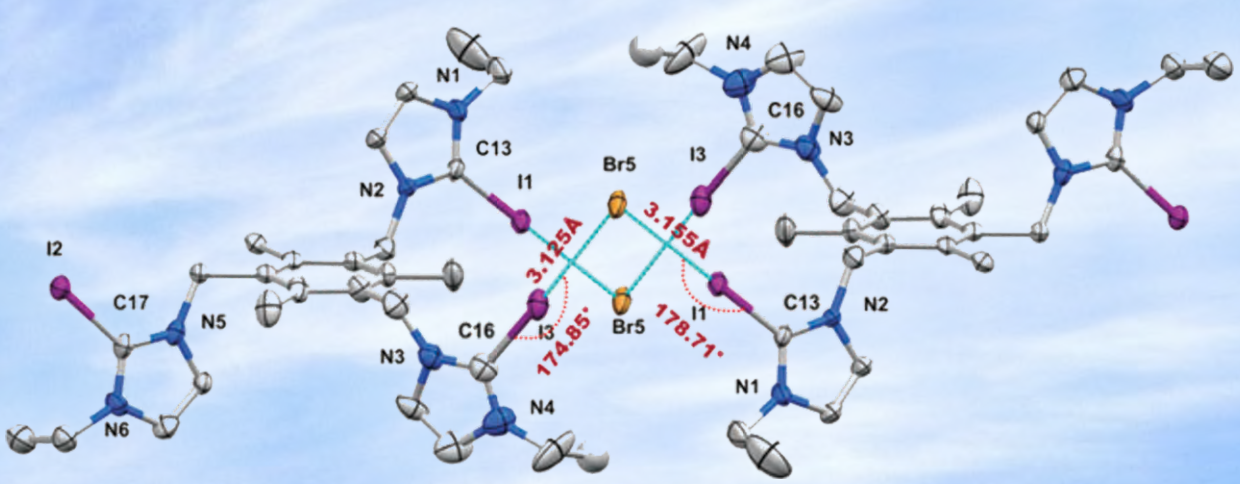
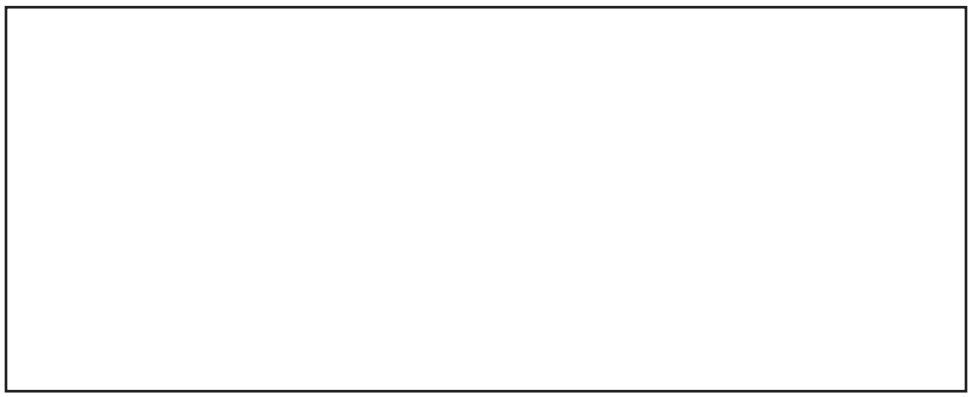
Annual Report
2016-17

Department of Science & Technology



सत्यमेव जयते

Government of India
Ministry of Science & Technology
New Delhi



Single crystal X-ray structures represent halogen bonding (XB) interactions in bromide complex with benzene scaffold based 2-iodoimidazole substituted tripodal XB donor receptor.

Annual Report
2016-17

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

CONTENTS

OVERVIEW

The Department of Science & Technology supports and encourages the whole gamut of S&T ecosystem from seeding and capacity building in the cutting-edge research areas to translational research; technology development and deployment; innovation and startup ecosystem; and international collaborations by supporting infrastructure, scientists and students in academic and R&D institutions across the country. During the last two years, the Department has aligned its activities with the National Agenda of the Government towards Make in India, Startup India, Digital India, Swachh Bharat, Swasth Bharat, etc. Some of the new initiatives conceptualized and launched during the past two years became fully operation during the year under report. While annual report presents a detailed account of achievements of Department's activities, some of the major achievements and initiatives of 2016-17 are briefly presented in the following sections:

Enhancing Quality and Quantity of S&T Research and Development

- Science and Engineering Research Board (SERB) has initiated a new scheme viz. **Visiting Advanced Joint Research (VAJRA) Faculty Scheme** for overseas scientists and academicians with emphasis on Non-resident Indians (NRI) and Persons of Indian Origin (PIO) / Overseas Citizen of India (OCI) to create an opportunity to contribute to growth of research and development in the country. The scheme envisages to associate distinguished international faculty as Adjunct/ Visiting Faculty in Indian institutions for a period of 1-3 month in a year.

- **Overseas Doctoral Fellowship:** The fellowship scheme has been formulated to facilitate overseas research training for Indian Ph.D. Scholars registered in Indian institutions. Fellowships will be implemented in overseas institutions of repute and areas of importance to the country. Fellowship amount of US $ 2000 p.m. for a period of up to 12 months will be provided. One visit by the Indian supervisor to the overseas institution and overseas faculty to the host Indian institution of the student during the tenure of the fellowship will also be supported. It is estimated that 350 fellowships will be awarded for the period 2016-19.

- A new programme on **Interdisciplinary Cyber-Physical-Systems (ICPS)** to foster and promote R&D in this emerging field of research has been launched. A Cyber Physical System (CPS) is a mechanism controlled or monitored by computer-based algorithms, tightly integrated with internet and its users. It is an engineered system that is built from and depend upon, the seamless integration of computational algorithms and physical components.

- The **104th Annual Session of the Indian Science Congress** was held from 3rd to 7th January, 2017 at SV University, Tirupati. It was inaugurated by the Hon'ble Prime Minister, Shri Narendra Modi, on 3rd January, 2017. The Focal Theme of 104th Session was "Science and Technology for National Development". Over 13000 scientists, teachers, students from all over the country and

6 Nobel Laureates participated in this mega science event. Large number of lectures and wide-ranging scientific discourse and discussion took place on a large variety of topics, ranging from gravitational waves and Human Microbiome to Blue Economy and Offshore Wind Farms.

- **Global Research Council Meeting:** Science and Engineering Research Board (SERB) jointly hosted the Fifth Annual Meeting of Global Research Council (GRC)-2016 from 25th to 27th of May 2016 with the Research Councils UK (RCUK). The Global Research Council (GRC) is a virtual organization comprising of the Heads of Research Councils from around the world, dedicated to promoting the sharing of data and best practices for high-quality collaboration among research funding agencies globally. Heads of Research Councils from 44 countries were among more than 100 delegates who attended the event to share the best practices and discuss policy issues in the field of Research Funding. A Statement on 'Principles of Interdisciplinarity' and 'Actions towards Equality and Status of Women in Research' was discussed and endorsed by participants representing the global research community.

- **Collaboration initiated with the Rutherford Appleton Laboratory (RAL), UK** to access its neutron facility for carrying out research in Nano Science and Technology.

- **Setting up a macromolecular crystallography and high pressure physics beam line at the Elettra Synchrotron Facility, Trieste, Italy:** The twin Indian beamlines, XRD2 and Xpress were inaugurated on 20th October 2016. The beamlines are now available for scientific experiments.

- **Associate Membership of CERN:** India signed the Agreement for Associate Membership of CERN at DAE Headquarters in Mumbai on 21st November, 2016. India has become an Associate Member State of CERN on 16th January 2017.

- **India and Israel agreed to step up the S&T collaboration** in the next two years by providing U.S. dollar 1 million from each side to support new R&D projects in the cutting edge areas of Big Data Analytics in Health Care and Security in Cyber Space. As a part of these projects, student exchanges will be encouraged in order to connect the next generation and sustain the pipeline of future collaboration.

- Relationship with Japan was substantially strengthened by establishing **Indo-Japan Joint Laboratories** in the areas of (i) Architecting Intelligent Dependable Cyber Physical System Targeting IoT and Mobile Big Data Analysis (ii) Security in the Internet of Things Space (iii) Data Science-based Farming Support System for Sustainable Crop Production under Climatic Change have been agreed to support. A new reciprocal fellowship program for young researcher was agreed with JSPS, Japan.

- **Indo-US Fulbright-Kalam Fellowships in Climate Change:** In pursuance of the Joint Statement of the Government of USA and the Government of India the Fulbright-Kalam Climate Fellowship has been launched. The United States-India Educational Foundation (USIEF) has been given the responsibility to administer the Fulbright-Kalam Climate Fellowship on behalf of both the

governments. The first batches of six fellows have been selected.

- **BRICS STI Cooperation:** To further strengthen the collaboration amongst the BRICS countries in the areas of Science, Technology and Innovation (STI), the 4th BRICS Science, Technology and Innovation Ministerial Meeting was convened on 8 October, 2016 at Jaipur.

Technology Development and Deployment

- **Surya Jyoti:** Photovoltaic integrated Micro Solar Dome, is the simple innovative technology developed to meet the lighting need for people who do not have access to reliable supply of electricity. The product has been included for subsidy under Off Grid and decentralized solar application scheme of Ministry of New and Renewable energy. The Ministry of Rural Development has informed to all States and Union Territories to explore the possibility of adopting this innovative technology of Surya Jyoti for the houses constructed under Prime Minister Awas Yojana-Gramin.

- **The National Award for the successful commercialization of indigenous technology** was presented to SMITA Research Lab, IIT Delhi for the commercialization of N9 Pure Silver by the Hon'ble President of India during the Technology Day function on 11th May 2016. Technology was jointly developed by M/s RESIL Chemicals Private Limited and ARCI, Hyderabad under Nano Mission of DST.

- **Deployment of a mobile RO unit:** DST has supported quick deployment and demonstration of a mobile water purification unit developed by CSIR-CSMCRI for producing portable water for drinking. It was demonstrated in Latur, Marathwada region which was facing severe scarcity of drinking water during this year's (2016) drought period.

- **Dielectric Barrier Discharge (DBD) based plasma system for portable water purification:** A technology developed at CEERI Pilani through support by DST's Water Technology Initiative (WTI) for Dielectric Barrier Discharge (DBD) based plasma system for disinfection has been successfully transferred for commercialization to Turners Pvt. Ltd. Jaipur.

- **The Water Quality Laboratory at Kohima, Nagaland:** The Referral Water Laboratory, fully equipped with the in house sophisticated analytical equipments for Water Quality analysis was inaugurated by the Hon'ble Union Minister of Science and Technology Dr. Harsh Vardhan at NASTEC, Kohima, Nagaland,

- **Solar Energy Research Institute for India and the United States (SERIIUS):** The Indo-US consortium has developed the crucial prototype test loop that demonstrates the multiscale aspects of the supercritical CO2 Brayton cycle (s-CO2) at IISc Bengaluru for development of high temperature concentrated solar power in the country.

- DST and RC-UK have agreed to launch **India-UK Clean Energy R&D Centre** on solar energy, storage and integration with an investment of £ 5 million from each side.

- Building upon the Thames-Ganga Partnership and recognising the importance of clean and portable

water, DST and RCUK have agreed to launch a new collaborative programme on **Improving Water Quality and Reusing Waste Water.**

- **DST-Intel Collaborative Research for Real-Time River Water and Air Quality Monitoring:** Recognizing the importance of developing the online River Water and Air Quality Monitoring systems, DST and Intel have initiated a joint programme at a cost of Rs.33 cr on a 50:50 cost sharing basis in Public-Private Partnership (PPP) mode.

- Successful demonstration of technology for **cyber-digital-physical reconstruction of Hampi** heritage structures was carried out.

- A **Networked programme on Imaging Spectroscopy and Applications (NISA)** has been launched considering the potential of this emerging technology to promote research on various aspects of imaging spectroscopy and its applications.

- Survey of India has put its 1:50000 scale topographical maps in the digital form on the web as **webfeature service.** This will facilitate users to download the maps and view it along with other imageries of Google and Bhuvan etc.

- S**urvey of India (SOI) has completed 250 years of its establishment.** As a part of 250th anniversary celebrations during 23rd Jan to 25th Jan. 2017, SOI will organize several technical activities and launch new initiatives.

- **Braille Mapping and Atlas compilation** initiated by NATMO has been greatly appreciated and recognized by Government of India and it received the National Award for S&T Intervention in Empowering the Physically Challenged.

Innovation and Start-up Ecosystem

- A programme viz. **NIDHI (National Initiative for Developing & Harnessing Innovations)** to address the complete chain of innovation ecosystem right from scouting to mentoring to scaling up innovations has been launched. Under the aegis of NIDHI, a research park at IIT Gandhinagar has been supported at a cost of Rs.90 cr besides implementation of several other components.

- In the context of Start-up India initiative of the Government, **INSPIRE Awards** scheme has been revamped to foster culture of innovation among school children of class VI to class X. The scheme has been rechristened as **INSPIRE Awards-MANAK** (Million Minds Augmenting National Aspiration and Knowledge).

- **PLUGIN:** A collaborative Incubation Program for Hardware and Systems Startups by DST, Intel, & SINE-IIT Bombay has been initiated. This is a first of its kind program to support hardware and systems-based startups in India.

- **DST-Texas Instruments "India Innovation Challenge 2016":** DST has partnered with the Texas Instruments to scout, motivate, validate and incubate engineering students driven innovative design

ideas with commercial potential in the electronics, semiconductor and embedded systems domain under Make in India, anchored by MyGov platform and implemented through Indian Institute of Management, Bengaluru.

- The 22nd **DST-CII Technology Summit with United Kingdom** as country partner was organized in New Delhi during 7-9 November, 2016. The Summit was inaugurated by the Prime Minister of India along with the Prime Minister of UK. The Summit saw participation with over 2500 delegates including 200 participants from UK. B2B meetings were held for exploring techno-business partnerships between the two countries. Several new India-UK R&D partnership programs were announced in the Tech Summit.

Science for Equity, Empowerment & Development

- A **Standing Committee for Promoting Women in Science** has been constituted to address low representation of women in Science & Technology (S&T) domain and to provide opportunities to women scientists and technologists for pursuing research in basic or applied sciences. During the year, 227 R&D projects of women scientists were recommended for support. Twenty nine projects to women scientist were supported for finding out solutions to challenges/issues at the grassroots level for social benefit. To create opportunity of self employment and/or also sustainable career for the women scientists, one year internship in the domain of Intellectual Property Rights (IPRs) to 111 women was provided during the year.

- Improvised **drying-cum-storage technology for large Cardamom** has been successfully introduced and demonstrated in Ziro, Arunachal Pradesh. Flue pipe system dryer provides good colour to the capsules and perfect drying in short span of time. Now, Cardamom farmers of Ziro are getting better economic returns through the introduction of this improved drying technology as compared to traditional system.

- Processing and production technology by **introducing mechanized potter's wheel and pug mill,** besides product diversification and value addition techniques have been demonstrated to revamp traditional pottery practices. The initiative is being integrated with the national programs/schemes such as Skill India, Swachh Bharath Abhiyan, Unnat Bharat Abhiyaan, etc.

- A **Network programme to address migration and malnutrition in tribal communities** (Kolam, Korku, Katkari, Mahadeokoli, Gond and Bill) through appropriate technologies is being implemented in 11 locations in the tribal pockets of Maharashtra covering 50 villages.

- A **soybean variety MACS 1281 has been released** and notified for cultivation in the Southern Zone. The variety has determinate plant habit with medium maturity range. It is resistant to stem fly, defoliators, pod borer and leaf folder, bacterial pustule and bacterial leaf blight.

- A **new durum wheat variety MACS 3949** has been identified for cultivation under timely sown irrigated conditions in Peninsular Zone. The variety has shown significantly superior yield performance over check variety NIDW 295 in three years of testing in coordinated trials.

- **Technology Interventions for Disabled and Elderly (TIDE)** is a unique initiative aimed at promoting basic research, development and adaptation of technology for improving quality-of-life of Elderly population and Disabled People in the country. This initiative complements the Accessible India Campaign (Sugamya Bharat Abhiyan) of the Government. A wide array of technology prototypes/products for elderly and PwDs to gain access for equal opportunity, live independently and participate fully in all aspects of life in an inclusive society were developed.

- In order to developing scientific temper in the society, specially young students, interesting aspects about the inspiration that guided 54 Indian stalwarts in Science and Technology were presented in a publication titled **"Indian Scientists:The Saga of Inspired Minds"** brought out by DST's autonomous organization Vigyan Prasar with a message from Hon'ble Prime Minister about the book.

Significant progress has been made during the year in the programmes initiated during the past two years such as National Super Computing Mission; Technical Research Centres; Waste Management; Advanced Manufacturing; Science and Technology of Yoga and Meditation etc. A brief account of the achievements of these programmes as also variety of other activities and programmes is described in the subsequent chapters of the report.

CHAPTER 1

HUMAN CAPACITY BUILDING IN S&T

HUMAN CAPACITY BUILDING THROUGH SCIENCE & ENGINEERING RESEARCH

Department of Science & Technology is the single largest support system for extra-mural R&D in the country. Promotion of basic research in all areas of science and engineering through Science and Engineering Research Board accelerates growth of research in new and inter-disciplinary areas. Innovation in Science Pursuit for Inspired Research (INSPIRE) programmes aims to attract young talent to pursue study of science and research careers in science. For encouraging and empowering women scientists, a dedicated programme viz. Knowledge Involvement in Research Advancement through Nurturing (KIRAN) is under implementation. Training programme for scientists and technologists working in the government sector to meet the challenges of national development and international competitiveness are some the programmes towards human capacity building in S&T in the country. Major outcomes of these programmes are described in the following sections.

Science and Engineering Research Board (SERB)

SERB is a Statutory Body under the administrative control of the Department. The Board has catalyzed research and development activities in several frontier areas of science and engineering. Some of new initiatives taken by the Board during the year and major highlights of outcomes are as following:

1. Visiting Advanced Joint Research (VAJRA) Faculty Scheme: SERB has approved VAJRA Faculty Scheme for overseas scientists and academicians with emphasis on Non-resident Indians (NRI) and Persons of Indian Origin (PIO) / Overseas Citizen of India (OCI) to create an opportunity to contribute to growth of research and development in the country. The VAJRA Faculty will serve up to 3 months in a year and they will be provided a lump-sum amount of US $ 15000 in the first month of engagement and US $ 10000 p.m. in the other two months. Total of not exceeding 1000 Adjunct / Visiting Faculty positions at any point in time starting from 2017-18 will be awarded. The area of research to be undertaken by the Adjunct / Visiting Faculty should be of interest to India.

2. Overseas Doctoral Fellowship: The fellowship scheme has been formulated to facilitate overseas research training for Indian Ph.D. Scholars registered in Indian institutions. Fellowships will be implemented in overseas institutions of repute and areas of importance to the country. Fellowship amount of US $ 2000 p.m. for a period of up to 12 months will be provided. One visit by the Indian supervisor to the overseas institution and overseas faculty to the host Indian institution of the student

during the tenure of the fellowship will also be supported. It is estimated that 350 fellowships will be awarded for the period 2016-19.

3. Partnering with MHRD for Uchchatar Avishkar Yojana (UAY): SERB shall be partnering with MHRD for UAY projects and fund those projects identified by the Apex Committee constituted for the purpose. The share of SERB funding will be 25%, while MHRD will contribute 50% and Industry the remaining 25%. The projects funded under this scheme will be named as "UAY SERB" projects. The first batch of 39 projects will be supported with SERB share of Rs. 30 crore.

4. IMPRINT (IMPacting Research INnovation and Technology): DST has signed a Memorandum of Understanding to support projects under IMPRINT program. 12 projects in different domain areas, particularly, in "Nanotechnology" and "Advanced Materials" were funded.

5. Expanding Research Base - Mobility Scheme: The scheme aims to facilitate mobility of faculty members working in a regular capacity in State Universities/ Colleges/ Academic Institutions in private sectors to work in established public funded institutions such as IITs, IISc, IISERs, National labs, etc. located nearer to the institution where the faculty member is working. Provision of fellowship amount of Rs. 5,000 p.m., contingency grant of Rs. 5 lakh per annum and overhead for a period of 3 years has been made. Maximum of 500 such awards would be granted per year.

6. Implementation of High Risk High Reward (HRHR): HRHR, a scheme approved earlier, has been implemented this year. The aim is to support proposals that are conceptually new and risky, and if successful, expected to have a paradigm-shifting influence on the S&T landscape. Outcome could be new and significant, theoretical or experimental advances, formulation of new hypotheses or breakthrough science which will lead to new technologies. The proposals need to contain significant risk elements but promise of high reward if the difficulties could be circumvented. It is expected that the success of such proposals will have far reaching implications in S&T.

7. Implementation of Industry Relevant R&D (IRRD): Recognizing the need to facilitate increased Public Private Partnerships, SERB has implemented another scheme this year that provides an opportunity for collaborative research between academic institutions and industry. This scheme aims to bridge the gap between public funded research and industrial R&D. It seeks to target solution driven research to address industry specific problems. The participating industry should ensure that the objectives are industrially relevant. The funding is shared between SERB and Industry. The support from SERB is extended only to the academic partner and not to the industry. The industry share should not be less than 50% of the budget.

Global Research Council Meeting: SERB jointly hosted the Fifth Annual Meeting of Global Research Council (GRC), 2016 from 25th to 27th of May with the Research Councils UK (RCUK). The Global Research Council (GRC) is a virtual organization comprising of the Heads of Research Councils from around the world, dedicated to promoting the sharing of data and best practice for high-quality collaboration among research funding agencies globally. Heads of Research Councils from 44 countries were among more than 100 delegates who attended the event to share the best practices and discuss

policy issues in the field of Research Funding (Figure 1). A Statement on 'Principles of Interdisciplinarity' and 'Actions towards Equality and Status of Women in Research' was discussed and endorsed by participants representing the global research community.

Figure 1: Opening remarks by Prof. Ashuthosh Sharma, Secretary DST at GRC 2016

A wide variety of projects were supported in the reporting period. Research highlights of some of the notable ones are given below.

• **Addressing The Twin Challenges of Alternate Energy and Environmental Protection at NCCRD (IIT Madras):** To study the effective utilization of combustion as a means of thermo-chemical energy conversion in India and address the twin challenges of alternate energy and environmental protection, SERB established the "National Centre for Combustion Research & Development" (NCCRD) at the Indian Institute of Technology Madras and Indian Institute of Science, Bengaluru. This is the largest grouping of academic combustion researchers globally with research interests in three major application sectors - automotive, thermal power and aerospace propulsion, besides fire research and microgravity combustion to minor extent. The NCCRD pursues key innovative R&D in various fields including gasoline direct injection (GDI), flame stabilization, lowering emissions and mitigating combustion instability in gas turbines and improved fuel-air mixing in supersonic combustors.

One of the major achievements at this combustion center is high-ash coal gasification for electricity generation and methanol or urea production. Highest levels of coal gas and carbon conversion efficiencies are reported for the first time in the world with high levels of ash content in the coal through optimized air and steam gasification in a bubbling fluidized bed. It is now being adopted for indirect coal gasification to increase or optimize the calorific value of the synthesis gas produced from high-ash coal.

• **Stratosphere-Troposphere (ST) Wind Profiler Radars at Cochin, Nainital and Kolkata:**

The ST Radars have been planned and supported at three locations, however a network is being envisaged in future. These radars have a variety of applications in the study of:

- Monsoon characteristics and variability
- Heavy rainfall events, severe droughts, landslides and floods
- Thunderstorm, lightning, scorching winds and heat burst, etc.

- Sea-level rise, coastal erosion, monsoon surges, etc.
- Monsoonal climate change
- Agriculture, plantation, crop yields, hydro-electrical power generation

The Cochin University of Science and Technology (CUSAT) is in the final stage of installing the most sophisticated and indigenously developed Stratosphere-Troposphere (ST) radar being operated at 205 MHz frequency. Perhaps being the first radar in the world operating at this frequency, it is also the first wind profiler radar in the near equatorial site set up primarily to study the characteristics of Indian summer monsoon, right at its Gateway at Cochin. The data from this radar is envisioned to add a new dimension to studies on monsoon dynamics. The Radar has been positioned in the campus of Advanced Centre for Atmospheric Radar Research (ACARR) under CUSAT (Figure 2). The ST radar bears 619 three element Yagi-Uda antennae capable of probing atmosphere from 315 m to 20 km. The technical aspects and initial results of the prototype radar were published in peer reviewed scientific journals. Scientific validation under different environmental condition is in progress.

Figure 2: Dr V K Saraswat, Member NITI Aayog with ST Radar Project Team at Kochi

• Different polyetheleneimine (PEI) based copolymers for the preparation and modification of poly (piperazineamide) [poly(PIP)] nanofiltration (NF) membranes have been synthesized. The main problem of conventional poly (PIP) based NF membrane is the poor fouling resistant property and trade-off rejection between divalent cationic and divalent anionic salts. A suitable surface modification process has been developed for the state-of-art poly(PIP) thin film composite (TFC) NF membrane by PEI and its copolymers (PEI-polyethylene glycol and PEI-dextran) to overcome the above mentioned problem (Figure 3). The modified membranes exhibited high rejection of divalent cations (88-91%), high rejection of divalent anions (85-92%) and low rejection of NaCl (30-50%).

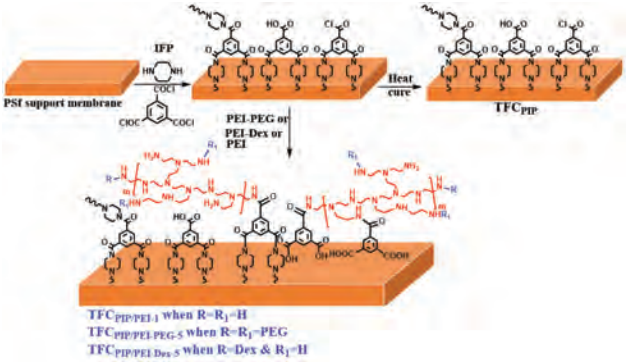


Figure 3: Strategy for the surface modification of poly (PIP) based NF membrane by PEI-PEG and PEI-Dex conjugates.

• A catalyst/solvent-free, one-pot and operationally simple method for the synthesis of quinoline substituted α-hydroxy carboxylic derivatives by hydroxyheteroarylation of olefins with quinoline N-oxides has been developed. The reaction features high atom-economy, mild and reagent/solvent-free conditions, broad substrate scope and good selectivity with high yields (Figure 4). Preliminary mechanistic study to shed light into the reaction pathway was also carried out.

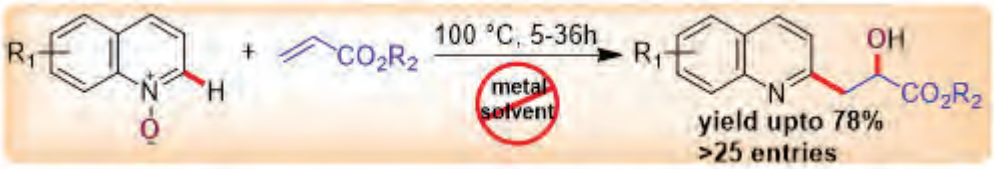


Figure 4: Reagent – free quinoline C(2)-H functionalization

• Studies on adaptive radiation of geckos in the dry zone of the Indian subcontinent, to understand how geography has affected patterns of distribution and to know if conservation measures are required, has revealed that, there are deeper divergences between samples of the rock dwelling species (H. treutleri) as opposed to samples of ground dwelling (H. cf gleadowi) or human commensal species (H. parvimaculatus). This can be attributed to the distribution of preferred habitats of these species. Rock dwelling species has a naturally fragmented habitat while ground dwelling species has a more or less continuous habitat. Human commensal species could potentially be dispersed through anthropogenic activities. Four new species of Hemidactylus geckos have been discovered during the course of this work. Several populations of the human commensal species have been found in the wild. The generated genetic data will help to address questions about whether these populations are ancestral populations of human commensals seen today or have the human commensals invaded these areas recently. The study reveals that Hemidactylus geckos are part of an adaptive radiation – rapid diversification of a single ancestral lineage into various forms that are each adaptively specialized to a specific environmental niche.

• Melon Necrotic Spot Virus-Hyd (MNSV-Hyd) encoded genes and its replications was studied in plant, using this virus as a model viral system which is spherical, positive strand RNA virus and identified as a Carmo-virus member (Figure 5). It is apparently the first report from the Indian subcontinent. Engineering the full length infectious cDNA clone of this virus can be used as 'viral tools' to functionally analyze each gene individually and delineates the viral mechanisms in planta directly.

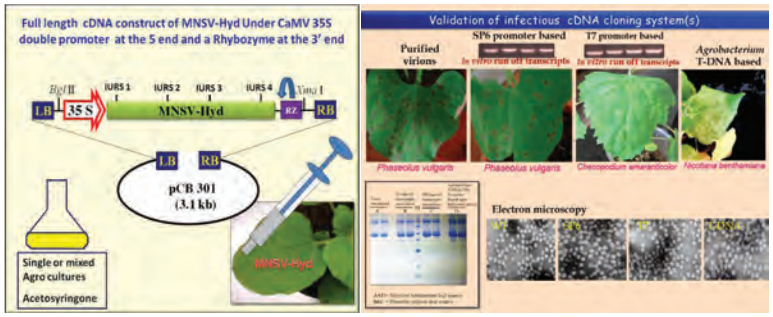


Figure 5: Melon Necrotic Spot Virus-Hyd (MNSV-Hyd) in plant

• Many epidemiological studies have shown a possible link between obesity and risk of cancers. In addition, obesity is associated with poor prognosis and outcome of cancer therapy. Obesity-associated factors are purported to promote growth, survival, proliferation and invasiveness of cancer cells. It emphasized that how obesity and obesity-associated factors contribute to increased melanoma progression and further how it impedes the outcome of the chemotherapy. A translational strategy has been devised, which brings that by controlling the adiposity may improve the chemotherapeutic outcome and prolongs the survival of obese cancer patients.

• Mosquito vectors that transmit many deadliest infectious diseases, like malaria, dengue, Zika virus infections killing millions of peoples globally, remains challenging to control using traditional insecticides due to fast emergence of resistance. Designing, new molecular tools are immediate need to fight vector borne diseases. Hemocytes are tiny circulating blood cells, play multiple roles in physiological as well as cellular immune responses. Though, the molecular nature of hemocytes is not well understood, it could be important to discover novel anti-pathogenic molecular target to block parasite transmission. The work opens up further research avenues in understanding the anti-plasmodial responses in malarial vectors and to design super immune mosquitoes, unable to transmit the disease.

• Systematic research and development efforts have been made to enhance agricultural productivity through development of farm machinery in selected areas to bridge the existing mechanization gaps with respect to International scenario and to facilitate precision & conservation farming. The following technologies have been developed:

- Pneumatic precision planter for vegetables for direct seeding of small, irregular shaped vegetable seeds leading timeliness in sowing, input cost saving, and reduction in total production cost.
- Development of electrostatic nozzle system along with high voltage generation module for charging of liquid sprays in air-assisted spraying system.
- Austempered ductile iron (ADI) rotavator blades for low cost, recyclable technology for mass manufacturing of blades.
- Automatic planter calibration test rig for testing all types of seed metering systems [vacuum type, inclined/horizontal/vertical plate, cell type and finger type] used in planters.
- Inter-row rotary cultivator for removing the weeds and shallow tilling in the inter-row space in the wide-row crops like sugarcane, cotton, soybean, maize and pulses.
- Application of computational technology in agricultural operations like harvesting for selective picking of cotton and same may be adopted for harvesting of other crops.
- Cotton picker head development for mechanical picking of cotton. It will help Indian Farm Machinery Manufacturers to develop a tractor-driven or self-propelled machine for cotton picking.

- Interrelationship between the interfacial layer and the interfacial sliding and failures in metal-semiconductor system due to a thermo-electro-mechanical stimulus have been studied at IISc Bangalore. Following are the highlights of the outcomes of the investigations undertaken:
  - Discovery of interfacial layer mediated thermos-migration-electro-migration coupling in metal-semiconductor systems.
  - Proposal of usage of high conductivity interfacial layer for reduction in electro-migration and electro-migration-thermo-migration coupling induced damages.
  - Discovery of role of interfacial layer in formation of unique periodic surface patterns in the electric current induced flow in liquid metals.
  - Design and development of a state-of-art experimental setup for studying electro-migration (Figure 6).

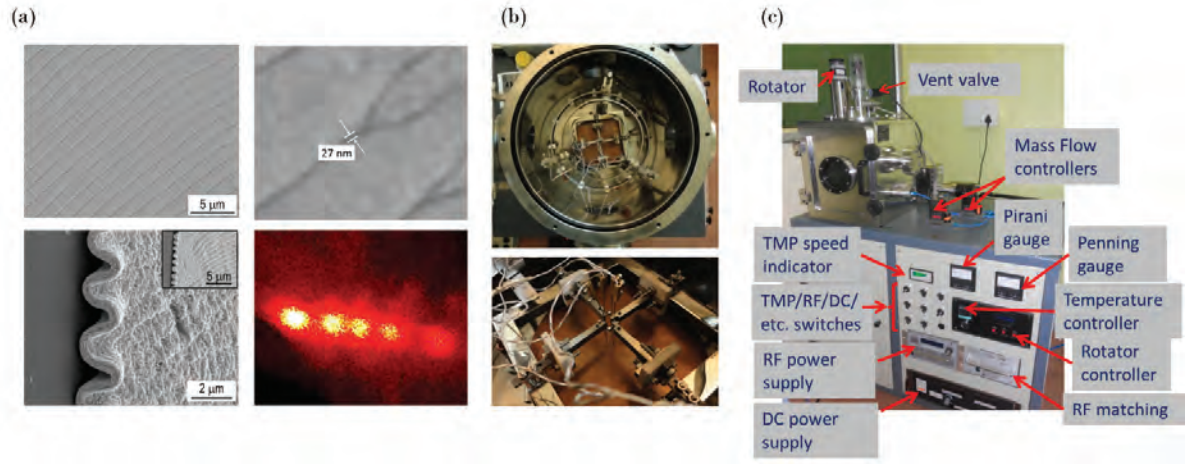


Figure 6: (a) (clockwise) (i) SEM micrograph of a ripple pattern of Ga formed on Au fabricated with electric field. (ii) Narrow channels in between the heel regions. Minimum channel width of 27 nm is achieved. (iii) Digital photograph of the diffraction patterns formed by ripple structures. (iv) SEM image of the edge of a ripple pattern; inset picture is showing the zoomed out view of the region. (b) state-of-art setup for performing electro-migration experiment in controlled environment. (c) Indigenously designed and build RF-cum-DC sputtering unit.

- An explicit formula for the Betti numbers were computed leading to a proof of the Periodicity conjecture. Equations defining the Rees algebra were computed for monomial curves defined by arithmetic sequences. Francia's conjecture was proved for monomial curves defined by arithmetic sequences. The structure and the representation theory of Lie Algebra bundles has been developed. It is found that the homotopic classification of Lie bundles does not follow the method of the homotopic classification of vector bundles. Lie algebra bundles in terms of characteristic ideal bundles over a field of arbitrary characteristic has also been studied. Pull back, clutching and collapsing constructions are defined for Lie algebra bundles. Equivalence between the category of Lie algebra bundles and finitely generated projective module which are Lie rings is established over a topological space.

SWARNAJAYANTI FELLOWSHIPS

The **SwarnaJayanti Fellowship Award** was initiated by the Government in 1997-1998 to commemorate 50th year of India's independence. The objective of this Fellowship Award Scheme was to award talented young scientists, upto 40 years of age, in their innovative and inter-disciplinary projects that may result in providing leadership to the country in advanced areas of science and technology. The internal analysis of the achievements of the Fellows selected during the first 10 years (1997-1998 to 2007-2008) of implementation of the SwarnaJayanti Fellowship scheme depicts the following:

i. Some of the areas in which the Swarnajayanti Fellows carried out high end scientific research in India are: Self-assembly in Colloidal Systems; chondrule formation in solar systems; Signaling in bacterial development; cancer signature in metastatic process; design and synthesis of anti-aromatic microcycles; Algebraic Complexity theory; Transcranial Direct Current Stimulation (tDCS) for neuropsychiatric disorders; Energy harvesting application using hybrids and nanostructures; RSK correspondence and Kronecker coefficients; Design of novel algorithms and protocols for digital security; Quantum field theory; Sustainable Manufacturing at micro-scale; Affine algebraic geometry; Dynamics of spray-swirl interactions; Virus mediated gene-transfer strategies; Device fabrication using Graphene; Massive star explosions; Designing of smart soft materials; Strongly correlated quantum systems; Experimental simulation of thermal core mantle interactions; Bio-inspired supra-molecular studies; Novel molecular materials for organic and hybrid solar cells; DNA structure mediated gene regulation and Cell cycle regulation of two human pathogens and Biology interface with Engineering through MicroRNA studies.

ii. Each completed project has resulted in average of 12 to 16 papers in reputed journals and has produced a minimum of 2 PhDs.

iii. A few Fellows have been awarded SS Bhatnagar Award and have received Fellowships of National and International Bodies along with other recognitions.

The list of fellows approved for the award for the last financial year which will be supported during 2016-17 is as follows:

S.No.	Name and Address of Fellow	Discipline
1.	Dr. Kausik Chakraborty, CSIR-IGIB, New Delhi	Life Science
2.	Dr. Dasaradhi Palakodeti, InStem, Bengaluru	Life Science
3.	Dr. Prahladh Harsha, TIFR, Mumbai	Mathematical Science
4.	Dr.(Ms) Jyotirmayee Dash, IACS, Kolkata	Chemical Science
5.	Dr. T. Govindaraju, JNCASR, Bengaluru	Chemical Science
6.	Dr. Goutam Sheet, IISER-Mohali	Physical Science
7.	Dr. Sanjit Mitra, IUCAA, Pune	Physical Science
8.	Dr. Rajesh Ganapathy, JNCASR, Bengaluru	Physical Science
9.	Dr. Debdeep Mukhopadhyay, IIT-Kharagpur, Kharagpur	Engineering Science
10.	Dr. Vijay Natarajan, IISc., Bengaluru	Engineering Science
11.	Dr. Santanu Misra, IIT-Kanpur, Kanpur	Earth&Atmospheric Science

ATTRACTION OF TALENT FOR SCIENCE

Innovation in Science Pursuit for Inspired Research (INSPIRE) is a national programme implemented by the Ministry of Science & Technology to tap students early in life and nurture the young intelligentsia to take up science and pursue a career in Research. The programme was launched by the Hon'ble Prime Minister on 13th December 2008 and is being implemented since 2009-10. All the 29 states and 7 UT's are participating in the scheme.

INSPIRE Programme covers students in the age group of 10-32 years, and has five components: INSPIRE Award (for 10-15 age group), INSPIRE Internship at a Science camp with opportunity for interaction with global Science leaders (for 16-17 age group), INSPIRE Scholarship for Higher Education (SHE) @ Rs 80000/ per year for continuing education at B.Sc. and M.Sc. levels (for 17-22 age group), INSPIRE Fellowship for Doctoral Research (for 22-27 age group) and INSPIRE faculty for assured career opportunity (for 27-32 age group).

While the first component of the Scheme i.e. INSPIRE Award is being implemented centrally through the States / UTs, the other components of the Scheme are being implemented centrally by Department of Science & Technology (DST) through the concerned academic/Research Institutes & Universities etc.

INSPIRE Award aims to motivate students, in the age group of 10-15 years and studying in classes 6 to 10, to pursue Science and a career in Research. Beginning this year the INSPIRE Award scheme has been revamped as **INSPIRE AWARDS-MANAK (Million Minds Augmenting National Aspiration and Knowledge)** to align it with the Action Plan for "Start-up India" initiative launched by the Hon'ble Prime Minister of India.

Under the revamped scheme thrust is on 'Original ideas' having potential to address societal needs through Science & Technology especially in context of National flagship programmes such as Swachh Bharat, Digital India, Swasth Bharat, Make in India, Energy, Environment, Sanitation etc. 10 lakh ideas will be targeted from 5 lakh schools across the country, in a Financial Year. 1 lakh top ideas will be shortlisted for an INSPIRE Award of Rs. 5000/- each, for preparation of a project/model and participation in District Level Exhibition & Project Competition (DLEPC). Out of this, 10,000 best projects will be shortlisted for State Level Exhibition & Project Competition (SLEPC) and top 1000 awardees shortlisted at State Level will be provided support for development of improved prototype for National level event. They will also be provided mentoring support by National Innovation Foundation (NIF) in coordination with reputed academic and technology institutions of the country such as Central Universities, NITs, IITs, IISERs for the purpose. 1000 best projects will be showcased at NLEPC and top 60 projects shortlisted for National Awards. These 60 best models/ projects will also be showcased at the Annual Festival of Innovations at Rashtrapati Bhawan, New Delhi.

In so far as INSPIRE Award component is concerned, 13.86 lakhs INSPIRE Awards have been sanctioned till date. About 47 % of the awardees are girls and 26% SCs/STs. Around 50000 best entries

of DLEPCs have participated in the SLEPCs. Five National competitions have been conducted so far, in which 4136 students have participated.

Out of the 4136 projects participated in the five NLEPCs held so far, Patent Facilitating Centre (PFC) of TIFAC along with its team of patent experts scrutinized the exhibits and scouted the patentable inventions for patenting. 20 projects from last four NLEPC were filed with complete specification.

Four Regional Workshops at Central(Bhopal), Western (Ahmedabad), Eastern (Guwahati) and Northern (Delhi) has already been organised in co-ordination with National Innovation Foundation targeting Districts/State functionaries to sensitize the changes envisaged in the existing scheme.

Nominations for INSPIRE Awards MANAK has been made open to all the schools, from class 6-10, across the country, since 1st December, 2016 and so far more than 18000 nominations has already been received from various schools across the country.

Considering its large scale, DST has started to e-manage the entire INSPIRE Award Scheme by using State-of-Art latest Information Technology which would enable e-filing of nominations by the schools across the country, its processing by the District and State authorities as well as DST in accordance with the norms of the scheme and the award money is sent to the students directly in his/her bank account through Direct Benefit Transfer.

The 6th NLEPC under the INSPIRE Award Scheme was organized by Department of Science & Technology at CSIR-NPL, New Delhi during December 10-11, 2016 along with India International Science Festival (IISF). About 560 selected Awardees from all over the country participated in the event. The top 60 innovative projects were felicitated on December 11, 2016 by **Dr. Harsh Vardhan, Hon'ble Minister for Science & Technology and Earth Sciences** during the valedictory function. Rakesh Krishna from Karnataka has won the Gold Medal for his project SEEDOGRAPHER. Shiva Jyoti Choudhury from Rajasthan won the Silver Medal and Sachindra Jadhav from Maharashtra won the Bronze Medal.

SAKURA Science High School Program (SSHP) is a sub-program in which Asian high school students are invited by Japan Science and Technology Agency (JST) to visit excellent Universities,

research institutions, to attend lectures and to get hands-on experiments from Japanese Nobel Laureates and also to experience Japanese culture. Through this program the JST invites INSPIRE Awardee students, presently studying in classes X, XI & XII and above 16 years of age, from India in two groups of 30 students each, to visit Japan in the month of May, who are also joined by students from Thailand, Philippines and Malaysia. In the year 2016, 59 students and 10 supervisors (in two batches of 30 & 29 students and 5 supervisors each batch) successfully completed the Programme during April 17-23, 2016 and May 08-14, 2016 respectively.

INSPIRE Internship is the second component of the **Scheme for Early Attraction of Talent for Science (SEATS).** It aims at providing exposure to young science students by organizing Science Camps either in summer or winter days. Around 50,000 students of Class XI pursuing science in any school are invited every year to participate at the 5 days' science camps and provided opportunity to interact with the Science icons from India and abroad including Nobel Laureates to experience the joy of innovations on an annual basis through **INSPIRE Internship.** Such Science Camps are being covered entire country in length and breadth i.e. from Leh to Portblair in one side and Goa to Arunachal Pradesh in other side. However, these Science Camps have been organized with the cooperation of Academicians, Scientists, Academic Institutions, Research Institutions, Indian Army, Indian Navy as well as NHPC to motivate the national youth to take up science as a career. During the year 2016-17 till date, 204 Science Camps were sanctioned and organized to cover 35050 students who have given an opportunity to interact with eminent scientists and academicians as Mentors of national and international repute including Nobel Laureates till November, 2016 **(Fig.1).**

This year Shri Mata Vaishno Devi University (SMVDU), Katra (J&K) organized the INSPIRE Internship Camp with an excellent logistical support of Army in this hostile terrain for the students of Ladakh Region. The residential camp was hosted by Ladakh Scouts Regimental Centre (LSRC) of 14 Corps.

