps published in the country and Inter-State Boundary (ISB) demarcation/Relocation/Interpretation matters on behalf of Govt of India.

#### *7.1.1 Technical activities in Survey of India:*

#### **1. National Topographical Data Base (NTDB) Preparation:**

**1.1 On 1:50K Scale:** Survey of India has Completed generation of National Topographical Data Base (NTDB) on 1:50,000 scale for entire country.

**OSM & DSM Maps:** SoI prepares two series of maps viz Defence Series Maps (DSMs) for Defence uses and the Open Series Maps (OSMs) for public use as per National Map Policy (NMP-2005). DSM Maps are printed exclusively for Defence uses as per defence requirements, where-as OSM Maps are printed strictly as per users requirements across the country and are prepared by State Geo-spatial data centres of SoI.

- OSM maps in pdf (watermarked) form have been made available as free download for all users in **MANCHITRA PORTAL:** <http://soinakshe.uk.gov.in>.
- OSM data can be procured by any user through MTR application in **MANCHITRA PORTAL:** <http://soinakshe.uk.gov.in>.

**1.2 On 1:250K Scale:** NTDB on 1:250,000 scale for entire country has been completed. New cycle of updation of DSM Maps has been started. 141 DSM Maps have been printed up to March 2019.

**1.3 High Resolution National Topographical Data Base (HRNTDB):** With the rapid development and industrialization in the country, there is a tremendous pressure on the resources which makes

planning & utilization of resources more challenging. Effective planning for the development requires accurate resource mapping at optimum resolution. Survey of India has undertaken preparation of HRNTDB for entire country by using High Resolution Satellite Imageries (HRSI) to cater for accurate high resolution data requirements/demands from various users and organisations.

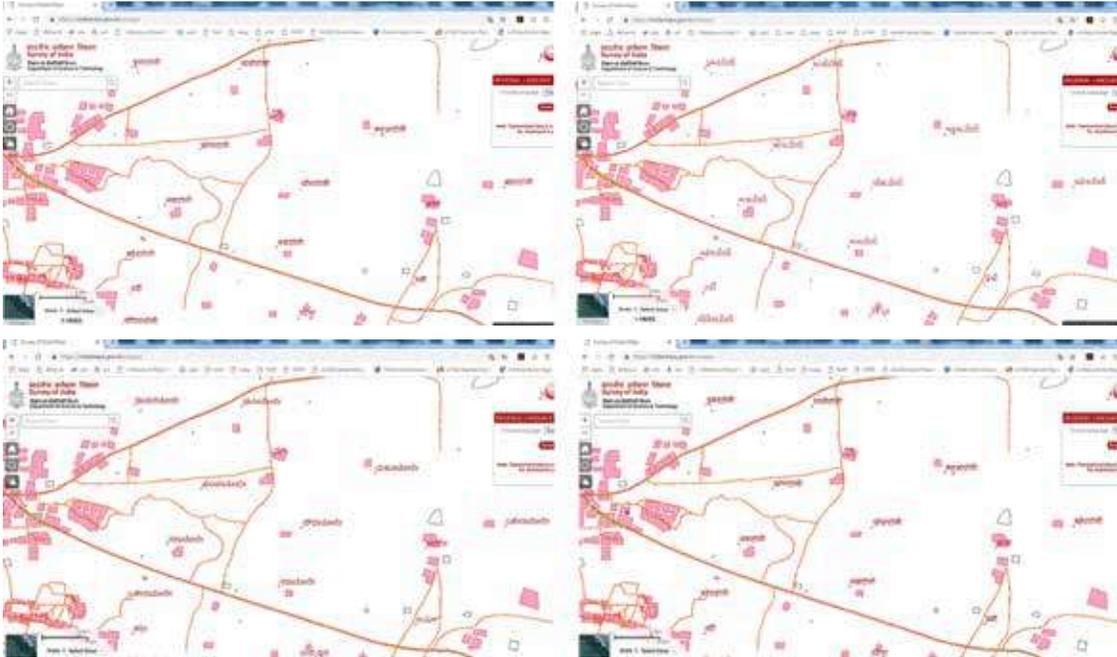
- Demand for HRSI of approx. 1.26 million sq km area has been submitted to the NRSC, DoS as per RSDP-2011 for HRNTDB activities. HRSI for approx. 0.83 lakh sq km area has been received, provisioning of tertiary Ground Control points followed with Geo-referencing, Feature extraction & field validation is under progress.

**1.4 HRNTDB for Coastal areas (ICZM Area):** SoI had prepared large scale data on 1:10K scale using Aerial Photographs including digital elevation Model (DEM) under ICZM project for MoEF&CC. This GIS data is based on year 2012-13 Aerial Photographs, hence this data needs to be updated and migrated to HRNTDB as per its schema. SoI has undertaken the work to ingest updated ICZM data into HRNTDB. Updation is being carried out using latest sub-meter resolution HRSI. Preparation of HRNTDB is being carried out strictly as per Spatial Data Model Structure (SDMS) of the NTDB.

- Demand for HRSI of  $\approx 1.06$  lakh km<sup>2</sup> area has been submitted to the NRSC, DoS for Coastal areas. HRSI for approx. 0.99 lakh km<sup>2</sup> area has been provided to State Coastal GDCs of SoI for preparation of HRNTDB. Work is under progress.

2 **Toponymy database:** National Map Policy (NMP) - 2005 mandates Survey of India to prepare Toponymy (Place Name) data layer as one of the fundamental dataset. Toponymy layer comprises standardised Geographical names as per Topographical Maps of the country. Place name data as collected during field data collection is used while preparing Toponymy data layer. SoI has generated the Toponymy layer in English/ Hindi/Bengali/Gujarati/ Kannada/Telugu/Malayalam / Tamil/ Punjabi and Marathi languages and the same has been made available for public in SoI public portal i.e. [www.indiamaps.gov.in](http://www.indiamaps.gov.in).

New names / Change names request received for 72 place names / Railway Station names were processed for Standardised /Romanized spelling as per Indian System of Transliteration. These requests are duly verified in the field by State Geo- spatial data centres before submission to the MHA.



3. **Administrative Boundary Database (ABDB):** Administrative boundaries database comprises data of the administrative set-ups across districts & states in the country. First cycle of preparing ABDB data up to village level had been completed in past, however next cycle of preparing latest up-to-date ABDB data is under process. ABDB data of Madhya Pradesh, Gujarat, Kerala and Delhi has been completed and rest is under progress.
4. **International Boundary (IB) Demarcation/Relocation/Maintenance/Relay work:** Ministry of External Affairs (MEA) has entrusted the responsibility for IB Survey activities (including STRIP Mapping of the IB) to the SoI. SoI acts as advisor to Govt. of India on International boundary matters.

SoI carries out all kinds of surveying tasks along the IB. These tasks include Demarcation, Relocation, Inspection, and Maintenance of IB pillars along International Borders. Following IBs are covered by SoI state GDCs as given under for Survey activities:

- **India–Bhutan IB:** Megh & Ar P GDC, Shillong
- **India – Bangladesh IB:** WB & Sikkim GDC, Kolkata
- **India – Myanmar IB:** Megh & Ar P GDC, Shillong
- **India – Pak IB:** Punjab H & Chandigarh GDC, Chandigarh and Rajasthan GDC, Jaipur.
- **India – Nepal IB:** Uttrakhand & W UP GDC, Dehradun



**Pillar construction at India- Nepal IB**

## 5. National Spatial Reference Frame (NSRF):

**5.1 Indian Vertical Datum:** Survey of India has been mandated for the establishment and maintenance of the National Horizontal & Vertical Reference Frame for entire country. SoI has modernized the Indian Vertical Reference Frame (IVRF) of the country and launched new Indian Vertical Datum (IVD-2009). A Technical Report was also published on IVD-2009 by SoI and the same was released by the Hon'ble Cabinet Minister Dr Harshvardhan in presence of Hon'ble President of India on 11th May, 2018.