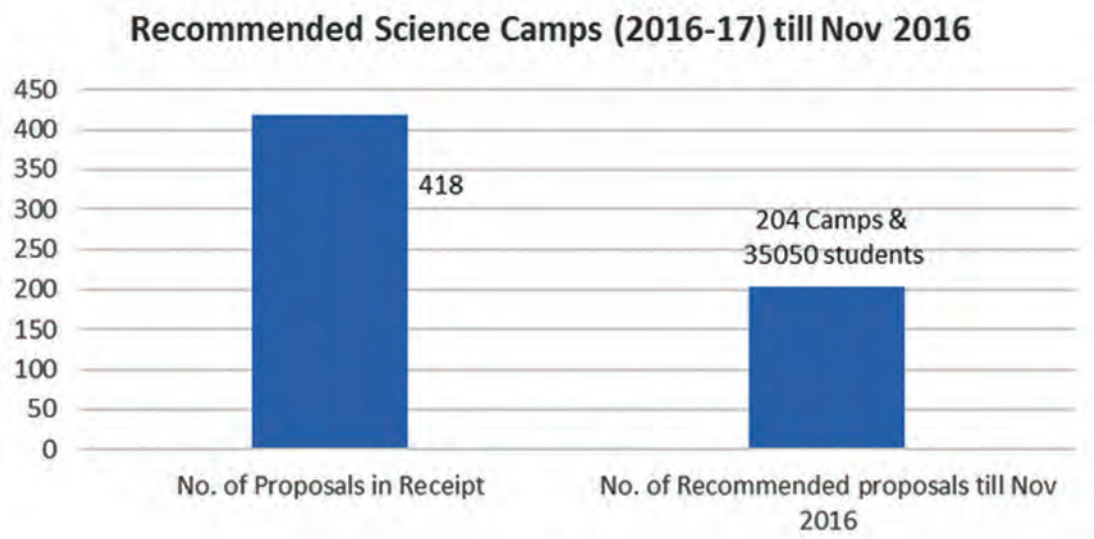


Figure- 1

Scholarship for Higher Education (SHE) aims at for enhancement in rate of attachment of talented youth to undertake higher education in science intensive program by providing scholarships and mentoring through summer attachment to performing researchers. The scheme offers 10,000 Scholarship every year @ Rs 0.80 lakh per year for undertaking Bachelor and Masters level education in natural and basic sciences for the talented youth in the age group 17-22 years. The main feature of the scheme is in mentorship support to carry out research during vacation period for every scholar through **INSPIRE Scholarship.** So far more than 63000 INSPIRE Scholars has been offered INSPIRE scholarship to pursue a career in sciences. During 2016-17, 19788 SHE scholarship applications for the 2015 batch were processed, out of these, 16388 INSPIRE Scholarship applications are eligible to receive the INSPIRE Scholarship and offer letter are being issued to these candidates based on their performance (top 1%) in + 2 examination of State/Central School Education Examination Boards and 1100 through competitive examination basis. All these Scholars are pursuing their academics at undergraduate level in basic and natural sciences.

Assured Opportunity for Research Careers (AORC) aims to attract, attach, retain and nourish talented young scientific Human Resource for strengthening the R&D foundation and base. It has two components. In the first component i.e. **INSPIRE Fellowship** in the age group of 22-27 years, it offers 1000 Fellowships every year for carrying out doctoral degree in both basic and applied sciences including engineering and medicine. In the second component i.e. **INSPIRE Faculty Scheme** assured opportunity for 1000 post- doctoral researchers in the age group of 27-32 years through contractual and tenure track positions for 5 years in both basic and applied sciences area.

INSPIRE Fellowship, the first component of AORC is offered to students having secured 1st Rank in Basic & Applied Sciences including engineering, medicine, agriculture, veterinary at the University/ academic institute of national importance i.e. IITs, NITs, IISERs level examination as well as Inspire Scholars having secure 65% marks in aggregate at the MSc level which are eligible for admission to the PhD Program in any recognized University/ academic Institutions in the country. The Fellowship shall be tenable maximum for 5 years (2 years as JRF and 3 years as SRF) or completion of PhD, whichever is earlier to pursue full-time PhD program. The Fellowship amount including the contingencies is equivalent to CSIR-UGC NET Fellowship and is governed time to time as per GOI norms & regulations. So far more than 5400 students are awarded the INSPIRE fellowship and are pursuing their Ph.D. in Basic & Applied Sciences including engineering, medicine, agriculture, veterinary at the University/ academic institute of national importance. Nearly, 30-35% INSPIRE Scholars have come back to pursue their doctoral degree in science after availing 5 years INSPIRE Scholarship to study science subjects. Out of these, 617 Fellowships have been offered in the year 2016-17 till November, 2015 **(Fig. 2 & Fig. 3)** and rest of the applications are at various stages of their evaluation for award of INSPIRE fellowship. Besides this, 9 INSPIRE Fellows have been selected for participating at the 4th HOPE meeting at Japan and 25 INSPIRE Fellows are selected for participating short-term Research Internship Program at the various Laboratories/ Universities of UK through Newton-Bhabha Program of DST and UK.

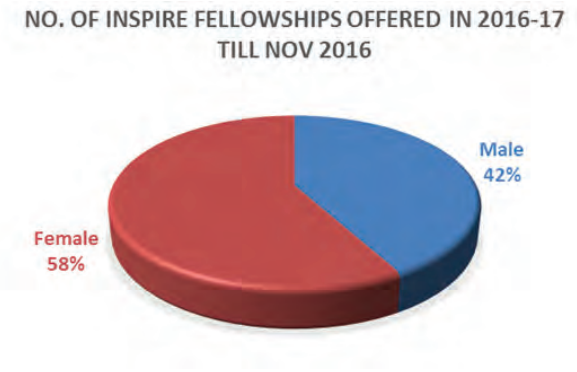


Figure- 2

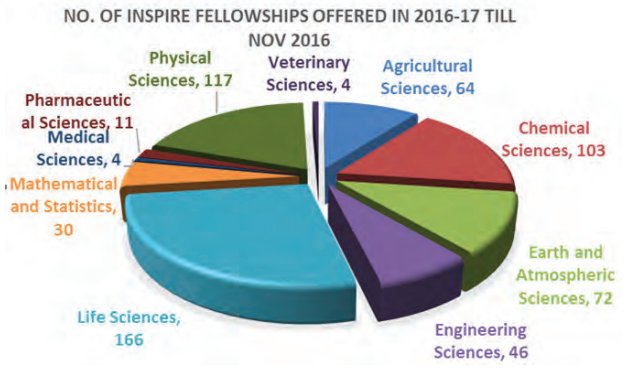


Figure- 3

INSPIRE FACULTY AWARD, the second component of **Assured Opportunity for Research Careers (AORC)** assures opportunities for post- doctoral researchers in the age group of 27-32 years through contractual and tenure track positions for 5 years in both basic and applied sciences area including engineering, agriculture, veterinary and medicine. It aims at following:

- To provide attractive opportunities to young achievers for developing independent scientific profiles and launch them in fulfilling long term careers.
- Expected to augment high quality scientific manpower for scientific and educational institutions, specially the Central and State universities.
- While the vertical migration among students in different INSPIRE components would be encouraged, the Scheme would also provide opportunity to students for lateral entry into this component.
- This component would provide a career opportunity and not a guarantee for tenure positions after 5 years.

So far more than 1000 fellows are provided an opportunity to pursue post- doctoral researcher through contractual and tenure track position for 5 years in both basic and applied sciences area including engineering, agriculture, veterinary and medicine. Out of these, more than 800 awardees have already positioned at various host institutes in India and remaining are in process of selecting their host. During the current year 96 awardees have been offered during the current year till November, 2016 **(Fig. 4).**

Nearly 34% candidates, who were pursuing research abroad, have come into the fold of this scheme. By

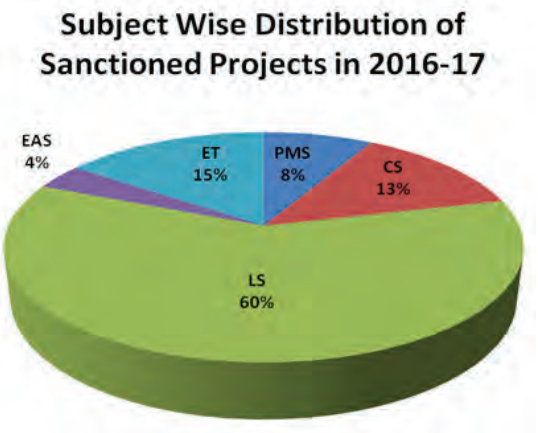


Figure- 4

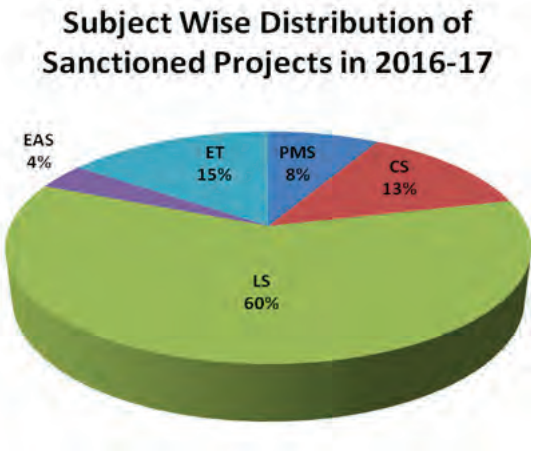
now out of 808 Faculty Awardees positioned since 1st round of selection, 347 (43%) have got their permanent positions at various academic/ research institutions in the country. At present 8 nos. Inspire Fellows have able to get selected as INSPIRE Faculty Awardees in the last 2-3 rounds of selection process.

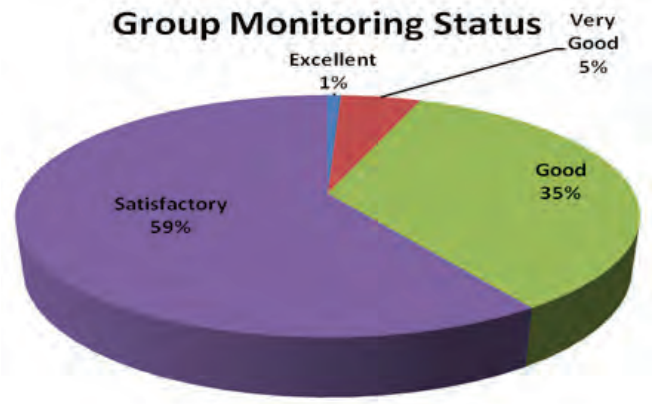
EMPOWERING WOMEN SCIENTISTS

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 gender mainstreaming. Different programs and components of KIRAN deal with various crucial issues (break in career primarily due to family responsibilities, self employment, part time career, relocation, etc.) faced by women scientists in their career path. The achievements of various programs under KIRAN during the year 2016-17 are as follows:

1. Women Scientist Scheme-A (WOS-A):

WOS-A is aimed to provide opportunities to women scientists and technologists for pursuing research in basic or applied sciences in frontier areas of science and engineering. This year DST received 1274 new proposals (Life Sciences–763, Chemical Sciences –167, Physical and Mathematical Sciences–104, Earth and Atmospheric Sciences–46, and Engineering Sciences–194) and after extensive as well as intensive scrutiny, 227 projects were recommended. Subject-wise distribution of recommended projects is given in the Chart:





Approximately 40% women scientists received Ph.D degree with the help of WOS-A during the tenancy of the project which proves the relevance and popularity of the scheme. During the year, **206** ongoing projects, funded under this component, were also monitored.

2. Women Scientists Scheme-B (WOS-B)

WOS-B is focused on S&T solutions of challenges/issues at the grassroots level for social benefit. Under this segment, women scientists are required to work in the domain of lab-to-land technology development, its adaptation, transfer and scaling up and is primarily location specific interventions. This year 29 new projects and 15 ongoing projects have been extended financial support.

3. Women Scientists Scheme-C (WOS-C):

WOS-C aims to create opportunity of self employment and/or also sustainable career for the women scientists. The scheme provides one year internship in the domain of Intellectual Property Rights (IPRs) which includes theory as well as hands-on training in law firms. In 2016, training of 8th batch comprising of 111 women was conducted. One month orientation programme covering 57 lectures on different aspects of IPR was held in April 2016 at New Delhi. Three days of hands-on training on patent search using various tools were also imparted. A course management system based on moodle platform was created to allow online access to all lectures delivered during the orientation program. It is planned to use the moodle for continuous training, feedback, assignments etc. After orientation, women scientists were placed with 40 agencies coordinated by 4 centres. These include IP divisions of CSIR, DRDO, ICMR as well as IP attorney firms, State PIC and industry. About 10% of the women from this scheme have also joined as Facilitators under the Scheme for Facilitating Startups Intellectual Property Protection (SIPP) launched by the Patent Office of India this year. Over one third of trainees have also succeeded in the first level of Patent Agent exam held in Nov 2016.

4. Mobility:

To address relocation issue of women scientists/academicians working in permanent position in Government organizations 'Mobility' component has been initiated by DST under KIRAN. Mobility' here is referred to geographic mobility for sustenance and career advancement of Women working in S&T domain. Two Brainstorming Sessions involving eminent scientists & academicians were organized to understand various facets of challenges faced by women and how best to address these. After in-depth deliberations and taking holistic view, basic structure and guidelines of Mobility were formulated. First Call for Proposals was made during mid 2016 and in response 10 proposals have been received. To screen the received proposals and recommend suitable cases for financial support, a Programme Advisory Committee (PAC) has been constituted which would also revisit the recommendations made earlier on issues such as eligibility conditions, emoluments, tenure, etc. and find better approaches for implementing.

5. S&T for Women: The program "Science and Technology for Women", under KIRAN was initiated in 1981-1982 with mandate to promote gender equality and empower women at grassroots level with inputs of S&T through development, adaptation, adoption, transfer, demonstration and replication of appropriate and successful technologies. Since inception, more than 2000 projects have been sponsored and more than 500 technologies developed through individual projects, coordinated programmes and Women Technology Parks. A few achievements are given below:

Under a project related to skill development of women for creating employment and income generation in rural areas of Pavagada Taluk, nearly 150 women were trained on Jute & Cotton Patti Weaving by adopting high speed leather stitching machine to enable accurate stitching. The technology adopted is innovative in terms of weaving on improved frame looms, instead of weaving on indigenous simple wooden made handlooms, and by developing various designs with color combinations and produce some colorful items. A training-cum-production centre of different types of handicrafts has been established and women's multipurpose cooperative society is promoted to bring all Self Help Groups under this platform.

Under Women and Nutrition program which aims at complementing the ICDS programme, a project for ensuring nutritional security with Spirulina supplementation and cultivation was taken up for poor women in Phailin affected areas of coastal Odisha. Organic leafy green gardens for self consumption as well as for income generation are being promoted under this project. The project is implemented in 15 villages with 100 women. 30 biofertlizer production units in 30 households and kitchen garden systems in another 30 households were established during the first phase of the project. The bio fertilizer and leafy vegetables production is a skill oriented programme and enable women to become entrepreneurs and establish their own production unit. The potential of biofertilizer using blue green algae and seaweed was tested on the 5 leafy green vegetables *A.viridis,A.oleraceous,S.oleraceous,C. benghalensis,A.caudatus.*

Similarly, a project on home based gardening and other strategies to reduce malnutrition and improve micronutrient intake among rural poor women is being implemented in Shivpuri, Madhya Pradesh. The

project benefit 36000 women and their families. This empowerment of women also addresses poverty alleviation and provides important socio-economic returns through lower health costs and welfare costs and lower maternal and infant mortality rates. The project engaged Horticulture & Agriculture Department for technology support and training of field staff in setting up of kitchen gardens results into proper guidance for execution of proposed activities and sustainability

Women Technology Parks: Thirteen Women Technology Parks became functional during the year in Andhra Pradesh, Telangana, Tamil Nadu, Rajasthan, Maharashtra, Jharkhand, Manipur, Assam, Mizoram These WTPs act as a single window hub for convergence of diversified technologies, leading to socio economic development of women through capacity building and adoption of location-specific technologies.. Diverse technology areas like agriculture (including fisheries, animal husbandry, horticulture technologies), aromatic and medicinal plants, forestry, alternate livelihoods, Post harvest technologies, natural resource management, health & sanitation, occupational hazards, construction, energy, management of natural resources, rural development, rural industry, rural engineering, micro enterprise, sustainable agricultural practices etc. form the core areas of interventions for WTP.

6. Training And Capacity Building: There are several training programmes specifically for capacity building of women scientists working in various sectors covering multifarious themes which are conducted in partnership with premier Institutions including a National Programme for Training of women Scientists & Technologists working in Government that provided an opportunity to over 1000 women scientists to upgrade their knowledge base and skills.

7. Standing Committee for Promoting Women in Science:

A low representation of women in Science & Technology (S&T) domain, particularly in planning and policy making, is a matter of concern. To address this issue, DST constituted 'Standing Committee for Promoting Women in Science' in March 2016 which has representation of eminent Scientists/

Educators/ Administrators. The 1st meeting of Standing Committee has also been conducted in May 2016 wherein members took stock of the existing women-centric programs and made recommendations to address several issues and improve women participation in S&T domain.

CONSOLIDATION OF UNIVERSITY RESEARCH FOR INNOVATION AND EXCELLENCE IN WOMEN UNIVERSITIES (CURIE)

CURIE was launched in 2009 to strengthen R&D infrastructure of women-only Universities. In the 1st Phase, 6 Women Universities have been supported for 3 years on the basis of overall performance. These are: i) Banasthali University, Banasthali (Rajasthan), ii) Avinashilingam Women University, Coimbatore, iii) Sri Padmavati Mahila Vishwavidyalayam, Tirupati, iv) SNDT Women University, Mumbai, v) Karnataka State Women University, Bijapur, and vi) Mother Teresa Women University, Kodaikanal. This unique model of support has led to significant increase in number of quality publications including papers in journals of repute by the faculty and researchers of beneficiary universities.

During 2016-17, under the 2nd Phase of CURIE, budgetary support has been extended to Avinashilingam Women University, Coimbatore and Sri Padmavati Mahila Vishvidhyalayam, Tirupati. During the year, DST also identified Indira Gandhi Delhi Technical University, Delhi, for exploring the possibility of extending financial support under CURIE and an expert team visited its campus and made preliminary recommendations.

COGNITIVE SCIENCE RESEARCH INITIATIVE (CSRI)

Cognitive Science Research Initiative (CSRI) was launched in the year 2008 to promote research, train and retain human resource in Cognitive Science. The Initiative supports multi-centric mega projects, individual projects, Post Doctoral Fellowship (PDF) and also facilitates infrastructure development and other promotional activities.

In 2016, DST received 378 individual proposals and 74 applications for PDF and supported 39 individual projects and 7 Post Doctoral Fellowships in Cognitive Science. In addition, creating state-of-the art infrastructure is one of the mandates of CSRI and DST is establishing 'Extensive Cognitive Neuroimaging' facility at Centre of Behavioural and Cognitive Sciences (CBCS), University of Allahabad under Top-down approach. The fMRI facility at Allahabad will not only improve research programmes at CBCS covering various aspects of cognitive science, yoga and meditation but also encourage researchers of large area of North India.

Science and Technology of Yoga and Meditation (SATYAM)

Science and Technology of Yoga and Meditation (SATYAM), is a new programme of DST, which was conceived and initiated in 2015-16. It is aimed to foster scientific research on the effects of yoga and meditation on physical & mental health besides on cognitive functioning in not only healthy people but also in patients with disorders with a focus on validation. Against the first Call for Proposals made in October 2015, DST received 578 research proposals from across the country, out of which 96 were

'screened' in and Principal Investigators of these proposals were called for presentation before a Task Force. Finally, 26 Projects have been recommended for financial support under SATYAM during 2016-17. It will be the endevour of DST to strengthen the efforts in the yoga & meditation domain further and address most aspects of research on the impact on physical and mental health.

Support for Conferences/Workshops:

DST has provided financial assistance to following Conferences and Workshops:

1. **Cogn-Ex1.0: Behavioural Workshop on Experimental Methods:** This was organized by IIT, Kanpur with focus on experimental methods in behavioural research in the field of Cognitive Science. The aim was to provide comprehensive overview of experimental methods used to investigate the various facets of human cognition.

2. **Third Annual Conference of the Association for Cognitive Science (ACS):** 3rd annual conference was organized by IIT, Gandhinagar with the objective to bring eminent researchers, actively working in cognitive science areas, to a common platform and extending an opportunity to initiate dialogues among scientists to address research problems that inherently require a cross-disciplinary approach.

3. **Nurturing Engineering Education through Cognitive Science (NEECS):** The main focus of this Conference was to understand human thought processes in order to capitalize human capabilities and creates better human-machine interface. This was organized by SR Engineering College, Warangal.

4. **National Symposium on Cognitive Science:** The rationale of this Symposium organised by IIT Guwahati is to disseminate knowledge among young researchers particularly from North-East about latest developments in Cognitive Science.

5. **XXXIV annual meeting of Indian Academy of Neurosciences:** The 34th Annual meeting of Indian Academy of Neurosciences was organized by National Brain Research Centre, Manesar, with the theme 'Molecules to mind'. The purpose of this Meet is to build strong enduring collaborative links between Indian and overseas groups to usher in new directions of S&T in this domain.

6. **National Workshop on "Delis-Kaplan Executive Function System Software":** It was conducted by Sophitorium Engineering College, Khurda and covered fine motor skill activities and various learning disabilities with special reference to DKEFS software which assess higher-level cognitive functions in children and adults.

7. **International Conference on Intelligent Human Computer Interaction (IHCI):** This was organised by CSIR-CEERI, BITS Pilani. IHCI is a series where participants can explore research challenges in the use of AI, machine learning, data analytics and applied perception for building improved & effective interfaces for communication and interaction with information systems and appliances.

8. **5th International Conference on Recent Advances in Cognition and Health (ICRACH):** This was held at Banaras Hindu University, Varanasi with an aim to examine the knowledge & understanding of the global academic community about interface of cognition and health.

9. **International Conference on Cognitive Science and Health Bioinformatics:** The main focus of this Conference is on data mining, evolutionary algorithms, medical image processing, artificial intelligence, bioinformatics, computational biology, Medicinal Biology, drug discovery, molecular modelling, protein-protein interaction, system biology, network biology, security data Science, computational intelligence and soft computing.

TRAINING SCIENTISTS AND TECHNOLOGISTS WORKING IN GOVERNMENT SECTOR

Department of Science & Technology, in consultation with DOPT, other Scientific Departments and various organizations initiated an ambitious project of Human Resource Development viz. National Programme for Training of Scientists & Technologists working in Government Sector for scientific and technical personnel during the Xth Plan to meet the challenges of national development and international competitiveness in S&T area. Considering the efficacy of the scheme, the Department has decided to continue it in XIth and XIIth Plan also.

During the year 2016-17, 28 training programmes are to be held under National Programme for Training of Scientists and Technologists working in the Government Sector and a total number of 700 scientists will be benefitted from these training programmes.

Under the foreign component of the Training Programme, 20 Junior and Middle/Senior level Scientists were deputed for five day's Exposure visit to Germany during the Financial year 2016-17.

Under Women Component Plan, 10 programmes are to be conducted exclusively for women scientists during 2016-17 in which 250 (approx.) women scientists would avail the opportunity.

CHAPTER 2

INSTITUTIONAL CAPACITY BUILDING

PROMOTING R&D THROUGH AUTONOMOUS INSTITUTIONS AND PROFESSIONAL BODIES

ARYABHATTA RESEARCH INSTITUTE OF OBSERVATION SCIENCES (ARIES), NAINITAL

Areas of Focus

The Institute carries out research in the area of Astronomy, Astrophysics and Atmospheric Sciences. The Institute builds and operates a suite of optical telescopes and instruments to study Sun, Planets, Stars and Galaxies. In Atmospheric Sciences, the Earth's Atmosphere is studied and research is focused on lower atmospheric processes that contribute to air pollution and climate changes. Measurements of atmospheric trace gases (including greenhouse gases), aerosols, and meteorological parameters are being made.

Some Major Accomplishments

- *Technical activation of the 3.6m Devasthal Optical Telescope:* The state-of-the-art 3.6m aperture telescope at the excellent Devasthal site in Uttarakhand was technically activated on 30th March 2016 jointly by the Honorable Prime Minister of India, Shri Narendra Modi and the Honorable Prime Minister of Belgium, Mr. Charles Michel, remotely from Brussels, and in the gracious presence of the Honorable Minister of Science and Technology and Earth Sciences, Government of India, Dr. Harsh Vardhan at Devasthal. India now has a world-class 3.6-m optical telescope at Devasthal in Uttarakhand ready to explore the deep celestial sky.
- Using R-band polarimetry, two molecular clouds, IC 59 & IC 63 were studied to map their magnetic field morphology. Both nebulae are illuminated by γCas with the direction of ionizing radiation being orientated parallel or perpendicular to the local magnetic field, allowing us to probe the importance of magnetic field pressure in the evolution of the clouds. Because of the proximity of the system (~200 pc) we have acquired a substantial sample of over 500 polarization measurements for stars background to the nebulae. On large scales, the magnetic field geometries of both the clouds are anchored to the ambient magnetic field. For IC 63, the magnetic field is aligned parallel to the head-tail morphology of the main condensation, with convex morphology relative to the direction of the ionizing radiation. Comparing the observations to published theoretical models, a good general agreement was found, supporting the importance of magnetic fields in the evolution of molecular clouds.

- Preliminary results from the observations and data analysis of the Doppler Lidar installed at Manora Peak, Nainital were obtained. Strong updrafts with vertical winds in the range of ~2–4 ms-1 occurred during the daytime and throughout the season indicating thermally driven convection. On the other hand, during nighttime, weak downdrafts persisted during stable conditions. Plan Position Indicator scan of Doppler Lidar showed north-northwesterly winds in the boundary layer. The mixing layer height, derived from the vertical velocity variance, showed diurnal variations, in the range ~0.7–1 km above ground level during daytime and very shallow during nighttime.

- An attempt was made to determine cloud base height (CBH) derived from the Doppler Lidar (DL), Ceilometer (CM) and Moderate Resolution Imaging Spectro-radiometer (MODIS) satellite over a high altitude station in the Himalayan mountain range region for the first time. Analyzed six cases of cloud overpass during the daytime convection period by using the cloud images captured by Total Sky Imager (TSI). The occurrence of thick clouds (> 50%) over the site is more frequent than thin clouds (< 40 %). In every case, the CBH is located less than 1.2 km, above ground level (AGL) observed by both DL and CM instruments. The presence of low level clouds in the height-time variation of signal to noise ratio of DL and backscatter of CM shows a similar pattern on all days. Cloud fraction is found to be maximum during the convective period. The CBH estimated by the DL and CM showed reasonably good correlation (R 2 =0.81). The DL observed updraft fraction and cloud base vertical velocity also showed good correlation (R 2 =0.71). The inter-comparison between DL and CM will have implications in filling the gap of CBH measurements by the DL, in absence of CM. More deployments of such instruments will be invaluable for validation of meteorological models over the observationally sparse Indian regions.

- *Participation in the TMT-India project:* ARIES is one of the three Institutes from India participating in this Mega Project. The ongoing prototyping of Segment Support Assemblies (SSAs) was nearly completed in March 2016 which will pave path for full scale production of all 580 SSAs for the primary mirror segments of the TMT as one of the major in-kind contributions by India.

- The project to develop and build a first light instrument for the 3.6m telescope project called 4KX4K CCD Imager was also completed during this year.

Some Important Output Indicators

S.No.	Parameters	Output
1	Papers in refereed journals	48
2	Papers in Conferences	10
3	Number of Ph.Ds. produced	02
4	Research Manpower trained (other than Ph.Ds)	13
5	B.Tech/ UG projects guided	2

MACS-AGHARKAR RESEARCH INSTITUTE (ARI), PUNE

Areas of focus

Biodiversity and Palaeobiology, Bioenergy, Bioprospecting, Developmental Biology, Genetics and Plant Breeding, Nanobioscience.

Some Major Accomplishments

An important finding, which shows that injury-induced connective tissue growth factor (ctgfa) directs glial bridging and spinal cord regeneration in zebrafish, has been published in Science, Volume 354 (6312).

Pleiotropic antidiabetic effects of zinc oxide nanoparticles, and radiofrequency triggered heating and drug release using doxorubicin-loaded LSMO nanoparticles for treatment of breast cancer have been demonstrated.

A new durum wheat variety MACS 3949 has been identified for cultivation under timely sown irrigated conditions in Peninsular Zone. The variety has shown significantly superior yield performance over check variety NIDW 295 in three years of testing in coordinated trials. It gives an average yield of 46.23 q/ha with yield potential 64.3 q/ha, has excellent pasta quality and better nutritional quality (with protein content 12.9 %, zinc 40.6 ppm, iron 38.6 ppm), is resistant to black and brown rusts and has a 1000-grain weight of 47 g.

A soybean variety MACS 1281has been released and notified for cultivation in the Southern Zone. The variety has determinate plant habit with medium maturity range. It is resistant to stem fly, defoliators, pod borer and leaf folder, bacterial pustule and bacterial leaf blight. MACS 1281 has non-shattering pod habit and has given a maximum yield of 3400 kg/ha in farmers' field. Another soybean variety MACS 1407 has been identified for release in North Eastern Zone. This variety is highly resistant to pod blight and has a maximum yield potential of 3900 kg/ha.

A field-usable diagnostic kit for detection of viral pathogens of shrimp and prawn, and bacterial cellulose-based nanocomposite scaffolds for the treatment of osteochondral defects have been developed. Fabrication of an efficient cell culture system in a concave microwell array using the ommatidium of the common fruit fly Drosophila has been successful.

It was found that UV radiation induces foot duplication in regenerating middle pieces of hydra.

In vitro fruiting in plant *Ceropegia rollae* Hemadri has been reported for the first time and its in vitro micropropagation has been successful. The first report of essential oil of *Pistacia chinensis* ssp. integerrima showing in vitro antioxidant and in vivo hepatoprotective activity was published. A new species of grass *Ischaemum agharkarii* has been reported. Study of the diatoms from semi-aquatic habitats of Western Ghats has led to the rediscovery of endemic diatoms ***Luticola jogensis*** and *Luticola gandhii* from the Western Ghats after four decades. The genus was earlier called *Navicula.*

Four new species of fungi have been discovered viz. *Moorella heterosporous, Helicoma eucalypti, Helicosporium myrtacearum* and *Helicosporium xylophilous.* Rediscovery and re-documentation of fungi include *Penicillium paradoxum, Porobeltraniella porosa, Acroconidiellina arecae* and *Hemibeltrania cinnamomi.* Other novel taxa described include *Cyanoboletus hymenoglutinosus, Leccinellum indoaurantiacum, Cyanoboletus hymenoglutinosus, Xerocomus doodhcha.*

Late Callovian micromorph ammonoids have been discovered from the Kanod section, NE Jaisalmer basin.

Two edible lichens *Everniastrum cirrhatum* and *Parmotrema reticulatum* from Western Ghats were assessed for cardioprotective and cytotoxic potential. The association of B12 deficiency and anemia synergistically increase TNF-α levels among adolescent girls, which may consequently impair their physical and mental health.

The Institute has conducted national level workshops and certificate courses on taxonomy, biodiversity, ex situ conservation and applications of fungi; hydra biology; role of diatoms in forensics; DNA barcoding and phylogenetics of plants, and standardization of medicinal plants.

Some Important Output Indicators

S.No.	Parameters	Output
1	Papers in refereed journals	60
2	Books	1
3	Chapters in Books	1
4	Papers in Conferences	1
5	Number of Ph.Ds. produced	6
6	Number of Technologies/Designs and other intellectual products commercialized	1
7	Research Manpower trained (other than Ph.Ds)	45
8	Technical Manpower trained	175
8	B.Tech/ UG projects guided	1
10	M.Tech/M.Sc./M.Phil projects guided	4

BOSE INSTITUTE (BI), KOLKATA

Areas of Focus

Plant Functional Biology of Stress Responses for Improvement and Exploring the Plant Genetic Resources: Effective exploitation of novel genes and regulatory elements is being done to improve plant performance in the field; and to combat biotic and abiotic stresses of crop plants.

Protein Structure, Function and Engineering: Resolution of Protein structure is the key criterion to determine functional organization of a protein. Study on the structure-function relation coupled with expression analyses are undertaken to design therapeutically and other economically important protein molecules.

Bioinformatics and Computational Biology: Network analysis of microRNA and neurodegenerative diseases, ii) Therapeutic molecular design including genomics and proteomics approaches, iii) Comparative genome analysis and protein evolution, iv) Protein structure, dynamics and protein-protein interactions, v) Development of bioinformatics tools and web-based servers.

Molecular Medicine: Study of molecules related to health and diseases and manipulating those molecules to improve diagnosis, prevention and treatment of diseases like Cancer, Diabetes, Cardiovascular problems, Leishmaniasis, Tuberculosis etc.

Microbial Genomics and Infection Biology: Genomic approaches to study the basic biology of microbes leading to useful insights into the mechanisms of their growth, proliferation and cell-cycle regulation. Identification of microorganisms with a potential for bioremediation also studied.

Systems Biology: High throughput approaches adopted to understand pathogen-tuned signalling networks in host cells. MicroRNA let-7 shown to regulate inflammatory signalling during mycobacterial infection. Mathematical modelling employed to understand stress responses in mammalian cells and in bacterial pathogens.

Basic and Applied Problems in Physical and Environmental Sciences: Contributions to both fundamental knowledge as well as applications relevant to industry. Current research activities are in the areas of Radiation Physics, Statistical Mechanics, Quantum Mechanics, Astroparticle Physics, Physics of Strongly Interacting Matter, Nuclear Physics, Materials Science, Soft Condensed Matter Physics, Nano Science, Millimeter-Microwaves and Atmospheric Sciences.

In 2017, the Centenary Year of Bose Institute, two new interdisciplinary programs on Complex Systems and Synthetic and Systems Biology to be launched.

Some Major Accomplishments

- The efficacy of Allium sativum leaf lectin (ASAL) as a potent control agent against sap-sucking insects and a new lectin from Arum, effective against whitefly and aphid, were established.
- Functional characterization of membrane-bound transcription factors during stresses in tomato as well as identification of key regulatory factors (mRNAs and miRNAs) from tomato during Alternaria solani infection were identified.
- Demonstration of Hsp90 to promote denovo maturation and stability of the RAF kinase CRAF. Interaction between Hsp90 and CRAF regulates actin-dependent translocation of the kinase during MAPK signaling.
- A novel role of ganglioside GM2 in tumor cell migration and invasion, through physical interaction with the integrin receptor was unraveled.
- Investigations into the mechanism of action of δ, a subunit of RNA polymerase (RNAP) revealed that it functioned as a transcriptional activator by binding to an A-rich sequence located immediately upstream of the -35 element.

- Using molecular modelling and experimental methods it was demonstrated that mycobacteriophages can kill mycobacteria, through non lytic mechanisms. The information derived could lead to the development of new drugs for the treatment of TB.
- A new approach towards information retrieval in diagnostics was developed by applying the theory of complex networks on multidimensional, dynamic images. The methods developed can be used to detect dry eye diseases in patients, who have undergone LASIK surgery.

Some Important Output Indicators

S.No.	Parameters	Output
1.	Papers in refereed journals	248
2.	Papers in Conferences	14
3.	Number of Ph.Ds. produced	30
4.	Number of Technology leads awaiting transfer	3
5.	Technical Manpower trained	20
6.	B.Tech/ UG projects guided	25
7.	M.Tech/M.Sc./M.Phil projects guided	30




Bose Institute is celebrating 100 years of its existence. In this connection a number of programs were launched. The museum of Bose Institute has been extensively renovated. A collection of various writings and notes by Acharya J. C. Bose, the founder of the Institute has been digitized so as to preserve them. The various equipment used by the Acharya are currently displayed in the museum. The centenary celebration was inaugurated by Prof. P. Balaram and the 78th Acharya J. C. Bose lecture was delivered by Prof. R. Gadagkar.

BIRBAL SAHNI INSTITUTE OF PALAEOBOTANY, LUCKNOW

Areas of Focus:

- Early life and environment: Documentation of evidence from Indian Precambrian basins.
- Phanerozoic terrestrial and coastal ecosystems: Biostratigraphical, palaeoenvironmental, palaeoecological and palaeogeographical aspects.
- Integrative marine micropalaeontology: Constructing high resolution biostratigraphy, sea level changes, palaeo-oceanographic and palaeoclimatic events
- Organic petrology: Characterization of solid fossil fuel for depositional and utilizational aspects.
- Quaternary palaeoclimate reconstructions, vegetation dynamics and relative sea level changes.
- Domestication of plants, early farming and ecosystem dynamics during Holocene/ Anthropocene.
- Geochronological and geochemical parameters for high resolution dating, correlation, palaeoclimatic, tectonic and provenance studies.
- India-Asia collision and Himalayan uplift: palaeobotanical and associated biotic signatures from the sedimentary records of northwest Himalaya.
- Preparation of books, catalogues, atlases, databases, digitization of library, museum, herbarium and other holdings.

Some Major Accomplishments:

Research activities in the Institute document the palaeobiological remains present on the Earth right from 3000 Million Years to the recent past (400 AD), to decipher the past plant life, evolution, palaeoclimate, palaeoecology and palaeobiogeography, archaeobotany and allied aspects. Ongoing multi-disciplinary research is directed at making the Institute a global centre of research in Palaeosciences.

Precambrian Palaeobiology— An assemblage of 1000 million-year old, large sized Organic-Walled Microfossils of Xanthophyte algae has been documented from the Chaporadih Formation of the Chhattisgarh Supergroup. Recently, BSIP organized the NASA Spaceward Bound India 2016 Programme in Leh-Ladakh to explore the signature of life in extreme conditions.

Phanerozoic Ecosystems— For the first time, fossil spore tetrads were reported, from an early Permian stratum of Singrauli Coalfield. The assemblage provides significant insights into the factors (such as extreme climatic conditions) responsible for the formation of spore tetrads in the past. The first record of palaeo-wildfire evidence in the form of charcoal was documented from the Late Permian Zewan Formation of the Kashmir region, northwest Himalaya. Abundant silicified fruits belonging

to family Arecaceae recorded from Ghughua (M.P.) of early Paleocene age indicates that palms were diverse in Central India during (~64-62 Ma). Fossil leaf of Aporosa Blume (Phyllanthaceae) (~55Ma) from the Gurha Lignite mine, Rajasthan (India) (age early Eocene) and its extant distribution in SE Asia suggest out of India dispersal of this genus. A diverse assemblage of well preserved fossil fauna and epiphytic lineages of bryophytes has also been recorded from 52 million year old amber from Cambay basin.

Quaternary Palaeoclimate—Based on varying tree-ring chronology of conifer taxa in different regions of Kashmir Himalaya, determined the spatial and temporal variation of past climate. A multi-proxy study of offshore-Saurashtra NE Arabian sea sediment core revealed three major phases of climatic variations, namely, Younger Dryas and early Holocene (12-8 Ka.), Middle Holocene (8-4 Ka.) and Late Holocene (4 Ka to recent). The area was deprived of Indus river discharge possibly due to weakened South West Monsoon (SWM) as a result of arid conditions. Another study was conducted using a sediment core from the Schirmacher Oasis (east Antarctica) Lake L-6 using a multiproxy approach to deduce the paleoproductivity and Holocene climate variation. It showed a warm phase from ~11.6 to ~10 cal ka BP (Pleistocene-Holocene boundary).

Some Important Output Indicators

S.No.	Parameters	Output
1	Papers in refereed journals	80
2	Books and Edited volumes	1
3	Chapters in Books	1
4	Papers in Conferences	42
5	Number of Ph.Ds. produced	03
6	Research Manpower trained (other than Ph. Ds)	12
7	Technical Manpower trained	05
	Other Products/Indicators	
	Conference/Symposium/Workshop organized	02
	Help to Industry	01
	Collaborative Research (International)	08
	Consultancy Services (in Carbon dating, SEM & Palynology)	25
	Extra Mural Research Projects Awarded	07
	Research Projects Completed	02

CENTRE FOR NANO AND SOFT MATTER SCIENCES (CNSMS), BENGALURU

Areas of Focus

Nano Science and Nanotechnology; Soft Matter including polymers, gels, membranes etc.

Some Major Accomplishments

- Tata Steel signed a Memorandum of Understanding on October 3, 2016 with CeNS to set up a Tata Steel Advanced Materials Research Center (TSAMRC) at CeNS. This initiative is in light of Tata Steel being entrusted with the responsibility of developing a long-term strategic roadmap in the area of advanced materials.
- Following in-house inventions were developed further to lead to prototypes: Optoelectric devices made of metal nanomesh electrodes; Triboelectric nano generator; Polysoft switchable glass; Fast responding Energy Efficient Anisotropic organogels. This translational activity is assisting the researchers to enter into dialogue with industries.
- Twisted Graphene stacks: The extraordinary properties of graphene are truly observable when it is suspended, being free from any substrate influence. A new type of multilayer graphene system was made wherein each layer is turbostatically decoupled, resembling the suspended graphene, while maintaining high degree of 2D crystallinity.
- The purest graphene in the form of turbostatic graphene showed metal-insulator transition behaviour with 2D/G spectral ratio of upto 16, the highest found so far globally.
- Unusual form of gold in non-cubic lattices was found to exhibit very high catalytic activity, while conventional gold possesses zero activity.
- Thermally invariant anisotropic photoluminescence observed in a nano-soft composite with non-metallic nanoparticles.
- NIR emissive discotics were investigated for their photophysical behavior.
- An economically feasible synthetic procedure for a coordination polymer (COP) exhibiting a range of device characteristics was stabilized.
- Discotic materials suitable for solar cell devices were identified.
- UV irradiation of a photo-active nematic liquid crystal gel showed that gelation got substantially influenced due to the change in the polar solubility parameter of the gelator environment. The bright and dark states thus obtained with and without light respectively could be stored permanently until the gel state transformed to sol making it viable for use in permanent optical data storage devices.
- Resistive switching in Mn doped ZnO : Individual manganese doped zinc oxide film (MnZnO) devices fabricated, Au/MnZnO/Pt, on Pt/TiO_2/Si substrate and Au/ZnO:Mn/Au devices with crossbar architecture on Si substrate using the multi-step projection lithography fabricated. The

Au electrode and MnZnO were deposited by DC and RF magnetron sputtering respectively, for fabrication of symmetric (Au/MnZnO/Au) and asymmetric (Au/MnZnO/Pt) devices. The symmetric device showed unipolar switching at ~ 1.5 V in both polarities with on-off resistance ratio of ~ 10. Further, asymmetric devices were being fabricated to study bipolar resistive switching properties.

- In order to showcase the inventions and scientific achievements of the Centre, a 'Prototype Gallery' was inaugurated on 3 October 2016, where 14 demo-kits/prototypes/posters and other informative material were put on display. This would be very useful in exhibiting the inventions for industry visitors, visiting students from different schools and colleges during the Centre's outreach programmes.

Some Important Output Indicators

S. No.	Parameters	Output
1.	Papers in refereed journals	36
2.	Patents	6
3.	Papers in Conferences	13
4.	Number of Ph.Ds. produced	4
5.	Number of Technology leads awaiting transfer	2
6.	Research Manpower trained (other than Ph.Ds)	13
7.	Other Products/Indicators (Lectures given at schools/colleges under popularization of science / V4 Programme)	Under V4 Programme and ROIS Programme of CeNS, overall, 1500 students of different schools/colleges of the country were benefitted.

Some of the demonstrable devices exhibited at the prototype gallery (a) Defogging panels (b) Gel display device (c) Graphene coated glass (d) Triboelectric nanogenerator

INDIAN ASSOCIATION FOR THE CULTIVATION OF SCIENCE (IACS), KOLKATA

Areas of Focus

Frontline studies in Theoretical Sciences, Molecular Science, Materials Science and Biological Sciences.

Some Major Accomplishments

Theoretical Sciences: Contemporary investigations such as: Ads-CFT correspondence in dilaton coupled n-dimensional black holes; Cosmological evolution in a two-brane warped geometry model; Reduced LHC constraints for higgsino-like heavier electroweakinos; Dark matter; Neutrino masses and high scale validity of an inert Higgs doublet model; Lattice QCD simulations at both zero and finite temperatures, both with and without dynamical fermions; Statistics of work distribution in periodically driven closed quantum systems; Dynamical detection of a topological phase transition in one-dimensional spin-orbit-coupled Fermigases; Velocity of excitations in ordered, disordered, and critical antiferromagnets; Modelling gene expression regulation by microRNA with non-conventional binding sites; Dynamic changes in global microRNAome and transcriptome reveal complex miRNA-mRNA regulated host response to Japanese Encephalitis Virus in microglial cells; Photo-redox processes atom-atom interaction in external fields and magnetic properties of molecules within relativistic and nonrelativistic framework; New strategies for H-storage; Simulation methods for probing fold-unfolding, hydration and motor protein dynamics in theoretical biophyneal chemistry.

Materials Science: Synthesis and study of materials with novel electrical, optical, magnetic and catalytic properties as well as to explore their applications in different fields. Some example were: organic materials based electronic devices; solar cells based on lower-dimensional structures of inorganic semiconductors; electrical, optical and magnetic properties of graphene-based functionalized nanostructures; growth of thin film-based quantum structures and study of their density and magnetic depth profiles; study of bulk transition metal oxides with fascinating magnetic dielectric and multiferroic properties; functionalized porous nanomaterials for gas storage; nano-structured materials including nano-ribbons, nano-rods, nano-composites for various applications.