**5.2 Geoid Model:** Beta version of the Geoid Model has been developed for the entire country.

For the development of high Resolution Geoid Model, accurate horizontal control coupled with vertical control and gravity observations thereon are needed to develop Hybrid Geoid Model. A Technical Report was also published on Geoid Model by SoI and the same was released by the Hon'ble Cabinet Minister Dr Harshvardhan in presence of Hon'ble President of India on 11th May, 2018.

- IVRF and Geoid Model activities are on the top-most priority in SoI and most of the SoI resources and resources under project activities have been dedicated for completion of this work. Gravity survey and densification of the High Precision (HP) Levelling network in the states of Uttarakhand, Jharkhand, Bihar and West Bengal & Sikkim GDCs is under progress in SoI for this purpose.

## 6. Geodetic Activities:

**6.1 Tidal Observations:** Survey of India has been carrying out Tidal observation at all major ports of the country since Year 1878. Tidal prediction and tide tables are published by SoI every year. Presently SoI is recording tidal data through series of the gauges located at 36 places across Eastern & Western Coasts of India. Publication of Indian Tide Table-2018 and Hugly River Tide Table-2018 has been completed and was made available to all Port authorities, Indian Navy and other users.

**6.2 Geomagnetic observations:** Geomagnetic observations are being recorded continuously at Digital Geomagnetic observatory, Sabhawala for determination of horizontal forces (HF), Vertical forces (VF) and declination (D). These observations are aimed to monitor and record different components of Geomagnetic variations and are necessary to control the baseline values of the magnetograms. In addition a study to analyse Geo-magnetic data for identifying earthquake precursors is underway.

**7. Large Scale Mapping with UAV/ Drone:** Large scale topographic data is the basic input for Planning of the developmental projects. Accurate and updated resource maps of the country with high resolution terrain & topographic information is the key requirement. UAV/Drone based data acquisition provides the high resolution source data for mapping requirements in less time in comparison to other comparative technologies like Aerial Photography. UAV is providing better than 5 cm GSD images for more than 5-10 km<sup>2</sup> area per day, resulting in drastically reduced mapping



UAV Image

timelines. It offers unique technological advantage such as flexibility of operation, convenience and low cost.

- SOI has undertaken Large Scale Mapping projects using UAV for States of **Karnataka, Haryana and Maharashtra.**

8. **Survey of India Portal:** SoI has developed two web-based Geo-Portal applications for Public & Government users. These web based applications offers National Topographical Data Base (NTDB) as map application or web service to various private & Govt users.

- Public Portal: [www.indiamaps.gov.in](http://www.indiamaps.gov.in)
- G2G Portal: [www.g2g.indiamaps.gov.in](http://www.g2g.indiamaps.gov.in)



Public Portal or G2C (Govt to Citizen) portal provides



free access of accurate & authoritative GIS-ready NTDB data for use by Citizens of India. Citizen can freely use this portal to access SoI data with given functionalities.

G2G (Govt to Govt) portal facilitates NTDB as web application or web service for various Government organizations, institutions & departments including security agencies. Web applications serviced using these web services indirectly benefits the citizens of the country as they improve the functioning of the govt agency. This portal provides specific functionalities to Govt users/departments to enable the effective use of geospatial data to build services and applications as per their needs. It allows such users to share feedback for data correction/updation for specific areas or programmes.

9. **SOI Mobile app “SAHYOG”** : Survey of India (SoI) has developed a Mobile application “Sahyog” for its users viz Government (Centre/State) departments, Organisations, Institutions, Govt. employees, Academic Institutions, Students and Citizens of India, to voluntary support and contribute in preparing, updating and enriching the national database of the country. Points of interest (POI) data collected using application will be used for creating various applications for everyone’s usage.

- SOI has collaborated with Tom Tom India Pvt. Ltd. For collection of POIs using SOI mobile Application on pilot basis to extend such co-operation with other partners in future.

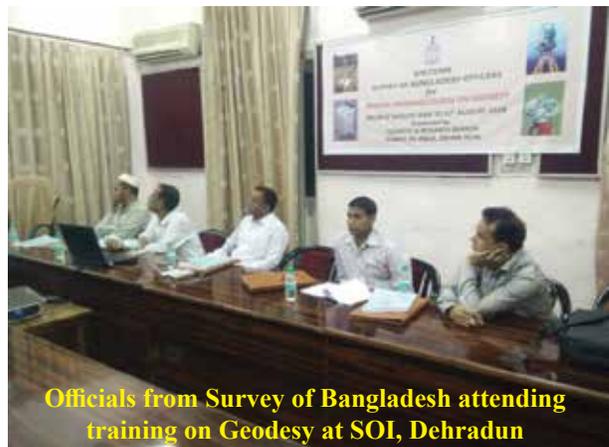
10. **“Manchitra” Web Portal:** This portal facilitates OSM maps/data dissemination to the users. Indian citizens can freely download OSM maps (Watermarked) of 1:50,000 scale through “Manchitra” application. Map Transaction Registry (MTR) application provided in this portal facilitates purchasing of SoI topographic Maps or data in different formats (dgn, gdb, mxd, shapefile, geotiff) with integrated Digital payment gateway. Users can make online payment through NTRP Portal or Bharatkosh website of Govt. of India.

**11. Training & Capacity building:** Indian Institute of Surveying & Mapping (IISM), Hyderabad is a premier institution providing training & capacity building in the field of Surveying, Mapping, Photogrammetry & GIS. Besides training to officers and staff of Survey of India, IISM also imparts training to other Government Organisations, Private Individuals and Scholars from various Afro-Asian countries.

- Total 644 trainees including 3 foreign, 266 extra departmental and 35 private students have undergone training in IISM, Hyderabad during the year.
- SOI has successfully conducted special course on Geodesy for officials of Survey of Bangladesh at Geodetic & Research Branch, Dehradun one of the specialized Directorates of SOI in Geodesy.
- A Special course on Surveying for the B.Tech. students of IIT, Hyderabad, was conducted by IISM, Hyderabad.
- A special course on Land information system was designed and conducted for 40 Patwaris of Uttarakhand state revenue department at SOI, Dehradun.
- As a part of capacity building under AMRUT Scheme of Town Country Planning organisation, MoUD, Govt. of India, a special course was conducted by IISM, Hyderabad for 63 officials during the period.
- SOI is conducting “Surveying & Mapping Module” for IFS probationers at IGNFA, Dehradun every year and providing faculty support for module under induction course at Central Academy of State Forest Service (CAOFS), Dehradun.



Officials from GSI attending the Inaugural function of the Special Course on "GPS Geodesy"



Officials from Survey of Bangladesh attending training on Geodesy at SOI, Dehradun

**12. Workshop on Indo-Thai Cooperation Project:** A workshop between India & Thailand on Geo-Spatial cooperation was organized from 19-22 June, 2018 in Survey of India, Dehradun to deliberate and discuss the future Co-operations areas in the field of Geo-spatial technology. Delegates from Survey of India, NATMO, GISTDA (Thailand) and Deptt of S&T participated and presented in the workshop.

In past, under Indo-Thai co-operation an Atlas was published jointly by GISTDA & NATMO. Large Scale Mapping (LSM) on 1:4,000 scale of Uthong town of Supanburi province of Thailand along with training of Thai officials in Photogrammetry & LSM at IISM, Hyderabad was completed jointly by SoI & GISTDA.



will be completed very soon. SGI inaugurating workshop on Indo-Thai Geo-Spatial Cooperation Project in SoI, Dehraun

### 13. Major Projects & MoUs:

**13.1 National Hydrology Project (NHP):** Survey of India (SoI) is a Central Implementation Agency in execution of National Hydrology Project (NHP).

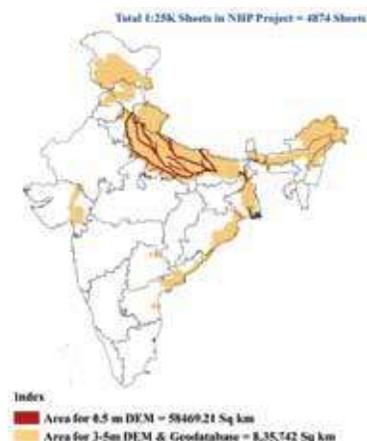
SoI has been entrusted with the responsibility to generate high resolution DEM (Digital Elevation Model) and GIS data base under the project for flood modeling and river basin management purposes under **Component B: Water Resources Information System.**

Project Deliverables:

- Establishment of CORS Network
- Ultra High Resolution DEM of 0.5m Resolution
- High Resolution DEM of 3-5m Resolution
- Updated GIS Database

### 13.2 Central Mine, Planning & Design Institute (CMPDI) Project:

SoI has prepared 1:5,000 scale Topographical Maps of the 27 Major Coal Fields covering  $\approx 30488$  sq. Km. using Aerial Photographs for CMPDI. GIS database of the coal fields and Large scale maps covering all 27 coal fields on 1:5,000 scale (with contours) have been prepared for the indentor and are being supplied. It was a challenging task to



carry out the ground survey as the area of work had many difficulties like treacherous terrain, area was infested with Naxalites and other anti-social elements, very poor approach or access to the areas under survey being coal field areas.

**13.3 National Mission for Clean Ganga (NMCG) Project:** This project is for high resolution geospatial data generation under Namami-Gange project. SOI is responsible to generate High Resolution DEM (0.5 metre resolution) and GIS ready database for the part of River Ganga covering up to 10 km extent on both sides of the river using latest Technology.

**13.4 LSM Project for State of Karnataka –** MoU has been signed with Revenue department, State Govt of Karnataka for undertaking the large scale mapping of the 51,000 km<sup>2</sup> area using UAV/Drone. Pilot Project of Jayanagar and surrounding areas and field work of Kengeri and surrounding areas for 217 Sq.Km.

**13.5 LSM Project for State of Haryana –** MoU has been signed with Revenue department, State Govt of Haryana for undertaking the large scale mapping of the entire state of Haryana i.e.  $\approx$ 44,000 km<sup>2</sup> area using UAV/Drone.

**13.6 LSM Project for State of Maharashtra:** MoU has been signed with Revenue department, State Govt of Maharashtra for undertaking the large scale mapping of the Village Abadi areas or Gaathan areas of  $\approx$  45,000 villages using UAV/Drone.

**13.7 3D Mapping Pilot for Prayagraj:** SOI had completed the pilot for 3D-mapping of the Prayagraj city area including Kumbh Mela Notification area using Drone/UAV technology. This data was provided to the Mela authorities as well to facilitate efficient planning and organization of the mega event of the Kumbh Mela.

MoU with Indian Railways: SOI has signed an MoU with Indian Railways (IR) for providing topographic data as web services for various web applications of the IR. SOI will also undertake the UAV/Drone based corridor mapping work for asset mapping of the resources/Asset of the IR. A pilot project for UAV/Drone based mapping was carried out using UAV/Drone for Indian Railways on Agra to Bhopal section.

## 7.2 National Atlas & Thematic Mapping Organisation (NATMO)

National Atlas and Thematic Mapping Organisation functions under the administrative control of the Union Ministry of Science & Technology (Department of Science & Technology), Government of India. This is the premiere and only Organisation to showcase natural, socio-economic, scientific & technological aspects of the country through maps and atlases. A large number of qualified professionals including geographers, geologists, statistician, mathematician, software applicants prepare maps and atlases in this organization.

Thematic maps and atlases compiled by NATMO contain the vital inputs for planning at various levels. The maps and atlases prepared by NATMO serve as visible tools to understand the changes and developments taking place in the domains of geo-environmental, political, socio-economic conditions

in the country. NATMO's publications like National Atlas of India, Cultural Heritage Atlas, Agriculture Atlas, Forest Atlas, atlas of different states of India, Tourist Atlas, DPMS maps and GMS maps are widely accepted as the basic tools for a wide range of users including planners, decision makers, researchers and students and the common public.

The organization motivates the planners and decision makers to use maps as complimentary documents for development planning at national level, state/UT level and district and sub-district levels. District planning maps are being prepared to meet the planners' demand.

**The mandate of this organization are:**

- Compilation of National Atlas in English, Hindi and other regional languages with regular updating.
- Preparation of School Atlases for all boards to provide accurate and standard base information for the educational institutions.
- Preparation of State Atlases and other special atlases.
- Generation of thematic maps and standardization of thematic information.
- Mapping of natural resource assessment towards sustainable socio-economic planning at district level.
- Large scale mapping and development of digital cartographic base for utility based services.
- Providing geographical education and training to visually impaired and low vision society through maps and atlases.
- Management of comprehensive Geo-informatics product for the service of the Nation through web portal.
- National and International cooperation on multidisciplinary geosciences through collaborative programmes.
- Providing unrestricted map service to all sections of the society.
- Other activities entrusted through the Administrative Ministry from time to time.

**ONGOING PROJECTS :**

**A) NATIONAL ATLAS OF INDIA**

**Initiative:**

In the year 1956, the then Prime Minister of India, Pundit Jawaharlal Nehru approved the formation of National Atlas & Thematic Mapping Organisation (then it was National Atlas Organisation) and granted the 'National Atlas Project' to NATMO. Hence, National Atlas is the flagship publication of

NATMO. Accordingly 'भारत राष्ट्रीय एटलस' first published in the year 1957 and its English Version, 'National Atlas of India' was published in the year 1986. Since then, this publication is being updated and revised keeping pace with the administrative changes in respect of states, districts etc along with conversion in digital mode is under process.

**Objectives:**

- I. To have India's National Atlas like the other countries of the world.
- II. To depict the country in respect of its physical, physiographical, soil, geology, geography, geomorphology, demography, culture, administration, etc. in thematic map form.

**Achievement:**

Revision of National Atlas of India in English has now been taken-up for web publication. It is expected to provide this atlas in Web Map Service (WMS) through NATMO Website by 2020. The vertical demand of the users compelled NATMO to publish the different editions of the Atlas and regular updating and revision of the same. About 100 plates of this atlas have already been processed for uploading in NATMO geoportal.

**B) GOLDEN MAP SERVICE (GMS):**

**Initiative:**

On the occasion of Golden Jubilee Celebration of NATMO, this project was taken up with the aim to prepare large-scale map of the cities and towns of the country consisting minute level information relevant to the available utilities, communication, and land use. This map is very much useful for the planners, architects and tourists as well.

**Objective :**

- a) Primary : To provide location base geo-spatial information of a particular site.
- b) Secondary : To provide route maps between two points in the country.
- c) Tertiary : To provide a basis for a variety of social, economic, administrative operations related to elections, crime, rural marketing, relief and supply etc.

**Achievement:**

In the current year, 5 maps under this project have been published and another five maps are in advanced stage of publication.

### **C) DISTRICT PLANNING MAP SERIES (DPMS)**

#### **Initiative:**

As per the decision of Ministry, NATMO has been assigned this project by DST in the year 1992 and work on the same had been initiated in the year 2002 after formulating the detailed specification. Though this project was shared between NATMO and Survey of India initially, but later on NATMO has been assigned this project solely.

#### **Objective:**

To provide a ready-reckoner to the planners, researchers, students in respect of complete geographical, geological, geomorphological, demographic, cultural information and features along with administrative boundary, blocks, speciality, etc. of a particular district both in paper format and in digitized format both in Hindi and English.

#### **Achievement:**

This year NATMO has published six district maps which totals 265 districts maps under this project. Digital version of the maps are also going on in the final stage and will be published for the users very soon. However, revision and updating work on account of formation of new districts, are in progress along with the rest project. Another seven district maps are going to be published very soon.

### **D) ATLAS FOR VISUALLY IMPAIRED (BRAILLE MAP)**

#### **Initiative:**

The visually challenged persons cannot use the traditional maps or atlases. Keeping the issue in mind, NATMO initiated the project to prepare Atlas for visually impaired in Braille script. Department of Science & Technology, Govt. of India provided financial support and approval for the same. And NATMO become the first ever in the country to publish 'Atlas for Visually Impaired' in Braille script, depicting all the continents and with special emphasis on India.