Molecular Science: Preparation and characterization of organic, inorganic and macromolecular compounds with potential applications in drug development, catalysis and material development. In that direction, a novel molecular transporter was synthesized and shown to deliver antisense morpholino oligonucleotides both in vitro and in zebrafish model for gene silencing. An effective antifungal agent capable of curing renal failure, and heart failure was developed. A new method for the separation of alkyl/hydrated metal sulfates was also developed. For application as sustainable materials, new supramolecular and conducting polymeric materials were isolated.

Biological Sciences: Research work in the area of nucleic acid recognition and therapeutics; bioactive gene delivery and knockdown; lipid design and synthetic molecular membranes; Molecular mechanism of DNA damage and repair in cancer; reactivity of heme amyloid beta peptides associated with Alzheimer's diseases;application of carbon nanomaterial included supramolecular systems in

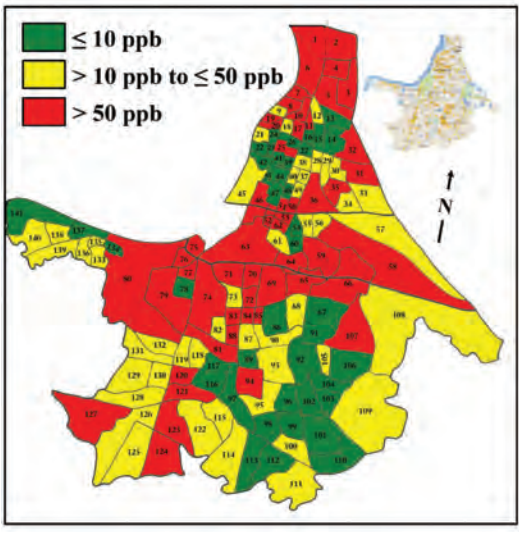
biomedicine, and flourescent carbon dots in bio-sensing and imaging; nanoscale nucleic acid sensing using force-based assay and nanoscale bioelectronics.

Applied Work: A synthetic receptor was delivered to Industry for removal of cyanide from steel wastewater.

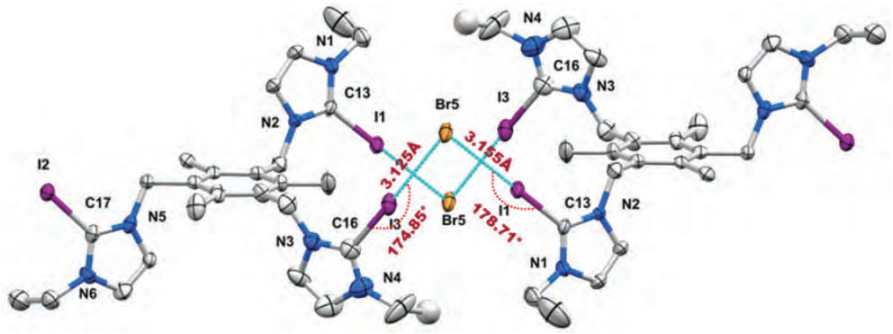
Honours, Awards, etc.: One faculty member was awarded the Shanti Swarup Bhatnagar Prize, one faculty member became a Fellow of the Indian National Science Academy, New Delhi (FNA); two faculty members became Fellows of the Indian Academy of Sciences, Bangalore (FASc.) and one faculty member became a Fellow of the National Academy of Science, India, Allahabad (FNASc.); Two faculty members were awarded the Swarna Jayanti Fellowship, DST; One faculty member was awarded the JC Bose National Fellowship; One faculty member was nominated Senior Editor, JPC A/B/C;

Some Important Output Indicators

Sl. No.	Parameters	Output
1.	Papers in refereed journals	432
2.	Chapters in Books	04
3.	Papers in Conferences	23
4.	Number of Ph.Ds. produced	64
5.	Foreign Patents filed	02
6.	Foreign Patents granted	01
7.	Indian Patents Filed	05
8.	Indian Patents granted	01
9.	M. Tech/M.Sc./M.Phil project guided	27



Rapid decadal evolution in the groundwater arsenic content of
Kolkata, India and its correlation with the practices of her dwellers



Single crystal X-ray structures represent halogen bonding (XB) interactions in bromide complex with benzene scaffold based 2-iodoimidazole substituted tripodal XB donor receptor. [Chem. Commun., 51, 14793 (2015)]

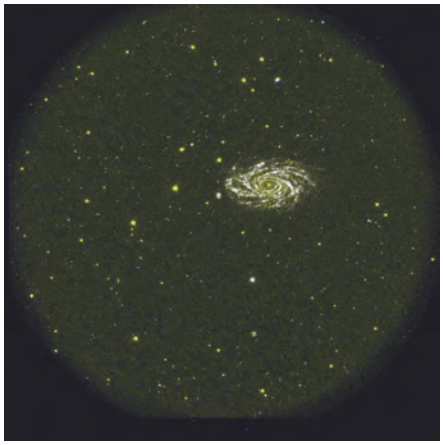
INDIAN INSTITUTE OF ASTROPHYSICS (IIA), BENGALURU

Areas of Focus

Astronomy, Astrophysics, Planetary Science and related subjects including development of instruments and techniques for internal as well as external institutes / facilities. Establishing and operating observational facilities for research in Astronomy and Astrophysics for the Indian Astronomy community.

Some Major Accomplishments

Important results have been obtained by making observations, carefully analyzing data from national and international sources and by theoretical modellings on topics ranging from the Sun and solar system, stellar and galactic astrophysics, cosmology and extra galactic astronomy, theoretical physics and astrophysics. Results of these findings have been published in leading journals.



A composite image of NGC2336 using FUV and NUV data from UVIT.

The initial results from the UVIT were communicated to scientific community; a payload data processing centre was set up for this purpose.

Design Review of the Visible Emission Line Coronagraph payload for the Aditya-1 Mission was successfully completed.

Major steps were initiated towards establishing a Large Optics Facility in the Institute which would serve long-term needs of the optical astronomy groups.

The 100-year Kodaikanal Solar Archives was made accessible to the astronomy community;

Prepared and submitted Detailed Project Report to the DST seeking Government's approval for establishment of a world class solar observatory at Merak, in Ladakh.

The Hanle Echelle Spectrometer (HESP), a backend instrument to augment the observing capability of the Himalayan Chandra Telescope, went online for the wider user community.

Process of procurement of a 70 cm telescope for installation at the Indian Astronomical Observatory, Hanle under the DST/SERB programme was started.

The telescope facilities at Kavalur, Kodaikanal, Gauribidanur and Hanle were fully utilised by national and international astronomers. The remote operations of the HCT continued without downtime. Efforts underway to develop the JCB Telescope a remotely operated facility.

As the Lead Indian Institution for India's participation in the Mega Thirty Metre Telescope (TMT) Project, the Institute continued with necessary R&D and prototyping work and also in the international management aspects of the project.

Some Important Output Indicators

S.No.	Parameters	Output
1.	Papers in refereed journals	82
2.	Books	2
3.	Chapters in Books	3
4.	Papers in Conferences	14
5.	Number of Ph.Ds. produced	4
6.	Research Manpower trained (other than Ph.Ds)	81
7.	Technical Manpower trained	24
8.	B.Tech/ UG projects guided	7
9.	M.Tech/M.Sc./M.Phil projects guided	6
10.	The Institute is jointly developing technologies with several Indian industries for its programmes/activities. The Indian industries are able to apply these for other applications/requirements which form an important capacity building exercise in the country.	

INDIAN INSTITUTE OF GEOMAGNETISM (IIG), NAVI MUMBAI

Areas of Focus: The Indian Institute of Geomagnetism (IIG) has the mandate to carry out basic and applied research in Geomagnetism and allied fields.

Some Major Accomplishments:

IIG maintains various facilities to monitor the geomagnetic field and several atmospheric and ionospheric parameters at its twelve magnetic observatories, its three regional centres at Equatorial Geophysical Research Lab (EGRL) at Tirunelveli, Dr. K.S. Krishnan Geomagnetic Research Lab (KSKGRL) at Allahabad and Shillong Geophysical Research Center (SGRC) at Shillong; and at the

Indian Antarctic stations in Maitri and Bharati.

The Institute maintains a World Data Center for Geomagnetism, WDC- Mumbai, which is the only international center for geomagnetic data in South Asia, and caters to the need of Space and Earth Scientists, making available world-wide magnetic data in computer compatible form. Recently, it joined the World Data System (WDS) of the International Council for Science (ICSU). Jaipur magnetic observatory has the distinction of being part of the International Real time Magnetic Observatory Network (INTERMAGNET) in addition to the Alibag Observatory, the first one to be awarded to join INTERMAGNET.

IIG continues to operate its suite of instruments at the two Indian Antarctic stations, Maitri and Bharati. The effects of a geomagnetic storm on the variation of the atmospheric electric field over Maitri, Dome C, and Vostok Antarctic research stations have been established for the first time. Deformation fields gleaned from GPS observations and GRACE satellite measurements revealed that maximum uplift and horizontal movement dominate Peninsular Antarctica and West Antarctica, while low rate of horizontal movement and subsidence is observed over eastern Antarctica. Studies concerning the ice sheet dynamics involving both velocity and strain field are in progress for the Polar Regions.

Entropy-based modelling of geomagnetic data from the Indian observatories has established a clear connection of day-to-day variability between the equatorial electrojet (EEJ) and solar quiet (Sq) currents revealing that both EEJ and Sq are indeed coupled systems.

Theoretical and numerical simulation studies of space plasma processes based on spacecraft observations indicate that electromagnetic ion (proton) cyclotron (EMIC) waves are coherent to quasi-coherent in nature. Further, coherent wave structures such as electrostatic solitary waves, double layers and ULF/VLF waves have been observed in the Earth's magnetosphere, which play an important role in the transfer of mass and energy across different boundary layer regions of the Earth's magnetosphere. These results provide valuable clues to understand the particle acceleration processes in the Earth's magnetosphere.

Several super intense geomagnetic storms that occurred prior to 1900 have been revisited to understand the probable interplanetary conditions leading to such intense geomagnetic storms. A major geomagnetic storm occurred on 17 March 2015 wherein Dst reached its minimum of -228 nT, thus making it the largest geomagnetic storm ever occurring in current solar cycle-24. A remarkable observation derived from this storm is that the Traveling Ionospheric Disturbances (TIDs) associated with disturbance in meridional wind flow during recovery phase of the storm is usually excited due to particle precipitation at high latitude and their subsequent propagation to low latitudes.

The association of lightning activity with the long-term as well as seasonal spatio-temporal distribution of convective available potential energy (CAPE), surface convective precipitation, vegetation cover and anthropogenic aerosol loading over the Indian sub-continent has been studied for the period 2000–2014, and their correlation reveals the definite entity that is responsible for changing the lightning activity in different parts of this tropical region. The north-east to north-west arc including

the foothills of the Himalayas is the primary seats of lightning occurrences. Modelling studies suggest that upper tropospheric water vapor (300 hPa) has a significant linkage with the lightning occurrences associated with convective activities and strong updraft.

Under the program "Integrated studies on the earth's upper atmosphere using ground and space-based instrumentation and numerical modeling tools" scientists at IIG are devoted to study the Mesosphere-lower Thermosphere (MLT) region, which is a very important transition region of the atmosphere that acts as an interface between the lower, middle and the upper atmosphere.

Analysis of InSAR and GPS data reveals coseismic and early postseismic (4-88 days) surface displacements associated with the 25 April 2015, Mw 7.8 Gorkha, Nepal earthquake. The pattern of early postseismic surface uplift and subsidence is found to be opposite to that of the coseismic motion suggesting the possibility of MHT playing host to future large events.

Geoelectrical studies carried out in Sindhudurg district of coastal Maharashtra helped in delineating the zones and extent of saline water ingress and also in locating fresh groundwater pockets to meet the water demands of society. Furthermore, aquifer parameters such as hydraulic conductivity, formation factor, porosity and transmissivity analysis of existing wells and the respective vertical electrical sounding (VES) points have been found useful to characterize the aquifer system over western Maharashtra.

Ground magnetic data collected over Chikotra River in the peripheral region of Deccan Volcanic Province (DVP) of Maharashtra located in Kolhapur district was analysed. Qualitative interpretation suggests that the Chikotra basin is composed of three structural units; a NE–SW unit superposed on deeper NW–SE unit with randomly distributed trap flows on the surface. One of the major findings of the present study is the delineation of almost 900-m thick Proterozoic Kaladgi sediments below the Deccan trap flows.

The recently developed L–band scintillation technique is applied to evolve the spatio-temporal map of scintillation patches over low latitude regions of India.

Electromagnetic imaging over selected profiles in Cambay basin indicates very high conductive sediments (Tertiary) with deepest part at the centre of the Cambay basin.

Environmental magnetic measurements were undertaken along Tirna, Girna and Anjani river sediments of western Maharashtra, for studying the palaeoclimate and palaeomagnetic characteristics, the variations in anisotropy of magnetic susceptibility, determination of palaeointensity, rock magnetic, particle size and geochemical characteristics.

Some Important Output Indicators:

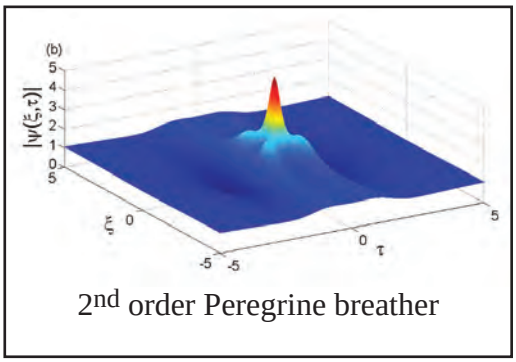
S.No.	Parameters	Output
1.	Papers in refereed journals	58
2.	Chapters in Books	02
3.	Papers in Conferences	57
4.	Number of Ph.Ds. produced	05
5.	Indian Patents filed	01
6.	Research Manpower trained (other than Ph.Ds)	22
7.	B.Tech/ UG projects guided	02
8.	M.Tech/M.Sc./M.Phil projects guided	20

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.

Some Major Accomplishments:

- The experimental observation of second order Peregrine breather (also known as super rogue wave in water wave context) in multicomponent plasma with negative ions was reported, for the first time.



2nd order Peregrine breather

- Utilization of fused hollow cathode cold atmospheric pressure plasma for direct growth of hierarchical carbon nanostructures on metallic substrates.
- Developed a cost effective method for production of Rhamnolipid biosurfactant by a bacterial strain Pseudomonas aeruginosa SR17 using paneer whey waste as a sole source of media.
- A bio-degradable green nanostructured bio-film has been developed that can be used to remove Ca2+ and Mg2+ from water using sulphonated carbon dots-chitosan hybrid hydrogel nanocomposite.
- A smart in-vitro stimuli-responsive drug delivery system (DDS) has been developed that can release drug depending upon the amount of pathogen (MRSA) present in the target.
- A technique of fermentation for production of high content of ethanol (>30%) from rice developed.
- A technology on aroma production by fermentation of agarwood which envisages pre and post proof of concept (POC) for generation of license and/or start-up in line with the start-up India Programme has been initiated (under BIRAC).

- A mega project on authentication of traditional knowledge based herbal formulation for cure of diabetes is initiated.
- High ethanol tolerant (>30%) yeast isolated.

Some Important Output Indicators

S.No.	Parameters	Output
1	Papers in refereed journals	54
2	Books	1
3	Chapters in Books	4
4	Papers in Conferences	44
5	Number of Ph.Ds. produced	6
6	Indian Patents filed	11
7	Number of Technology leads awaiting transfer	1
8	Research Manpower trained (other than Ph.Ds)	31
9	B.Tech/ UG projects guided	5
10	M.Tech/M.Sc./M.Phil projects guided	14
11	Extramural projects	4

INSTITUTE OF NANO SCIENCE AND TECHNOLOGY (INST), MOHALI

Areas of Focus:

Research in all areas of nano science and, understanding nanoscale phenomena. Application of Nano technology in agriculture, health and other allied areas.

Some Major Accomplishments:

- Reported electrochemical detection of Cardiac biomarker using specific aptamers and bio-functionalized few layer black phosphorus by measuring direct electron transfer. The aptasensor shows record low detection limit (0.524 pgmL-1) and sensitivity.(Ref ACS Appl Mater Interface 2016, 8, 22860-22868).
- Recently demonstrated the emergence of ferromagnetism in a centrosymmetry broken oxide nano-magnet. Nano-crystalline Cu2OSeO3, is synthesized for the first time which exhibit ferromagnetic properties in contrast to spiral magnetic state of its bulk counterpart. This is a new discovery and the only insulating multiferroic skyrmionic material reported so far in its bulk state.
- Developed hierarchically porous inhalable microspheres for efficient pulmonary drug delivery. A series of customized inhalable mono-dispersed poly-L-lactide microspheres (PLA-MS) having hierarchical pore structures with either open or closed porosity were developed using various molar concentrations of porogens. The prototypes with potential therapeutic utility for pulmonary

delivery of drugs of variable molecular weight and size can be prepared by this convenient protocol. (Ref: Microporous and Mesoporous Materials. 2016, Vol 235: 195-203).

- Developed Cubic Mesoporous Ag-doped Carbon Nitride materials for humidity sensing applications, which exhibit extremely high sensitivity, super rapid response/recovery time, excellent reversible response and long-term stability compared with previously reported metal oxide based humidity sensors.(Ref: Nanoscale, 2016,8, 19794-19803).
- Developed low cost Cartridges for purification of industrial and domestic waste water. Plans are afoot to test this modified adsorbent on real waste water contaminated with arsenic collected from rural area and cities. Lab tests show excellent results with removal of > 90% of Arsenic when the concentration is around 100 ppm.
- Prof Aviad Frydman, Bar Ilan University, Israel delivered 2nd INST-Feynman lecture on 22nd November, 2016.
- Dissemination of information on nanoscience and technology and initiation of nanotechnology outreach activities for promoting public awareness of the subject.
- Till date 38 sponsored-research projects amounting to Rs. 16.09 crores have been / are being implemented.
- On the industrial front, INST has taken three industrial project (total worth of INR 42 lacs). Several projects are under discussion with private sector units (Indian Oil Pvt. Ltd and NTPC) to make number of useful nano-products at affordable price.

Some Output Parameters:

S.No.	Parameters	Output
1	Papers in refereed journals	72 (till date)
2	Foreign Patents filed	01 (under process)
3	Foreign Patents granted	
4	Indian Patents filed	06 (under process)
5	Indian Patents granted	
6	Number of Technologies/Designs and other intellectual products commercialized	03 (under process)
7	Number of Technology leads awaiting transfer	07 (under process)
8	Technical Manpower trained	65
9	B.Tech/ UG projects guided	18
10	M.Tech/M.Sc./M.Phil projects guided	25

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.

Some Major Accomplishments

Technology Demonstration / Transfer:

(a) Silica aerogel flexible sheets technology has been transferred to a private company. Product has extensive applications in industrial thermal insulation and has attracted the highest technology transfer fees among any single technology transfers effected by ARCI till date. Company plans to establish pilot scale production plant at ARCI's incubation facility.

(b) Demonstration of Polymer Electrolyte Membrane Fuel Cells (PEMFC) at Neyveli Lignite Corporation, Neyveli for about 3 months by installing a PEMFC system of 5 kW capacity and operated the system using hydrogen available at Neyveli.

(c) Large-scale synthesis of Lithium Titanate Powder for Li-ion battery anode application was demonstrated.

(d) Prototype Li-ion cell of 10Ah has been developed and modules of 12V-24Ah, 24V-10Ah and 48V-10Ah have been assembled and performance being evaluated.

(e) Using newly developed Fe-P soft magnetic materials, prototype brushed DC motor of 24V-35W have been developed, and demonstrated its performance superior to commercial counterparts.

Technology / Application Development:

- Developed Iron-Tungsten alloy coatings by electrodeposition for replacing hard chrome plating.
- Establishment of demonstration centre for advanced nano-mechanical characterization.
- Detonation spray-based wear resistant coatings were developed for aerospace components.
- Developed hard and wear resistant coatings on coin dies for MINT.
- Developed thin Copper coatings on Steel for ITER.
- Based on the ARCI-Boeing project on "Environmental friendly coatings: to replace hexavalent chrome conversion coatings with chrome free sol-gel coatings" Boeing, USA has filed for three US patent applications.
    - Development of Silicon Carbide (SiC) foams/tubes for solar thermal applications.
    - Development of nano-sheets based transition metal sulphates for application as catalysts in chemical industries.

- Development of design guidelines and generation of performance data of various dissimilar material joints / configurations for the identified material combination of joining techniques for automotive applications.
- Development of laser surface texturing technology for automotive applications.
- Development and demonstration of laser assisted additive manufacturing technology for aerospace components.
- Fabrication of all-ambient processed lab-scale perovskite solar cell with ~ 9 % power conversion efficiency.
- Synthesis of mixed halide perovskite (MAPbI3-xCl-x) with unique cuboid structure, with 6.0% efficiency for solar applications.
- Development of highly visible active Smart carbon materials for self-cleaning textile and paint applications.
- Development of high performance broad-band antireflective coatings using novel synthesis of Hollow MgF2 nanoparticles.
- Cu-Ni-Mn/NiO solar absorber layers with AR layer tandem coating exhibiting absorbance >95% are prepared by pulsed electrodeposition.

Some Important Output Indicators

S.No.	Parameters	Output
1	Papers in refereed (SCI) journals	63
2	Books & Chapters in Books	4
3	Papers in Conferences	33
4	Number of Ph.Ds. produced (including employees and Fellows)	7
5	Foreign Patents filed (PCT)	1
	Foreign Patents granted	1
6	Indian Patents filed	5
	Indian Patents granted	1
7	Number of Technologies Transferred/applications developed/products supplied	7
8	Number of Technology leads awaiting transfer	16
9	Research Manpower trained (other than Ph.Ds)	10
10	Technical Manpower trained	50
11	B.Tech/ M.Sc projects guided	100
12	M.Tech/ projects guided	94
13	Number of Fellows Pursuing Ph.D	41

JAWAHARLAL NEHRU CENTRE FOR ADVANCED SCIENTIFIC RESEARCH (JNCASR), BENGALURU

Areas of Focus

Chemistry and Physics of Materials, Engineering Mechanics, Evolutionary and Organismal Biology, Geodynamics, Molecular Biology and Genetics, Neurosciences, Theoretical Sciences and New Chemistry.

Some Major Accomplishments

Several breakthroughs, discoveries, and inventions were reported in each of the areas mentioned above. To mention a few, a team of scientists from the Indian Institute of Science and the Jawaharlal Nehru Centre for Advanced Scientific Research in Bangalore suggested a potential physical mechanism that enhances our understanding of how molecular machines function. These results were reported in the journal Nature-Physics. Another recent research on post-synthetic metalation in an anionic MOF for efficient catalytic activity and removal of heavy metal ions from aqueous solution was highlighted in the Atlas of Science. An important result on organic thin-film and hydrogel based ferroelectric materials was published in the Journal of the American Chemical Society. These ferroelectric materials enable switching of electric dipoles and have the potential of finding wide range of applications. A group of scientists from the Centre cleared the first round of international competition - Breathe. This Indian team participating in the NRG Cosia Carbon XPRIZE, plans to convert waste from a coal-fueled power plant into usable methanol. During the reporting year, the researchers of the Centre also recorded several new inventions. 18 patent applications were filed: India-3, PCT-3, USA-3, Europe-3, Canada-2, Japan-1, South Korea-1, South Africa-1 and Singapore-1. The Centre also obtained 9 patents: India-1, USA-5, Europe-2, Australia-1.

The Centre initiated measures to establish greater interaction between academia and industry with an objective to license its discoveries. The visit of Shell Global R&D team and Singapore Astar team provided an opportunity to expand Centre's international collaborations in this regard. The Centre also organized its first-ever JNCASR-industry meeting to reach out to, and engage with, potential industry partners to explore avenues for licensing technologies. About forty participants from the industry attended the meeting and provided valuable feedback.

The Centre vigorously continued its science popularization programmes and also initiated newer activities such as Festival of Science. Events were also organized for school children to mark 100-years of the discovery of the chemical bond. These events were successful in inculcating the joys of learning science and provided an orientation towards research among school children. Various Fellowships and Extension Programmes also contributed significantly towards popularizing science and encouraging scientists from developing countries.

The Centre was registered with the National Apex Committee for Stem Cell Research & Therapy under the Ministry of Health & Family Welfare for a period of three years from 2016, stregthening its association with government agencies for stem cell research.

The student strength was 314 and 52 students joined the Centre during August 2016 session. 35 students were awarded Ph.D. and 3 were awarded M.S. (Engg.). Under the Integrated Ph. D. Programme, 7 students were awarded M. S. in Biological Sciences, 5 with M.S. in Chemical Sciences and 3 with M.S. in Materials Science. In addition, 3 students were awarded Post-Graduate Diploma in Materials Science (PGDMS).

A new programme named "Student Buddy" was launched with the aim to expose class XI/XII students to one day in the life of a research scholar, through individual interactions. Under this programme, 76 students from Jawahar Navodaya Vidyalaya and Kendriya Vidyalaya were benefitted.

Summer Research Fellowships, Project Oriented Chemistry Education Programme, Project Oriented Biology Education Programme, Visiting Fellowships Programmes and several other academic exchange programmes continued to attract wide attention.

During the year, 15 discussion meetings, 12 international conferences, workshops, and symposia were supported, either wholly or partially by the Centre. Around 55 seminars were held, in addition to 7 Endowment Lectures, 7 Fluid Dynamics Colloquia and 2 Special Lectures by eminent scientists.

JNCASR became the nodal Institute for PETRA III Beam Lines at DESY, Hamburg, Germany. The ever-growing community of synchrotron users have now the possibility of doing their experiments on all the beam lines of PETRA III at DESY, Hamburg, Germany under the cooperation agreement.

The Centre was accredited by the National Assessment and Accreditation Council (NAAC) with 3.76 points (A++ Grade).

A delegation of the Parliamentary Standing Committee on S&T, Environment and Forests, led by Smt. Renuka Chowdhury, visited JNCASR on August 29, 2016 and had interactions with the faculty and staff. They also interacted with the students and research scholars who presented posters on JNC research activities. After visiting a few laboratories and facilities, the delegation expressed deep appreciation of the research activities as well as the extensive Science Outreach Programmes of the Centre.

Smt. Renuka Chowdhury, Chairperson, Parliamentary Standing Committee on Science and Technology, Environment and Forest addressing the JNCASR Community.

Inauguration of Neuroscience building by Hon'ble Union Minister of Science & Technology and Earth Sciences, Dr. Harsh Vardhan

The Hon'ble Union Minister of Science and Technology and Earth Sciences, Dr Harsh Vardhan, inaugurated the Neuroscience Building of the Centre and addressed the faculty members.

Chemistry Views published by Wiley-VCH. (Anqewandte family) announced that a survey conducted by them found Prof. C.N.R. Rao to have received the maximum number of votes in the choice for the 2016 Nobel Prize in Chemistry.

Prof Umesh V. Waghmare received the prestigious Infosys Prize (Engineering & Computer Science) 2015 from the Hon'ble President of India, Shri Pranab Mukherjee.

Several Ph.D. students received awards and Best Poster prizes at national and international fora as recognition to their contributions to science.

Prof Umesh V. Waghmare receiving the prestigious Infosys prize (Engineering & Computer Science) 2015 from the Hon'ble President of India, Shri Pranab Mukherjee.

Some Important Output Indicators

S.No.	Parameters	Output
1.	Papers in refereed journals	281
2.	Books	02
3.	Papers in Conferences	08
4.	Number of Ph.Ds. produced	35
5.	Foreign Patents filed	15
	Foreign Patents granted	08
6.	Indian Patents filed	03
	Indian Patents granted	01
7.	Number of Technologies/Designs and other intellectual products commercialized	06
8.	Number of Technology leads awaiting transfer	48
9.	Research Manpower trained (other than Ph.Ds)	
	Summer Research Fellowships availed	64
	Project Oriented Chemical Education - Diploma awarded	11
	Project Oriented Biological Education- Diploma awarded	10
	Visiting Fellowship Programme-offers made	15

NORTH EAST CENTRE FOR TECHNOLOGY APPLICATION AND REACH (NECTAR), SHILLONG

Areas of Focus

The North East Centre for Technology Application and Reach (NECTAR) assists the North-East region of the country in ensuring applications of appropriate technologies for development in the areas of biodiversity, watershed management, telemedicine, horticulture, infrastructure planning and development, planning and monitoring, tele-schooling using cutting edge MESHNET solutions, employment generation, etc. through utilization of local products/resources and resulting in associated skill development.

Some Major Accomplishments and Outputs

Mapping of Ganol River Catchment for Meghalaya State: Meghalaya is one of the highest rainfall areas in the world. There are 26 rivers flowing from the Meghalaya hill watersheds into either the river Brahmaputra or towards Bangladesh. While these heavy flows cause damage during the monsoon season, there is an acute shortage of water during the remaining months of the year. In large parts of the state farmers grow only crop. Water scarcity has also, to some extent, been one reasons for farmers resorting to Jhoom cultivation. With the constitution of the Meghalaya Basin Development Authority, the State Government has been focusing on planning for water management, livelihood programmes and skill development. However, availability of data to undertake water management programme in a scientific way has not been possible due to lack of high resolution surface data. Owing

to thick vegetation, it has been difficult to undertake ground surveys. After exploring different options it was decided to use Unmanned Ariel vehicles for developing high resolution Digital Surface models. Aero-2 system designed and developed by NECTAR was used to photograph the Ganol river. The pixel resolution was 5cm. Using a combination of ground control points and UAV imagery, horizontal accuracy of 10 cm and vertical accuracy of 14 cm was achieved. Some of the examples of possible usage may be seen in the figures.

3D mapping of Ganol River basin and planning of small & multipurpose reservoir for water resource applications.

Application in flood plain mapping (Brahmaputra River embankment mapping and Erosion Study for Government of Assam): A case study on generation of Digital Surface Model and Land Use data from RPAS acquired image over Brahmaputra plains has been accomplished to show case the visualization of water-related disaster and its mitigation. Also, 3D GIS analysis over DSM of the area has been performed to help the State Government authorities for mitigation of flood related disaster. It is also realized that periodic imaging through small RPAS (Micro-UAV) platform over the area could be very much useful to monitor and record high quality information for modeling water in the river and its flood plain area. This could also assist the authorities to analyze the pattern of erosion and river sedimentation of Brahmaputra river and suitable preventive measures viz. location and size of protective embankments to be constructed along the river banks to prevent loss of human lives, their households and agricultural crops. Around 4500 sq km of area on both flanks of the Brahmaputra River is under consideration for imaging through RPAS, as a result of this case study.

3D mapping of protective Embankments and Erosion along Brahmaputra River Bank

NECTAR's Achievement in Contributing to Development of Health Infrastructure in the North East: NECTAR in partnership with Eleutheros Christian Society (ECS) is upgrading the health infrastructure in Tuensang district of Nagaland. This district, which has an area of 2500 sq. km, has only two health facilities at Tuensang and Longpang which is 28 km from Tuensang. Rest of the district does not have any health facilities. Dimapur and Kohima, major towns of Nagaland are 350 km and this district is located on the Indo-Burmese Border. Given the poor road conditions, it takes almost 12 hours to reach. As part of the partnership, it was decided to construct five PHCs along with Doctor's quarters, Nurses' Quarters and Bathrooms; the total number of houses to be constructed are 20. NECTAR with its long experience of constructing with bamboo engineered material, with a tested life of 25 years, has completed these houses in three months. For construction of the plinth the community contributed its labour and the material was supplied by NECTAR. In case further expansion takes place of this infrastructure, we propose to undertake training programme for the local youth for construction. Despite the remoteness of the locations which are spread out across the district, some being on the Indo-Burmese Border, these have been completed in 3 months time. NECTAR would be providing solar power lighting and basic health infrastructure in these PHCs. The beneficiaries of this development would be Chang tribe. This was also discussed with Chief Secretary, Nagaland and they would provide staff to man the PHC's.

Skill and entrepreneurial development of vulnerable women in Manipur–weaving: NECTAR has approved support for this project with Control Arms Foundation of India (CAFI).

CAFI in association with sister concern Manipur Women Gun Survivors Network (MWGSN) were formed to help women whose lives have been changed dramatically by conflicts caused by small arms and light weapons. Thousands of women and more than 300 villages are covered under this program and over 1000 women are getting financial assistance for small-scale entrepreneurial work. Women are involved in work of weaving, silk reeling, bamboo crafts manufacturing etc. Under TOSS project, NECTAR has supported CAFI for 30 looms and accessories and 1500 kg yarns. This project has led to the following deliverables/ outcomes: Skill up gradation of more than 300 women; and completion of order of supplying 3000 fabrics received from Fabindia.

NATIONAL INNOVATION FOUNDATION-INDIA, AHMEDABAD

Areas of Focus: Incubation and promotion of contemporary technological grassroots innovations and add value to India's outstanding traditional knowledge base.

Some Major Accomplishments:

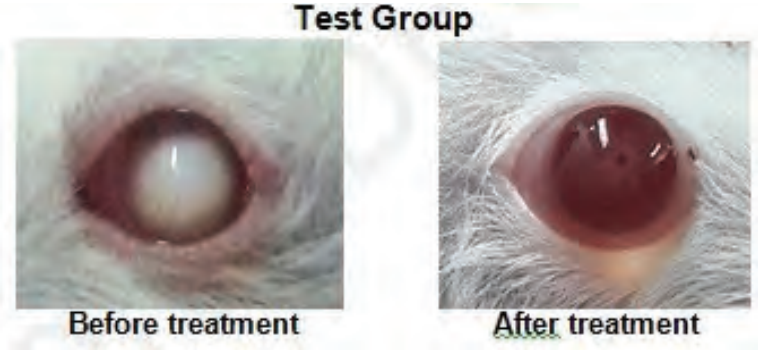
- Partnering with DST for the INSPIRE Award - MANAK (Million Minds Augmenting National Aspirations and Knowledge) aimed to attract young talent to science, technology and innovations. The scheme envisions an investment of Rs. 5000 each for best one lakh ideas and Rs. 20,000 for 1000 ideas every year. NIF will incubate the top 60 ideas and facilitate their participation in the annual Festival of Innovation (FOIN) at Rashtrapati Bhavan, New Delhi.
- The Hon'ble President of India, Shri Pranab Mukherjee gave away the 'Dr. APJ Abdul Kalam IGNITE Awards 2016' of NIF at Rashtrapati Bhavan on 7th November 2016. IGNITE is a national competition of technological ideas and innovations by school students, aims to trigger and harness the creativity of the children and promote original inclusive and compassionate thinking among them.
- The Hon'ble President of India, Shri Pranab Mukherjee inaugurated Navachara - II, a permanent exhibition of Grassroots Innovation at Rashtrapati Bhavan on 11th December, 2016. The gallery is open for public every Friday to Sunday.

Dr. A P J Abdul Kalam IGNITE Awards 2016 at Rashtrapati Bhavan, New Delhi

- NIF in collaboration with IIM A, Institute of Pesticide Formulation Technology, Department of Biotechnology, GoI, and Society for Research and Initiatives for Sustainable Technologies and Institutions, organized two days' workshop on Sustaining Botanical Pesticides through Innovation and Enterprise Development during 24-25 May, 2016 at IIM-Ahmedabad.
- NIF developed improved prototypes of wrapper picker and multipurpose drier for use in North Eastern region.
- A herbal practice for treating cataract in human was validated in Sodium Selenite induced animal model. The herbal formulation successfully removed cataract without any surgical intervention, within a month time. Joint Research for product development has been initiated with Dabur Research Foundation.

a) NIF was the knowledge partner in the 1st International Agrobiodiversity Congress, during November 6-9, 2016 at New Delhi where over five hundred participants from all over the world participated.

b) NIF co-organized India-South Africa Joint Workshop on Grassroots Innovations 06-07 July, 2016, Pretoria, South Africa where institutional arrangements to support grassroots innovations, role of Research Development and Innovation (RDI) in supporting grassroots innovations and incubation, capacity building and technical support where stressed upon.



Effect of herbal formulation for cataract

Improved prototype of the wrapper picker

Some Output Indicators:

Major National Facilities created:

NIF strengthened the Digital Fabrication Laboratory (FAB LAB) established earlier with support of the Massachusetts Institute of Technology (MIT) USA.

Important collaborations (national and global) established:

- NIF and IIT Bombay joined hands to take up a joint collaborative programme pertaining to Design Innovation Centre (DIC), an initiative of MHRD, GoI. Under this collaboration, DIC will be set up at NIF working under the concept of Hub and Spoke under IITB through IDC. The focus of DIC is fostering innovation to solve real life problems, creative problem solving, project implementation, and building synergistic relationship with industry and to encourage entrepreneurial activities. IITB shall provide funds to NIF to set-up DIC and also provide online resources.
- Dabur Research Foundation (DRF), Ghaziabad after thorough evaluation of the formulation for cataract, developed by NIF, based on community knowledge, signed an expression of interest with NIF for taking it to the market.

Important Output Indicators for 2016-17

S. No.	Parameters	Output
1.	Papers in refereed journals	15
2.	Books/Monographs/booklets	07
3.	Chapters in Books	2
4.	Papers in Conferences	11
5.	National Conferences Organized	1
6.	Prototypes/ products developed	46
7.	Patents filed	63
8.	Patents granted	1
9.	Applications under PPV&FR Act 2001	9
10.	Certificates of Registration of plant varieties from PPV&FR Authority	1
11.	Number of Technologies/Designs and other intellectual products licensed/ commercialized	3
12.	M. Tech./M.Sc./M. Phil. /B. Tech./ UG projects guided	14
13.	Scientific Outreach Programmes organized	152
14.	Scientific Lectures/Training Programmes organized	¬14
15.	Number of students trained (at various training programmes)	1000+
16.	Number of Innovators trained	120
17.	Number of Innovations Registered (including ideas and traditional knowledge practices)	33000
18.	Data Bases Compiled	02
19.	National Missions Led and Coordinated	04

RAMAN RESEARCH INSTITUTE (RRI), BENGALURU

Areas of Focus: Astronomy & Astrophysics, Light & Matter Physics, Soft Condensed Matter and Theoretical Physics, Physics in Biology, Chemistry, Liquid Crystals, Quantum Information, Quantum Communications and Signal Processing and Imaging.

Some Major Accomplishments:

Participating in the International Square Kilometre Array (SKA) Radio Telescope, which is a mega project of the nation, by engaging in key science and engineering of an SKA precursor telescope in the Australian outback in collaboration with MIT, Harvard and other universities and institutions in the US, Australia, New Zealand and Canada. RRI engineers successfully designed and built in-house the digital receivers for this international radio telescope, and commissioned the systems in the Western Australian outback (see Picture 1).

ISRO has formally approved the RRI designed and built X-ray polarimeter POLIX as a payload for an XPoSat, which will be the first space X-ray polarization mission for the world.

Ultrafine nanopores development in the RRI Nano-Biophysics lab for precision sequencing of chromatic/DNA and studies of the biophysics behind the role of chromatin in packaging DNA inside a eukaryotic cell nucleus through sensitive nanopore based measurements.

A novel pico-Newton scale force-apparatus invented at RRI purpose-built for studies of the stability and physical properties of axons of nerve cells, to advance our understanding of neurodegenerative mechanisms and develop strategies to prevent axonal loss.

Development of a real-time imaging technology for use in foggy conditions, through smoke or muddy waters or even opaque human tissues. Potential applications are in navigation or rescue operations or deep-sea diving and medical imaging.

Development in-house of single photon and entangled photon pair sources as advanced tools for basic science in quantum communications and information.

An impedance measurement based ‘hand held milk purity testing device’ to detect synthetic milk adulteration has been developed in collaboration with the DST-National Hub for Health Care Instrumentation (NHHID), Chennai and IISc, Bangalore.

A novel optical storage device that, under UV radiation, uses the trans-cis isomerization property of gold nanoparticles doped with azobenzene liquid crystal molecules containing organo-sulfur chains, and back-isomerization under visible light has been developed. The application potential is its use as ‘e-paper’ on which one can ‘write’ using a UV pen, then erase using visible light and rewrite again.

The RRI Brain Computer interface laboratory developed a generic visually-activated control system

that can be used in conjunction with a variety of devices (robotic arm, wheelchair, etc.) and voice-controlled moving platform for use in wheel-chairs, elevators etc. The technology has potential applications in robotics, defense, navigation, surgery, assembly lines in industry, among others.

Some Important Output Indicators

Sl.No.	Output parameters	2016-2017 (upto Dec 2016)
1.	Papers in refereed journals	74
2.	Book chapters	1
3.	Papers in Conferences	1 +
4.	Number of Ph.Ds. produced (Awarded and submitted)	9 awarded+9 submitted
5.	Foreign Patents under process	4
6.	Foreign Patents granted	Nil
7.	Indian Patents under process	3
	Indian Patents granted	3
8.	Visiting students (includes BTech/UG? M.Tech, MSc, MPhil Projects)	122

SKA Precursor Radio Telescope built by RRI with an International collaboration and located in the Western Australian outback. Courtesy – Curtin University

S. N. BOSE NATIONAL CENTRE FOR BASIC SCIENCES (SNBNCBS), KOLKATA

Areas of Focus

- Selected areas of Theoretical Sciences like Field Theory, Quantum Information Theory, Statistical Physics and Non-Linear Dynamics.
- Areas of Physical and Quantum Chemistry that interface with biological molecules, ionic liquids and energy harvesting using tools of simulation and precision ultra-fast spectroscopy.
- Advanced Materials Science and Condensed Matter Physics including nanomaterials and computational materials science. New materials development including nanomaterials, nanodevices and related condensed matter sciences including theory, experiment and simulations.
- Selected areas of astrophysics and cosmology like investigations on black holes, dark matter and observational astronomy.
- Networked research programmes through the visitor and associateship programmes.

Some Major Accomplishments

Astrophysics & Cosmology: Estimation of mass of several black holes using Chakrabarti-Titarchuk Two Component Advective Flow solution; Reproduced solar injected spectra from Very Low Frequency radio signals by using inverse methods applied on our Ionosphere; Studies on phase and time lag behaviour of X-rays of different energies from several black hole candidates; Determination of the stellar content of a young cluster NGC 2282 in Monoceros constellation from observations in optical to mid-infrared wavelengths; Studies on the effect of particle statistics on the gravitational equivalence principle applied to quantum particles (WEQ) showing that WEQ emerges smoothly in the limit of large mass; Derivation of a fine-grained uncertainty relation for continuous variable systems and showed that it led to an improved lower bound on the secret key rate of a one-sided device-independent quantum key distribution protocol; Studies showing that the nonlocality of a single member of an entangled pair of spin 1/2 particles cannot be shared among multiple observers who acted sequentially and independently of each other; Photoionization analysis and modelling of optical spectra of RS Oph observed during 2006 outburst and quiescence period; Construction of a comprehensive grid of NLTE, spherical, hydrostatic model atmospheres for basic parameter combinations spanning the entire parameter space appropriate for novae.

Department of Chemical, Biological & Macro-Molecular Sciences: Nonequilibrium thermodynamic response of a voltage-gated Sodium ion channel studied; Effects of noise due to thermo-coherence in the source on quantum current explored; Model simulations to understand Troponin I interaction with Calcium (Ca2+) ion bound TnC were carried out; Quantum Chemical (QC) calculations for macromolecules with truncation were carried out to understand the effects of capping; STY3178, a yfdX protein from a MDR strain of typhoid fever causing Salmonella Typhi was studied; Early detection of insulin resistance by means of non-invasive human breath analysis developed; Glucose metabolism of the gastric pathogen Helicobacter pylori infection in human stomach investigated; Terahertz studies on the effects of hydrophilic and hydrophobic cations on water structure carried out; Molecular recognition of small ligands/drugs by biological macromolecules explored; Low-cost spectroscopic gadgets for biomedical/environmental usage developed; Two-step procedure to fabricate halloysite/metal nanocomposites (NCs) on large scale developed.

Department of Condensed Matter Physics and Materials Science: Study of magnetism in different morphologies in various transition metals and oxides through ab initio band structure calculation methods; Calculation of thermoelectric properties of graphene/h-BN/graphene heterostructures; Ab initio and Model Hamiltonian-based calculations to find electronic structures of transition metal dichalcogenides; Development of numerical techniques in DMRG type methods and theoretical studies on quantum phase transitions; Investigation of connections between topological excitations and conventional excitations in two-dimensional spins; Molecular Dynamics simulation and experimental studies on plasticity-mediated collapse and recrystallization of hollow copper nanowires; Tuning of ultrafast magnetization dynamics in bilayer thin wires and nano stripes; Investigation of THz conductivity in ferrite nano structures; Synthesis, characterization and tuning of fluorescent properties of ferrite nano particles; Discovery of a new multipolar type anisotropic dependence of magnetic field on yield stress of magneto rheological fluids; Control of coexisting phases and electronic properties in thin films by electric bilayer gates.