#### **Objective:**

To disperse the technological development amongst the people who cannot get it due to their physical disability, i.e. blindness. Publishing Maps and Atlases in Braille Script will definitely provide the utility of maps to the visually challenged person.



### Releasing Ceremony of Braille Atlas of India in Bengali Braille Script and Workshop

#### Achievement:

Atlas of India (for visually impaired students) in Bengali Braille script has been published during this year. To provide training on how to use tactile maps, a state-level Workshop for Geography Teachers engaged in teaching the Visually Impaired students has been conducted. The workshop was aimed to train Braille Map interpretation and create awareness among the teachers. About 100 teachers from different Schools and Institutions of West Bengal participated in this Workshop.

Regular training program on map reading for the visually impaired students held at different parts of the country. During this year NATMO imparted training to about 600 visually impaired students and teachers on use of tactile maps and atlases.

Having seen the enthusiasm and increasing response to National Level Braille maps Quiz conducted by NATMO in collaboration with **Indian National Cartographic Association**, NATMO conducted the similar quiz for the second time. This time more schools came forward to participate in Braille quiz competition.



### Participants of Braille Quiz competition conducted at Dehradun

NATMO has been receiving several requests to provide copies of Braille atlas in regional languages also. Accordingly action has been taken to publish Braille atlas in different regional languages including Hindi version. By the end of this Year Atlas of India (in Telugu Braille Script) will be published.

#### **E) DISTRICT RESOURCE PLANNING ATLAS :**

**Objectives:** Major objectives of this project are

1. To prepare resource maps including socio-economic resources of the district.
2. To find out the problems and prospect areas of the district
3. To suggest viable and suitable action plans to overcome the issues.

#### **Methodology:**

Base level information for the preparation of thematic maps is being done using satellite imagery of different resolution suitable to the scale of the maps under preparation. Primary data checking and first-hand information is being done through field survey. All other ancillary data are being procured from different sources like, Census of India, GSI, CGWB, ICAR-NBSS, Economics and Statistics, State administration etc.

Project undertaken : Primarily Keonjhar District of Odisha has been chosen as pilot programme. Image processing followed by ground truth surveys have already been completed.

**F) OTHER THEMATIC MAPS:** Following thematic maps have been completed during this year:-

**Medical Tourism map of Kolkata:** This map has been prepared for providing detailed information of health facilities available both in private and public hospitals in Kolkata including the services and hospitalities available in the city during the visit of international patients.

**Tribal Population Map of India:** This map has been prepared for providing information on distribution of tribal population in the country. Special emphasis has been given for depicting spatial information on sex-ratio, education and livelihood patterns of the community.

**India Administrative Map (in Hindi) :** Revised edition of this map has been prepared depicting the latest information on states and its boundaries. This map has been released by the Secretary, Department of Science & Technology in the meeting of the Hindi Salahkar Samiti in New Delhi.

#### **G) MONOGRAPH**

NATMO has completed one Monograph titled 'Delhi: The City of Cities' during the current year. The evolution of the city of Delhi, its transition and changing pattern, are being explored in this monograph with detail information.

## MAJOR ACTIVITIES AND ACHIEVEMENTS DURING THE YEAR 2018-19

### I. INTERNATIONAL COLLABORATION

After the successful completion of the India ASEAN Archaeological Atlas, a joint collaboration between NATMO and GISTDA, further programme of cooperation was agreed upon by both the sides (Government of India and the Kingdom of Thailand) during the joint meeting held at New Delhi. Accordingly in the joint meeting held at New Delhi it was decided to take up Socio Economic Atlas of Thailand in collaboration with NATMO. Further, during the 4 days Workshop held at Survey of India, discussions were held regarding the themes and methodology to be adopted and the data sources in preparing the said atlas.



**Delegates of the Indo Thai Geospatial Cooperation attended 4 days workshop held at Survey of India at Dehra Dun from 19th to 22nd June 2018**

### II. STATE ATLAS OF GOA

State Atlas of Goa has been completed entirely in GIS environment and the atlas has been released by the Governor of Goa, Her Excellency Smt Mridula Sinha. The atlas covers more than thirty themes grouped under major titles like political, physical, demographic, environmental, tourism etc.



**Release of Goa State Atlas by Her Excellency Governor of Goa Smt. Mridula Sinha**

### III. EXTRA DEPARTMENTAL PROJECT:

During this year, the following extra-departmental projects had been taken up:-

1) **Soil Atlas of Available Micro-Nutrients:** NATMO has signed a MoU with Bidhan Chandra Krishi Viswavidyalaya(BCKV) for preparation of atlas on ‘Soil Micronutrient Status’ of 14 districts of West Bengal. NATMO completed the work in time and 200 copies of the atlas have been handed over to BCKV.

Further, discussion is in advanced stage for the following extra-departmental projects during this year;

2) **Women Empowerment Atlas :** The SEED Division, Department of Science & Technology, has awarded this job to NATMO. The atlas will be prepared for showcasing the chronological initiatives and programmes taken up by the government from time to time for empowering women population of the country through the intervention of science and technology. Compilation of data is under process, and the atlas will be published by the year 2020.

3) **Village Information System :** Department of Science & Technology has awarded a project on ‘Livelihood of Scheduled Caste and Scheduled Tribe Population’ to Vivekananda Institute of Bio-Technology, Ramkrishna Mission Ashram, Neempith, West Bengal. This institution engaged NATMO for preparing resource maps of villages for further analysis and development. It is proposed that the primary data of a village will be gathered using drone technology. Primary field survey of one village has been completed for this project.

4) **Irrigation Atlas :** NATMO prepared the first ever ‘Irrigation Atlas’ of India in collaboration with Central Ground Water Board in the year 1978. Now, Central Ground Water Board, Government of India, approached NATMO to prepare the revised edition of ‘Irrigation Atlas of India’ incorporating up-to-date information for their department. The preliminary work has been initiated already and the atlas will be prepared by the year 2020.

### COMMITTEES AND ACHIEVEMENTS

During the year two committees have been constituted by the Ministry for NATMO.

I. **High Powered Committee:** One High-Powered Committee for evaluating the need of Manpower/ Cadre Restructuring of NATMO has been constituted by the Ministry of Science & Technology. Draft report of the Committee is now ready for final discussion.



**High Power Committee Meeting in Progress**

## **II. Technical Specification Committee:**

This Committee has been reconstituted under the Chairmanship of Dr. P. S. Acharya, Scientific ‘G’, DST to monitor the setting up of NATMO’s own Geo-Portal. This committee successfully recommended and guided to set up of NATMO Geo-Portal. The geoportal installation job has already been started and it is expected that NATMO Geo-Portal will go live by September 2019.

### **TECHNOLOGY DEVELOPMENT PROGRAMMES**

#### **A) NATMO’S OWN GEO-PORTAL DEVELOPMENT**

**Initiative:** Geospatial data generated in pieces over the years under several projects, is now to be made available in the public domain for 24 x 7 accesses by the users. Keeping this objective in view NATMO has taken up the initiative to set-up its own Geo-Portal.



**Setting up of Geoportal: Mounting of Active Devices in progress**

**Achievement:** Technical Specification Committee (constituted by DST) has given necessary guidelines and technical know-how to achieve the goal. Installation of data-centre is completed. Data-engineering work is in progress. The formal kick-off of the geo-portal will be conducted in September, 2019.

**B) ONLINE MAPS/MOBILE APPS :**

NATMO is committed to provide accurate information not only in the form of paper maps but also in web platforms. There is increasing demand for the NATMO maps to publish in internet for the benefit of the stakeholders. Keeping these things in view, a new attempt has been made to publish the map of Salt Lake with special emphasis on the services of Medical Shops to be made available online as web service and mobile apps service. Benefits of this project are manifold. People with internet facility can locate the medical shops nearby to them, they can get information regarding the availability of the medicines and also about the services like home delivery. For those on the move, information will be available through web apps that can be downloaded to their smart phones. Online editing and crowd sourcing will also be allowed to register users thereby helps NATMO to gather more data. This project proposed by NATMO has been tweeted by the Hon'ble Union Minister of Science & Technology Dr. Harsha Vardhan during his visit to NATMO on 3rd May 2017.

Development of Mobile apps is underway and is expected to launch soon after the Geoportal is made Go Live.

**OTHER SERVICES:****1. TRAINING AND DEVELOPMENT FOR S&T ADVANCEMENT OF THE COUNTRY**

NATMO also provides training on Thematic Cartography, Digital Cartography, Photogrammetry, Remote Sensing and GIS, Aerial Photography to the officers and staff of various govt. and private departments, university and college teachers, scholars and students of the country.

NATMO has signed a MoU with South Asian Institute of Advance Research and Development (SAIARD) for collaboration in training. Training calendar for the year has been compiled and the first batch of training will be conducted during July, 2019.

**2. LIBRARY & DOCUMENTATION CENTRE:**

NATMO has a very rich and well equipped library and documentation centre and Archive, where researchers and scholars can gather a vast ready-made data/information using the database and resources in the library and documentation centre (Fig 7). NATMO library has 22,216 books, 65000 maps and topographical sheets at present. About 550 teachers, research scholars and students get benefited from NATMO Library this year. This year NATMO has procured about 52 books on different themes such as Atlas on Climate Change, Atlas on Bengal, Urban Heritage and Development, Physical and Cultural Geography, Population Geography.



### **NATMO Documentation Centre and Archive**

#### **NUMBER OF PEOPLE GETTING BENEFITED FROM THE PROJECTS/SCHEMES:**

Millions of students all over the country, research scholars, teachers, professors are using NATMO maps and atlases. Recently NCERT has expressed interest towards school atlases and atlas for visually handicapped. These will soon be recommended by NCERT in school curriculum.

Hundreds of scholars, technocrats, teachers, engineers take training in digital cartography, remote sensing, GIS, GPS technology application from NATMO so far.

#### **INTERNATIONAL SCIENCE AND TECHNOLOGY COOPERATION:**

Government of India, in its policy to strengthen bilateral relation with the neighbouring countries, has signed an agreement Geospatial cooperation and Technology Transfer with Kingdom Thailand. Accordingly a project entitled 'India-ASEAN Archaeological Atlas from Satellite Data – Connectivity of Regional Culture' has been completed (Fig 8) and the atlas was released in Thailand on 3rd August 2017.

It was also decided to conduct a joint workshop in the month of February 2018 to finalise the themes and methodology for joint collaboration. The probable venue of the workshop will be at the office of Survey of India, Dehra Dun.

#### **INFRASTRUCTURE DEVELOPMENT:**

During the year, NATMO has almost completed the construction of **Rashtriya Atlas Bhavan** to get a dedicated place for its research activities.



### Rashtriya Atlas Bhavan

Official Takeover of the building is in process. NATMO is awaiting submission of all the relevant documents like Completion Certificate, Final Drawing, Electrical Circuit Diagrams, Power Consumption details etc by CPWD. Letters are already served to Chief Executive Engineer CPWD and it is expected that CPWD will respond to positively and comply with NATMO's demands.

### PARTICIPATION IN NATIONAL AND INTERNATIONAL SEMINARS

- A good number of NATMO officials actively participated in various conferences.



**Officials of NATMO participating in various national and international conferences & seminars**

**OTHER ACTIVITIES DONE DURING THE PERIOD:**

- In response to several requests from universities and colleges, NATMO is organizing internship courses for the benefit of students as part of the Outreach activities.
- NATMO participated in regional, national and international conferences, exhibitions, book fairs in order to popularize maps, atlases and Geographical Information System technology.
- NATMO is continuously engaged in data base creation at grass root level, sub-district level, district level, state level and national level.



**Prof. Rana P B Singh delivering his speech as subject expert in brain-storming session**

**GLIMPSES OF IMPORTANT ACTIVITIES IN NATMO DURING THE YEAR:**

- **SWACHH BHARAT ABHIYAN IN NATMO:**
  - o Awareness programme on cleanliness among the school children.
  - o Installation of indoor plants for air purification.



**Cleanliness Awareness camping conducted by NATMO officials at Kendrya Vidyalaya, Salt Lake**



**NATMO officials engaged in cleaning activities organized as part of Swachh Bharat Abhiyan**



**Prof. S P Chatterjee, Founder Director's Birthday Celebration at NATMO on 22nd Feb 2018**



**NATMO celebrating Independence Day on 15th August 2018**



**Vigilance awareness Day Celebration**

**Hindi Divas Samaroh and release of  
Pratibimb Annual Magazine published by  
NATMO**

### **REVENUE GENERATED DURING FINANCIAL YEAR OF 2018-2019 (APRIL TO JANUARY 2018)**

The Organisation generated revenue more than rupees 2.5 lakh by selling maps, atlases and monographs from the sales counters of Kolkata Headquarters, Delhi Sales Counter, Exhibition stalls and SOI outlets.

### **CONCLUSION:**

NATMO as a pioneer mapping organisation has been playing a substantial role in contributing to nation development. NATMO's achievements are just the open proof of its integrity and commitment to the societal needs. We expect to provide more and better map services using state of art technology in the coming years.

## Chapter 8

## ADMINISTRATRION AND FINANCE

The administration and finance divisions of the Department continued to provide support and necessary administrative decisions for smooth functioning of the Department as well as its subordinate offices.

## 8.1 Staff Position

Department has a total number of 173 Group 'A' and Group 'B' (Gazetted) officers as per the table below:

Group	General	SC	ST	OBC	PH	Total
<b>Group A</b>						
Scientific	81	07	02	03	04	97
Non-Scientific	33	10	02	01	01	47
<b>Group B</b>						
Scientific	04	--	01	01	--	06
Non-Scientific	39	05	01	--	01	46
<b>Grand Total</b>	<b>157</b>	<b>22</b>	<b>06</b>	<b>05</b>	<b>06</b>	<b>196</b>

Department has a total number of 123 non-gazetted staff on its rolls as per the break-up given below :

Group	General	SC	ST	OBC	PH	Total
Group B (non-gazetted)	46	5	6	11	1	68
Group C	58	56	11	27	4	152
<b>Total</b>	<b>104</b>	<b>61</b>	<b>17</b>	<b>38</b>	<b>5</b>	<b>220</b>

## 8.2 Parliamentary Work

Parliament Unit of DST is assigned with the responsibility of handling entire parliamentary work of the Department. It ensures that the parliamentary work pertaining to the Ministry of Science & Technology is accomplished as per the prescribed schedules and procedures. The unit maintains liaison with the Ministry of Parliamentary Affairs, Secretariats of Lok Sabha & Rajya Sabha as well as other Ministries/Departments (including Scientific Departments) with a view to fully discharge the parliamentary obligations of the Ministry of Science & Technology. The Unit also coordinates visits of various Parliamentary Committees to different scientific institutions under the administrative control of the Department.

## 8.3 Implementation of Official Language Policy

The Department continued to make concerted efforts to promote the use of Hindi in official work and to ensure compliance with the provisions of the Official Language Act, 1963 as amended in 1967 and

Rules 1976 framed there under as also the various orders/instructions issued by the Department of Official Language from time to time with a view to ensure proper implementation of the Official Language Policy of the Government.

DST has a full-fledged Hindi Section catering to the translational needs of the Department of Science & Technology. Besides monitoring the implementation of the Official Language Policy and the Annual Programme, Hindi Section arranges for in-service training of the staff in Hindi Language, Hindi Typewriting and Hindi Stenography. It also undertakes translation of material received from various Sections/Desks of the Department from English to Hindi and vice-versa.

For promotion of use of Hindi in this Department and to create conducive environment for the officials to work more in Hindi, various programmes are being undertaken:

All documents coming under Section 3(3) of the official language Act, 1963 like general orders, notification, cabinet note, annual report and any paper which is to be laid in the parliament were issued bilingually in both Hindi and English. Letters received in Hindi were invariably replied to in Hindi.