Department of Theoretical Sciences: Nonrelativistic diffeomorphism symmetry and its applications to fluid dynamics, Newton-Cartan geometry, fractional quantum Hall effect etc.; Action principles for fluid dynamics and magnetohydrodynamics; Non-commutative geometry and Quantum Field Theory, computations of infinitesimal spectral distance, a la Connes on Non-commutative spaces; Investigations on spin dynamics induced by topological excitations in spin-½ layered anti-ferromagnetic systems; calculation of the effect of a small gluon mass on the anomalous chromomagnetic moment of quarks, both for a Proca mass and for a topologically generated mass; Extention of the integrability analysis to four dimensions and investigation of the behavior of chaotic dynamical systems; Construction of Canonical Transformations leading to a Loop Formulation of SU(N) Lattice Gauge Theories; Study of desert roses and their geometrical structure using computer assisted tomography; Study of complexity in nature and intelligent system; Study of additivity property and fluctuations in nonequilibrium steady state; Study of phase separation in interacting particle systems; Study of chemotaxis of E.coli bacteria.

Some Important Output Indicators

S.No.	Parameters	Output
1	Papers in refereed journals	164
2	Chapters in Books	1
3	Papers in Conferences	10
4	Number of Ph.Ds. produced	13
5	Indian Patents filed	1
	Indian Patents granted	2
6	Research Manpower trained (other than Ph.Ds) PDRA	23
7	B.Tech/ UG projects guided	3
8	M.Tech/M.Sc./M.Phil projects guided	17
9	Summer Project at PG level	20
10	M.Sc. under IPhD	9

SREE CHITRA TIRUNAL INSTITUTE FOR MEDICAL SCIENCES AND TECHNOLOGY (SCTIMST), TRIVANDRUM

Areas of Focus

Biomaterials Research and Development, Product Development, Technology Transfer and Industrial Linkages, Quality Management Systems, Testing and Technical services, Patient Care and Public Health.

Some Major Accomplishments

- *Technology Research Centre (TRC):* Under the Technology Research Centre (TRC) for development of Biomedical Devices funded by DST, 15 research projects on biomedical devices were going on and 14 new research projects for medical devices were launched by Shri Y S Chowdary, the Hon`ble Minister of State for Science and Technology and Earth Sciences, Government of India, in the Technology Conclave 2016, organized by SCTIMST on 19th November 2016.
- Sree Chitra Institute has been involved in R&D for improving and enhancing the features of two prestigious cardiovascular implants, the heart valve and vascular graft. The TTK-Chitra Valve Model TC2 and TTK Chitra Vascular Graft Model TCG2, both second generation products jointly developed by the Institute and the partner industry, M/s. TTK Healthcare Ltd, are now ready for clinical evaluation.

Sri Pinarayi Vijayan, Hon'ble Chief Minister of Kerala, receiving the Consent Note from Sri TT Jagannathan, Chairman, TTK Group of Companies, to provide free TTK-Chitra heart valves to twenty-five deserving patients on the occasion of the successful completion of twenty-five years of clinical use of TTK-Chitra Heart Valve.

- SCTIMST-TIMED, the Technology Business Incubator of SCTIMST, has currently six incubatees. More incubatees are expected during 2017. There is a proposal to have a pilot study for production of coated vascular graft in partnership with TTK Healthcare Ltd.
- An E-consultation system was launched by SCTIMST at the Technology Conclave on 19th November 2016 for review consultancy through internet-based video conferencing. Patients can access the e-consultation system through Akshaya centres or other widely accessed facilities or even from their homes if they have sufficiently high bandwidth internet connectivity and other basic audiovisual aids like a webcam and headphone. The system is integrated with SCTIMST's existing patient portal. Patients can login into the patient's portal and can access the E-consultation system.
- COFRAC Surveillance Assessment was conducted during 15-16 October 2015. Extended scope received from COFRAC is effective from 15 January 2016.
- NABL Assessment: Reassessment of NABL at Calibration Cell was carried out on 6th and 7th February 2016 and NABL renewed the accreditation.
- Product development & Technology Transfer: A compendium of products already developed and those that are in various stages of development in the Institute was compiled to impart awareness to the medical devices industry and facilitate collaboration.
- Substantial progress was made in the development of a number of prototypes, biomaterials, biological products and devices.
- Quality management system and testing services: The Institute continued to support the medical devices industry and the academia by providing testing services for medical devices and biomaterials for physico-chemical tests, biological tests and calibration.
- An agreement for academic cooperation and exchange between BNERC, Toyo University, Graduate School of Interdisciplinary New Science, Toyo University, and SCTIMST signed on 22 May 2015.

Some Important Output Indicators

S. No.	Parameters	Output
1	Papers in refereed Journals	186
2	Papers in Conferences	1
3	Number of Ph.Ds produced	15
4	Indian Patents filed	9
	Indian patents granted	0
5	Number of Technologies/designs and other intellectual products commercialized	3
6	Number of Technology leads awaiting transfer	5
7	Technical Manpower Trained	15
8	B.Tec/UG Projects guided	1
9	M Tech/M Phil/MPH projects guided	58

TECHNOLOGY INFORMATION, FORECASTING AND ASSESSMENT COUNCIL (TIFAC), NEW DELHI

Areas of Focus

Technology Foresight Exercises, Vision 2035, Nurturing Innovation, Supporting MSME Clusters, Capacity Building, Electric Mobility, Collaborative Linkages etc.

Some Major Accomplishments

- Technology Vision (TV)-2035 Technology Roadmaps in 5 sectors, viz. Materials, Manufacturing, Information & Communication Technologies, Medical Sciences & Health Care and Transportation Technologies were released. Further, 3 more TV-2035 Technology Roadmaps are being lined-up for release.
- Four innovations successfully scaled up by industries under the TIFAC-SIDBI Technology Innovation Programme (Srijan). Out of these, one technology was transferred by a CSIR lab to industry and was commercialized.
- Under the programme on Bioprocess & Bioproducts, a roadmap on Methanol & Di-Methyl- Ether (DME) being prepared for India and two specialised survey study focusing on their production and utilisation aspects were completed at the behest of NITI Aayog and DST. Also, two technology assessment studies were initiated aiming to develop zone-wise recommendations for appropriate technologies for conversion of crop residues to biofuel and to provide technological options for the concerned industries. Indian Agricultural Research Institute (IARI), New Delhi and National Remote Sensing Centre (NRSC), Hyderabad have started studies for estimating the generation and surplus amounts of crop residues (rice, wheat, maize, sugarcane, cotton, pulses (Gram, Tur) and oilseeds: groundnut, mustard and castor etc) in India.
- The R&D Plan for the Technology Platform under the FAME India Scheme of National Mission on Electric Mobility was validated in a Validation Workshop held in December 2016.
- TIFAC undertook Technology Foresight studies in three areas namely, Natural Resources & Environment Security, Information & Communication and Financial Sector Security and Individual, Societal & Infrastructure Security.
- Several new technical gap analysis studies were initiated in a number of MSME clusters such as General Engineering Cluster, Coimbatore-Tamil Nadu, Saree Cluster, Varanasi-Uttar Pradesh, Agricultural Implements Cluster, Noorsarai-Bihar, Copper & Bronze Utensils Cluster, Vaishali-Bihar, Refractory Cluster, Bangabhoomi-West Bengal, Textile and Garment Manufacturing Cluster, Erode-Tamil Nadu, Kanaihaganj Jhula Cluster, Nalanda-Bihar, Surgical Dressing Manufacturers Cluster, Chatrapatti-Tamil Nadu etc.
- TIFAC-SIDBI Technology Innovation Programme (Srijan): Mobile Autonomous Stabilization System (MASS) and Mobile Autonomous Robotic System(MARS), the two Unmanned Ground

Vehicles (UGVs) launched by DRDO in Defence Expo 2016 were equipped with indigenous inertial navigation systems developed and scaled up by a startup company M/s. Aeron Systems Pvt. Ltd. in Pune under the Srijan Programme. TIFAC, jointly with INAE on behalf of Ministry of Urban Development and DST, prepared technology classification database on Municipal Solid Waste based on identified critical parameters to provide guidance to states / urban local bodies for taking informed decision on use of appropriate technologies under the Swacch Bharat Mission of Govt. of India.

- As a spinoff from grand challenges identified in the Technology Vision 2035 document, TIFAC collaborated with Indian Council of Medical Research (ICMR) and Ministry of Health and Family Welfare (MoH&FW) to study the feasibility of ongoing programmes related to elimination of anaemia in child and women and to identify research priorities in this area.

Some Important Output Indicators

S. No.	Parameters	Output
1.	Papers in refereed journals	6
2.	Papers in Conferences	5
3.	International Conferences Organized	1
4.	National Conferences Organized	3
5.	State-of-the-art-Reports Published	7
6.	Scientific Outreach Programmes organized	5
7.	Original Science Communication Content Designed	5
8.	Number of persons who attended various science outreach programmes/ conferences etc.	714
9.	Scientific Lectures/Training Programmes organized	2
10.	Number of students trained	130
11.	Number of Innovations Registered	23
12.	Data Bases Compiled	1
13.	National Missions Led and Coordinated	1
14.	Foresight Reports and Analyses Prepared	12
15.	Patent Searches	150
16.	Invited lectures	23

VIGYAN PRASAR (VP), NOIDA

Areas of Focus: Science & Technology Communication and Popularization

Some Major Accomplishments

Radio, TV and Social Media Activities

- The total number of radio episodes delivered are 598 and number of people reached out to is 50 Lakhs. Further, radio modules are being made in three tribal languages namely, Santhali, Karbi and Gondi and programmes in tribal areas are being implemented. New activities have been initiated in Maharastra, Chattisgarh, Telungana and Andhra Pradesh.
- Web hosting of 110 write ups on the Vigyan Prasar site.
- Initiated the Indian Science News Feature Service where 443 tweets have been made on S&T related activities and secured 80,410 impressions. In addition, posted around 1500 tweets and many write ups on the Facebook of DST.
- Oriented around 150 students in Himachal Pradesh and Sikkim to take their Amateur Station (Ham) Operator's Certificate Exam.
- A total of 446 television episodes produced, reaching out to 50 Lakh people – some important ones are 143 new episodes for telecast on India @ IT Revolution and Prakash Kirno Ke Rahasya, documentaries on Indian Scientists and "Achievements of IMD".
- VP's video resources made available through CSIR-NISCAIR- Tube and The NROER of the NCERT.
- Produced 26-part video programme "A Question of Science" and the 13 – part video programme "The Maths Factor" for telecasting in 10 regional languages (Assamese, Oriya, Punjabi, Bengali, Marathi, Tamil, Malayalam, Urdu, Telugu and Gujarati) from different Doordarshan Kendras and regular production and transmission of the TV show "Eureka- conversation with Indian Scientists" in collaboration with NISCAIR and RSTV.

Publication and Related Activities

- Vigyan Prasar and the Indian Science News Association jointly commissioned a three-month long course on "science writing".
- The Publications programme of VP delivered its books and the DREAM magazine as scheduled.
- A comprehensive book on inspirational moments in the lives of leading Indian scientists is ready for publication.
- With respect to the Network Programme on Convergence of Traditional Knowledge Systems for Sustainable Development in the Indian Himalayan Region: Database structuring has progressed significantly for conversion of data into e-form/CMS base.

- Telescope making involving VIPNET clubs and a special interactive lecture series through EDUSAT were with the NCSTC.
- A national initiative Vidhyarthi Vigyan Manthan was provided content based technical assistance to reach out to thousands of students and a large number of teachers successfully.
- A multimedia CD on Women Friendly Improved Farm tools for Drudgery Reduction was published along with a Sourcebook.
- Science clubs related orientation workshops for school teachers in tribal areas were held in several locations.
- Training programmes on science communication were organized at the national level.
- Detailed inputs on Urban Floods management and preparedness at the national level were provided at the meeting of experts at the NDMA as an Expert member.

Some Important Output Indicators

SN.	Parameters	Output
1.	Papers in refereed journals	28
2.	Books/Monographs	10
3.	Chapters in Books	07
4.	Papers in Conferences	19
5.	International Conferences / Events on communication Organized	One International Science Film Festival at the IISF
6.	National Conferences / Film Festival Organized	One National Science Film Festival organized by VP
7.	State-of-the-art-Reports Published	Framework for "Emerging trends in Science Popularization" finalized.
8.	Scientific Outreach Programmes organized	i. Television and Radio based Programmes ii. Training of science communicators iii. National level quiz, science village activity for school students. iv. Edusat programmes for students v. Activity in corner in different Mela's & Fairs
9.	Original Science Communication Content Designed	All the above stated had original inputs from VP
10.	Popular Science Books/Newsletters published	• 12 issues of DREAM 2047. • Ten books

11.	Number of persons who attended various science outreach programmes/ conferences etc.	Fifty Lakhs listeners and viewers of Radio & TV programmes, Eight Lakhs visited exhibitions / activity corners organized in different parts of country.
12.	Scientific Lectures/Training Programmes organized	28
13.	Number of students trained	1,28,560
14.	Number of school/college/ university teachers trained	15885

WADIA INSTITUTE OF HIMALAYAN GEOLOGY (WIHG), DEHRADUN

Areas of Focus

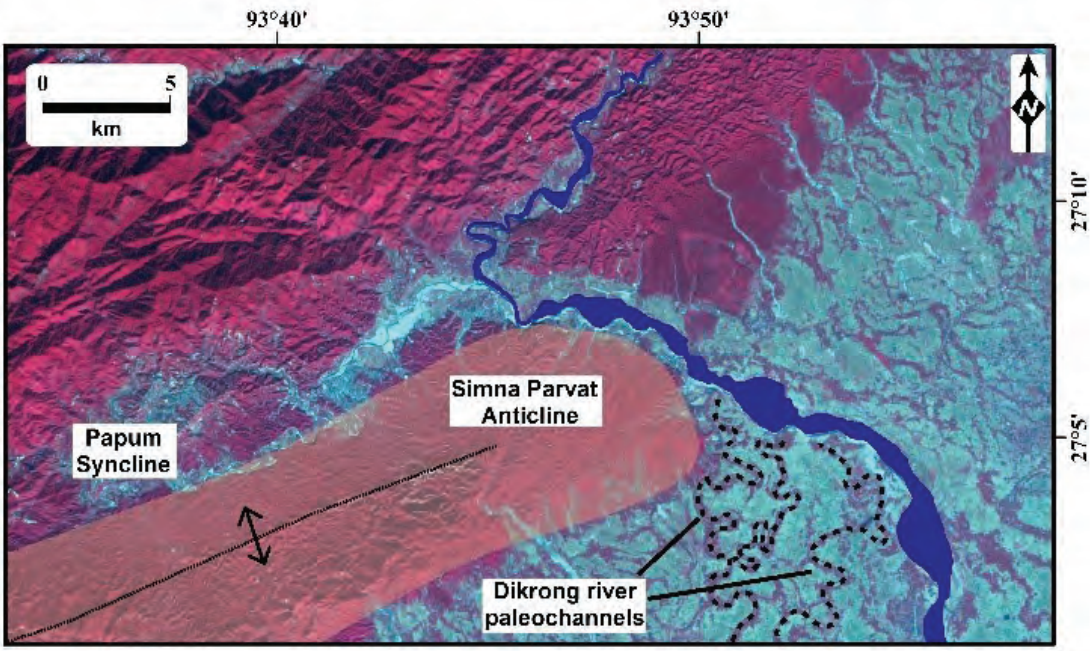
The Institute's main focus of research is on study of Himalayan river systems, glaciers, earthquake precursors, landslides, biodiversity and climate-tectonic interaction with major emphasis on the geodynamics of the Himalaya.

Some Major Accomplishments

- Using the LA-MC-ICP-MS laboratory facility, it has become possible to measure with internal precision well within 1%, the igneous zircons from the footwall of the MCT of the inner Lesser Himalaya thereby obtaining magmatic crystallization age of 1901±11 Ma.
- For the first time, the occurrence of albitite from the Shyok Suture Zone (SSZ) in Nubra valley of Trans Himalaya, Ladakh has been reported, thereby opening new vistas for exploring the possible uranium - REE mineralization.
- The study of twenty geothermal springs from the NW Himalaya show that they have the potential to degas ~2.9×107 mol CO_2 per year in the atmosphere, and further their reservoir temperatures (42 to 107oC) indicate their application in space heating and in rare cases, as a potential source for electricity generation.
- Crustal thickness and Poisson's ratios are estimated using 10 Broad Band Seismic stations along a profile of Satluj valley, NW Himalaya, which reveal gradual thickening of crust from ~46 km beneath Sub-Himalaya to ~50 km beneath Higher Himalaya and to ~62 km in the Tethyan Himalaya.
- The spatial variation in cooling ages, exhumation rates and seismicity of Kumaun-Garhwal region indicates that the Kumaun region, as a single block, has undergone a rapid exhumation rate of ~4 m/Ma and Garhwal region with the rate of ~1.5 m/Ma, a result of tectonic activity along the Main Central Thrust/Munsiari Thrust.
- The use of channel steepness index (ksn) as a proxy for the detachment-limited model to estimate

the differential uplift across the fold-thrust belt in the Dikrong river valley, NE Himalaya, showed higher ksn values (86-214) across the nose of the Simna Parvat Anticline suggesting the propagation of anticline towards ENE direction, resulting in the gradual shifting of the Dikrong River towards east..

- The surface exposure dating (SED) technique using Cosmogenic Radionuclides has been used to highlight the existing gaps in the Himalayan glacial chronology.



LISS-III imagery showing the lateral eastward shifting of the Dikrong river due to the propagation of the Simna Parvat Anticline towards ENE direction.

- The chronology of paleoflood deposits of Himalaya established by OSL and 14C AMS dating techniques, indicate: (i) The Alaknanda-Mandakini Rivers experienced large floods during the wet and warm Medieval Climate Anomaly; (ii) the Indus River experienced at least 14 large floods during the Holocene climatic optimum and the magnetic susceptibility of flood sediments indicates that 10 out of 14 floods originated in the catchments draining the Ladakh Batholith; and (iii) the Brahmaputra River experienced a megaflood between 8 and 6 ka.
- The Institute has carried out field and analytical studies of the buried course of River Saraswati and found signature of existence of this river until ~1.7 kilo years before present.

Some Important Output Indicators

S.No.	Parameters	Output
1	Papers in refereed journals	62
2	Papers in Conferences	2
3	Number of Ph.Ds. produced (3 awarded and 3 submitted)	6
4	Research Manpower trained (other than Ph.Ds)	98
5	B.Tech/ UG projects guided	22
6	M.Tech/M.Sc./M.Phil projects guided	18
7	Other Products/ Indicators • 1st National Geo Research Scholar's Meet was organized by the Institute during June 1-4, 2016. • The Curtain Raiser Event of the 2nd India International Science Festival was organized in the Institute during November 28-29, 2016, which included science exhibition, lectures, student-scientists discussions, screening of science movies etc. More than 3000 students, teachers and general public participated. • Institute scientists have actively volunteered for the Science outreach programme.	7

INDIAN ACADEMY OF SCIENCES (IASc), BENGALURU

Areas of focus

The Academy promotes original research and dissemination of scientific knowledge to the scientific community through a number of activities. Some of the important activities are: publication of scientific journals; election of Fellows and selection of Associates; organizing mid-year and annual scientific meetings; curation of Fellows' repository of publications; Women in Science Programme; Chair Professorships and other activities in promotion of Science.

Some Major Accomplishments

Publications: Over 14200 peer-reviewed articles have been published in 10 thematic journals and the entire contents are available in free access platform (www.ias.ac.in/Journals/Overview). Over 21456 print versions of these journals were circulated to institutions/individuals on subscription basis. These journals have gained worldwide visibility. Submission of articles to these journals has increased. Journals citations have also increased over the years. The journal- wise account for 2016 is given below:

Name of the Journal	No. of articles received	No. of articles published	No. of issues published	No. of pages published	Circulation figures
Pramana	592	202	12	2560	2971
Journal of Astrophy. & Astron.	200	39	4	668	1109
Proceedings Mathematical Sci.	461	50	4	654	1645
Journal of Chemical Sciences	660	207	12	1968	1714
Bulletin of Materials Science	1357	226	7	1878	1605
Sadhana-Proceedings in Engg. Sci.	1450	126	12	1524	1467
Journal of Biosciences	750	71	4	806	1734
Journal of Genetics	687	132	4	1270	1396
Journal of Earth System Science	620	120	8	1732	1164
Resonance- J. of Science Education	159	89	12	1151	3536

Science Education Programmes: A total of 1651 students availed Summer Research Fellowship. 23 refresher courses in Physics, Life Sciences, Engineering and Earth & Planetary Science were conducted for university science teachers in different parts of the country. 92 Lecture Workshops were held in Physics, Life Sciences, Engineering, Earth & Planetary Science, Mathematics and Chemistry in different parts of the country.

Election of Fellows and Associates: 469 nominations for Fellowship and 79 nominations for Associateship were considered for 2016. 27 outstanding scientists and 2 foreign scientists were inducted to the Academy Fellowship and Honorary Fellowship respectively. 17 Associates were also selected.

Organizing Scientific Meetings: The mid-year meeting was organized during 1-2 July 2016 at the Indian Institute of Science, Bengaluru. The annual meeting was organized at IISER-Bhopal during 4-6 November 2016. Symposia, public lectures and scientific talks by Fellows/Associates were organized during these meetings.

Fellows' Repository: Through this initiative, 94021 metadata of important researches in all branches of science carried out by Fellows of the Academy was made freely available online. The number of full text made available was 21035.

Important collaborations: The Academy collaborated with the other two National Science Academies of the country, viz., INSA, New Delhi and NASI, Allahabad for implementing Science Education Programmes. Collaboration with Springer continued for marketing online versions of Academy journals overseas.

Some Important Output Indicators

S. No.	Parameters	Output
1.	Books	Linear Algebra and Analysis Lilavati's Daughters (Reprint)
2.	National Conferences Organized	Two meetings were held: the mid-year meeting during 1-2 July 2016 at Indian Institute of Science and the annual meeting at IISER-Bhopal during 4-6 November 2016
3.	Journals Published	The Academy published 11 eleven journals (including the Current Science), covering all areas of S&T.
4.	Newsletter published	Published 2 editions of 'Patrika', the newsletter of the Academy.
5.	Scientific Lectures/Training Programmes organized	Scientific Lectures: 800 Lectures in 92 Lecture workshops and 60 in Annual and Midyear meetings. Training Programmes: 23
6.	Number of persons who attended various conferences	Around 600
7.	Number of college/university teachers trained	Around 14000

INDIAN NATIONAL ACADEMY OF ENGINEERING (INAE), GURUGRAM

Areas of Focus

The Indian National Academy of Engineering (INAE), a professional body founded in 1987, provides a forum for futuristic planning for country's development requiring engineering and technological inputs and brings together specialists from such fields as may be necessary for comprehensive solutions to the needs of the country. It is the only engineering Academy in India. INAE is a Member of the International Council of Academies of Engineering and Technological Sciences (CAETS). It consists of India's most distinguished engineers, engineer-scientists and technologists covering the entire spectrum of engineering disciplines.

Some Major Accomplishments

Initiatives in Environmental Protection - Research Study on Recycling of Automotive Waste: With the increase in the number of automobiles in the country; Principal Scientific Advisor (PSA) to Govt. of India desired INAE to take up a Research Study on "Development of scientific recycling of 'End of Life' Automobiles with special focus on rubber, plastics and residues in India- The role of Research and Development" under its auspices. The objective of the Research Study was to develop systems

for recycling rubber and plastics and to carry out R&D activities on recovery of useful materials from auto shredded residue and minimize the extent of residues going into refills. The report has resulted in pertinent, actionable recommendations on automotive recycling in general and also generated specific recommendations on the methodologies for disposal of rubber, plastics and auto shredder residues. The report was submitted to office of PSA, Govt of India and further submitted by PSA to Minister of Environment, Forest and Climate Change for assisting in formulation of National Policy. A pilot plant has been set up in Chennai based on the findings of the study.

INAE-DST Initiative on Clean Coal technologies – INAE-DST Round Table Meetings on "Clean Coal Technologies in India: Current Status, Demands and Aspirations – Pathways to Achievements": DST desired to invite proposals in the area of Clean Coal Technologies; a current thrust area of the Government. DST requested INAE to convene a meeting of experts from INAE, R&D, Industry and Academia and assist in identifying the thrust areas of research in Clean Coal technologies for funding of projects by DST. Accordingly, INAE identified suitable experts and conducted two meetings on Clean Coal technologies on the topic "Clean Coal Technologies in India: Current Status, Demands and Aspirations – Pathways to Achievements" on June 10, 2016 and Oct 26, 2016. During the first meeting on June 10, 2016, the experts deliberated on the current status of the technologies available in India vis a vis the current international status of Clean Coal technologies so as to assist in identifying the gaps which need to be addressed on priority. 35 experts in the area of clean coal technologies participated in the meeting. With this, INAE was able to provide inputs to the DST on the existing state of technologies in the country, technologies available internationally and the short-term and long-term plans for adoption of technologies in the field of Clean Coal Technologies. Based on the areas chosen, the experts during the second meeting on October 26, 2016 identified the research areas in Clean Coal Technologies relevant for the country. 11 research proposals covering various aspects of Clean Coal technologies were discussed and approved; which were submitted to DST for consideration during a meeting on November 19, 2016.

Engineers Conclave 2016: The "Engineers Conclave 2016" was held at IIT Madras during September 1-3, 2016. The Chief Guest, Shri M Venkaiah Naidu, Hon'ble Minister for Urban Development, Housing & Urban Poverty Alleviation and Information & Broadcasting, delivered his address in the Inaugural Session on September 1, 2016. The themes of the Conclave were "Engineering Education 2020" and "Smart Cities" Eminent experts from Academia, R&D and Industry besides about 70 Fellows of INAE and Executives of the Ministry of Urban Development participated in the Conclave. The recommendations of the Engineers Conclave 2016 were under final stages of compilation. The recommendations on the theme of "Engineering Education" will be submitted to the Ministry of Human Resource Development (MHRD) and those on "Smart Cities" will be submitted to Ministry of Urban Development during meetings planned shortly.

Some Important Output Indicators

S. No.	Parameters	Output
1.	National Conferences Organized	6
2.	Journals Published	1

INDIAN NATIONAL SCIENCE ACADEMY (INSA), NEW DELHI

Areas of Focus

Science Promotion and Recognition of Scientists.

Some Major Accomplishments

- The Academy elected 34 Fellows, three Foreign Fellows and two Pravasi Fellows to its Fellowship during the year.
- Five scientists were awarded INSA Research Professorship, 91 were awarded Senior Scientistship and 72 were recognized as Honorary Scientists.
- 57 scientists were provided with Young Scientist Research grant.
- 26 projects under History of Science Programme were supported.
- Financial support to 67 Conferences/Seminars/Symposia/Workshops were also provided.
- 29 Young researchers were selected by the Academy for the INSA Medal for Young Scientists and two young historians for INSA Young Historian of Science Award.
- The Academy established Indian National Young Academy of Sciences (INYAS).
- 12 outstanding teachers were honoured with INSA Teachers Award.
- Three general and nine subject-wise medals/lectures awards were announced by the Academy.
- The Academy supported 53 scientists/researchers for attending various ICSU/ Non-ICSU sponsored conferences abroad.
- 52 researchers from abroad were awarded INSA JRD-TATA, DBT-TWAS Post Graduate and Post-Doctoral and ISRF Fellowships and 713 Indian scientists/researchers were awarded with INSA-CSIR-DAE/BRNS-CICS Travel Fellowship.
- The Academy supported 88 Indian scientists to work in overseas laboratories and R&D institutions and facilitated 75 overseas scientists to work in India under various Exchange/ International Programmes.
- The Academy supported several national and international joint bilateral meetings/workshops/ symposia such as IAP/IAC/IAMP, INSA-German National Academy of Sciences Leopoldina Symposium.

- 13 award lectures under the aegis of different local chapters of the Academy were delivered under Science and Society Programme.
- 59 popular lectures were delivered to young students and teachers of schools and colleges by the Fellows in remote/rural areas.
- All the 41 volumes of Biographical Memoirs of Deceased Fellows of the Academy were digitized and uploaded on the Academy's website.

Some Important Output Indicators

S. No.	Parameters	Output
1.	Journals Published	14
2.	Refresher Courses	19
3.	Lecture workshops	65
4.	Research Projects in History of Science	26
5.	Conferences/Workshops/Symposia Organized	67
6.	Number of persons who attended various science outreach programmes	146
7.	Scientific Outreach Programmes organized	1
8.	Scientific Lectures/Training Programmes organized	52
9.	Number of students trained	1234
10.	Number of school/college/university teachers trained	112

THE INDIAN SCIENCE CONGRESS ASSOCIATION (ISCA), KOLKATA

Areas of Focus

The Indian Science Congress Association was established in 1914 with the following objectives:

- To advance and promote the cause of Science in India;
- To hold an Annual Congress at a suitable place in India;
- To publish such proceedings, journals, transactions and other publications as may be considered desirable;
- To secure and manage funds and endowments for the promotion of Science including the rights of disposing of, or selling all or any portion of the properties of the Association;
- To do perform any or all other acts, matters and things as are conducive to, or incidental to, or necessary for, the above objects.

Some Major Accomplishments

Holding of the 104th Indian Science Congress Session from 3-7 January 2017 at S.V. University, Tirupati with Prof. D. Narayana Rao as the General President. The Focal Theme of the Congress was "Science and Technology for National Development".

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 Journal of the Association, "Everyman's Science", which is circulated to all members free of cost was published regularly.

ISCA Chapter Activities and Science Awareness Programmes for Popularisation of Science: The Association carried out a number of activities popularization and advancement of science by organizing seminars, symposia, discussions, popular lectures, quiz contest, etc. throughout the year under its 28 ISCA Chapters. The Association through its Chapters observed the Science Day, Environment Day, Doctor's Day, Engineer's Day, Technology Day, World Yoga Day and also organized joint collaborative programmes with other organizations. The Association also organized a number of Seminars, Symposia, Discussions, Workshops etc.

THE NATIONAL ACADEMY OF SCIENCES, INDIA (NASI), ALLAHABAD

Areas of Focus: Promotion & Popularisation of Science, Aid & advise in Policy Making

Some Major Accomplishments:

Publications

Regularly publishing the Proceedings of NASI, Section - A & B, each in IV parts & Science Letters in VI parts. This apart, in collaboration with the Springer India, the Academy published a Monograph by Prof P N Tandon, a world famous medical scientist providing a fascinating account of his tryst with bio-medical research. Another important publication was 'Festschrift', dedicated to the legendary scientist Prof. M. G. K. Menon, released by Hon'ble Minister for Science & Technology, Govt. of India on August 27, 2016 at New Delhi. The 9 volumes published on the History of Science in India were distributed to the concerned government and non-government agencies for dissemination of knowledge. A 'Vision Document' on women in science has also been released.

Science Communication Activities

- The highlights of activities were Children Science Meet, Summer & Winter Schools, Vocational Training Programmes, Teachers' Workshops, Scientific Writing Contest, Vigyan, Jal & Health Chaupals, Seminars, and celebration of National Technology Day, National Science Day and 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 18 Chapters organized hundreds of science communication activities, benefitting more than 10000 students and teachers, in and around their respective region throughout the year.
- Two workshops on Scientific Paper Writing were organized in 2016 to train the young researchers.
- Two Science Awareness Programmes (relating to health issues) were organized for the Army personnel; and four workshops on 'Entrepreneurship Development' were organised.

Science Education Programmes

NASI, in partnership with the other two Science Academies, sponsors the Summer/Winter Research Fellowship under the joint Science Education Panel to provide opportunities to bright graduate and post-graduate students and teachers to spend their summer/winter vacations in a national science institution.

Annual Session/Symposia/Seminars & Scientific Discussions

Academy organised during its 86th Annual Session, a Symposium on 'Science, Technology and Entrepreneurship for Human Welfare in The Himalayan Region' at Dehradun on December 2-4, 2016.

Fellowship / Membership

Recognizing the outstanding scientific contributions, the Academy awarded the prestigious Fellowship/ Membership to more than **100** scientists, during the year 2016. It also awarded a few Foreign Fellowships to scientists who are working in different countries.

Recognition and Awards- The following awards were given in the year 2016-17:

- NASI-Reliance Industries Platinum Jubilee Awards for the Application Oriented Innovations covering both Physical and Biological Sciences.;
- NASI-Young Scientist Platinum Jubilee Awards in the fields of Biological/Physical/ Chemical Sciences;
- 10th NASI Scopus Awards;
- Senior Scientist Platinum Jubilee Fellowships;
- Prof. M. G. K. Menon Lecture Award (instituted in 2015) given to Prof. Govind Swarup, Formerly Homi Bhabha Senior Fellow, National Centre for Radio Astrophysics, TIFR, Pune in the year 2015; and to Prof. P. N. Tandon in the year 2016;
- NASI – Swarna Jayanti Puruskars for Best Paper Presentation in the 86th Annual Session;
- NASI – Springer Awards for Best Paper Presentation in the Annual Session (started in 2015 in collaboration with the Springer India Pvt. Ltd.);
- Memorial Lecture Awards to about dozen eminent scientists;
- NASI – Science and Maths Teacher Awards by NASI HQ.

Programmes of the Academy

- Following the establishment of Ganga and the Brahmaputra river galleries. a third gallery on River Cauvery has been initiated at Mysuru, Karnataka with the financial support of the Govt. of Karnataka.
- In the year 2016-17, the Academy organized four workshops on Technological Empowerment of Women at different centers of the country; a Vision Document on women scientists in India was also released.
- Under the 'Safe Water' programme, the Academy restored 5 Baolies (Step wells) at Bundelkhand area to assure the availability of safe water to the local tribals and have-nots of the area. NASI also connected to MP Council of Science & Technology (MPCOST) with this programme for community schemes.

- The Academy took up a project against malnutrition in collaboration with ICMR- National Institute of Nutrition (NIN), Hyderabad in three places- Allahabad, Ahmedabad and Hyderabad. The first phase of study has been completed at Allahabad; further extension of this programme is being planned.

Some Output Indicators

S.No.	Parameters	Output
1.	Papers in refereed journals	About 200 (by NASI-Senior Scientists & researchers)
2.	Books/Monographs	05 books published by NASI
3.	Chapters in Books	About 12 (by NASI-Senior Scientists & researchers)
4.	Papers in Conferences	Many
5.	International Conferences Organized	nil
6.	National Conferences Organized	06
7.	State-of-the-art-Reports Published	02
8.	Journals Published	Total 14 issues of PNASI-A & B; & Sci. Letters
9.	Scientific Outreach Programmes organized	About 200
10.	Original Science Communication Content Designed	Several – 'in soft'
11.	Popular Science Books/Newsletters published	two
12.	Number of persons who attended various science outreach programmes/conferences etc.	About one lac
13. .	Scientific Lectures/Training Programmes organized	About 50
14. .	Number of students trained	About 500
15. .	Number of school/college/university teachers trained	About 200
16. .	Number of Innovators trained	About 100
17. .	Number of Innovations Registered	About 30
18. .	Data Bases Compiled	07 booklets
19. .	Compendia of Historical Data compiled	09 volumes on 'History of science in India'.
20. .	National Missions Led and Coordinated	Swastha Bharat, Swachh Bharat and Samarth Bharat Missions.
21. .	Foresight Reports and Analyses Prepared	Vision Document on Women in science, Safe Water and Communicable and non-communicable diseases.

CAPACITY BUILDING OF R&D INSTITUTIONS

Fund for Improvement of S&T Infrastructure in Universities and Higher Educational Institutions (FIST)

FIST Program is the major flagship infrastructure program which was launched by the Government in FY 2000-01. The Program 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.

The Program is currently operated in competitive mode of support at three levels i.e. Level 0, Level 1 and Level II 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 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. The quantum of support is limited to Rs 1.50 Crore, Rs 3.0 Crore and Rs 10.0 Crore for Level 0, Level I and Level II respectively, depending upon the type of department or college and quality of research/ teaching imparted.

Highlights of activities during 2016-17

The 16th round of operation was initiated and fresh proposals were invited in March 2016 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, 514 new proposals in all levels (L0- 177, Level I-234 and Level II –103) were received and finally165 proposals (L0-52, Level I-97 and Level II-16) were identified through the available mechanism of the FIST Program to consider financial support of varying quantum (from Rs.28 lakh to Rs. 685 Lakh) at a total budget of about Rs 233 Crores for 5 years. Apart from the process of evaluation and identification of new proposals to consider of support, progresses of 222 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 2310 S&T departments spread over 611 Academic Institutions and PG colleges (Level 0-301, Level I-1795 and Level II-216) have been supported with a total investment of Rs 2146 crores.

Outcome

Ever since its beginning, the FIST Program has provided sustainable funding over last fifteen 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: X-ray photoelectron spectroscopy (XPS), Micro CT, Confocal Microscope, Micro-scale thermophoresis, Reflection High Energy Electron Diffraction, Femto-second Ultrafast Spectrometer, Scanning Near Field Optical Microscopy, Electron Probe Micro Analyzer, High Resolution Transmission Electron Microscopy, FIB Based Scanning Electron Microscope, 600 MHz NMR, Thermo-Mechanical Stimulator, Hyper-Spectral Imaging System and etc.

The infrastructure provided by FIST Program has benefitted many prestigious medical/ veterinary/ paramedical institutions in the country like All India Institute of Medical Sciences, New Delhi; Sanjay Gandhi Post Graduate Institute of Medical Sciences, Lucknow; Postgraduate Institute of Medical Education and Research, Chandigarh; Maulana Azad Medical College, New Delhi; University College of Medical Sciences, Delhi; Mahatma Gandhi Institute of Medical Sciences, Wardha, JIPMER, Pondicherry; Christian Medical College, Vellore; Cancer Institute, Chennai; All India Institute of Speech and Hearing, Mysore; Institute of Post-Graduate Medical Education & Research, Kolkata etc.

Further, several departments of renowned Engineering Institutions have been regular beneficiaries of the FIST Projects both at Level I and II. This 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, Indore, Ropar and Mandi), Indian Institute of Sciences, Bangalore, National Institutes of Technology (Tiruichirapalli, Suratkhal, Calicut, Silchar, Kurukshetra, Durgapur, Agartala, Allahabad, Jaipur, Rourkela, Srinagar, Surat, Warangal, Raipur, Tripura), many Private Engineering Institutions such as Birla Institute of Technology, Vellore Institute of Technology etc., University Departments and Engineering Colleges.

Smart Grid Laboratory and Electric Machines & Drive Laboratory developed out of FIST Support at Department of Electrical & Electronics Enggineering, Birla Institute of Technology, Mesra, Jharkhand

Under the Networking facilities, support is provided for creation of Central Computer Lab in the Departments which includes Hardware, Software's and Could 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.

FIST Program has supported more than 300 PG Science/ Engineering/ Medical Colleges for rejuvenation of teaching and research facilities during the last fifteen rounds of support. The program has supported many prestigious Women's Colleges in the country such as Kanya Mahavidyalaya, Jalandhar, Sarojini Naidu Girls College, Gwalior, Governments Girls College, Kota, Mahila Mahavidyalaya, Varanasi, Providence Women's College, Kozhikode, St. Xavier's College for Women, Ernakulum, Sophia College for Women, Mumbai, Justice Basheer Ahmed Sayeed College for Women, Chennai, PSGR Krishnammal College for Women, Coimbatore, Lady Doak College, Madurai, Loyala College, Chennai, Stella Maris College, Chennai, Lady Brabourne College, Kolkata, Raja Narendralal Khan Women's College, Midnapore etc.

Research infrastructure Supported at the Department of Botany, University of Delhi

Promotion of University Research and Scientific Excellence(PURSE)

Department has proactively initiated a scheme **"Promotion of University Research and Scientific Excellence (PURSE)"** during 2009. The scheme was initiated with the purpose of building the research capacity of 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 whose h-index ranging from 56 to 26 have been supported ranging from Rs 30.0 Crores to Rs 6.0 Crores for 4 years' period based on the study report by NISTADS "Status of India in Science and Technology" as reflected in its publication output in Scopus International Database, for the three study periods 1996-2006, 1998-2008 and 2000-2010. However, the criteria has been revised recently as given below:

Table- 1: Criteria for Support in PURSE Program

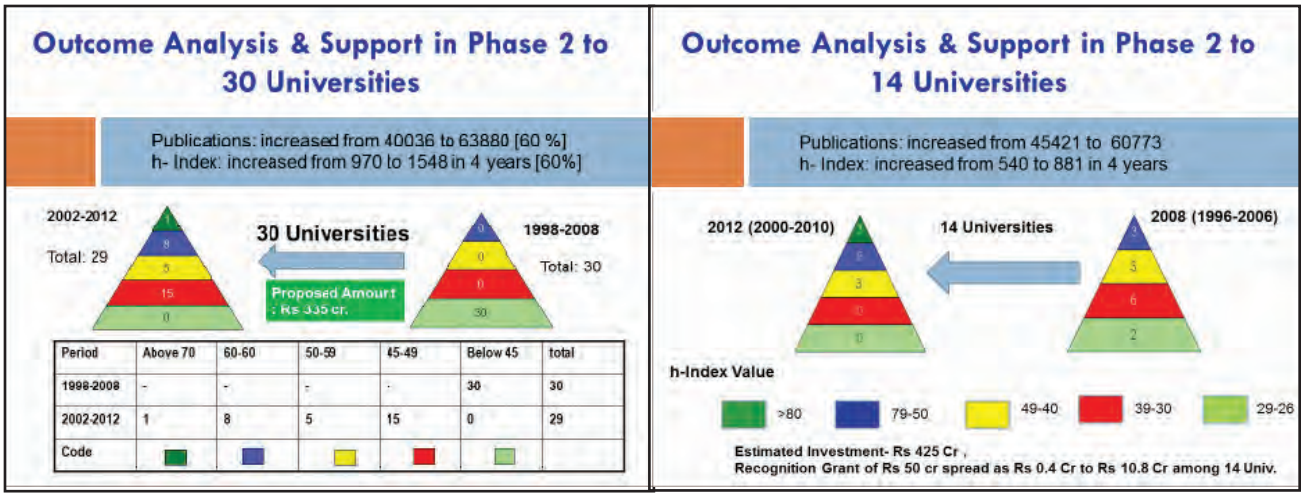
Initial h-Index	Revised h-index	Research Grant for 3 years
More than 50	More than 70	**Category A** (Rs 30.0 cr.)
40-49	60-69	**Category B** (Rs 15.0 cr.)
30-39	50-59	**Category C** (Rs 9.0 Cr.)
26-29	45-49	**Category D** (Rs 6.0 cr.)

Highlights of activities during 2016-17

Under this program large investments have been made to encourage, nourish and sustain research performance of the leading universities. The grant released in the scheme is for augmentation of research infrastructure at the University level. The Universities supported under the PURSE scheme are provided immense flexibilities with respect to choice of budget projection and selection of equipment required for conducting research etc. Under the PURSE initiative support is provide 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.

Outcome

PURSE Scheme has provided a triggering mechanism for promoting publication oriented research in the University sector deploying evidence based approaches. There has been significant increase in R & D outputs in PURSE supported Universities. Performance for the period of 1996-2006 and 2000-2010 for Set of 14 Universities has also been compared. Publications of this group of 14 Universities have increased by nearly 34% i.e. from 45421 to 60773 and h- Index increased from 540 to 881 in 4 years. Similarly, the increase in publications is about 60% i.e. from 40036 to 63880 for the period of 1998-2008 and 2002-2012 for another set of 30 Universities and h- Index also increased from 970 to 1548 in that corresponding period of 4 years.



An investment of Rs 890 crore was planned for 44 performing Universities identified and supported 14 Universities for 2 rounds and 30 Universities for 1 round since FY 2009-10 to till date and an amount of about Rs 550 Crores has already been made available so far to these Universities.

DST has re-constituted Program Management Board (PMB) this year to guide the DST on PURSE and to review the progress in PURSE Project at performing universities. Regular reviews of the PURSE Projects at various Universities have been performed. The monitoring has been further strengthened by introducing recently another review process at the University site under the chairmanship of the concerned Vice-Chancellor of the University.

Recently, DST had commissioned a study with Elsevier using SCOPUS database for studying performance of universities and academic institutes for the period 2002-2012. Based on the recommendations of the Program Management Board (PMB) on PURSE, 29 Universities have been identified by the department to consider of varying quantum of support depending upon the h-index value. This includes 5 new Universities in this list and dropping of 6 Universities supported in previous round based on their performance. The Table-2 below shows a set of 29 Universities under PURSE for their 2nd round of support (first 24 Universities) at a total planned investment of Rs 335 cores for 4 years'. The support to select all 29 Universities will be made available in the current financial year along with the second round of support to the ongoing set of fourteen Universities.

Table – 2: List of Selected 29 Universities under PURSE

Sr No	Phase II (Set of 29 Universities for 2nd round of support)
1	Annamalai University
2	Bharathidasan University
3	Bharathiar University
4	Guru Nanak Dev University
15	University of Lucknow
16	Madurai Kamaraj University
17	University of Kerala
18	Osmania University
19	Pondicherry University
20	University of Burdwan

5	Sri Venkateswara University
6	University of Jammu
7	University of Calcutta
8	Cochin University of Science and Technology
9	Dr. Harisingh Gour University, Sagar
10	Shivaji University
11	Punjab Agricultural University
12	Mahatma Gandhi University
13	University of Mysore
14	M.S. University of Baroda

21	Mangalore University
22	Bangalore University
23	University of Kalyani
24	Alagappa University
25	Hamdard University
26	Guru Jambeshwar University of Science and Technology
27	Punjabi University
28	Visva-Bharati University
29	University of Allahabad

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 of Science & Technology has thus set up **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 the institutions which do not have such instruments and enable them to pursue R&D activities requiring such facilities and keep pace with developments taking place globally.

At present, there are 18 Nos. Sophisticated Analytical Instrument Facility (SAIF) Centres viz. at IIT, Chennai; IIT, Mumbai; CDRI, Lucknow; Panjab University, Chandigarh; NEHU, Shillong; IISc, Bangalore; AIIMS, New Delhi; Gauhati University, Guwahati; IIT Roorkee; CVM, Vallabh Vidyanagar; Sophisticated Test & Instrumentation Centre (STIC), Kochi; IIT Patna; IIEST, Shibpur, Guru Ghasidas University, Bilaspur; Shivaji University, Kolhapur; University of Rajasthan, Jaipur; MG University, Kottyam and Karnataka University, Dharwad, and these are being supported by the Department of Science and Technology.

The SAIFs are equipped with instruments such as Nuclear Magnetic Resonance Spectrometer, Scanning Electron Microscopes, Transmission Electron Microscopes, Electron Probe Micro-analyzer, Secondary Ion Mass Spectrometer, ICP, EPR Spectrometers, Mass Spectrometers, X-ray Diffractometers and Thermal Analysis Systems etc. to meet the needs of research workers in various areas of science & 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 outside the host institutes and are being used extensively by the researchers from all parts of the country.

a) Instrument Facilities Strengthened in Various SAIFs

Instrument facilities were strengthened during the year in the areas of Electron Paramagnetic Resonance Spectroscopy, High Resolution Mass Spectrometry, Elemental Analysis and Thermal Analysis to meet the current and emerging needs of research community. Some of the major instrument facilities installed at the SAIFs during the year are Single Crystal XRD at SAIF Centre, IIEST, Shibpur and at SAIF Centre at IIT, Patna, Confocal Raman Spectrometer with AFM and Fluorescence Spectrometer with Life Time Detector at M.G. University, Kottayam. Accessories including EDAX at SAIF, Kochi and coating unit for FEG-SEM at SAIF at IIT, Bombay to make them more useful to the users. Cryo TEM at SAIF AIIMS, New Delhi, 500 MHz FT-NMR at Panjab University, Chandigarh and 400 MHz FT-NMR Spectrometer at Karnataka University, Dharwad are being added to the SAIFs to further strengthen them.

b) Analysis Provided/ Usage of the facilities

- The instrument facilities at the SAIFs are meeting the analytical needs of scientists for materials characterization including qualitative/quantitative elemental, molecular/compound analysis/ characterization, structure determination, microstructure analysis and surface topographic studies etc., and enabling them to pursue research in various frontline areas of S&T.
- About 2,000 research papers were published by the users of the SAIFs with the support from the facilities provided by the SAIFs during the year.
- About 16,000 researchers from all over the country utilized and benefited from the facilities provided by the SAIFs during the year. These included research workers from almost all the universities in the country. About 90% of the users are from academic sector.
- About 1,20,000 samples were analyzed at the facilities during the year.

c) Workshops/Training programs/Short term courses organized

Workshops and trainings 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 the instruments for technicians. About 30 participants attended each of these workshops/trainings. Some of the workshops/training programs/ short term courses organized are as follows:

No	Name of Workshops/ Training Program
1.	A National Workshop on Vibrational Spectroscopy in Structure and Chemical Property Studies by SAIF at IIT Chennai
2	An "Electron Microscopy Course" was conducted at SAIF, IIT, Bombay with lecturers on Bio and Cryo TEM Sample preparation, Instrumentation, Beam Specimen Interaction (SEM), Imaging 9SEI, BSE) and SEM Applications.
3	A Workshop on "X-Ray Diffraction, Scanning and Transmission microscopy was organized by SAIF at Panjab University, Chandigarh
4.	a. Workshop on Electron Microscopy in Material Science and related fields was organized by SAIF at NEHU, Shillong
5	Workshop on Recent Advances in NMR Spectroscopy was organized by IISc., Bangalore
6.	Workshop on the Application of Instrumental Technique in EPMA was held in IIT Roorkee
7	XXXII National Program in Electron Microscopy for Scientific Investigators, AIIMS, New Delhi

Confocal Raman Spectrometer with AFM

Joint Collaborative R & D activities between DST and RCUK

Since 2008, towards enhancement of linkages between India and UK, the Department of Science & Technology (DST), New Delhi and Research Councils (RC) UK have instituted a few collaborative research and development programs. Broadly the objectives of this partnership are for helping to develop innovative and entrepreneurial skills amongst researchers and support the commercial development of technology and expertise in spin-offs. The aims of such joint research and development collaborative programs is also raising the impact & profile of collaborative activity and facilitates innovation from existing research between these two countries. Moreover, these activities would also accelerate the deployment of research knowledge, deepen & strengthen current research links, enable the acquisition

of new skills and encourage wealth creation through improving transfer of research and expertise from the research base to businesses and other users by building science and innovation bridges with world-class universities and high-tech businesses. So far the Department of Science & Technology (DST) and Research Council of UK (RCUK) have collaborated in programs like Science Bridges (2008), Next Generation Networks (2008), Solar Energy (2009), Fuel Cell (2010), BURD (2010), Advanced Manufacturing (2012-13), Smart Grid & Energy Storage (2012-13) and Applied Mathematics (2013) with an expected investment of about 30 M UK Pound by each country.

In all these areas, the specific theme areas of collaboration having common interest from both countries were identified by organizing the joint Workshops between the Academicians/ Scientists/ Industry partners from both countries. Subsequently on the basis of Joint Call announcement on these theme areas, projects were identified and recommended through the Joint Expert Panel specific to each area and financial supports are being considered and provided subsequently by the respective country to their part of activities. These programs are currently being coordinated by R & D, Infrastructure Division and financial supports are provided through R&D support budget.

a) Research Collaborations on Solar Energy

The 2nd Phase of Indo UK joint collaborative project "Advancing the Efficiency and Production Potential of Excitonic Solar cells (APEX)" project was sanctioned at a total cost of Rs. 5.4 Crores for 2 years at seven participating institutes, NPL, New Delhi, NCL, Pune, JNCASR, Bangalore, IITD, IICT, Hyderabad, IISc, Bangalore and IIT Kanpur and the first installment of funds was released in August, 2015. The project had been focusing on the development of new functional materials, device structures, materials processing and engineering of photo-volataic modules, utilizing excitonic solar cells.

b) Research Initiatives on Smart Grid and Storage

DST in collaboration with the Engineering and Physical Sciences Research Council (EPSRC) has identified Smart Energy Grids and Energy Storage as areas of significance in providing solutions of meeting future energy needs. 5 research proposals have been supported focusing in the areas namely, Appropriate distributed storage technologies, On/Off grid energy systems, DC networks and Control & communications, which are currently under joint implementations.

Nine national institutions supported during the project include Indian Institute of Technology Delhi, Indian Institute of Technology Kanpur, Indian Institute of Technology Kharagpur, Indian Institute of Technology (IIT) Madras, Delhi Technological University (DTU), Visvesvaraya National Institute of Technology(VNIT), Nagpur, Indian Institute of Technology (IIT) Roorkee, Malaviya National Institute of Technology (MNIT), Jaipur and Indian Institute of Technology (IIT) Bombay. The participating UK institutions are The University of Manchester, Imperial College London, University of Strathclyde, University of Exeter, Queen's University of Belfast, University of Bath, Cardiff University, Durham University, University of Nottingham, University of Warwick. The following 5 proposals have been approved for funding under DST-RCUK under the areas of Smart Energy Grids and Energy Storage

(SEGES) Technologies. The approximate commitment of DST is Rs. 35.01 Crores for 3 years.

PI Name	Project Title
Dr. Nilanjan Senroy, IIT Delhi	Advanced Communication and Control for the Prevention of Blackouts (ACCEPT)
Prof. Chandan Chakraborty, IIT Kharagpur	Reliable and Efficient System for Community Energy Solutions- RESCUES
Prof. N. P. Padhy, IIT Roorkee	High Energy And Power Density (HEAPD) Solutions to Large Energy Deficits
Dr. Prakash C Ghosh, IIT Bombay	Intelligent Microgrids with Appropriate Storage for Energy (IMASE)
Dr. Prabodh Bajpai, IIT Kharagpur	Reconfigurable Distribution Networks

i) Advanced Communication and Control for the Prevention of Blackouts (ACCEPT)

(IIT-Delhi, IIT-Kanpur and IIT-Kharagpur)

- Developed a technique to identify the tripped line(s) after a fault with negligible computational burden.
- Developed a technique to apply the transient energy function (TEF) method for assessment and alleviation of transient stability in real time.
- A procedure has been presented to design a robust controller to deal with the problem of imperfect communication.
- A periodic output feedback (POF) based wide area damping controller has been presented. The advantage of this controller is that it receives system output measurements at a lower sampling rate, and the controller output is generated at a higher rate.
- A Recurrence Quantification Analysis based methodology has been presented to cluster generators based on similarity of their post disturbance oscillatory behavior. The methodology focuses on cases that do not exhibit aperiodic first-swing instability.
- Developed two protection techniques using generated as well as available data.

ii) Reliable and Efficient System for Community Energy Solutions (RESCUES)

(IIT- Kharagpur, IIT- Delhi, IIT- Madras, DTU- New Delhi and NIT- Nagpur)

- Developed the converter based system for solar power integration
- Developed voltage/frequency stabilization algorithms for the AC grid
- Developed controller to support unbalanced loading in solar PV fed micro-grid

- Developed dual active bridge based voltage regulator for DC grid
- Developed Brushless and magnet-less generating system for wind power extraction in remote areas.
- Single stage and double stage Solar PV systems.
- Finite volume method based mathematical modelling of packed bed thermal energy storage system.
- 2kW Modular Soft-Switched High Step-up DC-DC Converter and a 3 kW Resonant Converter for DC micro-grid have been developed

Micro-grid Prototype facility at IIT Kharagpur & VNIT Nagpur under RESCUES

iii) High Energy And Power Density (HEAPD) Solutions to Large Energy Deficits

(IIT- Roorkee, IIT- Delhi, IIT- Kharagpur and MNIT, Jaipur)

- DC micro-grid bench mark setup has been developed for the investigation of DC grids insertion at distribution and transmission
- A scheme is proposed to diminish stress on conventional grid during peak and non-peak hours by utilizing DC micro-grid at low and medium voltage level domestic or industrial consumer with sensitive loads. Optimal utilization of renewable resources by providing effective coordination between sources, storage and loads.
- Method for load flow solution of ac-dc radial distribution networks is proposed.
- Bidirectional DC-DC converter proposed for integration of low voltage storage devices in DC micro-grids.
- A reactive power management scheme has been proposed by employing converter fed with wind

and Photovoltaic based plants.

iv) Intelligent MicroGrids with Appropriate Storage for Energy (IMASE)

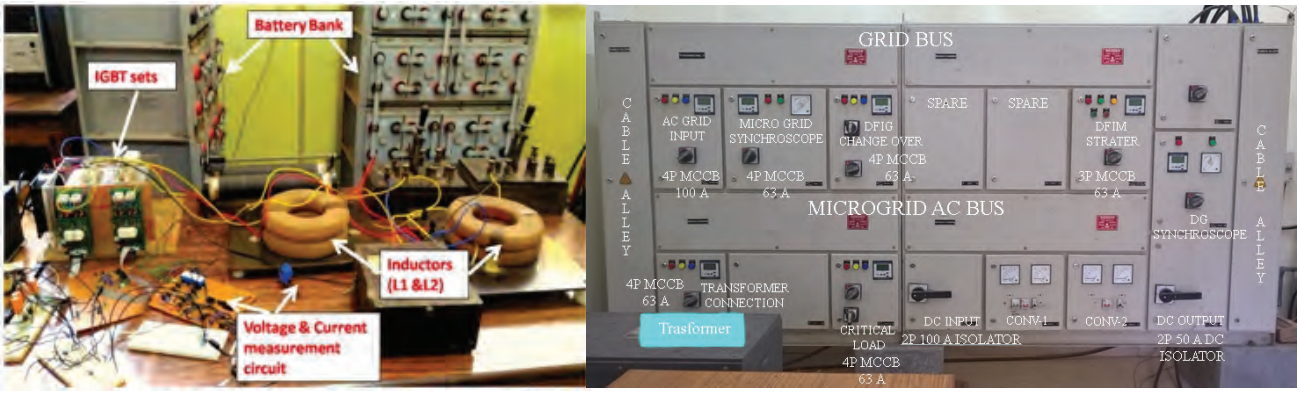
(IIT- Bombay)

- Designed the controllers for solar PV, battery, fuel cell and Ultra Capacitor(UC) interfaces with the micro-grid.
- Real time simulations done for solar PV and battery based DC micro grid system.
- Identified real time scenarios with instantaneously varying load profiles.
- Identified suitable materials for stationary hydrogen storage applications.
- Developed single fuel cell and tested with air and oxygen.

v) Reconfigurable Distrubuted Networks

(IIT- Kharagpur, IIT- Bombay and IIT- Kanpur)

- Design of hybrid (AC-DC) micro-grid system, composed of solar PV array, Wind emulator system, Fuel cell system, Diesel generator and storage of Battery and super-capacitor along with control platforms to host prototype new devices for interfacing AC and DC micro-grid buses.
- Designed 5 kW module which could be inserted in a 3-phase 3-wire to 3-phase 3-wire configuration.
- Developed distributed control strategy to perform without any supervisory controller even at light loaded condition.



c) Research Initiatives on Advanced Manufacturing

The Department under the DST-RCUK collaborative program in "Advanced Manufacturing" had approved 6 joint proposals within a total investment of Rs 16.0 crore from India side in the area of Advanced Manufacturing with an investment plan of 3M UK Pound by each country during 3 years of project duration. The review of the projects supported under this initiative was performed in the

current financial year. These proposals were reviewed for their progress during this financial year, and the progress of one joint project between IIT-Delhi & IIT-Mumbai and University College, London on Creation of a process understanding of Chromatographic Performance Loss during Bio-therapeutic Manufacture was rated as "Excellent". The synergy between the Indian institutions and the University College, London has been reached and they have developed a process of explaining the mechanistic understanding of fouling and the process of Protein A chromatography for purification of the bio-therapeutic products with support from Dr Reddy's Lab. They are now involved in process optimization working for development of bio-sensor for the detection of Protein A in the chromatography process with sensitivity 3 ng/ml. The team has filed one patent from the project and has 3 joint publications.

In another project on Development of On-line, High Temperature, Non-destructive Measurement/ Sensing Techniques During Manufacturing of Power Plant Components the team from IIT-Chennai and University of Warwick have studied interaction of guided ultrasonic waves with previously induced defects particularly in the areas of welding and bending joints on pipes. They have experimented using piezo based transducing system for online monitoring at the welding joints and few bending junctions and welding work at BHEL Boiler Plant, Tiruchirappalli which is their industrial partner. The progress has been rated as "Very Good".

In another project rated as "Good" was related to Improvements in Gas Turbine Performance Via Novel Plasma Spray Coatings Offering Protection against Ingested Species the team at ARCI-Hyderabad and its partnering Institute University of Cambridge have developed a new protection layer using appropriate choice of RE based zirconates.

The other 3 projects at IIT-Delhi with IISc-Bengaluru & IIT-Guwahati and Loughborough University; IIT-Mumbai with IIT-Indore & CMTI-Bengaluru and Cranfield University & IIT-Ropar & IIM-Lucknow and University of Cambridge have been suitably guided by the Experts to get tangible output from the groups.

d) Initiative on Applied Mathematics

The initiative on Applied Mathematics between India and UK has been implemented on the following objectives:

(i) Encourage and enable closer collaboration between the Indian & UK Researchers in this strategically important area

(ii) Develop networking between young Indian and UK scientists and students

(iii) Identification of specific topic for the development of Joint Project

(iv) Pedagogical course content development

(v) Encourage students to take Mathematics as a Research Carrier.

Under this initiative, in different theme areas eight (8) Workshops (4 each in India and UK) have been

organized. In these Workshops, around 300 Faculty Members and students participated from both countries. They have immensely benefited from these joint workshops, organized by DST and RC-UK.

e) UK - India Joint Virtual Centre (JVC) on Clean Energy

i. In the Area of Energy India and UK have collaborated in the area of solar energy, fuel cells, smart grids and energy storage and rural energy systems. The scope of these program included advanced research in the area of organic solar cells, performance assessment of solar cells, fuel cells, distributed storage, DC Networks, controls and communication as well as systems for practical rural application such as biomass and biomass photovoltaic hybrid systems.

ii. The proposed two JVCs will operate through two projects in the areas of solar energy, energy storage and networks. It would aim at development of pre-competitive technologies with integral end user engagement and though Centres would build upon existing collaboration, its scope would be beyond the existing collaboration in terms of demand orientation technology focus and resource sharing by consortia with multi-institutes participation. It was agreed that the Centre should also have a major role in integrating the existing DST-EPSRC portfolio of research and innovation on clean energy systems. The two proposals are being supported as given below:

a. UK India Clean Energy Research Institute (UKICERI) - IIT Kharagpur

b. India-UK Centre for Education and Research in Clean Energy (IUCERCE)- IIT Bombay.

PROVIDING MEGA FACILITIES FOR BASIC RESEARCH

The Mega Facilities for Basic Research Programme, or the Mega Science Programme, as it is popularly known, aims at creating 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. Such projects, being technically extremely complex and requiring huge funds and other resources, are mostly, and naturally, multi-agency, multi-institutional and, most often, international in character. Most of the projects currently under implementation under this programme, in the areas of nuclear physics, high energy physics, astronomy and astrophysics etc., have been jointly funded and overseen by the Department of Science & Technology (DST) and the Department of Atomic Energy (DAE). DST and DAE have a long-standing MOU on joint funding, implementation and monitoring of such projects and the inter-agency cooperation has been exemplary. Several important developments took place during the year under this Programme.

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

The implementation of FAIR project gained further momentum during the year and the project reached several important milestones. India has to supply the following items to FAIR as its in-kind contribution: Power Converters, Vacuum Chambers, Beam Stoppers, Superconducting Magnets and Advanced Detector Systems. During the year, significant progress was made in each segment as mentioned below:

Power Converters: Two prototype power converters underwent Factory Acceptance Test by FAIR engineers at ECIL, Hyderabad and these were sent to FAIR, Germany for Site Acceptance Test.

Fig.1: Factory Acceptance Test for Prototype Power Converters under progress

Vacuum Chambers: About 100 units of ultra-high vacuum chambers are to be fabricated and supplied to FAIR as India's in-kind contribution. A German team visited India and carried out inspection at the industry site in Pune regarding facilities for fabrication and testing of vacuum chambers that would be manufactured. The German team inspected the facilities for material handling, welding, ultra-sonic cleaning and vacuum testing. The prototype chambers have gone through successful vacuum tests and they would be sent to FAIR, Germany after completing some mechanical work.

Fig. 2: Factory Acceptance Test of Ultra-High Vacuum Chambers in progress

Beam Stoppers: The purpose of this device is to absorb high energy and high intensity primary and secondary beam particles. There will be three such absorbers and Indian contribution will be to design, build and test the entire system. The design is fairly specialized as the system will be in high radiation environment and needs to deal with static and dynamic beam profiles. CMERI, Durgapur completed the design of beam stopper and it is under examination at FAIR.

Superconducting Magnets: Several large-aperture superconducting magnets are to be designed and built in India. During the year, rework to find a cost-effective design continued and was brought to an advanced stage and would be completed shortly.

Advanced Detector Systems: During the year, the Executive Council for FAIR project, co-chaired by Secretary-DST and Chairman-Atomic Energy Commission (AEC), approved funding for development of Muon Chamber System for Compressed Baryonic Matter (CBM) experiment and spectrometer and neutron detector system for Nuclear Structure and Reactions (NuSTAR) experiment. R&D and Technical Design Report work were completed and their fabrication would start shortly. The Muon Chamber project for the CBM Experiment at FAIR reached an important milestone in terms of building and testing of real size GEM chambers. A specialized Application Specific Integrated Chip (ASIC) has been developed and tested successfully for reading the GEM chambers. Real-size prototype mechanical stand for the muon chamber station has been setup at VECC, Kolkata. Two specialized water-cooling systems have been fabricated at Bose Institute, Kolkata and VECC, Kolkata using two separate techniques. Two real-size prototype chambers, cooling systems, readout and DAQ were used in the test beam experiment at CERN, Geneva in November-December 2016 to take data with Pb+Pb collisions at beam energies of 13, 32 and 150 GeV.

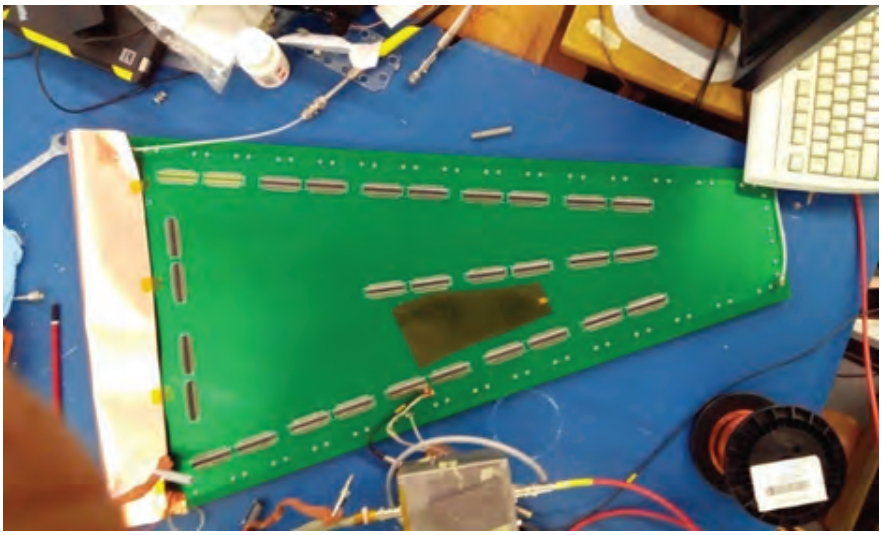


Fig. 3: A real-size prototype GEM chamber under test

During the year, FAIR-MONSTER Collaboration in India successfully fabricated prototype neutron detectors.

Participation in FAIR Experiments: Indian researchers will participate in a big way in two large experimental collaborations at FAIR viz., NuSTAR and CBM. A large number of teams from national labs and universities submitted proposals for their participation. The proposals were evaluated by an Expert Committee and funding for the projects would start shortly.

3 Workshops on different aspects of FAIR project, viz., “Electronics at FAIR: Indian Perspective”, “Physics of CBM Experiments”, and “Nuclear Physics at FAIR” were organized during the year.

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

Participation in the CMS, ALICE and GRID projects continued to be supported during the year. 5 new groups joined the India-CMS Collaboration during the year. Indian researchers and Ph.D. students from the participating institutions continued their research work under these projects.

Associate Membership of CERN

India signed the Agreement for Associate Membership of CERN at DAE Headquarters in Mumbai on 21st November, 2016.

Fig. 4: Signing of Agreement for India's Associate Membership of CERN

The ratification of this is expected during 2016-17 in the CERN Council meeting. This will complete the process for India becoming an Associate Member of CERN.

India-based Neutrino Observatory (INO), Madurai

Support to 13 university groups for INO-related R&D and prototyping work continued during the year.

Thirty Metre Telescope (TMT) Project at Mauna Kea, Hawaii

As civil work on the summit of Mauna Kea, Hawaii had to be stalled because of the Order of the Supreme Court of Hawaii directing the TMT Authorities to seek the Permits afresh, the TMT Board adopted a two-pronged strategy to mitigate the uncertainties arising out of this situation – (i) the TMT Board applied for the Permits afresh, as Mauna Kea still remains the preferred site owing to its favourable characteristics; and (ii) decided, after elaborate scientific and logistic considerations, that the La Palma site in Canary Islands, Spain would be the fall-back option in case the Permits for Mauna Kea get unduly delayed.

Work on development of components continued in full swing, both in India and in other partner countries. The Indian scientists and engineers, in association with a number of Indian industries, continued work on different aspects of the Work Packages assigned to India. Significant progress was made in this direction as mentioned below:

Hardware

M1 Segment Polishing: As part of in-kind contribution, India has to carry out polishing of 90 TMT segments, each of 1.44 metre diameter. At present, no Indian industry exists having capability to fabricate large optics with high precision. The challenge of this work has been taken by IIA, Bengaluru and the work will be done at its CREST Campus, Bengaluru over a 5-year period. Construction work on CREST campus commenced in August, 2016. The Optics Team also carried out important scientific studies on stress mirror polishing techniques and simulations on optimizing mirror warping forces.

Segment Support Assembly (SSA): Prototyping of three sets of SSAs each from two Indian industries was completed during the year. Study of non-conformances observed by both the industries were also conducted separately and plans for overcoming the mistakes were prepared. A Request for Proposal (RFP) for the next stage viz. the Production Qualification Process (PQP) was prepared and sent separately to three industries. For the critical parts of SSA, viz. central diaphragms, mirror rod flexures etc., for which none of the industries could meet design specifications, India-TMT is conducting trials and studies at Central Tool Room and Training Centre, Bhubaneswar, Techno Tools Pvt. Ltd., Bengaluru and National Centre for Aerospace Innovation and Research of IIT-Bombay. India-TMT is hoping that these R&D Centres will provide details of process development which can be transferred to the industries in the country for manufacturing.

Actuators: 10 prototype actuators were manufactured in collaboration with Indian Industry after undergoing successful tests at Jet Propulsion Lab, Pasadena (USA).

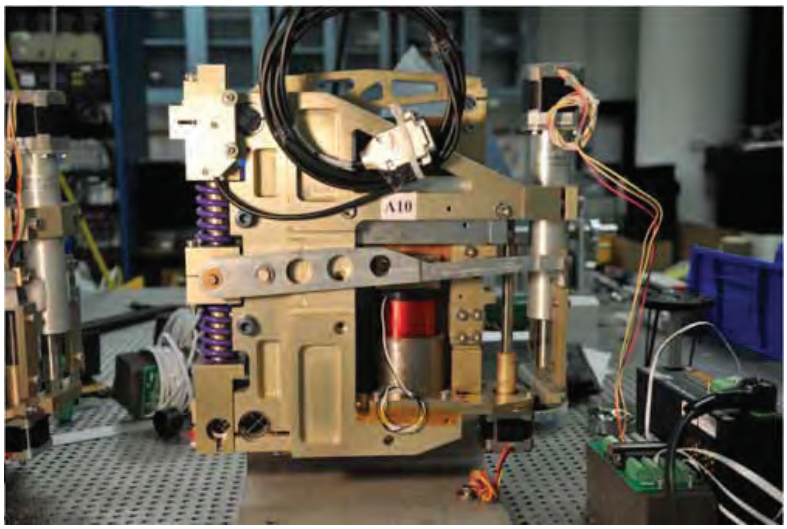


Fig. 5: Prototype of Actuator

Edge Sensors: Sensors for TMT are based on capacitive sensor technology, which allows high precision contact-less measurement, over a large operational range. Each mirror segment will have 12 edge sensors and, in total, 3234 sensors are required for TMT. As a part of India's commitment towards in-kind contribution, TMT edge sensors are to be supplied by India. Prototypes of 25 edge sensor pairs were successfully completed by Indian industry. The prototype sensors went through rigorous inspection for dimensionality as well as tests for humidity and temperature cycling, adhesion and abrasion etc. and it was found that they met all technical specifications and the gold coating done on polished surfaces was found to have better coating adhesion compared to earlier prototypes manufactured in USA. As only one industry was identified for manufacturing edge sensors in India, efforts were made to identify more such industries. Another company in Mumbai has been identified. Since they do not have expertise in precision lithography, the sensor prototyping work has been divided in two parts. The industry has been entrusted with machining work on glass, whereas work related to lithography development and coating process have been entrusted to RRCAT, Indore.

Instrumentation: India-TMT is continuing its work on development of the first light instrument called Wide Field Optical Spectrograph and Imager (WFOS). In order to put together good teams for design, development and testing of state-of-the-art instruments for TMT and upcoming instrumentation facilities in the country, India-TMT conducted Workshops at Srinagar (J&K), Tezpur and Hyderabad during the year. India-TMT continued helping and motivating students to do doctoral and post-doctoral research on TMT- related technologies.

Observatory Control Software (OSW): TMT Observatory Software consists of a set of software components that control the operations of the telescope, the mirrors, the telescope dome or enclosure and various instruments. Three modules of Observatory Software are, Common Software, Data Management System and Executive Software. India's work share includes 49% of the Observatory Software. Preliminary Design Review of the Common Software was completed. Management Review of the Common Software was also successfully completed during the year. Common Software development was under progress.

Telescope Control System (TCS): TCS is responsible for coordination and control of various telescope subsystems. India-TMT will develop TCS by taking it through its various phases − preliminary design, final design, code and test, integration and test and, finally, assembly, integration and verification at TMT site. IUCAA is the Lead Institution for development of TCS. The first phase of the project which focuses on a small representative subset of the TCS, both in terms of subsystem content and in terms of the type of work that will be needed for the subsequent project phases, was initiated during the year.

Outreach Activities

As part of outreach activities, a "High Resolution Spectroscopy" Workshop was organized with participation of about 60 participants from all over the country including 20 participants from the universities.

Besides development work, 12 scientific and technical publications emerged from the project during the year. 5 Project Engineers, 1 Post-Doctoral fellow, 4 Ph.D students, 3 M.Tech. students and 2 Project Interns received training regarding different aspects of the project. The Executive Council of the project, co-chaired by Secretary-DST and Chairman-AEC, reviewed the progress made in the project during the year.

Laser Interferometer Gravitational-Wave Observatory (LIGO) Project

LIGO-India is the proposed advanced gravitational-wave (GW) observatory which will be located in India as part of a worldwide network and it will be the world's third advanced Laser Interferometer Gravitational Wave Observatory. The LIGO-India observatory will be set up as a joint scientific collaboration between LIGO laboratories of California Institute of Technology (Caltech) and Massachusetts Institute of Technology (MIT), USA and three lead Indian institutions, Inter-University Centre for Astronomy and Astrophysics (IUCAA), Pune, Institute for Plasma Research (IPR), Gandhinagar and Raja Ramanna Centre for Advanced Technology (RRCAT), Indore.

The site selection for LIGO-India project was completed during the year. Preparation of the Detailed Project Report (DPR) for the project was initiated during the year.

Square Kilometre Array (SKA) Project, South Africa and Australia

Scientific deliberations on this project continued during the year. SKA will be the largest radio telescope to be built in the world and it will be located in South Africa and Australia. India has also joined this project. National Centre for Radio Astrophysics (NCRA) of the Tata Institute of Fundamental Research (TIFR), Pune and Raman Research Institute, Bengaluru (RRI) are the Lead Institutions. NCRA is being funded by DAE and RRI by DST through its institutional support.

Indian Participation in Neutrino Experiments at Fermi National Accelerator Laboratory, USA (Fermilab)

Support to 8 institutions involved in the project continued during the year. Indian faculty members and Ph.D. students from different institutions across the country continued research work on different experiments at Fermilab.

Setting up a macromolecular crystallography and high pressure physics beam line at the Elettra Synchrotron Facility, Trieste, Italy.

The twin Indian beamlines, XRD2 and Xpress were inaugurated on 20th October 2016. The beamlines are now available for scientific experiments.

Fig. 6: Inauguration of XRD2 and Xpress beamlines at Elletra site, Trieste, Italy

Low-Energy Accelerator-based Research Facilities

Support to the low-energy accelerator-based research facility at Kurukshetra University continued during the year. The facility is being utilized for scientific experiments.

A high-fluence ion beam accelerator-based research facility was installed and commissioned at Allahabad University during the year. The facility is undergoing trials for experiments.

International Recognitions

The discovery of gravitational waves was reported in February 2016 in which 37 Indian scientists had also contributed. The Selection Committee of the Breakthrough Prize in Fundamental Physics announced an award of $3 Million in recognition of contributions of scientists involved in the discovery. This award was shared among the contributing scientists including 37 Indian scientists.

Prof. Sibaji Raha, Bose Institute, Kolkata was chosen as a Member of the GSI-FAIR Joint Scientific Council and also elected unanimously as its first Chairman. He is the first Indian scientist working in India to be accorded such an honour.

Dr. Tapan Nayak, Spokesperson, India-ALICE Collaboration was elected as the Deputy Spokesperson of the ALICE experiment.

Others

As most of these projects are very long-term projects, DST and DAE provided funds to the scientific community to participate in international discussions on the International Linear Collider (ILC) and to participate in the deliberations of the Asian and International Committee for Future Accelerators (ACFA and ICFA).

One School on "Accelerator Science and Technology" was organized at the Inter-University Accelerator Centre (IUAC), New Delhi through DST funding in which 45 faculty and students participated. Indian

scientists also participated in deliberations of the ICFA andACFA meetings during the year. Another Workshop on "RF System for Accelerators" was organized at IUAC, New Delhi during February 6-8, 2017.

STRENGTHENING SURVEY AND MAPPING CAPABILITY

SURVEY OF INDIA: Topographical Data Base plays very significant role in the planning for developmental activities of the nation. Survey of India, the National Survey and Mapping Organisation of the country has the unique responsibility of providing timely, updated, cost effective and accurate Topographical Data Base for expeditious and integrated development and ensure that all resources contribute their full measure to the progress, prosperity and security of our country now and for generations to come. In this prominent role, the Department ensures that the country's domain is explored and mapped suitably to meet the emerging needs of the user community.

Survey of India is also responsible for Geodetic Control (Horizontal and Vertical) and Geodetic & Geophysical surveys, Production of Aeronautical Charts; undertaking specialised surveys for Developmental Projects, demarcation of the external boundaries of India, ensuring their accurate depiction on the maps published in the country and also advice on the demarcation of inter-state boundaries.

Outputs/Services Produced:

a) Antarctica Expedition

Initiative: Survey of India started participation in Indian Antarctica Research Programme from 10th Expedition, since then a network of Ground Control Points and Large scale mapping has been carried out during all Expedition.

Detail Survey work carried out at Larsemann hills in Antarctica by Survey of India Team

Achievement: Survey of India Team completed detail survey work in Larsman Hills 5.6 Sq. Km. on scale 1:5,000 with contour Interval of 2m and at Schimacher Osis 3.7 Sq. Km. on scale 1:10,000 scale wit contour Interval 5m respectively during 35th Indian Scientific Expedition. Digitisation of the maps is also completed.

Four members Team from Survey of India departed for 36th Indian Scientific Expedition to Antarctica. The team will carried out Large Scale mapping at Sciirmachar Oasis & at Larsemann Hill and study of Interplate movement between Indian Plate and Antarctica Plate during the Expedition.

(b) R&D manpower trained/generated (Ph Ds etc.):

Indian Institute of Surveying & Mapping (IISM), imparts training to the Officers and Staff of Survey of India and other Government Organisations, Private Individuals and Scholars from various Afro-Asian countries.

22 departmental Officers, 62 extra-departmental and 106 trainees (s) have been trained up to November, 2016. Further 154 departmental officers, 30 extra departmental trainees from Centre/State Government organizations, 06 foreign trainee and 20 others are undergoing the training.

(c) Technologies developed and transferred:

1. Departmental work:

1.1 Updation of National Topographical Database on various Scales:

Initiative:

To fulfill the requirements of updated high quality spatial data for socio-economic developmental activities, conservation of natural resources, planning for disaster mitigation, expeditious infrastructure and development works of the Nation, Survey of India has proposed and executed the work of Preparation of updated OSM and DSM datasets (DTDB & DCDB) with pre-field updation using High Resolution Satellite Imagery (HRSI) followed by revision survey on ground and the same is being undertaken by all Geo-spatial Data Centers.

Achievements:

Survey of India has completed the updation of topographical data on the 1: 50,000 scale and 1:25,000 scale as detailed below:

1:50K scale sheets

Pre-field updation	=	50 sheets (including Trans border sheets)
(Using latest Satellite Imagery)		
Revision survey	=	44 sheets

1:25K scale sheets

Pre-field updation	=	245 sheets
(Using latest Satellite Imagery)		
Revision survey	=	200 sheets
Post field updation	=	95 sheets

1.2 Generation of National Topographical Digital Database on various scales:

Initiative: Digital Topographical Data Base of some parts of the country on the 1:25,000 scale has already been completed and Digital Topographical Data Base of remaining existing maps on 1:25,000 Scale available in the Hard copy as printed maps, PT section, Air survey section, Scribing section etc and preparation of OSM are in progress.

Achievement: Digitization of 1:25,000 scale maps, QC/ Examination of digital data and OSM preparation completed during the year.

Digitization	=	356 sheets
QC	=	1061 sheets
Preparation of OSM	=	700 sheets

1.3 Generation of OSM Hindi version and OSM Regional Language (s) version:

Initiative: Survey of India has completed Open Series Maps (OSMs) on 1:50,000 Scale English version and are available for use by the users. To fulfill the requirements for Hindi version and regional language (s) version preparation of OSM (Hindi) and OSM (Regional Languages) on 1:50,000 scale is under progress.

Achievements: Survey of India has completed the preparation 41 Nos. of OSM Hindi version and 06 Nos. of OSM Regional Language during the year.

1.4 Providing OSM DTDB Data for Web Services like WMS/WFS:

Initiative: Survey of India is providing Web Map service (WMS) based on 1:50K OSMs through SoI portal "surveykshan.gov.in" for the open viewing as mandated by the NDSAP-2012. Efforts are underway to provide the data service of feature data through Web Feature Service (WFS).

Achievements: Preparation of Quality controlled base data on 1:50,000 scale for Web Map Service (WMS) was completed for 285 sheets and for Web Feature Service (WFS) 357 sheets have been quality controlled by various GDCs during the year.

Total OSM sheets Quality controlled and hosted as WMS = 4334Sheets

2. Extra Departmental Project:

Specialized Survey:

Initiative: Survey of India is responsible for defining the horizontal and vertical frame work for entire country, maintains a series of tidal observatories located all along Indian Coast and Islands and also has the responsibility to Provide and Maintain the Gravimetric and Geomagnetic control network of country.

Achievements: Geodetic & Research Branch of Survey of India carried out the flowing activities during the year.

a) Preparation of Geomagnetic Bulletin, 2015 and magnetic Declination chart Epoch 2015.

b) Geo-magnetic observations are continued at Digital Geomagnetic Observatory, Sabhawala Dehradun for determination of Horizontal Force (HF), Vertical Force and Declination (D). These observations are helpful to monitor and record different components of geomagnetic variations and are necessary to control the baseline values of the Magnetogram.

c) Geo-magnetic observation on 49 Repeat stations at central India.

d) Gravity Observation on 150 Station and processing of data.

e) Processing for tidal prediction for 76 Primary ports (30 Indian & 14 foreign ports). Tidal Predictions one year in advance in the form of India Tide Table and Hugli River Tide Table for safe navigation. Indian Tide Table 2017 and Hugli River Tide Table, 2017 has been Published.

f) Work of Inspection and maintenance of Tide Gauges at 26 ports and HP/Secondary Leveling approx 280 lin. km. (Connecting 14 Ports).

g) 32 days Tidal observation in Andaman & Nicobar Islands 5 ports and 30 lin. km. HP/Secondary levelling.

h) Provision of Monthly and Annual Mean Sea Level to Permanent Services for Mean Sea Level (PSMSL), UK as an international commitment.

i) Non-harmonic tide levels for Harbour / Port developmental activities.

j) Provision of tidal data to Early Tsunami Warning Centre, Indian National Centre for Ocean Information Services (INCOIS), Hyderabad.

k) Provision of tidal data to Bhaba Atomic Research Centre (BARC), Mumbai.

International Boundary Demarcation/Pillar Re-location or Relay Survey Works:

Initiative: Survey of India has been given the responsibility by the Ministry of External Affairs for all surveying works i.e. boundary demarcation, relocation of boundary pillars of International boundary

with Nepal, Bhutan, Bangladesh, Myanmar, Pakistan and China. SoI also advises State Govts. and Govt. of India on matters of International boundary and States/ UTs boundaries and carries out surveys as and when required to resolve the disputes as Extra-Departmental jobs.

Achievements: All Surveying tasks associated with the International Boundary like Joint Inspection/ Maintenance /Relocation of boundary pillars etc along International Border as given below were carried out during the year:

- Joint Inspection/Maintenance of boundary pillars along Indo – Bhutan boundary.
- Joint Inspection/Maintenance of boundary pillars along Indo – Myanmar boundary.
- Joint survey construction / relocation of missing pillars along Indo - Pak Boundary (Punjab and Rajasthan Sector).
- Joint survey construction / relocation of missing pillars and coordinating by GPS along Indo – Nepal boundary.

Mapping and Delineation of Hazard Line:

Initiative:

To delineate, map and benchmark the coastal hazard line all along the mainland coast of India under World Bank Assisted "Integrated Coastal Zone Management" (ICZM) project, where Survey of India has to generate a 0.5 meter elevation contour map on 1:10,000 scale as base map to delineate the Hazard Line for the entire mainland coast of India. (Strip width of maximum 7 km from line towards main-land)

Achievement: Control work consisting of GPS observation and levelling of the entire coastal area, QA/QC of Aerial photography and 32 days tidal observations for densification of secondary ports has already completed by Survey of India during up to 2015.

Work up to Feature Extraction has been completed for Zones 1, 2, 3 & 4 and work of the remaining Zones i.e. 5, 6, 7 & 8 are in progress. QA/QC of mapping work carried out by the Vendors is under progress by the Eight coastal GDCs of Survey of India i.e. Gujarat, Maharashtra, Karnataka, Kerala, Tamilnadu, Andhra Pradesh, Orissa and West Bengal are engaged in various ICZM activities viz. Field control, Quality control works, Data handling etc.

Coal Mine Project

Initiative: - Preparation of Updated Topographical Maps of Major India Coal fields (27 Coal fields) based on remote sensing technique.

Achievement: - All activities covering various work stages are being carried out continuously by the 07 GDCs of Survey of India i.e. Chhattisgarh, Orissa, Madhya Pradesh, Jharkhand, Maharashtra &

Goa, West Bengal and Meghalaya & Arunachal Pradesh GDCs and some part of work i.e. 2D feature extraction & 3D feature extraction are distributed to other GDC so that project work can be completed up to July 2016.

Present status of the work is as under:

Primary Control:

12 hours GPS observation on 172 points has been completed for all 27 coal fields

DT levelling completed. = 9922.3 Lin. Km.

Block Control point:

2 hours GPS observation = 3095 points.

ST levelling = 13245.6 Lin. Km.

Detail Survey:

2D feature extraction = 1922 Sheets

3D feature extraction = 1749 Sheets

Field verification during = 1295 Sheets

Sheets finalized in all respect = 858 sheets

Map the Neighbourhood in Uttarakhand (MANU) Project:

Initiative: To prepare DEM (Digital Elevation Model) and map on 1:10K scale for disaster affected area of Uttarakhand for macro and micro level planning and post disaster scientific application by other agencies involved in MANU project.

Achievement: Data Acquisition work in part of the area by using Modern Techniques of Air- Borne LiDAR and digital Aerial Photography of Disaster affected Areas of "Char Dham and Pindar Valley" has been already completed and the following work for carried out the Quality Control & further processing to generate deliverables has been completed during the year:

(i) Reconnaissance = 340 Lin. Km.

(ii) Grid Generation = 7 Grid

(iii) GPS Observations = 302 Point Observed for Horizontal & Vertical Control.

(iv) Levelling observations for spreading the grid to check DEM. = 370 Lin. Km.

GPS Observation for providing Horizontal Control
using Trimble GPS receiver at Rudraprayag, Uttarakhand.

Control Survey for H.E. project:

Initiative: Providing Control Points for different Hydro Electric Power Projects (HEPP) as per indentors requirement.

Achievement: Control points (Horizontal & Vertical) has been provided by GPS observation and Levelling and data has been supplied to indentor for the following projects:

(i) Surgani-Sundla HEP Project

(ii) Manali-Aut HEP Project

(iii) Deothal-Chanju HEP Project

(iv) Sunni Dam HEP Project

(iv) Tapovan Vishnugad HEP Project

Study reports produced/generated and their brief findings:

i) Geomagnetic Bulletin for the year 2015, listing magnetic declination, Horizontal & Vertical Force recorded at Sabhawala Geomagnetic Observatory have been prepared.

ii) Indian Tide Table 2017 and Hugli River Tide Table 2017 have been published.

New Plan Schemes conceptualized/approved/launched for implement:

Following sub-schemes under the Main Plan scheme "Modernisation of Mapping Organisation, Survey of India" were approved/ implemented:

i) Work order for setting up of Virtual Reference System in three state Andhra Pradesh, Karnataka and Orissa has been finalized under the Scheme "Foundation of Geospatial Dataset for NGIS".

ii) Development of Geoid Model by using already available data i.e. the phase-I for development of Geoid Model INDGEOID version -1.0 under the scheme "Development of Geoid model for India".

Special Survey for Indian Air Force:

Initiative: Survey of India also prepared IAF-OGM, PGM, JGM, Land Approach Chart (LAC), LNC etc. and Carried out abstracting survey work for Indian Air Force.