Officers of Hindi Section conducted inspections of Subordinate offices / Autonomous Institutions and 6 sections of the department regarding progressive use of Hindi.

During the year, quarterly meetings of Departmental Official Language Implementation

Committee were organized regularly. Likewise, Hindi workshops were organized to encourage the officers / staff of the department to carry out more of their work in Hindi.

Following activities were undertaken during the year:

- Joint Hindi Advisory Committee (JHAC): Regular meetings of Joint Hindi Advisory Committee were organized under the chairmanship of Hon'ble Minister of Science & Technology and Earth Sciences. The 29th meeting of JHAC was organized on 29th March, 2019 to seek views/ advice from prominent personalities/poets/Writers for promoting use of Hindi in official work.
- Celebration of Hindi Pakhwada: Hindi Pakhwada was organized from 12 to 24 September, 2018 in the Ministry of Science and Technology. Various Hindi competitions were organized and successful participants were given cash awards and certificates.

#### **8.4 Right to Information:**

The Right to Information Act, 2005 was enacted by the Government of India to promote transparency and accountability in its functioning. Department of Science and Technology has been implementing the RTI Act in letter and spirit.

To ensure transparency in its functioning, DST has been regularly making suo-moto disclosures on its web-site, as required under Section 4(1)(b) of the RTI Act, 2005.

During the period from 1st April, 2018 to 31st March, 2019, a total of 1428 RTI applications and 115 First Appeals were received by the Department. All applications and Appeals have been disposed of as per the provisions of RTI Act, 2005.

### 8.5 Public Grievances

An essential pre-requisite to make the public service delivery system more citizen-centric is to have a robust public grievance redress and monitoring mechanism.

Department of Science and Technology has made concerted efforts to redress the grievances received from its stakeholders and the public at large. A total of 2020 public grievances were received by the Department during the period from 1st April, 2018 to 31st March, 2019. Out of these, 1907 had been disposed of by 31st March, 2019.

### 8.6 Citizens' Charter

The basic objective of the Citizen's Charter is to empower the citizen in relation to public service delivery. Department of Science and Technology has prepared Citizens' Charter indicating the various services being provided by it and the time line for delivery of these services. This Citizens' Charter was uploaded on the department's website in December, 2013. The Department has initiated action to update the Citizens' Charter.

### 8.7 Vigilance

The Vigilance Unit in the Department of Science & Technology (DST) is headed by Chief Vigilance Officer, an Officer in the rank of Scientist 'G'. He is supported by a Deputy Secretary, Section Officer and other secretarial staff.

Apart from handling Vigilance related cases of the Department, its subordinate offices and aided institutions; it also deals with complaints, received from the Central Vigilance Commission (CVC)/ Central Bureau of Investigation (CBI) and other sources. It plays a proactive role in ensuring the prompt disposal of the complaints.

During 2018, Vigilance Unit dealt with the following number of complaints:

Source	Opening Balance	Recd. during the year	Total	Disposed	Balance
CVC	13	60	73	61	12
OTHERS	20	213	233	172	61

The balance complaints are at various stages of examination and are under process.

Vigilance Unit consolidates reports/returns received from the subordinate offices and aided institutions on vigilance matters and furnishes the reports (monthly, quarterly and annual basis) to various agencies, like Central Vigilance Commission, Central Bureau of Investigation, Department of Personnel &

Training. The Department also maintains Agreed List and List of Officers of Doubtful Integrity of Gazetted status, in consultation with CBI.

Besides this, the Chief Vigilance Officer maintains close liaison with all Vigilance Officers of attached/subordinate offices to ensure timely completion of various vigilance tasks/works. The CVO keeps a watch over all cases pending at different stages including the cases of its attached and subordinate offices to ensure a time bound disposal of such cases.

An Administrative Vigilance course for Vigilance officers of various Autonomous, Aided and Subordinate Institutes under DST was also organised in the Department during 10-12 September, 2018 with the objective to improve their knowledge in Vigilance and Disciplinary matters.

In accordance with the directives of CVC to spread awareness about vigilance matters, Vigilance Awareness Week was observed in the Department from 29th October to 3rd November, 2018 in association with Dept. of Scientific and Industrial Research (DSIR). During this occasion an Integrity Pledge was administered to all employees of these two Departments and several events were organised for them like Essay Writing Competition, Turncoat Debate, Slogan Writing Competition, Poster Making Competition and Story Weaving competition. A Drawing Competition was also organised for the children of DST employees. The Closing Ceremony was graced by Shri Ajit Kumar Seth, former Cabinet Secretary; who delivered a speech on this year's theme i.e. "Eradicate Corruption – Build a New India".

A "Workshop on Preventive Vigilance" was also organised for the officers of DST & DSIR during the Vigilance Awareness Week.

Other miscellaneous activities include identification of sensitive posts, rotational transfer thereon in the organization and its subordinate offices, are being done on regular basis



**VIGILANCE AWARENESS WEEK 2018**



**ADMINISTRATIVE VIGILANCE COURSE, 2018**

## DATA CELL MANAGEMENT

A data Management Cell (DMC) was set up in the Department of Science & Technology in 2018 to have a mechanism of monitoring, evaluation and course correction, wherever required for the schemes and programmes of DST. The schemes and activities of DST have to play a very significant role in achieving the Sustainable Development Goals (SDGs) by 2030. For achieving the desired outcomes through the schemes and activities of DST, data-driven decisions are of utmost importance. The establishment of a Data Management Cell is a novel kind of initiative in Government of India.

### **Broad Framework of the DMC**

- Identification of data sources
- Establishing Data Management Protocols
- Digital auditing, Data analytics and Visualization strategy
- Infrastructure, capacity building and change management

### **DMC may start its operation with the following activities:**

- Identifying Core Data Assets of the Department of Science & Technology
- Supplementing the core data with external data sources which is not directly maintained by DST, but is of direct relevance
- Curate the data, have protocols to ensure that the users of data can trust it
- Create a few good Data products and organize presentation of Dashboards and Data stories frequently for the senior officials of the DST. Creating love and appetite for Data analytics in the department will make the objectives of DMC more meaningful.
- Data products may also be shared in the public domain to get the responses from different quarters and use of the data products by researchers and the media.
- Identifying the platforms on which the DMC will work, standardise and conduct training with the recommendations of the expert advisory group (EAG) of DMC.
- Using the services of DMC for auditing the scheme and other advanced analytics. Organising workshops, talks and seminars in the areas of data management and analytics for the officials of DST.
- Exploring opportunities of Capacity building of Officials in the various aspects of Data management and Analytics.

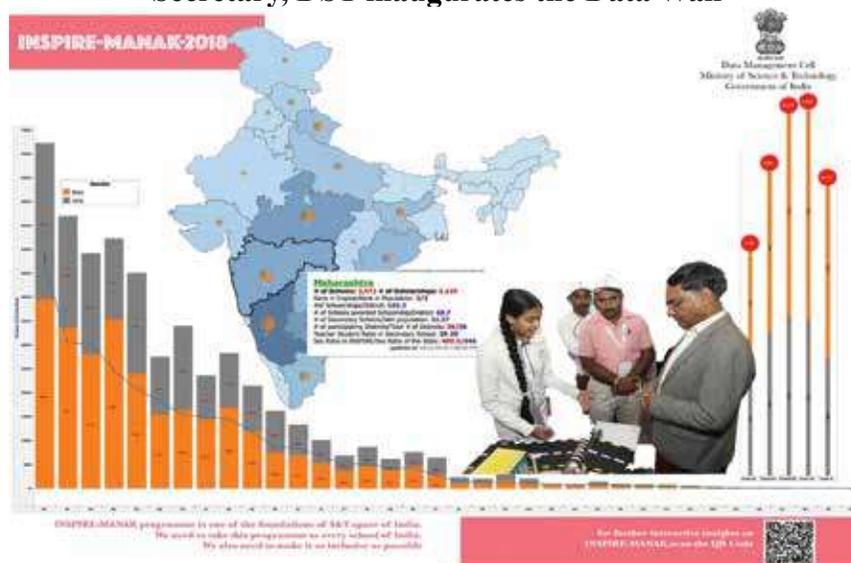
An Expert Advisory Group (EAG) was also set up under the DMC to garner expert advice.