Achievement: Survey of India has completed the following maps and Data for IAF during the Year:

a) IAF (OGM) -38 Sheets, IAF- (PGM) – 49 Sheets, & Land Approach Chart (LAC), IAF - LNC (scale 1:2M) 15 Parts. JGM-17 Sheets

b) Verification of 18 Landing charts on 1:50k Scale including Obstruction Survey for 30 NM from ARP for IAF.

Special Survey for ISRO:

Initiative: Establishment of Accurate Geodetic Location of the Centre for Satellite Photometry Laser Ranging and Optical Communication (SPROC), ISRO.

Achievement: Reconnaissance regarding Establishment of Accurate Geodetic Location of the Centre of the Telescope work has been completed.

NATIONAL ATLAS & THEMATIC MAPPING ORGANISATION

National Atlas and Thematic Mapping Organisation prepares thematic maps and atlases which are 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 most popular themes such as physiography, hydrology, climate, administrative, political, socio-economic, agriculture, industry, history, culture, tourism, archaeology etc serve as the basic tools for a wide range of users including planners, decision makers, researchers and students and the common public.

Brief account of the ongoing projects under implementation by NATMO are as following:

NATMO's own geo-portal development: 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 access by the users. Keeping this objective in view NATMO has taken up the initiative to set-up its own Geo-Portal.

Golden Map Service (GMS): 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.

GPS Survey and Field Verification by NATMO officials

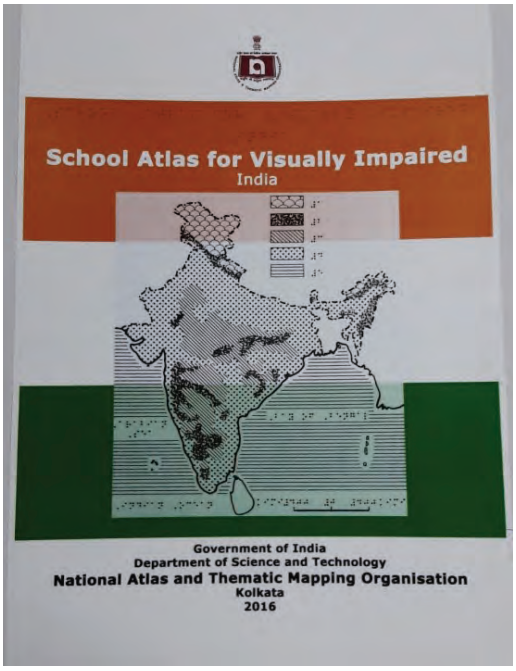
So far, NATMO has completed 13 cities. In the current year three GMS are ready for final publication (Panaji, Ooty and Kulu-Manali)

District Planning Map Series (DPMS): Maps of 260 districts have been published for the users. 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 updation work on account of formation of new districts is in progress.

National Atlas of India: National Atlas is the flagship publication of NATMO. First Hindi version 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. alongwith conversion in digital mode is under process.

Large-scale Mapping: NATMO has taken the initiative for preparation of large-scale maps (1:10,000 scale) on various themes to facilitate micro-level planning like irrigation, agriculture etc. using its own database and methodology.

Atlas for visually impaired (Braille Map): Braille Mapping and Atlas compilation initiated by NATMO has been greatly appreciated and recognized by Government of India and it received the NATIONAL AWARD for S&T Intervention in Empowering the Physically Challenged. The award was presented by the Hon'ble Prime Minister of India on 3rd January 2017 during the inauguration of 104th Indian Science Congress at Tirupati.



Atlas for Visually Impaired

Revenue generated during financial year of 2016-2017: The Organisation generated revenue about rupees two lakh by selling maps, atlases and monographs from the sales counters of Kolkata Headquarters, Delhi Sales Counter, Exhibition stalls and SOI outlets.

Hon'ble Minister of Science & Technology in NATMO Stall in India International Trade Fair, 2016

BUILDING GEOINFORMATION CAPACITY

Natural Resources Data Management System (NRDMS) and National Spatial Data Infrastructure (NSDI)

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 level. 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. New areas have been identified like geothermal energy, mapping of hotspots in Uttarakhand, health GIS, Village Information System and Revival of Village Ponds. In the area of disaster management, methodologies are being developed for early warning system of landslides and simulation modelling for urban flood. Human Resource Development is the key programme to promote absorption of geospatial technology in implementation of the developmental schemes. A comprehensive programme for geospatial training is being supported regularly.

2. National Spatial Data Infrastructure (NSDI) has been a major initiative for enabling nodal agencies towards setting up mechanisms for provision of standardized spatial data sets to user agencies. During the current year, NSDI is re-oriented to upgrade the software and hardware of Indian Geo-portal to ensure easy and fast access of geospatial data by the users.

3. National Data Sharing and Accessibility Policy (NDSAP) – notified in March, 2012 is a national open data sharing portal i.e. data.gov.in which was developed to proactively share the government shareable data to the general public. At present more than 40000 data sets contributed by more than 100 Central Govt. departments/ Ministries have been uploaded on the portal for sharing to the general public. Efforts are also being made to enroll all the State Governments to adopt the NDSAP.

4. National Geospatial Policy (NGP) : It focuses on geospatial data, products, services and solutions. DST has formed a committee to draft the NGP. It will empower people through geospatial data and easy accessibility of the products, solutions and services offered by Govt., private organisations NGOs and individuals. Policy is under consideration for approval.

5. Sub – programmes under NRDMS

5.1 State Data Infrastructure (State SDIs)

State Geo Portal prototypes are being set up in the States of West Bengal, Haryana, Jammu & Kashmir, Karnataka, Odisha and Uttarakhand. Two more States from North-Eastern region i.e. Mizoram and Nagaland are also recommended for developing the State Geo-portal during the current financial year.

5.2 Health GIS

In order to explore the potential of GIS technology, a programme on Health GIS was launched during 2014-15 basically to map the diseases using spatial pattern and also help in developing the health emergency management system. For the last two years, more than one dozen projects have been supported on various aspects of health diseases and are being monitored in the networking mode. The

major outcome would be: geospatial health data of different diseases and their diagnostic schedule, interactive health maps to allow citizens to understand health performance, mobile application for detecting the patient and providing medical aid etc.

5.3 Village Information System

As per the Government initiatives to identify villages for drawing development plan using geospatial technologies, under NRDMS about 120 villages in different States have been selected to design a spatial data model for local level planning. It will also help in development of an integrated information system using geospatial technologies. Finally, a decision support information module to empower planners and citizens would be developed. Programme is being implemented with the participation of more than 12 R&D agencies in the networking mode.

5.4 Revival of Village Ponds

Village ponds are considered to be the life line of the village for utilising rain water for different purposes. Over the years, the storage of rain water through village ponds becomes almost non functional due to various reasons. In order to revive the village ponds with more S&T inputs to ensure availability of water in the ponds which basically help in recharging the ground water and bringing the ground water table water up in addition to the various usages of the pond water. Considering this in view a networking programme has been formulated with the involvement of academic institutions and village farmers. The programme will be launched in different agro-ecological regions to ensure proper representation of the test sites. The programme is being supported in the current financial year.

6. Disaster Management (Landslides, Tsunami and Floods Mitigation)

Disaster Management is considered very important as far as the resource management is concerned. Under NRDMS, efforts are being made to develop scientific capability for handling landslide, tsunami and floods by supporting various R&D projects to address the issues related to these disasters.

6.1 Landslide forewarning System

As part of the integrated landslide programme, efforts are being made to develop forewarning system to monitor the critical landslides in different geo-environmental areas. At present instrument monitoring is being carried out in 3 locations i.e. Himachal near Naptha Jhakri Project, Linga landslide in Ooty and Munnar slide in Kerala. Efforts are being made to develop a correlation between threshold of the rainfall intensity and landslide occurrence. Once it is established, it would be easier to simulate the landslide hazard and risk assessment near accuracy and the products would be of great help for maintaining the problematic roads section along with the major infrastructure in the country.

6.2 Tsunami Modelling

As per the historical data for last 100 years, East Coast of India is frequently facing tsunami in different time which results huge damage to property and loss of life. To provide scientific management of tsunami modelling, R&D projects have been supported to develop the wave propagation models to estimate the height of the wave after touching the land inundation modelling thereafter to estimate the probable loss of the crops, infrastructure and human life. Some pilot studies have been initiated in this direction in Chennai, Cuddalore and Nagapattanam along with East Coast.

6.3. Urban Flood Monitoring

Using ALTM technique, about 500sq km area of Chennai City has been taken up for flood risk mapping. The study has been focused on the following:

- Selection of flood mitigation techniques to manage flood risk in the study area using Orthomaps, DEM and thematic layers in GIS
- Site specific mitigation strategies for the 36 flood prone hotspots in Chennai Corporation limits and Ambattur Industrial Estate
- Implementing intensive Artificial Recharge and Rain Water harvesting in the CMA and Chennai Corporation area.
- Post project activities and follow up project for Chennai Corporation using ALTM data and automatic weather stations (development of DSS and EWS for a pilot area) to make the best use of the resolution database
- A real time monitoring of meteorological parameters is being developed to forecast the inundated areas in the event of abnormal rainfall in short span of time
- Total area has been divided into 22 micro-watersheds and all the micro watersheds have been adequately instrumented to collect field data for undertaking modeling for forecasting the flood pattern.

6.4 Large Scale Geological and Geotechnical Mapping from Rishikesh to Kedarnath in Uttarakhand.

As the outcome of the pilot study conducted during the Kedarnath tragedy in June, 2013 for damage assessment mapping in Uttarakhand, it was felt that detailed study of geological and geotechnical aspects may be undertaken to develop the co-relation between the parameters of damage assessment viz-a-viz. Geological and geotechnical aspects. This process will help to identify the more critical hotspots for disaster management. In pursuance of this, networking programmes have been initiated during 2015-16 along with a corridor between Rishikesh to Kedarnath (Uttarakhand) about 155 km long stretch. The result of this study would be of immense help for the State Government to develop the State by selecting the safer places for infrastructure development.

6.5 National Geotechnical Facility

The National Geotechnical Facility has been set up in Poonch House, Dehradun. Wadia Institute of Himalayan Geology, Dehradun is coordinating the activities. As part of this, state of the art facility on rock and soil mechanics testing facilities have been set up. This facility is providing enough scope to meet the requirement from academic as well as stakeholders to analyse the soil and rock samples for their strength parameters. This is important to draw a comprehensive action plan for implementation of major developmental projects.

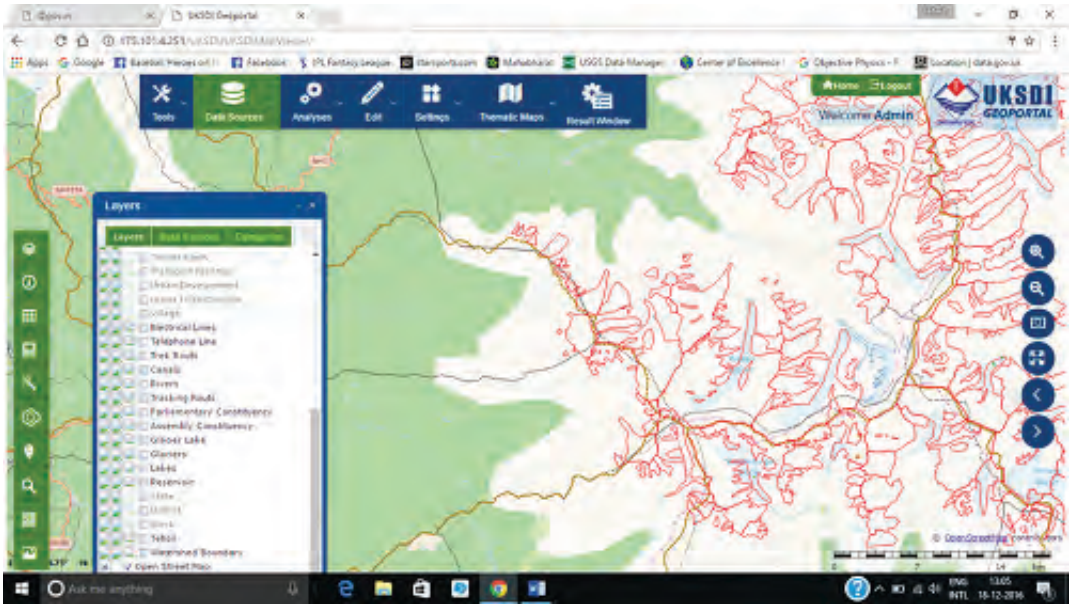
7. R& D Applications and Demonstration of the use of Geospatial Technology.

7.1 An Interactive Visual Analytic Tool for Semantic Classification of 3D Urban LiDAR Point Cloud (Research Agency: IIIT Bengaulru)

A novel unsupervised machine learning approach for effective semantic labeling by combining two different multi-class classification (structural and contextual) of points in airborne LiDAR point cloud of an urban environment has been demonstrated. The tool can be used to extract structural as well as contextual features and combine them together to give an augmented classification, in comparison to the existing methods. Novelties of such classification are that (a) it includes an interactive hierarchical (top-down) clustering, hence is unsupervised, and (b) it is geometric- as well as contextual- aware.

7.2 An indoor toolkit for configuring indoor spaces, framing indoor queries, and locating people/ assets using localization algorithms in a Smart Building (Research Agency: Amrita Vishwa Vidyapeetham, Coimbatore)

A WiFi based Indoor localization toolkit for tracking and locating people in Indoor spaces has been developed and demonstrated. This querying system can be used in different application scenarios irrespective of the underlying data models. A new Indoor Localization algorithm for locating people/ assets using WiFi and RFID has been also developed along with a new path loss model for indoor cluttered environments. This system is capable of helping users configure a complete localization application over a selected space. There are facilities for configuring the localization system, customizing and adding different localization algorithms, tracking users in real time and analyzing the performance of different algorithms to engineer software products useful in indoor applications related to development of smart buildings.



(Figure 1: A screenshot of the Uttarakhand State Geo-portal showing a Web Map Service of a part of the State)

7.3 A GIS & Sensor Web based system for monitoring & measuring Green House Gas Emission (GHG) in dump yards (Research Agency: Sathyabama University, Chennai)

Perungudi and Kodungaiyur dump yards of Chennai city, located within its residential perimeter, have been instrumented with GIS and Sensor Web-based systems for continuous monitoring of CO2 and CH4 concentrations. A web server has been installed for creation and storage of the data transmitted from the sensors and sharing those with the users and decisions-makers. Data from sensors could be recorded continuously to monitor threshold limits and generation of alerts. The GHG data helps in planning control measures regulating the threshold level. Further, it helps in providing primary data for the architect and engineers in designing a sustainable monument/ building.

7.4 Mobile-based 'Emergency Tech Support (ETS)' Application for disaster management (Research Agency: Adhiyamaan College of Engineering, Hosur)

In order to acquire real time data for disaster management (Figure 2) and a web-portal to provide an interoperable and semantically-enabled solution for disaster management, an application has been developed. This facility is capable of sharing and using disaster-related geospatial data with the end user with the help of a workflow process chained together through OGC-compliant WMS, WFS and WPS standards-based service.

8. Capacity Building and Training

In order to create awareness and build up capacity among different types of stakeholders in academia and government, the division has supported 16 training programmes of 21 days and 16 training programmes of 3 days. As a result around 500 stakeholders were exposed to the advances in the Geospatial Science and Technology, its application and hands on training.

Development of Training Modules/ Kits along with Training-cum-Review activities has been an important priority. A training module developed at IIT Kharagpur has been recently used to train and review NSDI activities in July 2016.

9. International Collaboration

9.1 Indo Norway Cooperation on Geo-hazards and Geothermal Energy

Over the last one decade, DST and Norwegian Geotechnical Institute are working in the area of geo-hazards (landslides and tsunami) and Geothermal Energy as part of the joint bilateral cooperation programme. Following studies have been undertaken over the years :

(a) Landslide: The forewarning system of landslide is being developed as test site in number of locations in Uttarakhand with the help of NGI, Norway. The equipment being used are the automatic weather station, drone for large scale mapping, soil moisture detector and profiling of the slope. With the combination of the above, efforts are being made to develop a co-relation with the rain fall intensity vis-a-vis Landslide forewarning system.

(b) Tsunami: With the help of NGI modelling team, the existing model of tsunami and cyclone are being upgraded with additional inputs / parameterisation to ensure improvement of accuracy. In the process, tsunami modelling have been tested with the historical data in Chennai coast and other areas like Nagapattnam and Cuddalore. Two Ph.Ds and two research papers in International Journal have been published.

(c) Geothermal Energy

(i) Geothermal space heating in Chumathang, Leh: As part of bilateral programme with Norway, a pilot project was installed in Chumathang, Leh to demonstrate the use of geothermal energy for space heating. The demonstrative project is operational in the Chumathang for the last two years.

(ii) Development of ground source heat pump: In order to demonstrate the use of ground source heat pump technology in heating the space /room a pilot project has been installed in WIHG, Dehradun during 2015-16. The site is operational in Guest House, WIHG to use the ground source heat converting into steam for heating the target space.

9.2 Brazil Russia India China South Africa (BRICS) Working Group on Geospatial Technology.

In order to promote geospatial research, technology development and applications at national, regional and global levels amongst the BRICS countries, India is leading the BRICS working Group on Geospatial Technology. The 1st coordinated call for BRICS multilateral projects under the BRICS STI Framework Programme was announced in august, 2016. The call was announced in the priority areas of cooperation viz. Geosciences collaboration, earth observation and its people centric applications and geospatial policies and data availability. 19 Joint project proposals with at least 3 countries as partners have been received against the call.

In persuasion of the BRICS Science, Technology and Innovation (STI) Action Plan 2016 – 2017 adopted during the recent 4th BRICS STI Ministers' Meeting held on 8th October, 2016 at Jaipur, the 2nd BRICS Working Group on Geospatial Technology (WG-GS) Meeting and 1st BRICS Workshop on Geodesy are being held at Hyderabad on 24th January, 2017 at the sidelines of World Geospatial Forum.

10. New Initiatives

Under NRDMS, efforts are being made to provide support for R&D on geospatial science and technology. Considering the advancement of data acquisition techniques, analytical tool and the scope of geospatial technologies for attending various applications, it is felt essential to develop following new sub programmes under NRDMS during next two years to widen the horizon of the NRDMS programme.

10.1 Indo-US Space Borne Gravity Observation Collaboration: In order to strengthen the collaboration between India and US in the field of space borne gravity observations, especially under the GRACE and GRACE FO missions, an India US bilateral workshop on "Assessment of Regional

Hydrology using Space Borne Gravity Observations" was organised during 14th to 16th November, 2016 at NGRI, Hyderabad. The meeting resulted in the opportunities for establishing an Indo-US Joint Network Centre on GRACE, which will benefit a proposed a National network project on "Assessment of Regional Hydrological Systems using Space Borne Gravity Observations".

10.2 Geodesy : Considering the importance of Geodesy in developing geoid model of the country, it is felt essential to develop a national programme. A meeting of the experts was held on 14th Dec, 2016 in DST to discuss various aspects of the national programme and the components to be taken up by participating agencies. A comprehensive national programme is proposed to be developed soon.

10.3 Heat Flux of Urban areas: Considering the impact of climate change over the last few years, it is observed that heat flux of major cities is required to be studied in detail due to their impact on various resources and long term strategy to make the major cities more safer for living. In this direction, it is proposed to hold a brainstorming session soon to decide the structural component of the programme.

10.4 Coastal Hazard Assessment and Mitigation: India has very accurate observational network for detecting the location, path and the target tsunami waves will hit the coastal areas. As per the traditional data collection methods, IMD is having all the records more than 100 years about the tracking of cyclone and tsunami along west and east coast of India. They are also capable of issuing forewarning to the concerned State Govt for developing contingency plan. In order to make use of the IMD forewarning system to develop the damage assessment mapping along with the coastal areas, it is proposed to carry out large scale mapping along with the east coast of India to develop the hazard assessment and mitigation model to help State Govt. for better management of the contingency plan. This sub programme will be developed and implemented in Networking mode in next one year under NRDMS.

PROMOTING GOOD LABORATORY PRACTICES

The **National Good Laboratory Practice (GLP) Compliance Monitoring Authority (NGCMA)** was set up under the administrative control of Department of Science and Technology (DST) in August, 2002. GLP is a quality system under which **non-clinical health and environmental safety studies** are conducted on various **chemicals** for their submission to regulatory authorities e.g. Drugs Controller General of India, This assures that test facilities can be relied upon in assessing of hazards or risks to man, animals and/or the environment.

The NGCMA provides **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) w.e.f March 3, 2011. As a result, the data generated by the GLP certified Test facilities in India are acceptable in the 34 member-countries of the OECD and other countries, thus removing the technical barriers to trade.

Some of the major achievements of the Indian GLP programme during the financial year 2016-17 are given below:

- Four **new test facilities were granted the GLP-compliance status.** These include:
  a) Bioscience Research Foundation, Chennai
  b) GLR Laboratories, Chennai
  c) Micro Therapeutic Research Labs, Chennai
  d) Shriram Institute of Industrial Research, Delhi
- Eleven test facilities were **re-certified.** These include:
  a) Laboratory Animal Research Services (LARS), Reliance Life Sciences, Navi Mumbai
  b) Intox Private Limited, Pune
  c) Indian Institute of Toxicology, Pune
  d) Indofil Industries Limited, Thane
  e) Gharda Chemicals Limited, Thane
  f) Venus Medicine Research Centre, Baddi
  g) Jai Research Foundation, Valvada
  h) Aurigene Discovery Technologies, Hyderabad
  i) Torrent Pharmaceuticals Limited, Gandhinagar
  j) Syngene International Limited, Bangalore
  k) International Institute of Biotechnology and Toxicology, Padappai
- **Surveillance inspection** of following test facilities was conducted and their GLP-compliance status was continued till the validity of current GLP certificate :
  a) Orchid Chemicals, Chennai
  b) Vivo Bio Tech, Pregnapur, Medak district
  c) PI Industries, Udaipur
  d) Centre for Toxicology and Developmental Research, Sri Ramachandra University, Chennai
  e) Bioneeds India Private Limited, Bengaluru
  f) Lupin Limited, Pune

- **Surveillance cum extension in scope inspection** of following test facilities was conducted and their compliance status was continued & GLP-compliance status was granted in additional areas of expertise:

  a) Indian Institute of Toxicology Research, Lucknow

  b) Laila Nutraceuticals, Vijaywada

- **Extension in scope inspection** of following test facilities was conducted and GLP-compliance status was granted in additional areas of expertise:

  a) Vivo Biotech, Pregnapur (Andhra Pradesh)

  b) Krish Biotech Private Limited, Kalyani (West Bengal)

- **Joint-inspection and Study Audits with United States Food and Drug Administration** were conducted for the following test facilities as per MAD:

  a) Zydus Research Centre, Ahmedabad

  b) Advinus Therapeutics Limited, Bangalore

  c) Indian Institute of Toxicology, Pune

- The following training courses were organized by NGCMA during the 2016-17:

  o **Interactive Meet on GLP** - August 31, 2016

  o **Sensitization Workshop on GLP** – October 17&18, 2016

  o **Training Course for Quality Assurance Professionals of GLP Test Facilities** – November 15-17, 2016.

- India was the Team Leader for conducting the Mutual Joint Visit (MJV) of Standards Council of Canada (SCC) for evaluating the GLP Compliance Monitoring programme of Canada.

- India has been elected as a member for conducting the MJV of Thailand for evaluating its GLP compliance monitoring procedures & its adherence to MAD status.

- A representative of NGCMA, India attended the 30th meeting of OECD's Working Group on GLP and provided inputs for revision/updating of the technical OECD documents on GLP.

- The website of National GLP Programme "www.indiaglp.gov.in" has been merged with DST website "www.dst.gov.in" and is continuously being updated.

CHAPTER 3

TECHNOLOGY CAPACITY STRENGTHENING

TECHNOLOGY DEVELOPMENT

CLEAN ENERGY RESEARCH INITIATIVE

Clean Energy Research initiative aims to develop national core competence in developing indigenous research led competitive and cost effective clean energy options for power, buildings, storage, thermal heat, cooling, desalination etc. The areas of research are identified through stakeholder consultation based on national needs. The current areas of thrust are solar energy, building energy efficiency and new materials. It supports upstream end of research, where knowledge, more advanced than the current practice in the industry finds a space. The initiative also supports translational research utilising available knowhow to consolidate research outputs and advance current technology to drive down cost of delivered energy. During the year 2016-17, several new dimensions were added to the programme to accelerate the development of clean technologies in the country:

I. New Initiatives:

1. Mission Innovation: A multilateral initiative for Clean Energy R&D– The inaugural Mission Innovation Ministerial, comprising of 20 founding Members and European Commission on behalf of the European Union as the 21st partner, and held in June, at San Francisco. Dr. Harsh Vardhan, Hon'ble Minister, Science & Technology and Earth Sciences pledged to double Government funded clean energy research and development over 5 years and enhance international engagement in programmes on clean energy R&D. India, through DST, will lead Smart Grids and Innovation Challenge under Mission Innovation which was launched by Hon'ble PM along with 20 world leaders during COP21 at Paris. Smart Grid and Innovation Challenge is one of the seven top challenges identified for multi lateral Research Partnership to accelerate the pace of clean energy R&D innovation. This challenge will address development of future smart grids powered by affordable reliable decentralized renewable electricity system. It will lead to development and demonstration of smart grid technologies that can accommodate 100% renewable based power plants in large scale across the globe.

Mission Innovation and Clean Energy Ministerial (June 1-2, 2016) San Francisco, US.
Hon'ble Minister of Science & Technology and Earth Sciences led the Indian Delegation

2. Initiative to Promote Habitat Energy Efficiency (I-PHEE): A new national programme on "Initiative to Promote Habitat Energy Efficiency (I-PHEE)" to improve energy performance of buildings and cities was launched. It would support enhancement of knowledge and practice to save energy in design, construction and operation of buildings. 105 research proposals were received, out of wich 31 have been recommended for funding.

3. Materials on Energy Storage (MES): A new programme on the Materials on Energy Storage (MES) to support R&D activities aimed at innovative materials for energy storage, and to build energy storage device with enhanced output for multifunctional applications was launched during the year. Aiming the efficient use and further increase of renewable energy, and demonstrating its value in terms of flexibility in the energy systems are the prime objective of the initiative. 130 proposals were received and 18 were approved for funding.

4. Joint Clean Energy Reserch and Development Centre on Smart Grids and Energy Storage: India and the United States expanded collaboration under Partnership to Advance Clean Energy-Research (PACE-R) observing to include smart grid and grid storage critical importance of expanding clean energy research, development, manufacturing, and deployment, which increases energy access and reduces greenhouse gas emissions. A funding Opportunity Announcement (FoA) was made on July, 2016 to support multi-institutional network projects using public-private partnership model of funding. Award will be made to consortium with the knowledge and experience to undertake high-quality collaborative research programs. 7 applications have been jointly submitted by the US and Indian researchers who would be members of the Consortia based on their mutual interests, priorities and strengths.

5. Mission Programme on Methanol and Di Methyl Ether: The Methanol Economy hold promise to help India to mitigate its petroleum import cost and at the same time counter problem associated with global warming due to excess CO_2 emission. An International Seminar on 'India's Leap to Methanol Economy- Opportunities and Option for Energy Security' was held at **Manekshaw Centre, Delhi Cantt., New Delhi** for knowledge sharing and aggregation for chalking out a strategy for preparing road map on Methanol & DME economy for the country. DST actively contributed in preparation of Roadmaps for Methanol DME and Di methyl ether. A survey report on Production & Utilisation issues of Methanol & DME was finalized. DST initiated research programme on methanol and DME, which evinced great interest and 94 proposals were received.


International Seminar on 'India's Leap to Methanol Economy- Opportunities and Option for Energy Security

6. Research and Development on Clean Coal Technologies: DST has identified priority research areas through stakeholders consultation. DST is participating in National Mission on Advanced Ultra Super Critical Technology for Cleaner Coal technologies. Two virtual research centres on Advanced Ultra Supercritical (AUSC) have been initiated at IISC and ARCI Hyderabad.

7. Indo UK Joint Virtual Centre for Clean Energy (JVCCE): Towards joint commitment to clean energy led low carbon economy, India and UK together have set up virtual Joint Clean Energy Centre on Clean Energy. This centre focuses on integration of intermittent clean energy with storage for stable power supply at grid as well grid isolated communities at a total investment of £ 10 million. The UK partners comprises of SUPERGEN hubs in the UK which will link to leading academic centres in India in the areas of solar energy, energy storage and networks. The proposed centres will operate through one UK consortium which is linked with two Indian consortia working in the areas of solar energy, energy storage and networks. It would aim at development of pre-competitive technologies with integral end user engagement and though the centre would build upon existing collaboration, its scope would be beyond the existing collaboration in terms of demand orientation technology focus and resource sharing by consortia.

The UK consortia led by Loughborough University and two Indian consortia led by IIT Kharagpur and IIT Bombay will bring together experts from national laboratories, universities and industry in both India and the UK to leverage their expertise and resources to unlock the huge potential of clean energy technologies that can reduce energy use and dependence on fossil fuel, and accelerate the deployment of renewable energy sources. This knowledge network has partnership of 11 Indian institutions and 8 UK institutions besides several industries and utilities from both sides.

8. Indo-UK Cooperation Programme on "Energy demand reduction in the built environment" India and UK have jointly agreed to commit £3.8 million each to undertake collaborative research that can have impact on urbanization and infrastructure development utilizing clean energy. R&D programme will support projects in the area of energy demand reduction in built environment.

9. Surya Jyoti- a Micro Solar Dome: Surya Jytoti is a unique solar energy operated lighting device, which works during daytime in passive mode and in the night time through photovoltaic mode. The integrated PV module fitted in the dome charges a special battery during day time which in turn provides light during night. About 1000 Micro Solar domes now working in the slums of Delhi, Kolkata, Agartala, Guwahati, Bhopal and Bengaluru. However, demand of the product is increasing manifold as more and more people are becoming aware of the unique benefits of using the product. There are about 130 number of Surya Jyoti at Lalbag Cluster, New Delhi and nearby areas.

In order to cater to this ever increasing demand, an entrepreneurship development programme for manufacturing and installation of Surya Jyoti was organised during 18-22 October, 2016 in which 25 entrepreneurs and 7 voluntary organisation from 11 States of different regions were trained. The manufacturing process of the device is labour intensive and is expected to generate huge job opportunities. It is expected that once the design of the dome is made available along with assured demand, many entrepreneurs would venture in manufacture MSD.

The product has been included for subsidy under off grid and decentralized solar application scheme of Ministry of New and Renewable energy. The present cost of the product is about Rs.1500 and is eligible for a subsidy of Rs. 720 (Dome with 6 Watt PV panel). On upscaling the cost of the product is likely to come down to Rs. 1200. Attempts are being made to integrate Surya Jyoti for subsidy in rural and urban housing schemes, MP Local Area Development Schemes and corporate social responsibility activities of public sector enterprises. Ministry of Rural Development has informed to all Principal Secretary /Secretary (Rural development) States and Union Territory to explore the possibility of adopting this innovative technology of Surya Jyoti for the houses constructed under Prime Minister Gramin Awas Yojana.

Solar Micro Dome “Surya Jyoti”

Surya Jyoti attached on a ceiling for lighting

Surya Jyoti in Operation in Delhi

Surya Jyoti installed in Tribal areas of Tripura

II Ongoing Programmes:

The achievements made in the ongoing projects during the year are as under:

1. Solar Energy Research Institute for India and the United States (SERIIUS)

The Solar Energy Research Institute for India and the United States (SERIIUS) is co-led by the Indian Institute of Science (IISc)-Bangalore and the National Renewable Energy Laboratory (NREL). SERIIUS carries out fundamental and applied research, analysis and assessment, outreach and workforce development through specific bi-national projects in three Research Thrusts of Sustainable Photovoltaics (PV), Multiscale Concentrated Solar Power (CSP) and Solar Energy Integration (SEI). SERIIUS collaborative work has resulted in 193 publications (121 peer review papers and 72 proceedings papers). In addition, SERIIUS has Seven Invention Disclosures to its credit. The scientific highlights are as under:

Sustainable Photovoltaics (PV)

- In thin-film PV, SERIIUS has thematically integrated around roll-to-roll processing using flexible Corning® Willow® glass.
- New atom-to-module multiscale modeling, is being developed, which is being used to model the potential of various systems and to provide direct feedback to core partners.
- The project is currently analyzing the overall resource and reliability of PV in different climate zones in India and the U.S., encompassing dust mitigation, non-traditional failure modes, and new approaches, such as encapsulants and transparent conductors, to provide superior performance

Multiscale Concentrated Solar Power (CSP)

- The CSP thrust has transitioned from a predominately modeling phase to one of developing prototype systems that demonstrate the multiscale aspects of the supercritical CO_2 Brayton cycle (s-CO_2).
- Initial work has also demonstrated the potential of multiscale lower-temperature Rankine cycle approaches. The initial part has been very successful, with a number of new technologies demonstrated in the form of new materials, the design and fabrication of prototypes, and test rigs.

Solar Energy Integration (SEI)

- Completion and publication of an initial set of roadmaps on PV, CSP, and energy storage. Increased focus on tech-to-market analysis. Analyzing the feasibility and manufacturability of both mature and new SERIIUS-developed technologies in India (and the U.S.) and impact of SERIIUS reliability and mitigation studies on bankability
- Ongoing development of techno-economic tools (CSTEM tools and Indian-specific version of the System Advisor Model (SAM) in collaboration with the NREL SAM team) and its use in analyses to contextualize application and deployment
- Initial engagement with implementation agencies to conduct relevant grid and storage analyses.

2. India- UK Smart Grids and Energy Storage (SEGES) Projects:

DST in collaboration with the Engineering and Physical Sciences Research Council (EPSRC) has identified Smart Energy Grids and Energy Storage as areas of significance in providing solutions of meeting future energy needs. 5 research proposals have been supported focusing in the areas namely, Appropriate distributed storage technologies, On/off grid energy systems, DC networks and Control & communications, which are currently under joint implementations. 9 national institutions supported in the project.

3. Centre for Building Energy Research and Development (CBERD)

The U.S.-India Centre for Building Energy Research and Development (CBERD) conducts collaborative research and promote clean energy innovation in the area of energy efficiency in building with measurable results and significant reduction in energy use in both nations. CBERD focuses on the integration of information technology with building controls and physical systems for commercial/ high-rise residential units.

CBERD has focus on development of Life Cycle Performance Analysis Framework (LPAF) for commercial multi storey buildings. The important component included decision support systems, hardware for improved functioning and enabling buildings to become grid responsive. CBERD collaborative work has resulted in 60 joint journal, conference papers and technical reports. 2 prototype technologies have been developed and 2 patents have been filled. 2 Tools available to the public, 34 Researcher exchanges, including 1 scholarship and 14 joint workshops have been conducted.

CEPT CBERD Window Testing

MNIT CBERD Field work

4. Solar Photovoltaic hub at IIEST, Shibpur

About 200 crystalline silicon solar cells has been fabricated during the year with baseline efficiency of 16-18.5% having SiNx AR cells on pre-commercial indigenous manufacture processing equipments established in Centre of Excellence for Green Energy & Sensor Systems (CEGESS) at Indian Institute of Engineering Science and Technology (IIEST) Shibpur. A network of 5 academic institutions and 3 industrial organizations have been developed to further R&D activities for enhancing the efficiency of crystalline silicon and amorphous solar cells from their baseline values through metal plasmonics and other nanostructures.

16 technical papers have been published in peer reviewed reputed journals, and 23 papers have been presented in national and international conferences. The theoretical modelling has predicted that a regular array of controlled nano strustured nanoparticles on thin layer layer of identical or different material can reduce the front surface reflection or enhance the back surface reflection in both the short (near UV) and long (near IR) significantly leading to significant increase in efficiency. Substarte Conformal Imprint Lithography (SCIL) is being used to fabricate (i) 2D regular array of metal plasmonic / dielectric nanostructures at the rear surface of silicon solar cells (ii) thin film – nanoparticle double layer 2D regular array structure on the front surface of solar cells for light trapping and enhancement of efficiency cells. 2 patents have also been filed based on the work carried out in the solar hub.

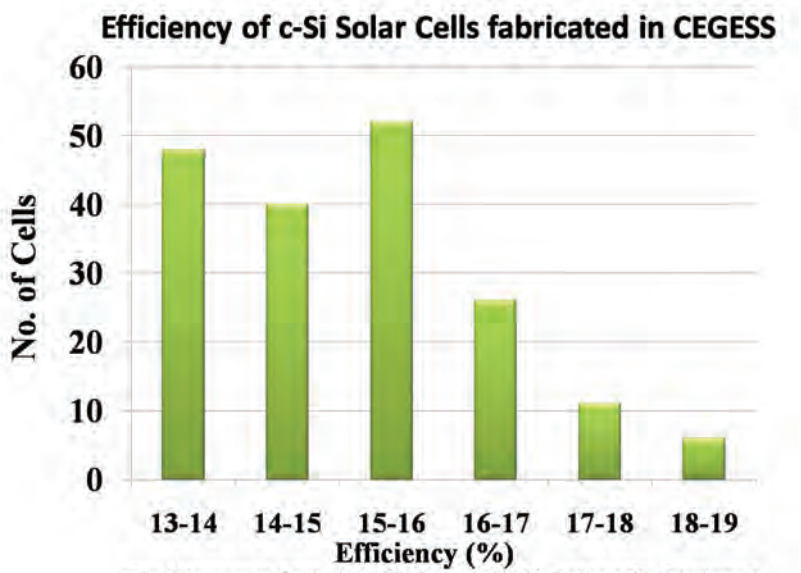


Fig. Histogram depicting efficiency of c-Si Solar cells fabricated in CEGESS since April 2016 (183 cells)

Facilities at Solar PV Hub at (IIEST), Shibpur formerly known as BESU

5. Bhaskara Advanced Solar Energy Programme

The programme has attracted the interest of the young research community to put their efforts in the area of Solar Energy and to build long term knowledge relationship with leading laboratory of United States. 25 fellows and 37 interns have been benefitted from the programme. While 29 publication has been reported, it is noteworthy to mention that scientific work "Quantum dot–induced phase stabilization of α-CsPbI3 perovskite for high-efficiency photovoltaics by A.

Swarnkar et al."carried out by an intern of batch 2015 was published as a first author in one of the top scientific journal 'Science', in October, 2016 which is reflection of the cutting edge collaborative work being carried out in the area of Solar Energy in partnership mode.

6. Building Energy Efficiency Higher & Advanced Network (BHAVAN) Fellowships

Considering the importance of capacity building in energy efficiency for built environments, a fellowship programme BHAVAN for Indian researchers have been launch to expose them to world class research facilities in US. The term of internship is 3-6 months and fellowships is 3-12 months. In the year 2015-16 8 fellows and 6 interns were supported under Bhavan fellowship.

7. Simultaneous Power and Cooling Production using solar operated absorption refrigeration systems for cold storage applications (Anna University)

In this project, Simulation and Experimental Studies have been carried out to analyze the actual useful output and performance of the combined power and cooling system that uses low-grade energy. The cycle was a combination of an absorption refrigeration cycle and Kalina cycle. The performance characteristics of the dual output system were evaluated using exergetic and energetic approach based on the quality of useful outputs. This study provides a feasible and flexible way to meet the desired power/cooling ratio to generate varying demand profiles using low-grade heat sources

Combined power and cooling system that uses low-grade energy

8. New Projects initiated: 31 projects have been supported under the Solar Energy Research in various institutions across the country.

WATER TECHNOLOGY INITIATIVE (WTI)

Water Technology Initiative is a demand oriented user centric initiative which includes development research in laboratories as well as application research in field.

Based on assessment of nations R&D technology and solution needs for meeting water challenges and to accomplish remaining work as per Technology Mission: WAR for Water, a theme based effort was mounted to mobilise proposals for three streams Research (WR), Technology (WT) and Solution demonstration (WS) under the Water Technology Initiative. The call could evince an overwhelming response of 301 proposals from academic and R&D organisations under all the three streams, which were evaluated. 72 proposals were supported. These proposals relate to water and waste water treatment, contaminant detection, desalination, water conservation and monitoring of water quality.

1. Development and Proving of Convergent Technology Solutions:-

1.1 Arsenic removing Technology based on nanomaterials

A technological solution has been supported to IIT Madras (IITM) for deployment and validation of nanomaterials based arsenic removing technology in South 24 Parganas district of West Bengal. The project envisages to install 200 online units and 200 storage units and about 1000 domestic units covering a population of 100000 people.

Inline and Storage Water purifiers based on nanomaterials

1.2 Establishment of two 1.5 MLD Wastewater Treatment plants using MBBR Probiotics Technology

Two 1.5 Million litres per day (MLD) Wastewater treatment plants demonstrating innovative Moving Bed Biofilm Reactor (MBBR) Probiotics Technology has been commissioned at SVECW, Bhimavaram benefitting a population of 6000 in the campus.

Moving Bed Biofilm Reactor

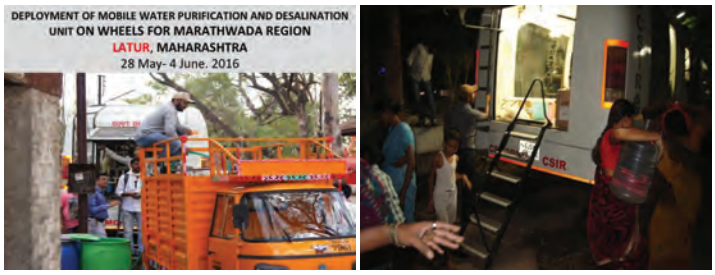
1.3 Community Based Participatory Aquifer Management System for Providing Equity and Sustainability in Water Resource Management

A convergent solution that aims to develop a community based ground water conservation and augmentation model for 35 villages of Chirawa block, Jhunjhunu District. Improved first flush devices are incorporated in water conveyance system of 218 roof top rain water harvesting benefitting 3200 families. 875 Field demonstrations of improved agricultural practices for Rabi and Kharif crops have been undertaken in the farmers' field.

Low Cost Device measuring GW table

Embedded Water Level Measurement & Control System Experimental Setup

1.4 Water on Wheels: Deployment of a mobile RO unit in Latur Marathwada



DST deployed a mobile water purification unit developed by CSIR-Central Salt & Marine Chemicals Research Institute (CSMCRI), Bhavnagar for portable water in Latur City—a city in the Marathwada region that is facing severe scarcity of drinking water. Through this deployment 40,000-50,000 liters of water per day water was made available and distributed to the people for 10 days in the months of May-June 2016.

1.5 Implementation of Scientific Rainwater Harvesting system for safe drinking water in interior villages of Kohima District

THE MORUNG EXPRESS

Experts in state for Scientific Rainwater Harvesting System

Scientific Rainwater Harvesting systems for safe drinking water have been sponsored by DST and implemented by Nagaland Science and Technology Council (NASTEC) covering a population of 7320 people over 6 villages to address the challenges of surface run off due to hilly terrain leading to low per capita availability in Nagaland.

2.0 Augmenting Water Quality:

2.1 Development and Assessment of online Water quality monitoring technology

An Indo German collaborative project has been supported to validate test kit for rapid water quality testing under both laboratory and field conditions through comparative assessments in state of Bihar. It involves developing valid scheme for acceptability; addressing regulatory, economic and social aspects.

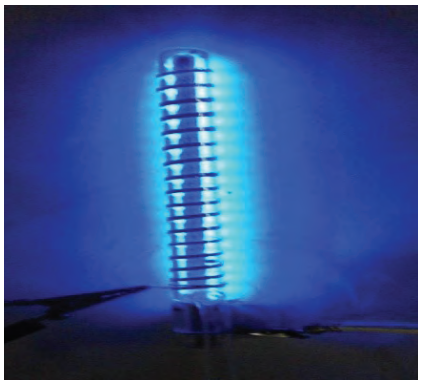
AC II in Field Usage

The Test Kit

2.2 Dielectric Barrier Discharge (DBD) based plasma system for portable water purification.

A technology developed at CEERI Pilani support by DST's initiative (WTI), for Dielectric Barrier Discharge (DBD) based plasma system for disinfection, has been successfully transferred for commercialization to Turners Pvt. Ltd. Jaipur. The prototype, an 8 inch tube Mercury Free Plasma UV (MFP-UV) lamp, produces UV radiations to disinfect the impure water.

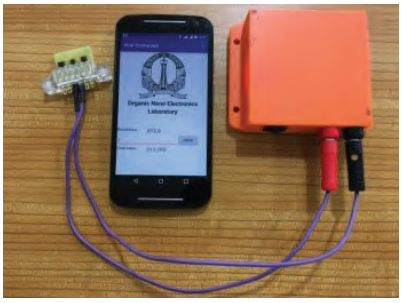
A Portable water purifier system



Dielectric Barrier Discharge (DBD) based plasma system for portable water purification

2.3 Development of a polymer based sensor for detecting nitrate in water

A handheld sensor measurement system has been designed and developed by Indian Institute of Science (IISc) Bangalore as a prototype for measuring nitrate ions in water. Prototype sensor testing apparatus has been fabricated; in addition android-based application was also developed for measuring change in resistance of the sensor in presence of nitrate ions.



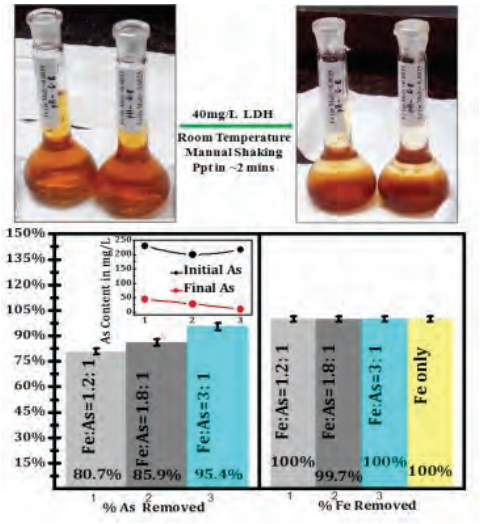
Prototype connected to phone

2.4 Development of Colorimetric sensor for Cr (III) detection:

A simple and cost-effective colorimetric probe for Chromium speciation in aqueous solutions using citrate-capped silver nanoparticles without further functionalization has been developed at Vellore Institute of Technology (VIT), Vellore. The technology provides a selective and sensitive detection method of Cr (III).

2.5 Development of an Arsenic and iron removing technology from ground water through synthetic mineralization:

A patented technology based on layered double hydroxide (LDH) structures has been developed at Indian Association for the Cultivation of Science (IACS) Kolkata for Arsenic and Iron removal through synthetic mineralization. The technology is able to remove 80-95% of As and 100% of Fe from aqueous solutions.



Ferrihydrite based Arsenic removal

2.6 Prototype Development of a Nanotechnology Based Pocket Friendly, Reusable Water Purifier

A non electrical prototype has been developed at Amity University for a water purifier based on nano technology. The present product in the form of a small portable tea bag is likely to be priced at a low cost as compared to other products in the segment. The Eco-friendly purifier provides decontamination of microbial load in the treated water. The device has good reusability and its efficacy remains the same even after 120-125 uses of the same pebbles within a time span of 6 months.

Labscale Prototype

Wall mounted Prototype

2.7 Development of Water Quality Monitoring and Surveillance mode in Selected Rural Areas of Uttarakhand

DST, Uttarakhand State Council for Science and Technology (UCOST), Uttarakhand Jal Sansthan (UJS), and DAV(PG) College, Dehradun came together to improve access to clean water, sanitation and hygiene at two Gram Panchayats (GPs) viz. Ghena GP of Tehri district and Lachchiwala GP of Dehradun district, Uttarakhand and is first attempt of its kind in Himalayan region. There are more than 3000 direct beneficiary villagers of 2 GPs of 2 districts of Uttarakhand through present intervention.

Project Team during Inspection and Survey of Water Facility at Lachiwala Gram Panchayat, Dehradun, Uttarakhand,

Demonstration and On-site Water Sample Collection and Analysis by Project Team in Ghena Gram Panchayat, Tehri, Uttarakhand

3.0 Waste Water treatment:-

3.1 Treatment of Mine Process Water in Laboratory and Pilot Scale using High Performance Flocculation

A high performance flocculant has been developed by Indian School of Mines, Dhanbad, based on functionalized guar gum/silica hybrid nanocomposite (g-GG/SiO_2) as high performance flocculants. The pilot scale study was performed at the Tata Steel R&D using laboratory developed flocculant and demonstrated excellent efficacy towards the treatment of mine process water in laboratory and pilot scale.

3.2 Establishment of a Water quality lab and Demonstration of ZLD technology in Aquaculture using bioflocculation

A water Quality facility has been established at Uddaraju Anand Raju Foundation, Bhimavaram with DST support and Zero Liquid discharge technology has been successfully demonstrated in Aquaculture using biofluccculation.

4.0 Capacity Building:-

4.1 Water Advanced Research &Innovation (WARI) fellowship program

Recognizing the accomplishments of Daugherty Water for Food Institute, University of Nebraska (UNL), USA in the field of water resources, capacity building programme on water resources has been initiated to support 15 fellowships and 15 interns for a period of 3 years. In the first year of the program 5 fellows and 6 interns have been exposed to relevant labs and groups at UNL for residencies for durations ranging from 3 months to one year.

4.2 Country-wide Capacity Building Programme on Bank Filtration for Sustainable Drinking Water Supply

A 5-day training course was sponsored by DST, on "Country-wide Capacity Building Programme on Bank Filtration for Sustainable Drinking Water Supply" and was organized by National Institute of Hydrology (NIH) Roorkee from 12th to16th September, 2016 targeted for the States representing Indo-Gangetic and Brahmaputra & Barrack basins covering all eight states of West Bengal, Bihar, Jharkhand, Uttar Pradesh, Uttarakhand, Himachal Pradesh, and Delhi. 30 participants attended the training course.

4.3 Establishment of a Water Quality Laboratory in Kohima, Nagaland

The Water Quality Laboratory was recently inaugrated by the Hon'ble Union Minister of Science and Technology Dr. Harsh Vardhan at NASTEC, Kohima, Nagaland, which has been established by the support of DST under WTI. The Referral Water Laboratory is fully equipped with the in house sophisticated analytical equipments for Water Quality analysis which is a one of its kind facility that can cater to the need of Water Analytical services in Nagaland and adjoining states.

4.4 Setting up of a Facility for Drinking Water quality analysis and monitoring in North Coastal districts of Andhra Pradesh

A continuous water quality analysis and monitoring facility has been established at GITAM university,

Vizag Andhra Pradesh especially for rural and tribal population with DST support at. The facility is creating awareness about drinking water quality deviations in the area and providing a source of an equipped water quality analytical facility.



5.0 International Cooperation:-

5.1 Indo-UK Collaboration on Water Quality Research in India and UK

Recognising the importance of clean water and Mission's focus on safe and portable water, India (DST) and UK (Natural Environment Research Council -NERC & Engineering and Physical Sciences Research Council -EPSRC) has jointly agreed to launch a collaborative research programme on improving Water Quality with a committed investment of 4.2 million £ from each side, having special thrust on addressing threats due to emerging contaminants (PPCP) online river water quality monitoring and sensor technology.

5.2 DST-Intel Collaborative Research on River and Air Quality Monitoring in PPP mode

A joint DST-Intel collaborative Research program on River Water and Air Quality has been evolved and launched by Hon'ble Minister of State of Science and Technology, Shri. Y.S Chowdary on 8th December 2016 in New Delhi to develop key technologies for sensing, communication and analysis of large-scale data collected from autonomous networks of perpetual/long-lived sensor nodes, followed by integration and deployment for water and air quality monitoring in real-time. This real time data will significantly further strengthen and complement the Missions of National priority like Namami Gange Programme and others by serving as critical data feeders for pre and post treatment analysis.

5.3 Indo-French Networking proposals on Water:

A bilateral Indo-French joint initiative has been launched for networking proposals in the area of waste water treatment and natural water treatment systems. The French Embassy in India and the Department of Science & Technology (DST) has joined hands for Indo-French Scientific Networking Programme in the field of water. The Indo-French Joint call was launched initiating a good response and two networking proposals in the area of Waste Water treatment and Natural Water treatment have been supported under this interaction.

TECHNOLOGY DEVELOPMENT PROGRAMMES

The Department is supporting Technology Development Programme in which projects related to the technology systems development and instrumentation development has been sanctioned. During the current year projects with thrust on Medical and Healthcare, Analytical, Industrial and Sensors & Allied Instrumentation have been supported.

New Initiatives/projects

Twenty-eight new projects in the area of textile, quality control, agriculture, food processing, medical and healthcare and sensor based technologies have been supported with industry collaboration at various National institutes/ Universities/ Engineering and Medical colleges. 10 technologies are demonstrated and are ready for field applications.

Proactive industry involvement in the technology development projects will be encouraged and aligned with National Agendas like Start Up India, Make in India, Swasth Bharat etc. Keeping in spirit, Low Cost Comfort Cooling Technologies was launched by the IDP-DST and 12 short listed proposals are under consideration. The stakeholder meetings for affordable biomedical devices/technologies, viable agriculture technologies for the field demonstration, Research and technology development for cultural Heritage are being conducted and will be launched during next year.

Major achievements:

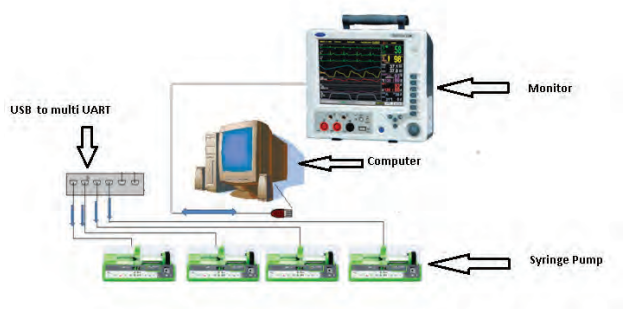
1. Development of Tactile Sensor Based Ligature Controller to Assess Pancreatic Leak after Whipple's Procedure by Anna University

A tactile force measurement system was developed which measures the surgeon's optimal knot tying force. If the force exerted by the surgeon is not within the optimal range, the system will indicate the surgeon by providing audio/visual alarm. This device will also be used as training tool for surgeons. The system is currently used in the Institute of Gastroenterology, Government Stanley Medical College and Hospital for data collection.

Tactile Sensor Based Ligature Controller

2. Design Closed Loop Automated Blood Pressure Control System by Postgraduate Institute of Medical Education & Research (PGIMER), Chandigarh and Indian Institute of Technology-Ropar

A closed loop automatic blood pressure control system called CLAPS has been developed an automatic control system for the control of blood pressure during surgical operation. This system will automatically monitor patient parameter with the help of transducers and then sent it to PC where software will apply logic on that and then drive syringe pumps according to an in-built algorithm based on feedback from the patient. Currently, up to six drugs can be controlled through six syringe pumps attached in the system. The CLAPS consists of i. multi-parameter patient monitor, ii. personal computer with the hemodynamic controller algorithm and iii. syringe pumps. CLAPS can function in an automatic mode and in the manual mode also.

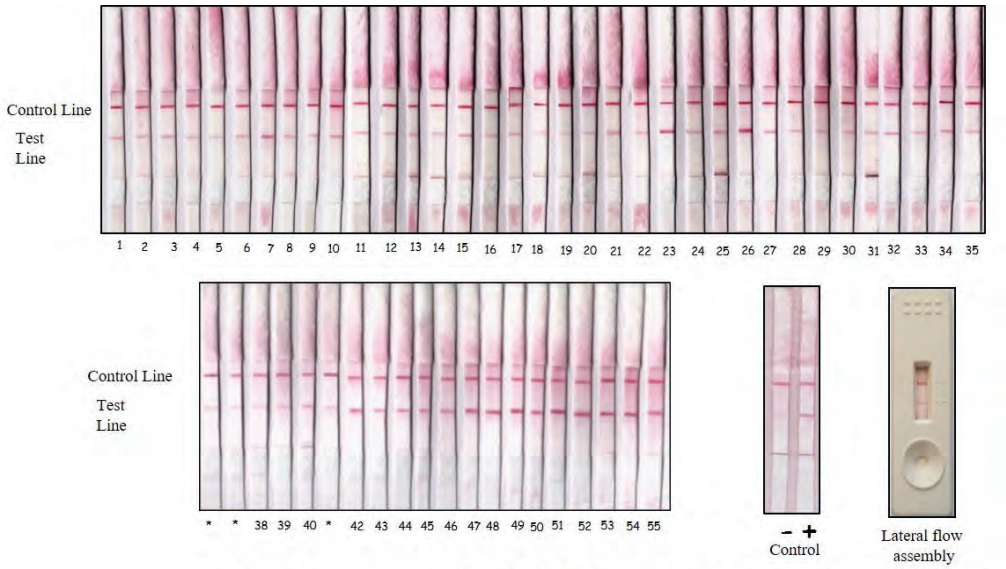


Diagrammatic representation of CLAPS

CLAPS Lab

3. Development of Nano Gold based Immunochromatography/Immuno Dot Blot Assay for Detection of Trypanosoma evansi Infection in Animals by Guru Jambheshwar University of Science & Technology, Hisar

Trypanosomosis is a parasitic disease caused by the flagellate protozoa belonging to the genus Trypanosoma. The animals like camel and horses are very susceptible to the infection and death may occur within weeks or months. In the present study, a novel gold nanoparticles based immuno chromatography technique (ICT)/lateral flow assay (LFA) has been developed for the rapid and early diagnosis of trypanosomosis. ICT results revealed no significant difference in sensitivity and specificity between LFA and ELISA, more number of samples are being tested to get statistical significant data. LFA has many advantages as compared to ELISA, such as no equipment or trained personnel needed and easily visually readable results obtained within 10 minutes. Further, this test can be employed during outbreaks and help in rapid screening of large number of suspected cases in endemic areas.



Lateral flow assay using ELISA-positive Field samples of *T. evansi*

4. Wireless Sensor Network Enabled Earlier Real Time Detection of Spoilage in Stored Grain by Velammal Engineering College, Chennai

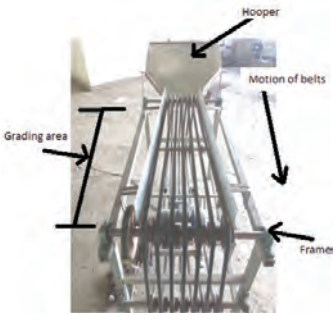
Food grain spoilage is an important social issue faced by our country. To monitor the spoilage, a low cost and ultra low power indigenous wireless sensor node has been designed and demonstrated. The device offers features like real-time wireless sensor network based monitoring and detection of food grain spoilage by the noninvasive method, portable handheld based spoilage inspection tool with wireless data acquisition using Wi-Fi and GSM, Internet of Things (IoT) based remote monitoring of acquired data and N/W coded wireless sensor network powered information kiosk for local monitoring. It can be a good replacement for conventional less efficient temperature cables installed for food spoilage detection.

Wireless sensor node

5. Electronic Saffron Corm Grader and Walnut Grader by Sher-e-Kashmir University of Agricultural Sciences and Technology of Kashmir (SKUAST-K), Srinagar Kashmir

The machine for grading of saffron corms and walnuts has been fabricated. Expanding pitch type conveyor belt mechanism has been used for grading. Round/circular shaped belts moving over pulleys are used for enhanced efficiency of grading. Compound pulley mechanism were incorporated for speed reduction which helped in reducing the fatigue and creep stresses generated in belts, it also helped to reduce the temperature of belt surfaces, which in turn helped to save the surface of the product being graded. The mass of the machine is evenly distributed to provide the necessary balancing of the unit which makes it free from vibrations and noise.

A patent has already been filed for the machine. The machine has been tested efficiently and five research papers have been published in leading Journals so far.



Demonstration of grader for saffron corms and walnuts

6. Design and Development of a Computerized Protray Filling, Dibbling, Seeding and Watering Machinery for Vegetable Nursery by ICAR-Indian Institute of Horticultural Research, Bangalore

The vegetable crops like tomato, brinjal, cabbage, chillies, cauliflower etc., need transplanting. The raising of nursery in protray under greenhouse / shade net is becoming popular and presently there are about 6,000 vegetable nurseries (with a capacity of about 300 protray per day) in India and about 1,000 of these are around Bangalore. The filling, dibbling and sowing of nurseries in protrays is primarily done manually and 10 man-hours are required to fill, dibble and sow 100 trays / 1 lakh seeds. As the vegetable seeds are small in size (2 – 4.5 mm), placing the individual seeds in cells of protrays is very tedious and time consuming unit operation. Hence, a prototype automatic portray dibbling, sowing and topping machine was designed and developed. The functional components of the step seeder are i) endless conveying belt operated by a step motor for protray movement , ii) reciprocating dibbler, iii) vibrating seed singulation tray, iv) vacuum operated seed nozzles and v) topping system. The complete cycle is controlled by PLC programme. The pneumatic components of the machine is operated under 5 – 6 bar pressure.

Automatic portray dibbling, sowing and topping machine

7. Feasibility Study for Development of Sensor Based Precision Fertilizer Application Device for Paddy by Tamil Nadu Agricultural University, TNAU, Coimbatore

A paddy leaf colour sensor unit and a precision application device were developed. The bench mark was optimized for Leaf colour analyser unit from the observations of the field trials. If the sensor value is higher than the value of 1820 Hz mm-2, then there is a deficiency of nitrogen fertilizer and needs an application of 30 kg ha-1. If the leaf colour analyser value is lower than 1820 Hz mm-2 then no

need nitrogen application. A forecasting chart was drawn for the developed sensing unit to find out the reading for each existing instruments.

Developed Leaf colour measuring sensor kit

The precision fertilizer applicator was tested at an average walking speed of 1.2 km h-1 in paddy field. From the results of the evaluation of prototype, it is observed that the application rate of 28, 64, 95 and 140 kg ha-1 could be achieved for the exposure length of flute 10, 20, 30 and 40 mm respectively. A prediction model on the amount of urea discharged was developed based on multiple quadratic regression analysis.

8. Development of De-seeding Machine for Custard Apple Pulp by Dr. Panjabrao Deshmukh Krishi Vidyapeeth (PDKV), Akola

The de-seeding machine for custard apple pulp has been developed and demonstrated. The de-seeding machine for custard apple pulp separate the seeds from the pulp with pulp extraction efficiency 98.16 % and flakes recovery 82.85 % at optimum machine parameters. The pulp thus extracted could the stored for six month in deep freeze at -20°C after treatment with 0.1% potassium metabisulphite (KMS) and packed in LDPE bags. The MoU has been signed between the University and Manufacturer for supply of machine. Total twenty eight (28) units of de-seeding machine for custard apple have been sold to the custard apple grower/processor in Maharashtra, Gujarat and Chhattisgarh through the manufacturer. All machines have installed and running successfully. Total 28 entrepreneurs have been developed in one and half year.

In this project hand operated portable custard apple deseeding machine has also been developed which will be useful for small entrepreneur and individual juice vendor.

9. An Electronic Device for Measuring Starch Content in Cassava (Tapioca) Tuber by ICAR-Central Tuber Crops Research Institute, Trivandrum

An electronic device for measuring the starch content of cassava (tapioca) tuber has been developed which is useful in estimation of cassava starch and sago industries. The sensor consists of two plates which act as an inductor measuring device and the same plate used for capacitance too. The polished plates are fixed at a finite distance. The sliced sample cassava is placed between the plates during measurement. Electronic starch indicator is portable and very easy to operate. It measures starch content of cassava tubers in a few seconds. The gadget was evaluated at SAGOSERVE, Salem and a high level of correlation was established between the gadget and chemical readings. During the demonstration of the gadget it is found that the gadget received good acceptability among the cassava farmers, traders, starch and sago manufacturers. It is proposed to multiply and commercialize the gadget through the industrial partner M/s Environmental Measurements and Controls (EMCON), Cochin.

Launching of Electronic Starch Indicator by Hon'ble Minister for Agriculture on 20 October 2016 during National Conference on Tropical Tuber Crops for the Sustenance and welfare of tribal Communities (NCTTC-2016) at Thiruvananthapuram

10. Development of Hand Held Instrument for On - Field Fibre Content Measurement in Sugarcane by ICAR Sugarcane Breeding and ICAR Central Institute of Agricultural Engineering

A hand held instrument for non destructive large scale estimation of fibre content in sugarcane in short time is developed. High correlation coefficient observed between fibre content and rind hardiness was the hypothesis for developing indirect method of estimation of fibre content. When force was applied on force sensitive resistor (FSR), it changes its resistance corresponding to the level of force. This change in resistance was converted into digital values through microprocessor. A working basic prototype was made by integrating the mechanical and electronic components. An appropriate algorithm was developed to convert the force value to fibre unit. The equipment was evaluated/ demonstrated at the ICAR – Sugarcane Breeding Institute and at a few sugarcane Mills.

Prototype model of hand held fibre content measurement equipment

Operation of prototype model of hand held fibre content measurement equipment

The technologies demonstrated during the year 2015 namely, Mechanized System for Effective Sett/ Bud Treatment of Sugarcane by ICAR- Central Institute of Agricultural Engineering (CIAE) and ICAR-Sugarcane Breeding Institute (SBI); Handheld Electronic Nose (HEN) for Detection of the optimum Fermentation point during Tea manufacturing process by Sensor Hub, Central Glass and Ceramic Research Institute, Kolkata and C-DAC, Kolkata; and Portable multi-analyte sensor for detection of renal disease by IIT Bombay, Mumbai have been transferred to M/s Cleantek, 43, Manalthottam, Ganapathy (PO), Coimbatore; M/s Nagarjuna Fertilizers and Chemicals Ltd., Hyderabad; and Biosense Technologies Private Limited, Mumbai respectively.

ADVANCED MANUFACTURING TECHNOLOGY (AMT) PROGRAMME

DST has initiated this program for developing Advanced Manufacturing Technologies in October 2015, in line with the Government's initiative of "Make in India" mission. A high level Expert Advisory Committee (EAC-AMT) was set up, chaired by Prof. Rudra Pratap, Center for Nano Science & Engineering, Indian Institute of Science, Bangalore. Five thrust areas were selected for developing novel manufacturing technologies viz. Nano materials & surfaces, Robotics & automation, Precision manufacturing, Manufacturing process of Pharmaceuticals & Bio manufacturing and Advanced forming & near net shaped processing. Also, Encourage R&D labs to move some of their activities from "discovery research" towards "Industrially relevant R&D" and encourage inter-disciplinary, multi-institutional research programs for innovation.

DST instituted a more pro-active approach for generating & screening project proposals that is more suited for industrial R&D program. This included a "Call for Proposals" that resulted in 245 applications, which was then screened directly by the Expert Committee, instead of going through the "peer evaluation process" that is usually adopted for S&T projects. This approach was recommended considering the comparative inexperience of the Indian research community in engaging with industrial technology activity.

The expert committee evaluated and shortlisted 58 project proposals for detailed evaluation in December 2015.

In January 2016, the Expert Committee interacted directly with the investigators, through focused presentations, and recommended 45 projects for funding support by DST. DST has already initiated a large number of these projects, and 42 projects has already been commissioned by end October, 2016.

The first phase of AMT activities was meant to harness the dormant talent among the R&D institutions to engage in technology development activities. These projects will be implemented over the next three years.

The next phase of activity will be launched shortly, and the call for proposal has already been initiated for **developing novel manufacturing technologies** from research institutes and in collaboration with industry in the following specific areas.

- Digital Manufacturing - Design tools and process innovations, modelling & simulation platforms;
- Near net shape processing for product development
- Flexible scale manufacturing (including die-less manufacturing; jig-less assembly; fixture-less inspection) - Additive manufacturing (AM).
- Production scale materials processing including nano materials & surface coatings
- Smart Manufacturing - Automation and Information & Communication Technologies (ICT); Advanced Robotics (AR) & Industrial Internet of Things (IIOT).
- Manufacturing Technologies for wearable low power electronics including energy harvesting & sensor Networks

WASTE MANAGEMENT TECHNOLOGY (WMT) PROGRAMME

This program is aligned to the "Swachh Bharat Mission" or "Clean India Mission" of the Government. DST initiated a special program on Waste Management Technologies (WMT) in October 2015, and constituted a high level Expert Advisory Committee (EAC-WMT) for this purpose, chaired by Dr. G.D. Yadav, Vice Chancellor, Institute of Chemical Technology (ICT), Mumbai.

Waste Management encompass a variety of interventions in the generation, prevention, characterization, monitoring, treatment, handling, reuse and ultimate residual disposal of solid wastes.

The objectives of the program is to take stock of technological development, assess, analyse and look for material recycling systems with low environment loading and improve upon them or find better alternatives, develop waste management technologies that can be adopted in small & medium scale enterprises in order to improve their productivity and global competitiveness and establish techno-economic feasibility of proposed methodologies/ technologies.

The program aims to promote the development of suitable technologies with potential to ameliorate the environmental load from the huge amount of residuals generated by industrial development and consumption lifestyle.

The initial focus is on four areas: (a) Electronic Waste, (b) Hospital Waste, (c) Plastic Waste, and (d) Solid Waste from Mining, Metallurgical & Ceramic Industries.

Technology Development Projects will be undertaken by R&D agencies, in association with industry, to develop pre-competitive technologies/ techniques/ processes.

The selection of projects is based on the criteria of novelty & scientific uniqueness, thereby DST aims to promote innovative technologies that can have commercial potential.

A call for proposals was initiated in September 2015 resulted in 186 project proposals received as a response to the call, in DST. They were screened by the Expert Committee and 42 project proposals were selected for detailed evaluation.

In February 2016, the screened in proposals were evaluated through direct interactions & presentation by the Investigators, and 19 projects were recommended for approval.

DST has already processed a majority of these projects and 17 projects has already been sanctioned by end October, 2016

In the course of next two years, it is planned to explore more proactive industry involvement in the technology projects, with the aim to eventually generate PPP-in-R&D projects with an active role for industry-led technology development programs in this area.

The next phase of activity will be launched shortly, and the call for proposal has already been initiated for developing waste management technologies in the following areas :-

1. E-Waste (Electrical & Electronics Waste): Recycling & Recovery
    - Development of simple indigenous material recovery technology for specific applications (precious & other metals, plastics, glass and rare earths) in collaboration with industry.
    - Green Product development and Design for recycling.
2. Industrial Hazardous & non-hazardous Wastes
    - Mining Waste: Overburden, Tailing Pond
    - Metallurgical Waste
    - Cost effective treatment of refractory organics
    - Recycling/recovery of value added materials from hazardous/non-hazardous wastes
    - Solid Waste from Chemical Industry (such as adsorbents like ion exchange resins, activated carbon, clays, membranes)
    - Membrane rejects and Salts
    - Industrial sludges
    - Industrial spent solvents and chemicals
3. Newer technologies for Biomedical Waste

4. Urban & Rural Solid Waste, including Plastic Waste
    - Existing Landfills: Gas Extraction, Leachate Treatment, Material Mining, Remediation, Value-added Material Recovery
    - Non-recyclable packaging material.
    - Household hazardous waste
    - Construction & demolition debris
    - Co-digestion of sewage sludge

INTERDISCIPLINARY CYBER PHYSICAL SYSTEMS (ICPS) PROGRAMME

DST has recently launched a new programme "Interdisciplinary Cyber Physical Systems (ICPS)" to foster and promote R&D in this emerging field of research. A Cyber Physical System (CPS) is a mechanism controlled or monitored by computer-based algorithms, tightly integrated with internet and its users. It is an engineered system that are build from and depend upon, the seamless integration of computational algorithms and physical components.

Networked Programme on Imaging Spectroscopy and Applications (NISA): Satellite technology has dramatically altered our perspective of the Earth and vastly expanded our understanding of the land, ocean, and atmosphere. So far, most of the space borne sensors have been multispectral systems having a few wavebands tailored for specific observational requirements. However, it is now well understood that more information about water, land, and atmospheres can be obtained from the full spectrum rather than from a few discrete wavebands. Imaging spectroscopy is a relatively new field of Earth Observation (EO) offering many advantages over conventional broadband remote sensing. hydrosphere and atmosphere.

Considering the potential of this emerging technology, the Interdisciplinary Cyber Physical Systems Division evolved a cluster based multidisciplinary Networked project on "Imaging Spectroscopy and Applications (NISA)" to promote research on various aspects of IS and its applications. This programme is also expected to evolve reference standards, protocols, database and research methodologies for adaptation in various fields relevant to society. This networked programme has 37 projects addressing various research problems (prioritized as per current need of the country and societal relevance) in seven theme areas such as geology, agriculture, forestry, water, snow and glacier ice, urban & built-in materials and algorithms. NISA also aims at developing four central laboratory facilities with sophisticated instruments in different parts of India to meet the scientific requirements and a centralised database management system for the storage and dissemination of generated data. Development of human resources on this specialized science through capacity building and training is an integral part of the programme.

This networked project is expected to bring out scientific understanding on Imaging Spectroscopy and methodology development for its applications in various fields like mineral exploration, agriculture production, forest mapping and inventory of species, terrain analyses and water quality. In addition, the state of the art laboratories relevant to IS, documents and protocols for spectral data generation and well trained human resources are additional benefits. Open source software tools for IS data processing is expected to save the overseas procurement of software.

Ongoing / completed schemes/projects and Achievement

(a) Restoration of Koleru Lake Ecosystems: The fresh water Lake Kolleru occupying around 1000SqKM and its surroundings have been subjected to significant changes in its geometry, size and its ecological characteristics. The changes in land use, land cover dominated by aquaculture and intense agriculture has not only interfered with the morphology of land form but also impinged on the hydrological, Physical, geological, geochemical and hydrochemical characteristics of the region. The unforeseen economic benefits in the aqua culture industry complimented by the serene ecological conditions in and around Kolleru lake have lead to an unprecedented transformation in land use pattern. S&T intervention was made by DST and composed and implemented a holistic study. The present multi disciplinary, multi institutional project is contemplated to focus on the major objective of restoring the ecosystems of Kolleru lake. Though, a number of investigators from different disciplines are involved in generating data and output in their subject arena, the integration contemplated and achieved has a high degree of value not only in providing comprehensive recommendations to address the main problem, but also in demonstrating the need and importance of inter disciplinary approach in addressing complex problems.

(b) Indian Digital Heritage-Hampi (IDH): The Indian Digital Heritage (IDH) Project is an unique initiative supporting collaborative projects between researchers in the areas of technology and humanities for the digital documentation and interpretation of our tangible and intangible heritage. The project highlights the art, architecture and cultural legacy of the world heritage site of Hampi in Karnataka, the medieval capital of the Vijayanagara dynasty. The only Indian effort of coordinated research in the domain of cultural heritage, IDH, received a funding of about 8 crores for a duration of 4 years. The entire project had 11 core technical sub-projects and 10 purely on cultural issues. This first of its kind project highlighted the need for a broader research framework to encompass all scientific research into digital heritage. The partners of the project discovered several new research challenges as they attempted to push the envelope of the state of the art in an effort to meet the concrete mandate of the project, i.e., capture, recreate and preserve the rich heritage of Hampi. The true outcome of the IDH project is therefore a realization of the need for a research framework on Indian digital heritage.

The following are the problems addressed in the project:

1. Investigation of the basic requirements related to digital heritage archiving and usage: Through collaboration between the culture and the technology communities; identify the nature and form of heritage that is most suitable for digital capture, storage and use.

2. Data collection and archiving: Create through a community based effort data, sources, standards, schemas as well as the necessary technology to enable the storage and processing of relevant media.

3. Research and creation of tools and technologies: Identify and address technological research issues that arise during the course of the project and further the state of the art by innovating new technologies.

4. User experience: create compelling and holistic end user experiences that highlight the historical and artistic significance of various monuments and other types of heritage content.

Contributions/ Achievements

There were 27 technical and cultural institutes which were part of the IDH initiative. The IDH outputs can be classified into the following broad categories:

- Techniques to generate virtual and physical models and representations of Tangible Heritage of Hampi, which include realistic walk-throughs of heritage sites,
- Technology frameworks for the analysis and digital restoration of heritage artifacts,
- Architectural and social life reconstruction and capturing living traditions of Hampi,
- Knowledge-based frameworks for intellectual exploration of heritage sites and themes, along with systems for digital archival of the tangible and intangible heritage artifacts.

This project involved development of algorithms and techniques to acquire a three dimensional digital replica of complex structures spread over a large area. The techniques developed were applied to Hampi, a world heritage site. In addition to acquiring the geometry and surface properties, research was carried out for efficient representation and visualization of this data, as well as tools and methods for users to experience the captured models, to virtually walkthrough and explore the digital recreations.

Reconstruction of Mahamantapa in Digital space using historical evidences

Greenlaw's picture of Mahamantapa Existing Mahamantapa image

(a) Existing Mahamandapa image, (b) Reconstructed view of Mahamandapa

SYNERGY PROJECTS

Synergy projects endeavor to bring in synergy among the various scientific departments and other ministries in creating an enabling S&T eco-system that encourages innovations across disciplines. It encourages R&D projects in `advanced high quality basic research', and `directed basic research', as also 'pre-competitive applied research' through academia –industry interactions. The development of specific projects, usually in partnership with other departments, revolves around this basic philosophy. These projects are in consonance with national S&T priorities, as perceived from time to time. The projects undertaken by this Office relate to energy sector, water, automotive, machine tools, electronic hardware, photonics, medical devices, science initiatives in Ayurveda, and rural technologies, etc. Synergy Projects scheme is under implementation by the Office of Principal Scientific Adviser to the Government of India.

TECHNOLOGY COMMERCIALISATION

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 the 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.

During the year 2016-17, TDB is slated to sign 23 agreements with a total project cost of Rs. 2200.00 crore with TDB's contribution of about Rs. 850 core spread over three years. The commitment for the F.Y. 2016-17 is about 180 crore. TDB's support covers various sectors such as Healthcare, Engineering, Agriculture, Energy & Waste Utilization, Telecommunications and Information Technology etc.

Some highlights are given below:

1) M/s Ampere Vehicles Pvt. Ltd, Coimbatore

TDB executed a Loan Agreement on 15th July 2016 with M/s Ampere Vehicles Pvt. Ltd., Coimbatore for 'Indigenized development and commercialization of key components such as motor, chargers, controllers and DC-DC converters for Electric Two Wheeler Vehicles'. The project envisages the indigenized, development and commercialization of the 4 key components for Battery Operated Vehicles that include Motor, Chargers, Controllers and DC-DC converters for electric vehicles

2) M/s Penn Bio Chemicals (India) Pvt. Ltd., Hyderabad

With M/s Penn Bio Chemicals (India) Pvt. Ltd, Hyderabad, TDB has signed an agreement for a loan assistance for 'Development and Commercialization of Darunavir and its Intermediates. Darunavir (Prezista) is a drug used to treat HIV infection.

3) M/s Sahajanand Laser Technology Limited, Gandhinagar

M/s Sahajanand Laser Technology Limited, Gandhinagar (SLTL) has entered into a Loan Agreement with TDB for in-house production of medium to high power 1 μm Continuous-Wave (CW) fiber laser sources. The company has already developed part of the basic modules of 500W single-mode fiber lasers and through this project they aim to build capability and infrastructure for in-house production of fiber lasers. This will narrow the gap in products and prices between foreign and domestic suppliers, and thus enables not only cost savings but also access to better and timely services to domestic customers, including government, defence labs and commercial organizations.

4) M/s Panacea Medical Technologies Pvt. Ltd., Bangalore

TDB signed an agreement with M/s Panacea Medical Technologies Pvt. Ltd., Bangalore for "Commercialization and Setting up of manufacturing facility for Indigenous Medical LINAC". The company has acquired the technology from SAMEER & Deity; and plans to introduce a fully loaded 6MV LINAC with features like remote diagnosis of the tumor, in addition to Intensity-modulated radiation therapy (IMRT), Image-guided radiation therapy (IGRT) and Volumetric Treatment modalities, which are already available in the current product line in the market. The key differentiators include IMRT enabled LINAC, the latest technology even in the emerging markets like SS Modulator.

5) M/s TATA Power Company Ltd. – Strategic Engineering Division, Bengaluru

TDB has sanctioned financial assistance to M/s Tata Power Company Limited- Strategic Engineering Division (Tata Power- SED), Bangalore for their project on "Setting up of Defence Manufacturing Facility at 50 acres Land at Vemagal Industrial Area, Kolar District, Karnataka to commence the mass production of the products" developed in DSIR approved R&D Centers at Mumbai and Bangalore of Tata Power- SED.

6) M/s Biological E Pvt. Ltd., Hyderabad

TDB has agreed for financial assistance to M/s Biological E limited (Hyderabad) for the project on "Manufacturing Facility for Pneumococcal Conjugate Vaccine (PCV)". They plan to supply PCV to the national program as well as WHO for infants under EPI.

7) M/s Sonodyne Technologies Pvt. Ltd., Kolkata

TDB sanctioned financial assistance of Rs. 500.00 lakh to M/s Sonodyne Technologies Pvt. Ltd., Kolkata for the project on "Specialized digital audio hardware solutions for residential and professional audio segment".

8) Projects sanctioned under Millennium Alliance: 4th Round

The Technology Development Board in collaboration with FICCI and USAID started a concept called Millennium Alliance (MA) in 2012. The MA was to identify and scale innovative solutions developed

and tested in India, to address development challenges to benefit the bottom of pyramid populations across India and the world. Subsequently, UK's Department for International Development (DFID); ICCO Cooperation, Netherlands; ICICI Foundation for Inclusive Growth; Wadhwani Initiative for Sustainable Health (WISH) and the World Bank have joined as partners in the program.

The MA is a unique platform that synchronizes with Hon'ble Prime Minister's vision for new India driven by innovation, digital and social enterprises. MA has sanctioned more than 100 social enterprises under its grant scheme in four (4) rounds. In the FY 2016-17, under 4th round, MA has sanctioned 40 enterprises for support.

International Events/Collaboration

MoU with Bpifrance, France and CEFIPRA

Memorandum of Understanding (MoU) between TDB and bpifrance has been renewed on 10th May, 2016 at New Delhi along with CEFIPRA to carry out activities related to the exchange of best practices and setting up of coordinated measures to foster technological exchanges in the field of Science, Technology and Innovation through collaboration between companies, organizations and institutions of France & India.

MoU is aiming to fund proposals in Aeronautics, Automotive & Biotechnology. Proposals on aeronautics and automotive are being shortlisted.

Visit to Kenya alongside the Hon'ble Prime Minister's visit to Africa

TDB and FICCI jointly organized an Innovation cum Business event and took a delegation to Kenya coinciding with the visit of the Hon'ble Prime Minister's visit to Africa under PM's vision that 'India shares because it cares for Africa and development partners' as enshrined in the Joint Statement of Hon'ble PM with the Heads of States in IAFS III. The delegation showcased more than 20 Indian

technologies and innovations that have been successfully tested in India and have potential to expand and replicate to international market, notably Africa. It is planned to initiate a new program proposed to be named "African Development through Indian Technology & Innovation (ADITI)".

MoU with Indian Institute of Corporate Affairs (IICA) and TIFAC

TDB has signed an MoU with Institute of Corporate Affairs (IICA) and Technology Information Forecasting and Assessment Council (TIFAC) to establish a pilot capacity building initiative in sourcing innovations for commercialization and joint workshop, seminars and conferences.

Through this MoU, these entities will collaborate with each other in the area/s of "scouting and sourcing agriculture-technology based innovations for improving form-land productivity".

MoU with Economic Development Board (EDB) of the A.P. Government.

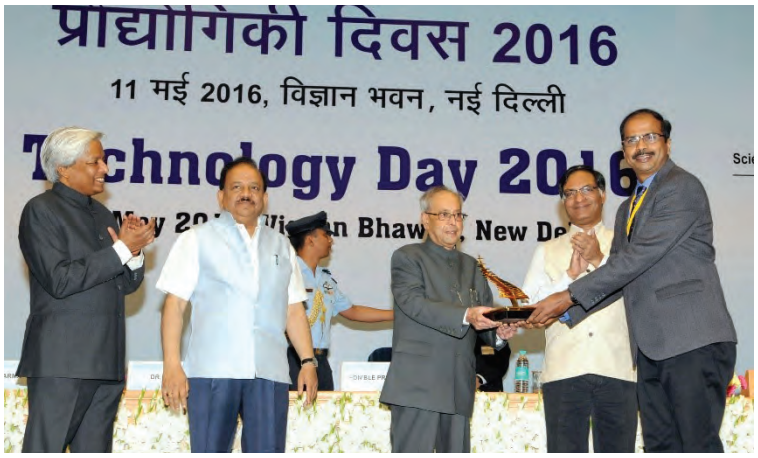
The Government of India launched the "Make in India" initiative in 2014 with the aim of transforming India into a global design and manufacturing hub. The initiative is focused on encouraging domestic and multinational companies to manufacture their products in India. In the backdrop of the above, TDB decided to send out Call for Proposals earlier this year in various strategic areas as identified in "Make in India", especially the Medical Devices sector including imaging equipment (such as CT scanners, MRI machines etc).

In this direction, TDB has joined hands with the Government of Andhra Pradesh to provide a major thrust to the indigenous manufacturing of medical devices in its Andhra Med Tech Zone spread over 270 acres. Med Tech Zone proposes to have at least 200-300 units, providing jobs to 20,000 or 25,000 persons, entailing investment of approximately Rs. 25,000 crores.

TDB expressed keen interest in funding at least 20 units that would like to set up their enterprises in the Andhra Med Tech Zone. An MoU in this regard has been signed between Economic Development Board (EDB) of the A.P. Government and TDB.

Technology Day Function- 2016

The Technology Day 2015 was celebrated on 11th May 2016 at Vigyan Bhawan, New Delhi. HE President of India, Shri Pranab Mukherjee graced the occasion as Chief Guest in presence of Hon'ble Union Minister of Science & Technology and Earth Sciences Dr. Harsh Vardhan who presided over the Function. The Lectures were delivered by Prof. Rudra Pratap, IISc. Bangalore on "Technology Enablers of Start-up India"; Dr. Mahima Datla, MD, M/s Biological E on "Experience: Amalgamation of India & Global Vaccine Strategy"; and Shri Vikram Gupta, M/s IvyCap Ventures on "Start-up India: Venture Capital Fund Investment Strategy".



The National Award was given to M/s RESIL Chemicals Pvt. Ltd., Bangalore for Indigenous Development and commercialization of N9 Pure Silver: developed by Resil Chemicals, jointly, in collaboration with SMITA Research Lab of IIT Delhi and ARCI Hyderabad.

N9 Pure Silver is an internationally certified silver-based antimicrobial that can be effectively used on textiles and other substrates. It finds applications in work wear, military uniforms, hospitality sector, healthcare industry, home care and fashion apparel industry.

Awards for SSI Unit 2016 were given to M/s Iatome Electric India Pvt. Ltd., Coimbatore for "Commercializing a cost-effective hand-held battery operated portable X-Ray machine, based on digital high frequency X-Ray generator technology with composite insulation" and M/s Tejas Networks Ltd., Bangalore for "commercialization of TJ1400-Packet Transport Node: A family of innovative, high-capacity fiber optic networking products that are developed in the modern day fiber optic transmission networks for mobile base-station connectivity (for 2G, 3G & 4G), enterprise data services and bandwidth service".

TDB also organized an exhibition of TDB supported successful projects during the event which was inaugurated by Hon'ble Union Minister for S&T and ES, Dr. Harsh Vardhan.

Celebration of 20th Foundation Day of TDB - 2016:

TDB has cerebrated it's 20th Foundation Day on 1st September, 2016 wherein two days symposium with the theme "Strategizing Commercialization through Technology and Innovation" was organized on 1st & 2nd September, 2016. Dignitaries from Government Sector, Academia, Institutions, Private Sectors were invited to talk on selected topics like Robotics, Health, Defence etc.

Address of Hon'ble Minister of State for S&T and ES, Shri Y. S. Chowdary
on 20th Foundation day of TDB

PATENT FACILITATION PROGRAMME

The increasing importance of intangible assets as a source of competitive advantage for a country has made the intellectual property (IP) system increasingly attractive and, in many cases the indispensable for all economic agents , Intellectual property (IP) is a key consideration in day to day business decisions of private and Govt. organizations . New brands and creative designs appears almost daily on the market and are the result of continuance human innovation and creativity. India enjoys a large asset of R&D personnel and infrastructural facilities. Scientists and policy makers need more information, orientation and facilities for protecting the products of intellectual prowess of Indian scientists.

As a step in this direction, Department of Science & Technology have established Patent Facilitation Centre (PFC) at its autonomous institution Technology Information Forecasting and Assessment Council (TIFAC) in the year 1995. and subsequently 26 Patent Information Centres (PICs) in various states under Patent Facilitation Cell (PFC) programme 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. As of now 71 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, Govt. industries for patent searches to find out the potential and assessment of the invention . Some of the PICs have also appointed the patent attorney to guide the inventor to file application with patent office in India and abroad.