## Data Wall

An innovative idea of a 'Data Wall' was introduced by DMC on which a detailed visual analysis of a scheme/programme is projected to provide insights to all the stakeholders and also to the public. This was inaugurated by Professor Ashutosh Sharma, Secretary, Department of Science & Technology. A QR code placed on the data wall makes it accessible through Internet.



Secretary, DST inaugurates the Data Wall



Data Wall: an analysis of INSPIRE-MANAK Scheme

## AUDIT OBSERVATION

### Detailed position of Action Taken Notes (ATNs)

Sl. No.	Year	No. of Paras/ PA Reports on which ATNs have been submitted to PAC after vetting by Audit	Details of the Paras/PA reports on which ATNs are pending.		
			No. of ATNs not sent by the Ministry even for the first time.	No. of ATNs sent but returned with observations and Audit is awaiting their resubmission by the Ministry	No. of ATNs which have been finally vetted by audit but have not been submitted by the Ministry to PAC
1	5 of 2004 UG(SD)	1 (3.1 to 3.11)	Nil	Nil	Nil
2	CA 3 of 2008(SD)DST	1(5.2)	Nil	Nil	Nil
3	CA 16 of 2008-2009(SD)DST	1(5.1)	Nil	Nil	Nil
4	27 of 2014(Compliance Audit), Union Government Scientific and Environmental Ministries/Departments	1(3.1)	Nil	Nil	Nil
5	30 of 2015 (Compliance Audit), Union Government Scientific and Environmental Ministries/Departments	1 (3.1)	Nil	Nil	Nil
6	26 of 2016 Department of Science and Technology (Compliance Audit), Union Government –Department of Science and Technology	1 (1.1 to 4.7) Entire Report	Nil	Nil	Nil
7	17 of 2017 (Compliance Audit), Union Government, Scientific and Environmental Ministries/Departments	1(4.1)	Nil	Nil	Nil
8	2 of 2018 (Compliance Audit), Union Government , Scientific and Environmental Ministries/Departments	1 (5.1)	Nil	Nil	Nil

**Avoidable expenditure towards price escalation**

Indian Association for the Cultivation of Science, Kolkata incurred avoidable expenditure of 52.78 lakh and further liability of 31.01 lakh towards price escalation in the execution of a short term contract.

(Paragraph 5.1 of C&AG Report No. 2 of 2018)

## BUDGET

DEPARTMENT OF SCIENCE AND TECHNOLOGY									
Summary of Financial Requirements									
SI No	Head of Development Projects/ Programmes/ Schemes	(Rs. in crore)							
		BE 2017-18	RE 2017-18	Actual 2017-18	BE 2018-19	RE 2018-19	Actual 2018-19		
1	Secretariat	83.15	78.95	74.64	134.10	134.10	129.62		
2	Survey of India	400.47	405.68	385.26	411.87	412.97	401.72		
3	NATMO	19.31	18.18	14.32	21.48	21.48	19.05		
4	Autonomous Institutions and Professional Bodies	1166.00	1065.00	1064.93	1102.50	1161.50	1142.50		
5	Science and Engineering Research Board	800.00	800.00	800.00	900.00	1000.00	1000.00		
6	Science and Technology Institutional and Human Capacity Building	1087.50	1022.86	1005.08	1124.43	1018.43	1004.10		
7	Research and Development	595.50	505.14	499.88	609.00	493.50	471.73		
8	Innovation, Technology Development and Deployment	651.90	670.00	613.53	720.00	781.40	772.60		
9	National Mission on Inter Disciplinary Cyber Physical System	0.0	0.0	0.0	0.0	0.01	0.01		
10	Technology Development Board	20.00	170.00	170.00	100.00	100.00	100.00		
11	Science Counsellors Abroad	13.54	11.00	7.57	11.50	11.50	6.52		
	<b>Total- DST</b>	<b>4837.37</b>	<b>4746.81</b>	<b>4635.21</b>	<b>5134.88</b>	<b>5134.89</b>	<b>5047.84</b>		

## ABBREVIATION

AAS	Agriculture & Allied Sciences
AASSA	Association of Academies, and Societies of Sciences in Asia
AED	Automated External Defibrillator
AMT	Advanced Manufacturing Technologies
ARCI	International Advanced Research Centre for Powder Metallurgy and New Materials
ARCI	International Advanced Research Centre for Powder Metallurgy and New Materials
ARI	Agharkar Research Institute
ARIES	Aryabhata Research Institute of Observational Sciences
ASTN	Asian STI Think Tanks Network
ASTRAD	ARIES Stratosphere Troposphere Radar
ATN	Action Taken Notes
AUSC	Advanced Ultra Super Critical
AWSAR	Augmenting Writing Skills through Articulating Research
BARC	Bhabha Atomic Research Centre
BDTD	Biomedical Device and Technology Development Program
BRICS	Brazil, Russia, India, China and South Africa
BSIP	Birbal Sahni Institute of Palaeosciences
CBG	Compressed Biogas
CBM	Compressed Baryonic Matter
C-DAC	Centre for Development of Advanced Computing
CENS	Centre for Nano and Soft Matter Sciences
CeNSE	Centre for Nano Science and Engineering
CERI	Clean Energy Research Initiative
CHORD	Centre for Human and Organizational Research Development
CHRA	Coastal Hazard and Risk Assessment
CII	Confederation of Indian Industry
CMERI	Central Mechanical Engineering Research Institute

CMET	Centre for Materials for Electronics Technology
CMS	Compact Muon Solenoid
CNG	Compressed Natural Gas
CoE	Centre of Excellence
CPR	Centre for Policy Research
CSIR	Council of Scientific & Industrial Research
CSRI	Cognitive Science Research Initiative
CSRI	Cyber Security for physical infrastructure
CURIE	Consolidation of University Research for Innovation & Excellence in Women Universities
DCM	Data Cell Management
DDP	Device Development Program
DPRP	Drugs and Pharmaceuticals Research Programme
DSRI	Data Science Research Initiative
EAC	Entrepreneurship Awareness
EAG	Expert Advisory Group
ECRA	Early Career Research Award
EDA	Epidemiology Data Analytics
EDP	Entrepreneurship Development Program
EFY	Elephant Foot Yam
EIR	Entrepreneurs-in- Residence
EMIC	Electromagnetic Ion Cyclotron
ESONN	European School on Nano-Sciences and Nanotechnologies
ETD	Engineering & Technology Development
FDP	Faculty Development Program
FINE	Festival of Innovation and Entrepreneurship
FISD	Forum for Indian Science Diplomacy
FIST	Fund for Improvement of S & T Infrastructure in Universities and Higher Educational Institutions

GCM	Google Cloud Message
GEM	Gas Electron Multiplier
GITA	Global Innovation and Technology Alliance
GLP	Good Laboratory Practice
GRACE	Gravity Recovery and Climate Experiment
GRAIN	Global Research Advanced Infrastructure Network'
GTWG	Global Technology Watch Group
HESCO	Himalayan Environmental Studies and Conservation Organization
HFN	Health Food & Nutrition
HIPSTER	Helmholtz-Indian Platform on Science, Technology, Education and Research
HPLC	High Performance Liquid Chromatography
IACS	Indian Association for the Cultivation of Science
IASc	Indian Academy of Sciences
IBCD	International Bilateral Cooperation Division
ICP	Inductively Coupled Plasma
ICPS	Interdisciplinary Cyber Physical Systems
ICTP	International Centre for theoretical Physics
IDH	Indian Digital Heritage
IFCPAR	Indo-French Centre for Promotion of Advanced Research
IFWN	Indo-French Water Networking
IGSTC	Indo-German Science & Technology Centre
IHDS	Indian Heritage in Digital Space
IIA	Israel Innovation Authority
IIA	Indian Institute of Astrophysics
IIGM	Indian Institute of Geomagnetism
IIGP	India Innovation Growth Program
IISER	Indian Institute of Science Education and Research
IISF	International Science Festival
IKCRI	Indo-Korean Centre for Research and Innovation

IMPRINT	Impacting Research Innovation and Technology
INO	India-based Neutrino Observatory
INSA	Indian National Science Academy
INSPIRE	Innovation in Science Pursuit for Inspired Research
INST	Institute of Nano Science and Technology
Intel-ISEF	Intel International Science and Engineering Fair
IoTTRI	Internet of Things Research Initiative
I-PEEE	Initiative to Promote Habitat Energy Efficiency
IPR	Intellectual Property Rights
IRHM	Intelligent Remote Health Monitoring of Bridge Systems
IRIGP	India Rwanda Innovation Growth Program
IRIS	Initiative for Research and Innovation in Science
ISCA	Indian Science Congress Association
ISRF	India Science and Research Fellowship
i-STED	Innovation, Science and Technology led Entrepreneurship Development
ITS	International Travel Support
IUAC	Inter-University Accelerator Centre
IUSSTF	Indo-U.S. Science & Technology Forum
JCERDC	Joint Clean Energy R&D Centre
JNCASR	Jawaharlal Nehru Centre for Advanced Scientific Research
KIRAN	Knowledge Involvement in Research Advancement through Nurturing
KISTEP	Korea Institute of S&T Evaluation and Planning
LEAFS	Livelihood Enhancement, Agriculture and Food Security
LHM	Landslide Hazard Mitigation
LIGO	Laser Interferometer Gravitational-Wave Observatory
LTCC	Low Temperature Co-fired Ceramic
MANAK	Million Minds Augmenting National Aspiration and Knowledge
MATRICS	Mathematical Research Impact Centric Support
MHRD	Ministry of Human Resource Development

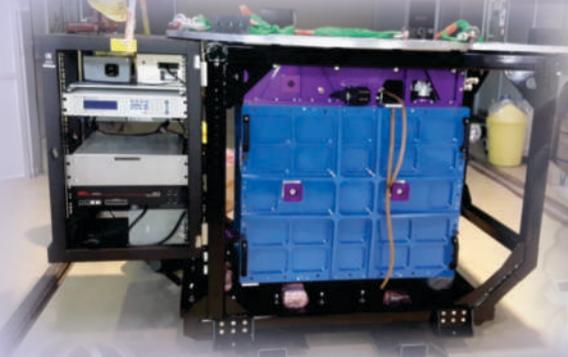
MIIC	MNIT Innovation and Incubation centre
MNIT	Malaviya National Institute of Technology
MoPAREST	Mobile Phone Assisted Remote Speech Therapy
MSE	Mobile Science Exhibition
MSME	Ministry of Micro, Small & Medium Enterprises
NASI	National Academy of Sciences
NCSTC	National Council for Science and Technology Communication
New-Gen IEDC	New Generation Innovation and Entrepreneurship Development Centre
NGCMA	National Good Laboratory Practice Compliance Monitoring Authority
NGF	National Geotechnical Facility
NIAS	National Institute of Advanced Studies
NIDHI	National Initiative for Developing and Harnessing Innovations
NIF	National Innovation Foundation
NIH	National Institute of Health
NIH	National Institute of Hydrology
NIIST	National Institute for Interdisciplinary Science and Technology
NIS	National Innovation Survey
NISA	Networked Programme on Imaging Spectroscopy & Applications
NLST	National Large Solar Telescope
NMD	National Mathematics Day
NM-ICPS	National Mission on Interdisciplinary Cyber Physical Systems
NPDF	National Postdoctoral Research Fellows
NRDMS	Natural Resources Data Management System
NSD	National Science Day
NSF	National Science Foundation
NSM	National Supercomputing Mission
NSTEDB	National Science & Technology Entrepreneurship Development Board
NSTMIS	National Science and Technology Management Information System
NTSC	National Teachers' Science Congress

OECD	Organization for Economic Co-operation and Development
PAC	Program Advisory Committee
PFC	Patent Facilitation Cell
PIC	Patent Information Centers
PLT	Partial Lorentz Transformations
PMB	Programme Management Board
PPVFRA	Protection of Plant Varieties & Farmers' Rights Authority
PURSE	Promotion of University Research and Scientific Excellence
QuEST	Quantum Enabled Science and Technology
RAIR	Facility for Antiproton and Ion Research
RAL	Rutherford Appleton Laboratory
RCP	Rapid Prototyping Camp
RFID	Radio Frequency Identification
RIS	Research and Information System
RRCAT	Raja Ramanna Centre for Advanced Technology
RRI	Raman Research Institute
RSF	Russian Science Foundation
RTF-DCS	Research & Training Fellowship for Developing Country Scientists
RWTP	Rural Women Technology Park
SAG	Sabarmati Ashram Gaushala
SAIF	Sophisticated Analytical Instrument Facilities
SATYAM	Science and Technology of Yoga and Meditation
SAXS	Small Angle X-ray Scattering
SCSP	Scheduled Caste Sub Plan
SCTMST	Sree Chitra Tirunal Institute for Medical Sciences and Technology
SDGs	Sustainable Development Goals
SEED	Science for Equity for Empowerment and Development
SERB	Science And Engineering Research Board
SHE	Scholarship for Higher Education

SHRI	Science and Heritage Research Initiative
SICART	Sophisticated Instrumentation Centre for Applied Research & Testing
SINP	Saha Institute of Nuclear Physics
SITRA	South India Textile Research Association
SKA	Square Kilometre Array
SNBNCBS	S N Bose National Centre for Basic Sciences
SPRERI	Sardar Patel Renewable Energy Research Institute
SRS	SERB Research Scientist
SSR	Scientific Social Responsibility
SSS	Seed Support System
STEMM	Science, Technology, Engineering, Mathematics and Medicine
STI	Science, Technology, and Innovation
STORM	Stochastic Technical Retroscope Microscopy
STPI	Science & Technology Policy Research and Information Center
SYST	Scheme for Young Scientists and Technologists
TARA	Technological Advancement for Rural Areas
TBI	Technology Business Incubator
TDB	Technology Development Board
TDP	Technology Development Program
TERI	The Energy and Resource Institute
TIASN	Technological Interventions for Addressing Societal Needs
TIDE	Technology Intervention for Disabled & Elderly
TIFAC	Technology Information, Forecasting and Assessment Council
TIFR	Tata Institute of Fundamental Research
TIME-LEARN	Technology Intervention for Mountain Ecosystems-Livelihood enhancement through Action Research & Networking
TITE	Technological Intervention for Tribal Empowerment
TMT	Thirty Metre Telescope
TNA	Technology Needs Assessment

TRC	Tribal Resource Centre
TRC	Technical Research Centres
TRL	Technology Readiness Level
TSP	Tribal Sub Plan
UIS	UNESCO Institutes of Statistics
UNIDO	The United Nations Industrial Development Organization,
UNU-MERIT	United Nations University- Maastricht Economic and Social Research and Training Centre on Innovation and Technology
UTMs	Universal Testing Machines
VAJRA	Visiting Advanced Joint Research
VARTM	Vacuum Assisted Resin transfer molding
VIB	Vivekanand Institute of Biotechnology
VTU	Visvesvaraya Technological University
WAQM	River Water and Air Quality Monitoring
WAYU	Wind Augmentation and purifYing Unit
WEE	Women Entrepreneurship and Empowerment
WEQ	Women Entrepreneur Quest
WICTRE	Water Innovation Center: Technology, Research & Education
WIHG	Wadia Institute of Himalayan Geology
WIPO	World Intellectual Property Organisation
WISTEMM	Indo-U.S. Fellowship for Women In STEMM
WLCG	Worldwide Large Hadron Collider Computing Grid
WMT	Waste Management Technologies
WOS-A	Women Scientist Scheme-A
WOS-B	Women Scientists Scheme-B
WOS-C	Women Scientists Scheme-C
WSC	Women Science Congress





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