Achievements:

Department through its Patent Facilitation Programme has facilitated in assessment of patentability of research during the last 5 year period from 2012-13 to 2016-17 as per the details mentioned below:

Year	Patent Applications filed	Granted Patents
2016-17	22 Indian (till 28-11-2016), 1 PCT	7 Indian (till 28-11-2016)
2015-16	38 Indian 1 PCT	10 Indian, 2 US, 2 Korean
2014-15	19 Indian+16 Indian for INSPIRE	10 Indian
2013-14	11 Indian+10 Indian for INSPIRE +	
18 Foreign	6 Indian, 1 European	
2012-13	31 Indian+1PCT International	4 Indian, 1 US

During the year, DST, through PFC has facilitated in assessment of the patentability of about 65 new cases for filing of patents on behalf of academic and government; out of which 22 new patent applications (about 30 more applications would be filed by March 2017 will make it 52) 1 copyright and 3 design application are being filed through patent attorneys in India. During this period 7 (five more more are likely to be granted by March 2017 which will make it 12) Indian patents have been granted as per the details given in the following table :

7 Patents Granted during 2016-17 till September 20, 2016				
S. No	**Patent No.**	**Grant Date**	**Applicant**	**Title**
1.	272480	04-04-2016	DST, New Delhi	An improved process for the alkylation of phenols
2.	272564	08-04-2016	DST, New Delhi	An improved narrow gap gas metal arc welding torch
3.	272938	04-05-2016	University of Calcutta	Microencapsulated enzyme biosensor for pesticide
4.	273805	29-06-2016	Indian Institute of Technology, Delhi	Engineered bamboo pipes made of radially split bamboo slats
5.	274256	25-07-2016	Indian Institute of Technology, Kharagpur	A method of separation of pectin during membrane clarification of fruit juice for productivity improvement
6.	275517	08-09-2016	M. S. University of Baroda	Liquid phase non-solvent oxidation of styrene with molecular oxygen
7.	*196749	20-06-2016	Indian Institute of Technology, Delhi	Process for the isolation and purification of a glycoprotein avidin

(*patent certificate was waiting for NBA permission hence certificate was issued in 2016)

1. Patent Licensing

Department through PFC for the first time facilitated a patent cum technology licensing. Patent on non invasive jaundice meter (owned by S N Bose Institute of Applied Sciences, Kolkata) was licensed to M/S AMIL Ltd on non-exclusive terms with upfront fee of Rs. 5 lakh and royalty of 5% on net sale and a condition of renewal of license after 5 years

DRUGS AND PHARMACEUTICALS RESEARCH PROGRAMME

The Drugs and Pharmaceuticals Research Programme (DPRP) was initiated in 1994-95 for promoting Industry – Institutional collaboration in drug and pharmaceuticals sector. This programme aims at enhancing capabilities of institutions and Indian Drugs & Pharmaceuticals 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;
- To extend soft loan for Pharma Industrial R&D projects; and
- To stimulate skill development of human resources in R&D for drugs and pharmaceuticals.

Achievements:

R&D initiatives with private participation

Clot Specific Streptokinase (SMRX 11), A Novel Thrombolytic for the Treatment of Cardiovascular Diseases: Phase 2 human clinical trial on SMRX-11 efficacy in the patients of heart attack (Acute Myocardial Infarction) by Symmetrix Biotech Pvt. Ltd., Chandigarh.

R&D initiatives as public private partnership

Preclinical evaluation of a polyherbal formulation (Pankare) for the management of Non-Insulin-Dependent Diabetes Mellitus and its complications was initiated by Pondicherry University, Puducherry and M/s. Arvind Remedies Ltd., Chennai

State-of-the-art facilities supported for R&D activities towards drug development

- National facility for Combinatorial Natural Products – Phase II by Indian Institute of Chemical Technology (IICT), Hyderabad.

Natural products are scarcely available and hence synthesis plays an important role in scaling up these natural molecules. CSIR-HCT, being expertise in synthetic organic chemistry and natural products

isolation chemistry, has established the State of the Art Facility in the name of National Molbank. The data generated from the stored compounds in Molbank would be utilized for designing potent therapeutic agents in drug discovery. The facility will facilitate synthesis of several diverse class of heterocycles (based on axiindole, benzoxazinone, and triazole based new chemical entities) via several combination type methodologies and other new methodologies mainly focusing on click chemistry. The work would be carried out under the following categories:

- Isolation of pharmacologically validated natural products
- Library Synthesis
- Sample procurement from academics
- Purchase of scaffolds
- Screening for biological activity

• National facility for Drug Discovery and Development Therapeutics by Rajiv Gandhi Centre for Biotechnology Thiruvananthapuram.

National Facility for Drug Discovery and Developmental Therapeutics (NFDDDT) is a strategic and bold move to engage the future of drug discovery and therapeutic development. The facility is located at Rajiv Gandhi Centre for Biotechnology (RGCB) in Thiruvananthapuram where there is a unique research ecosystem with an excellent track record of successfully translating basic science discoveries towards the clinic including clinical trials. NFDDDT will help to develop and propagate intellectual property and scholarship. It will allow collaboration between basic science and clinical researchers in oncology, infectious diseases, protein chemistry, computational biology and nanotechnology to develop novel therapies into Phase 1, which is the optimal point of entry for strategic commercial partnership.

A clinical drug development programme to evaluate and compare safety and efficacy of new regimens of Lifecare's Liposomal Amphotericin B (FUNGISOME) against currently accepted therapies for the treatment of Kala-Azar - A Phase III, open Label Randomized Trial of Three single Dose Treatment Regimens of FUNGISOME alone or in combination with Miltefosin compared with single Dose Treatment Regimen of Ambisome for Visceral Leishmaniasis in India" was taken up by Lifecare Innovation Pvt. Ltd., Gurgaon.

In a recent DST (under Neglected Disease Program of DPRP) supported phase II study conducted in Indian patients with VL, single dose of 10 mg/kg and 15 mg/kg FUNGISOME® i.v. (liposomal amphotericin B in saline for infusion) were found safe and well tolerated with Initial Cure rates of 100% in patients receiving either of these doses.

In the present Multi-Center Phase III Clinical Trial, FUNGISOME® i.v. will be used in three test arms. In two arms, FUNGISOME® i.v. will be administered to the subjects as a single dose of 10 mg/kg body weight and 15 mg/kg body weight, respectively; and in the third arm, a single dose of

FUNGISOME® i.v. (5 mg/kg body weight) will be followed by short course miltefosine for 7 days. The safety, efficacy and tolerability of these three arms would be evaluated and compared to reference VL treatment with AmBisome® (10 mg/kg, as a single dose).

TECHNICAL RESEARCH CENTRES

This programme was launched as a follow-up of the budget announcement made by the Hon'ble Finance Minister of India in his 2014 Budget Speech. Accordingly, Technical Research Centres (TRCs) were established in 2015-16 in 5 DST institutions namely, SCTIMST, Trivandrum, ARCI, Hyderabad, JNCASR, Bengaluru, IACS, Kolkata and SNBNCBS, Kolkata.

These institutions started work as per their specific targets to carry out applied and translational research in their respective domains.

Sree Chitra Tirunal Institute for Medical Sciences and Technology (SCTIMST), Trivandrum: 4 projects on Neuro-Prosthetic Devices, 7 projects on Cardiovascular Devices, 3 projects on Hard Tissues Devices, 6 projects on Biological and Combinational Products and 8 projects on Product/ Material Evaluation/Support were initiated during the year and they recorded good progress.

International Advanced Research Centre for Powder Metallurgy and New Materials (ARCI), Hyderabad : Activities carried out under the project were in the areas of – solar energy, energy storage, energy efficiency, energy conversion, electric/hybrid vehicle systems etc. Good scientific progress was made in various projects, resulting in 7 journal publications, 2 conference publications and 2 Book Chapters. 1 Patent was filed and one more was in the process of getting filed.

Jawaharlal Nehru Centre for Advanced Scientific Research (JNCASR), Bengaluru: Activities initiated under the project gained momentum during the year. The outputs are described in brief below –

Technologies Developed/Deployed/Demonstrated/Commercialized: Development of 7 technologies in progress.

Patents: 15 Indian and PCT applications were filed.

Industry-Academia Meeting: 1 meeting organized during the year.

Start-ups: One start-up 'Avinir' was incubated which would deal with DNA probes having potential for various applications, including diagnostics. Another start-up, which would deal with development of anti-bacteriasl for use in paints and surgical instruments, was under incubation.

Industry Collaborations: A number of industry collaborations were pursued during the year. For designing large area low melting alloy/metal deposition, collaboration was established with Elixir Technology, Bengaluru. For light weight solar module covered push-cart designs, collaboration was underway with Srishti Trust. For thermoelectric power generation for household use and car industry, Non-Disclosure Agreement was signed with Growtech Innovations India Private Limited. In the area of diagnostics, for use of the Raman markers with very high throughput, collaboration with Super

Wave Technology Private Limited, Bangalore was in progress. For developing a hand held Raman Spectrometer for miniaturization and portability, collaboration was being established with Sascan, Bangalore.

Indian Association for the Cultivation of Science (IACS), Kolkata and S.N. Bose National Centre for Basic Sciences, Kolkata: Both the institutions took steps to establish the necessary laboratory facilities for accelerating applied research.

International Recognitions: A team of JNCASR faculty members, supported by the TRC, were selected among the top 12 teams globally for $20M NRG COSIA Carbon XPRIZE Competition, USA. (http://carbon.xprize.org/press-release/27-teams-advancing-20m-nrg-cosia-carbon-xprize).

CHAPTER 4

S&T COMPETITIVENESS THROUGH ALLIANCES, PARTNERSHIPS AND R&D MISSIONS

ENHANCING S&T COMPETITIVENESS THROUGH INTERNATIONAL COOPERATION

A. INTERNATIONAL BILATERAL S&T COOPERATION

International Division of DST has the mandated responsibility of (i) negotiating, concluding and implementing S&T Agreements between India and partnering countries; (ii) providing interventions on S&T aspects in international forums. This responsibility is carried out by the Division in close consultation with the Ministry of External Affairs; Indian Missions abroad; S&T Counselors in Germany, Japan, Russia and USA; stakeholders in scientific, technological and academic institutions; sister scientific government departments; and with various industry associations in India.

Spectrum of Cooperative Activities undertaken

During the year, DST undertook a spectrum of bilateral cooperative activities such as: (i) bilateral S&T Joint Committee Meetings and ministerial missions; (ii) bilateral workshops and symposiums; (iii) joint research projects; (iv) multi-institutional networked R&D projects; (v) establishing virtual joint laboratories; (vi) training programs; (vii) access to advanced research facilities abroad & participation in international mega-science projects; (viii) continue support to bi-national S&T bodies; (ix) fellowships and visitation programs for both Indian and foreign researchers; (x) participation of young student researchers in international meets; (xi) promoting academia-industry partnerships for industrial R&D on bilateral level; and (xii) Technology summits, technology fairs, S&T exhibitions.

Salient activities during the year

Joint S&T Committee/Council meetings were held with Australia, Austria, Belarus, Belgium, Finland, Israel, Italy, Japan, Mexico, New Zealand, Norway, Russia, Sweden, Sri Lanka, Thailand, United Kingdom, USA, & Vietnam. Governing Body meeting of the bi-national Indo-U.S. S&T Forum (IUSSTF), Indo-French Centre for Promotion of Advanced (IFCPAR), and Indo-German S&T Centre (IGSTC) were also held during the year. These meetings led to the renewal of the Program of Cooperation (PoC) and Action Plan with the partnering countries.

Ministerial level meetings were held with Canada, Denmark, Germany, Hungary, Israel, Japan, UK, and USA for the review and up-scaling of the bilateral programs of cooperation.

About 270 Joint R&D projects and over 40 Joint workshops/seminars were supported. More than 700 exchange visits took place under various bilateral programs.

Asian Science Camp: India organized the 10th Asian Science Camp in Bengaluru during 21-27 August, 2016. The Camp was attended by 220 outstanding science students from across 23 countries in Asia, including India. The Camp was designed to motivate and inspire the next generation science leaders through dialogue with their peers and to develop networks between young researchers.

Participants in the Tenth Asian Science Camp, Bengaluru

New programs of cooperation were initiated with:

Australia: The Indo-Australia S&T cooperation was strengthened with the announcement of reciprocal fellowship program for Early and Mid-Career Researchers in S&T areas to undertake fellowship immersions in each other's country.

Belgium: A 3.6 meter diameter optical telescope, optimized for imaging and spectroscopic exploration of the Milky Way and the distant celestial objects in the universe has been successfully established by the Aryabhatta Research Institute of Observational Sciences, Nainital at Devasthal. This is the largest fully steerable optical telescope in Asia. The telescope was technically activated in March 2016 jointly by Hon Prime Ministers of India and Belgium, remotely from Brussels. The Belgian government participated in the project with the objective to get benefited by achieving science goals and also build back-end instruments for the telescope.

Germany: A new Indian centric beam line was inaugurated at the synchrotron facility at DESY in Hamburg, Germany which will enable Indian researchers to work in the frontier areas of nano-material fabrication, synthesis and characterization.

Italy: Secretary, DST along with Mayor of the city of Trieste, Italy inaugurated two joint experimental beam-lines 'XRD2' and 'XPRESS' at the Synchrotron facility in Trieste which is co-funded by DST. These two beam-lines will open a new era for experimental scientists in the exciting field of Macromolecular Crystallography and X-ray diffraction of materials under extreme conditions.

Israel: The India-Israel agreed to step up the S&T collaboration in the next two years by providing U.S. dollar 1 million from each side to support new R&D projects in the cutting edge areas of Big Data

Analytics in Health Care and Security in Cyber Space. As a part of these projects, student exchanges will be encouraged in order to connect the next generation and sustain the pipeline of future collaboration.

Japan: Relationship with Japan was substantially strengthened by establishing Indo-Japan Joint Laboratories in the areas of (i) Architecting Intelligent Dependable Cyber Physical System Targeting IoT and Mobile Big Data Analysis (ii) Security in the Internet of Things Space (iii) Data Science-based Farming Support System for Sustainable Crop Production under Climatic Change have been agreed to support. A new reciprocal fellowship program for young researcher was agreed with JSPS, Japan.

Neighbouring Countries: India Science and Research Fellowship (ISRF) scheme was expanded for seven neighbouring country scientists for undertaking R&D work in India. These include fellowships for Afghanistan, Bhutan, Bangladesh, Maldives, Myanmar, Nepal and Sri Lanka. In 2016, twenty seven fellowships were awarded covering all the countries except Maldives.

South Africa: During the visit of the Hon. PM to South Africa in August 2016 a MoU for collaboration on grass-root Innovations was concluded for collaborating on affordable technology demonstration, training, capacity building, and sharing of open source technologies between India and S. Africa. This will help to provide technological solutions to meet the unmet needs of common people. A new initiative to undertake major R&D project in consortia mode for the prognosis of HIV-TB disease biology was also agreed.

UK: Various facets of cooperation under the Newton-Bhabha program were initiated through support to joint activities covering people, project and translation strands. This includes India-UK Clean Energy R&D Centre on solar energy, storage & integration and a joint R&D program on energy efficient building materials aimed at reduction of energy demand. Access for Indian researchers to the neutron facility at the Rutherford Appleton Laboratory in Oxford was concluded which will enable Indian scientists to work on frontiers of new materials. A new implementation arrangement for UKIERI phase III research and innovation strand with UK was also signed and launched.

USA: India agreed to set up an advanced Gravitational-wave (GW) observatory in the country which will be the world's third such Observatory. This will be a nationally coordinated project in joint scientific collaboration with Large Interferometer Gravitational-Wave Observatory (LIGO) laboratories of California Institute of Technology and Massachusetts Institute of Technology, USA. A MoU was signed, between India (DAE &DST) and National Science Foundation, USA in the presence of Hon. Prime Minister of India to pave the way for establishing an advanced gravitational-wave detector in India. To enhance the cooperation with USA the Partnership to Advance Clean Energy Research was expanded by adding a new priority R&D area on Smart Grids and Energy Storage.

Bilateral Research Projects & Programmes

International interactions through joint collaborative projects with countries mentioned below have been instrumental in accelerating outcome and adding value to national science, technology and innovation enterprises at large. Spectrum of impact can be gauged from illustrations such as (i) creation of new knowledge and research tools captured in co-authored papers with foreign scientists

published in world class scientific journals; (ii) joint patents filed with foreign scientists; (iii) project based mobility provides opportunity to Indian scientists for joining international R&D projects; (iv) absorbing experience of existing global research facilities in fine-tuning and/or coupling with upcoming or existing Indian research facilities; (v) building extended and stable institutional tie-ups with foreign partners to incubate feasibility of and/or scaling up of research, pilot scale production and high tech competence in India; etc.

Africa Initiative: Under the India-Africa Forum Summit (IAFS), DST in partnership with MEA is implementing the CV Raman Fellowships which enables researchers from across African nations to undertake research in Indian R&D and academic institutions under a fully paid fellowship. Against the 5th call, a total of 148 fellows were awarded the CV Raman Fellowship in 2016. Against the current call, 596 applications from 36 African countries have been received and the final selection of awardees is under process. Considering the success and positive impact of the Fellowship program, MEA has increased the number of fellowship slots to 200 per year. Towards the efforts in strengthening African institutions through a twinning program, the Institute of Mathematics and Physical Sciences (IMSP), Benin has been linked with a cohort of Indian institutions for human capacity building and strengthening of the R&D and academic set-up. Detailed project plan to strengthen IMSP, Benin has been developed and the recommendation has been submitted by DST to MEA.

Australia: Support continued for sixteen on-going competitive grant projects and seven major Grand Challenge projects under the Australia-India Strategic Research Fund (AISRF). Two new projects were supported under the competitive grant category in the areas "Clean Energy Technologies" under AISRF Phase-II. A new R&D project call was announced covering the areas of advanced manufacturing, smart cities and survey and exploration of natural resources. The cooperation was strengthened with the announcement of reciprocal fellowship awards for early and mid-career researchers to undertake fellowship immersions in each other's country.

Austria: The 4th Joint Committee meeting on S&T between India and Austria was held in New Delhi on 23rd November 2016. The committee reviewed the ongoing activities and technically recommended nine projects for funding out of 58 proposals received. The projects cover themes such as cancer research, bio fuels and energy, CAD tools etc.

Argentina: Eleven new bilateral R&D projects in areas of agri-biotechnology, automation engineering, drug discovery and bioenergy were approved out which nine have been sanctioned and are being fully realized while the five ongoing projects were continued to be supported.

Bulgaria: The 8th India-Bulgaria Joint Committee on Science & Technology held in New Delhi had concluded a Programme of Cooperation (POC) between the two governments in the fields of solar energy, water science, biotechnology etc. for the period 2015-2017. A fellowship program for Bulgarian scientists to work in R&D labs in India for a period up to six months was also agreed to. A bilateral workshop on Solar Energy was held in Sofia in Nov 2016.

Belarus: Days of 'Belarus Science in India' was celebrated in New Delhi in the annual Trade Fair held in November 2016, where Belarus was a partner country. In a meeting between Secretary DST

and Vice Chairman, State Committee on Science & Technology, Belarus it was agreed to support ten new joint R&D projects on solar harvesting materials, polymer coatings, biofuels and bioenergy, in addition to twelve ongoing R&D projects. An India Belarus Round Table meeting with participants of academic and research institutes was also organized. A joint workshop on cyber-security was organized at CDAC, Noida in November 2016.

Belgium: Shri Narendra Modi, Prime Minister of India and Mr Charles Michel, Prime Minister of Belgium jointly activated 3.6 m optical telescope installed at Devsthal, near Nainital. This activation was done remotely during the visit of Prime Minister to Brussels. This is largest optical telescope in Asia. First BINA (Belgium India Network of Astronomers) workshop was held at Nainital in October 2016 to make best possibile utilization of the facility.

Remote Technical Activation of Digital Optical Telescope located at Devasthal,
India from Brussels on March 30, 2016 by the Prime Ministers of India and Belgium.

In addition to the telescope projects, eight joint R&D projects in Earth Sciences, Astrophysics, Biology, and Material Sciences are being currently implemented.

Canada: The new model of R&D cooperation under the IC-IMPACTS (India-Canada Centre for Innovative Multidisciplinary Partnership to Accelerate Community Transformation and Sustainability) has helped to promote multidisciplinary research partnerships aimed at accelerating social transformation by providing solutions through application of science and technology. In addition to the five ongoing projects, another set of five new projects were agreed for support. The projects cover areas of sustainable infrastructure, energy conservation, and integrated water management. Three new Industrial R&D projects in the areas of Affordable health care and Clean Technology, implemented through the Global Innovation Technology Alliance (GITA) platform were also announced for joint implementation.

Egypt: A call for joint R&D projects proposal was announced in the areas of Agriculture Biotechnology,

Nano-materials and Information Technology. About 130 proposals have been received and evaluated. Both sides have agreed to support twenty new bilateral projects based on the technical evaluation.

Finland: Support was continued to six joint projects in the areas of nano-materials and three projects in the area of Energy Research. The 4th meeting of the Innovation Working Group was held in Finland in November 2016. It has been suggested to set up an Indo-Finnish Design Innovation Centre.

France: Targeted programs in focused areas enabling research funding agencies of both the nations were supported. These include (i) Indo-French Centre for Applied Mathematics (IFCAM), between DST and Centre National de la Recherche Scientifique (CNRS); (ii) DST-Inria program in Information and Communication Science & Technology; (iii) DST-ANR joint projects in the areas of Neuroscience and Engineering Sciences. Six joint projects against the third DST-Inria joint call were agreed for support during this period. The Indo-French Centre for Applied Mathematics (IFCAM) is proactively facilitating cross-disciplinary interactions between mathematicians, engineers and other scientists of the two countries. An active short-term visitors program and exchange of post-doctoral fellows/ research students are form important components of this Centre's activities. Under the Centre a summer school in applied mathematics was conducted jointly in July 2016 to train the next generation of mathematicians.

Germany: Under the DST-DAAD project based personnel exchange program, support to twenty on-going joint research projects was continued and selection of new projects for award in 2017 are underway in the various areas of basic research which includes areas of advance-materials, physical and chemical sciences; biotechnology, earth and atmospheric sciences. Under DST-DFG program support was extended to the eight on-going projects. Under the call launched in 2016, a total of seven new projects proposals have been recommended for award in the areas of chemical sciences, physics and astronomy. Under the DST-MPG Partner group program nine new partner groups were awarded during the year, in addition to the eight ongoing partner groups in the areas of atmospheric chemistry, plant-insect interaction, tumor specific drug delivery system, cosmology and gravity, mass black holes in gravitational wave window, human genetic diversity, health sciences and evolutionary biology and structure-function relationship in protein machinery. The India-Max Plank Research Centre in Computer Sciences involving six IIT's from India and two Max Plank Institutes was reviewed by both sides and was rated highly successful with the recommendation to support the Phase II of the Centre. Under DST-BMBF Civil Security cooperation, three maiden joint projects covering vulnerabilities & volunteerism; vulnerability of metro transport structures; and warning & evacuation during inland flooding were initiated for implementation.

Hon. Minister for S&T and ES visited Germany in September 2016. In a meeting with the German Minister for Education and Research, it was agreed that the bilateral Indo-German S&T Centre (IGSTC) in its next Phase should focus to co-develop and generate new industrial technologies that can contribute to the knowledge economy of both the countries covering areas such as advance manufacturing, automobile engineering, clean technologies, embedded systems, health care, renewable energy, and smart cities. All these areas are aligned with the various national missions of the GOI and the High Technology strategy of the German government. During the visit the Hon. Minister inaugurated the

India centric beam-line facility at PETRA-III, DESY in Hamburg constructed under the nano-science mission of DST. This facility will provide access to Indian scientists to investigate structures of next generation materials at nano-scale level and will enable them to undertake front ranking basic and applied materials research.

Hon'ble Minister for S&T and ES inaugurating the India centric beam-line at PETRA III, DESY in Hamburg, Germany in September 2016

Hungary: The meeting of the Joint Science & Technology Committee was held at Budapest in October 2016 which recommended award of four new proposals in addition to ten ongoing projects in the areas of Mathematics, Earth Science, Biology & Medical Sciences, Chemical Sciences, and Physics & Astrophysics.

Israel: Following the Joint S&T Committee meeting held in Jerusalem, a new call for proposal was been announced to invite the proposal in the areas of Big Data Analytics in Health Care and Security in Cyber Space. Support continued for the seven projects selected under the previous call in the areas covering engineering materials for energy. Following a ministerial level meeting held in Delhi in Dec 2016, it was agreed to support initiatives for women in science and technology through new joint programs in this area. Further, in order to engage best and bright researchers from India and Israel who can provide the future excitement in the science and technology relationship, it was suggested to hold 'Frontiers of Science and Engineering Symposium'. The industrial R&D program under the GITA platform continued with Israel.

A Declaration of Intent being concluded by the Hon'ble Minister for S&T and ES with Minister of Science, Technology and Space, State of Israel

Italy: Following the Joint S&T Committee meeting held in Rome several initiatives to re-launch cooperation in science, technology and innovation were agreed including the launch of a call for bilateral scientific R&D projects of significance. ICT, energy, environment & sustainable agriculture, health care, biotechnology & medicine, nanotechnology & advanced materials, physics & astrophysics and technology applied to the cultural &natural heritage, were areas identified for joint projects.

The two sides launched the next phase of cooperation established between Italian and Indian researchers in the India-Trento Program for Advanced Research (ITPAR). Secretary, DST also inaugurated the two Indian experimental beam-lines at the Synchrotron facility in Trieste for the ELETTRA 'XRD2' and 'XPRESS' accelerators which is funded by DST. About 25 Indian scientists visited Trieste to perform experiments on Elettra beam-line.

Japan: Twenty two new joint projects, four workshops, twenty exploratory visits were supported in the areas of fundamental and basic sciences under the DST-JSPS program. Three new India-Japan Joint Laboratories were approved and initiated in the space of ICT under the DST-JST cooperation framework. About sixty INSPIRE school students from across India visited Japan under the DST-SAKURA program. India participated in the Asia Heads of Research Council meeting organized by JSPS in Indonesia. Under DST-AMED framework three projects on biomedical devises were continued to be supported. DST and JSPS also agreed to launch a new reciprocal fellowship program to help networking and building human capacity through promotion of individual excellence.

Mexico: Following the S&T Joint Committee meeting held in Mexico City both sides outlined the review process adopted for the common 34 proposals received in the CONACYT-DST call 2015. The JCM agreed and approved 14 new projects in the areas covering health, seismology, renewable energy and waste water treatment. Support continued for twelve ongoing joint projects in areas of seismicity, nanomaterials, renewable energy, drug development and water technology under India-Mexico bilateral program.

New Zealand: The third meeting of the India-New Zealand Joint S&T Committee was held at New Delhi in May 2016 which recommended continuation of two ongoing projects in the area of Food & Dairy Technology. Reports on two seminars, conducted on Reinforced Infrastructure in Auckland and on Oost-harvest Technologies in Sonepat were also presented.

Norway: The Joint Working Group met in Oslo and reviewed the ongoing activities of cooperation and recommended to launch new joint project call on ICT and Bio-economy. It was also highlighted to initiate short term exchange of student visits from both sides. It was also agreed to hold bilateral workshops in the fields of Nano science & technology and on Renewable energy. A joint seminar on Indo-Norwegian Higher Education and Research Collaborations with a focus on knowledge triangle between higher education, research, and industry was organized at the University of Oslo in September 2016.

Poland: A new call for proposals in basic sciences was announced and 78 joint proposals were received. After independent assessment on both sides, eighteen projects have been identified for support in areas covering basic sciences and fundamental research.

Russia: Joint collaboration continued through the multi-agency partnerships. Under the DST- Russian Foundation of Basic Research (RFBR) program, twenty three new projects were approved in in addition to fifty one ongoing projects under this basic science cooperation framework. A new call for projects was launched in inter-disciplinary sciences, following which eighteen new projects were approved for joint implementation. In partnership with Russian Ministry of Education & Science (RMES), DST continued supporting six Applied R&D projects in the areas of Energy, Environment, Material sciences. Further, a new call was launched, which is being assessed. Under a new collaborative arrangement with Russian Science Foundation (RSF) the Department invited R&D proposals targeted for next generation outstanding researchers of India and Russia. Seventeen projects have been awarded to active mid-career researchers for joint implementation. Ninth meeting of the Working Group on Science & Technology was also held at New Delhi in November 2016 which reviewed the cooperation.

Singapore: Support continued to five joint projects in the areas of Materials and Energy and four in the areas of Advances in Chemistry; Biology & Technology for Medicine.

Slovenia: During the year, fifteen joint projects in areas of digital image processing, advanced manufacturing processes, sensors for various applications, smart textile, solar cells, water technology and health were continued for support. DST and the Slovenian Ministry of Education, Science & Sports have agreed for lunch of next R&D project call in 2017 covering health & biotechnology, new

materials, renewable energy, smart cities and ICT.

South Korea: Support continued to the sixteen on-going joint research projects in the areas of Nanotechnology, Robotics & Engineering Sciences; Biotechnology including Health & Medical Sciences and Renewable Energy. In addition, under the GITA platform two new industrial R&D projects were identified for support.

South Africa: DST, India and DST, S. Africa agreed to support fourteen new joint projects in the areas of indigenous knowledge systems and agriculture biotechnology. In addition eight network projects focused on astronomy were also identified for joint support. These projects will complement the SKA project in which India is a partner country. A new call for proposal in health sciences with a focus on HIV-TB was jointly announced with DBT, India under which 19 inter-disciplinary proposals have been received and are currently under review. During the visit of Hon'ble PM to South Africa, DST-India and DST-South Africa signed a MoU for establishing cooperation in grass-root innovations. This will enable co-development of affordable technologies, technology demonstration, capacity building, and sharing of open source technologies between India and S. Africa.

Sweden: Against the joint call between DST-VINNOVA joint projects on embedded systems are being implemented. The future cooperation envisages new areas of engagement through joint R&D projects in applied areas of industrial relevance covering Biotechnology and Biomedicine, Information & Communication Technology, Technologies for Eco-innovation, Sustainable Cities and Automotive. Under the maiden DST-VR (Sweden Research Council) call twelve projects have been agreed for joint support in areas of health sciences, genomics, bioinformatics and synthetic biology.

Switzerland: Eleven projects are under implementation under the Indo-Swiss Joint Research Program. The program on research in the field of glaciology was extended for the period 2016-19 which would include funding of joint R&D projects and training programs for capacity building. The new Academia-Industry Training (AIT) Program launched between DST and Swissnex supports promising Swiss and Indian researchers in transforming their research into market applications. In India, the participants through the workshop were provided the tools, information and contacts that would enable them to make the transition from researchers to entrepreneurs. In Switzerland, the participants will test out their research ideas in the market space.

Thailand: Under the Indo-Thai Program of Cooperation, support continued to 11 ongoing joint projects. To review the bilateral S&T programme a Joint Committee meeting was held in New Delhi in December 2016. Both sides agreed to collaborate through research projects in identified areas of national priority including human health, renewable energy, photonics and geospatial technologies. A unique archeological atlas using satellite data for regional connectivity in prominent Buddhist sites of eight countries has been compiled under the India-Thailand S&T collaboration. This will help to promote tourism in the Buddhist Circuit. Under the framework of cooperation the Survey of India is imparting training to Thai officials in mapping technologies.

Tunisia: Support continued to twelve ongoing projects. A call for joint project proposal was announced

under which 130 proposals were received. The projects are currently under review.

United Kingdom: 2016 marked as India-UK Year of Education Research and Innovation. Several activities were organized including the Indo-UK Tech Summit which was inaugurated by the Prime Ministers of India and UK on 7 Nov 2016 in New Delhi. An exhibition was also organized with displays of recent technological advances in Manufacturing, Health Sciences, Smart Cities etc.

Hon'ble Minister for S&T and ES visited UK in June 2016 for the meeting of Science & Innovation Council (SIC) which was co-chaired with UK Minister for Universities & Science in London. The SIC reviewed all ongoing scientific engagements between the two countries and recommended new areas of cooperation covering clean Energy, efficient built environment, data science, weather modeling, marine sciences, agricultural biotechnology and human & child health to be pursued under Newton Bhabha Program. Access for Indian researchers to the neutron facility at the Rutherford Appleton Laboratory in Oxford was concluded. This will enable Indian scientists to work on frontiers of new materials. Six industrial R&D projects under translation mode were announced in the areas of Affordable Healthcare, Clean Technology and Manufacturing Technology.

Conclusion of the 5th India-UK Science and Innovation Council meeting in London in June 2016

Various facets of cooperation under the Newton-Bhabha program were initiated during the year through support to joint activities covering people, project and translation strands. This includes India-UK Clean Energy R&D Centre on solar energy, storage & integration and a joint R&D program on

energy efficient building materials aimed at reduction of energy demand. The phase III of the DST-UKIERI (UK India Education & Research Initiative) program for the period 2016-2021 was also agreed, following which call for proposal in Climate Science, Marine Science, Human Health, Data Science and Material Science was launched. A total of 213 joint proposals were received, which are being assessed.

Announcement of the new activities under the Newton Bhabha Program by the Hon'ble Minister for S&T and ES along with UK Minister for University & Science in Nov 2016, New Delhi

U.S.A. : The 4th Joint Commission Meeting on S&T with United States of America was held in Washington DC in September 2016. The meeting was co-chaired by Hon. Minister for S&T and ES along with the Science Adviser to the U.S. President. It was agreed to substantially step up the bilateral S&T cooperation agenda which is one of the pillars of Indo-U.S. strategic partnership with a joint investment level of more than US $ 220 million. The Joint Commission agreed to initiate cooperation in the areas of water cycle modeling, weather forecasting and ocean dynamics. To enhance the cooperation in Clean Energy Research a new priority R&D area on Smart Grids and Energy Storage was also agreed. Under the flagship Vaccine Action Program it was agreed to collaborate on new vaccine candidates for dengue, TB and Respiratory Syncytial Virus, besides undertaking collaborative R&D programs on anti-microbial resistance and cancer research. A new strand of Indo-U.S. cooperation in agriculture sciences was also agreed covering topical areas like storage and processing for reducing post-harvest losses and climate smart agriculture system. The Joint Commission also endorsed the negotiation and finalization of the revised Indo-U.S. S&T Agreement including the Intellectual Property annexure. India has agreed to set up an advanced Gravitational-wave observatory in joint scientific collaboration

with Large Interferometer Gravitational-Wave Observatory (LIGO) laboratories of California Institute of Technology and Massachusetts Institute of Technology, USA.

In the area of innovation and entrepreneurship, India and USA have launched several successful initiatives including the U.S. India Endowment Fund for Innovation (24 projects under implementation), India Innovation Growth Program, Millennium Alliance, Stanford-India Biodesign, Indo-U.S. Sister Innovation Hub, Bengaluru-Boston Research Entrepreneurship Program etc. These will directly contribute to the Start-up India program.

Vietnam: The Joint Committee meeting was held in New Delhi in Dec 2016 which reviewed the ongoing activities of cooperation and identified new themes for future call in applications of ICT and nanotechnology for renewable energy, new materials, cyber security and medical sciences.

Bilateral Workshops

Nearly 40 joint S&T workshops/ symposia and training programs were supported in India and abroad in partnership with Brazil, Bulgaria, Belarus, Canada, Egypt, Finland, Germany, Italy, Japan, Mexico, Norway, Russia, Singapore, South Korea, South Africa, Switzerland, Taiwan, and UK. These activities were aimed towards information dissemination, networking and human capacity building and also helped to define the common areas of mutual interest for initiating cooperation with these countries. A trilateral workshop between Australia-India and UK on Women in STEMM was organized in New Delhi in Dec 2016.

Industrial R&D Programs

For ensuring that R&D output is translated beyond the realms of the laboratories with tangible outcome through creation of new IP, processes, prototype and products bilateral industrial R&D program on Applied R&D have been pursued with chosen partner countries like Israel, Canada, Finland, France, Germany, South Korea, Spain, UK and USA. These programs are based on a PPP model of funding and are being implemented through the Global Innovation Technology Alliance (GITA) platform, except those with France, Germany and USA. These projects directly feed to some of the national initiatives on Clean & Green India, Digital India, Make in India, Start-up India and Smart Cities. Ten new projects were approved for launch with various partnering countries in the year under reporting.

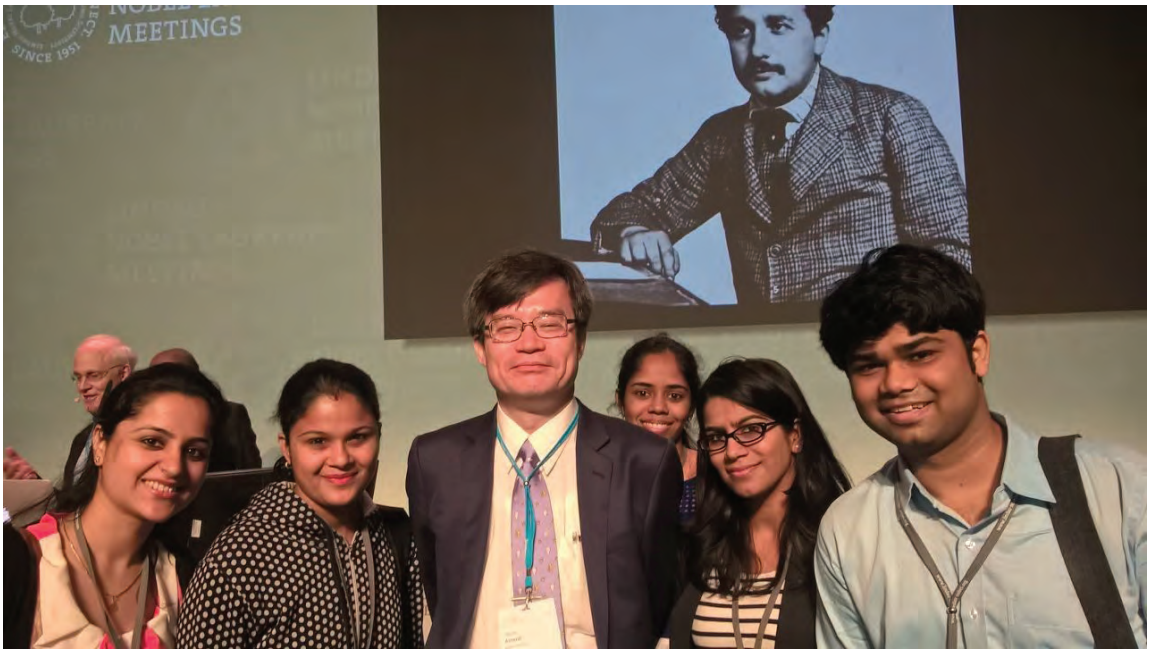
Joint R&D Centers

Twenty virtual R&D centers with networking between Indian and institutions abroad were continued to be supported. These Centers have been built on leveraging complementarity around existing capabilities, strengths and infrastructure towards optimal utilization of resources and also build human capital through seamless networking and mobility. These centers are meant for facilitating focused and integrated interaction and collaboration through networking of capabilities and infra-structure between Indian and institutions in partner countries like Australia, Canada, France, Germany, Japan, S. Africa, UK, and USA.

Fellowships/Internships

Outgoing Fellowships for Indians:

Nine PhD students in the area of Life Sciences, Chemical Sciences and Physical Sciences were sent to Japan for interaction meetings with Japanese Nobel Laureates under the HOPE meeting. DST signed an agreement with the Lindau Foundation to continue sending up to 25 Indian students to the yearly Lindau Nobel meet. Twenty PhD and Post Doctorate researchers in the areas of Physics participated in the 66th Meeting of Nobel Laureates and students at Lindau, Germany in June-July 2016. Twenty undergraduate science students from across the country along with three supervisors participated in the 8th Asian Science Camp with Nobel Laureates held at Thailand in August 2015. Eleven Indian Ph. D students were selected to visit South Korea under the India-Korea Research Internship Program. Seventeen Indian PhD students have been selected to visit France under the Raman-Charpak Scholarship. Thirty INSPIRE PhD students visited UK institutions as a part of DST-Royal Society exchange program under Newton-Bhabha scheme. Besides a large number of student research internship and young and mid-career research fellowship programs with USA were implemented through the bi-national Indo-US Science & Technology Forum. A new young and mid-career research fellowship programs with Australia was launched and implemented through INSA. Twenty young faculty/researchers have been selected for the Australian fellowship award. Thirty Indian students attended the 10th Asian Science Camp organized at IISc, Bengaluru in August 2016 under support of DST. The Camp was attended by 220 outstanding science students from across 23 countries in Asia, including India.



Indian students at the 2016 Lindau Nobel Meeting with Prof. Hiroshi Amano, 2014 Nobel Prize winner for discovery of efficient blue light emitting diode

Incoming Fellowships for Foreign Scientists to India:

Under ***India Science and Research Fellowship*** (ISRF), twenty seven researchers from six neighbouring countries including Afghanistan, Bhutan, Bangladesh, Myanmar, Nepal, Sri Lanka were awarded fellowships to work in Indian R&D institutions. 3rd Call in partnership with implementing agencies of five countries including Bangladesh, Bhutan, Nepal, Myanmar, Sri Lanka was announced in December 2016.

CV Raman Fellowships which enables researchers from across African nations to undertake research in Indian R&D and academic institutions under a fully paid fellowship. A total of 148 applicants were awarded the Fellowship in 2016. Against the current call, 596 applications from 36 African countries have been received and the final selection of awardees is under process. Five Korean students were selected under India-Korea Research Internship Program; and four French PhD students have been awarded the Raman-Charpak Fellowship to work in Indian laboratories and R&D Institutes.

Bi-national Centres

Bi-national R&D Centres are independent bilateral entities established under inter-governmental agreements between India and the partner country. The activities undertaken and implemented by these Centres which are supported through DST are as follows:

Indo-French Centre for Promotion of Advanced Research (CEFIPRA)

During the year 2016-17, under the collaborative scientific research programme, 16 proposals were recommended for support in the 57th & 58th Scientific Council (SC) meetings of CEFIPRA held on 17-20th May, 2016 at Tours, France and 23-25th November, 2016, at Varanasi, India respectively. 15 fresh projects were recommended in various areas of S&T and 72 projects are ongoing. Mobility of approx. 110 scientists and students between two countries was supported under the programme. During the year, 23 projects were completed which have resulted in more than 100 publications in SCI journals.

Industry-Academia Research and Development Programme and Projects: The meetings of the 28th and 29th Industrial Research Committee (IRC) were held from 20-21 May, 2016 at Tours, France and from 26th-27th November 2016 at Varanasi, India respectively. A total of 5 proposals were recommended for support in both the meetings.

Seminars/Workshops:The bilateral knowledge space had been further catalyzed through supporting 6 seminars/workshops/training schools in various areas of S&T.

Through these seminars, the Centre has brought more than approx. 200 scientists/students/researchers from India and France together to share the knowledge in the advanced areas for planning of future collaboration.

Targeted Programme: The Centre has continued to offer a platform for targeted programmes to the national funding agencies to come together and support collaborative scientific research in focused

areas of mutual interest. The targeted programmes operational during the year were as follows:

a) Under DST-ANR programme; six projects are ongoing.

b) Under DST-INRIA-CNRS programme; thirteen projects are on-going. Call for proposals-2017 was launched on 1st July, 2016 with deadline of submission by 30th September, 2016. The Expert Committee meeting for the evaluation of proposals was held on 20th December, 2016.

c) Under the DST-INRA targeted programme; one project is ongoing.

Considering the strong urge of the French and Indian governments to reinforce scientific collaboration to address prevalent and emerging challenges in water, the French Embassy in India and the Indian Department of Science & Technology (DST) have joined hands for Indo-French Water Networking (IFWN) programme. CEFIPRA is the implementing agency for this programme. The areas of interest identified were (a) Waste water treatment (Industrial/ Domestic); (b) Natural water treatment systems. Two projects were initiated during the FY 2016-17 are ongoing.

Dedicated Mobility Support Programme:

a) In order to strengthen the supply chain of human resource across the knowledge innovation chain & for improving doctoral skill, the already existing Raman-Charpak Fellowship programme, was renewed by Governing Body of CEFIPRA for next 3 years (2016-2018) during its 29th meeting on 4th March, 2016 at CEFIPRA office, New Delhi. A total of 25 Indian and 6 French doctoral students were awarded the fellowship in 2016.

b) For the CEFIPRA- European School on Nanosciences and Nanotechnologies (ESONN) fellowship programme, the Centre supported the participation of 8 Indian doctoral students in 12th Edition of ESONN programme held during 28th August – 17th September, 2016, Grenoble, France.

c) Under the CEFIPRA-SOLEIL Synchrotron Progarmme, the Centre supported visits of 3 scientists/ researchers to SOLEIL facility and 6 are expected to be further supported in FY 2016-17.

Public Private Partnership (PPP) Programme:

- Under the CEFIPRA-Saint Gobain Research India (SGRI) PPP Programme; four projects are ongoing in the areas of sustainable habitat for hot and humid climates.
- Under the Airbus Group-CEFIPRA Aerospace Programme; a meeting of the joint selection committee was held on 3rd June, 2016 and three proposals were recommended for support are expected to be initiated in FY 2016-17.
- Under the BIRAC, CEFIPRA and French Embassy in India programme in the area of red biotechnology; two projects are ongoing in cardiovascular diseases. One proposal was recommended under the second call is expected to be initiated in FY 2016-17.
- Under the BIRAC-CEFIPRA-Bpifrance Programme; the call for proposal was launched in

November 2015 in the areas of digital healthcare (e-health, tele-care, health IT, m-health, etc.) and individualized medicine (therapeutic solutions for individual patients, pharmacogenetics, etc.). Two proposals were evaluated and one is under the process of final review. The meeting of the Joint Selection Committee is scheduled to be held on 7th December, 2016.

- Under Technology Development Board (TDB)-CEFIPRA-Bpifrance Programme; TDB and Bpifrance have signed a MoU on 11th April, 2016 & CEFIPRA-TDB have signed LoI and Procedure Document on 10th May, 2016. Accordingly, call for proposals for Indian and French Researchers/ Companies launched with the deadline of 31st October, 2016. The deadline has been extended up to 31st January, 2017.

Annual Lecture Series and Outreach Programme: The 4th Lecture in Annual Lecture Series was delivered by Prof. D.D.Sarma, IISc Bangalore at College de France, Paris on 27th June, 2016, at École Polytechnique, Palaiseau on 29th June, 2016 and CRISMAT, Cean on 30th June, 2016.

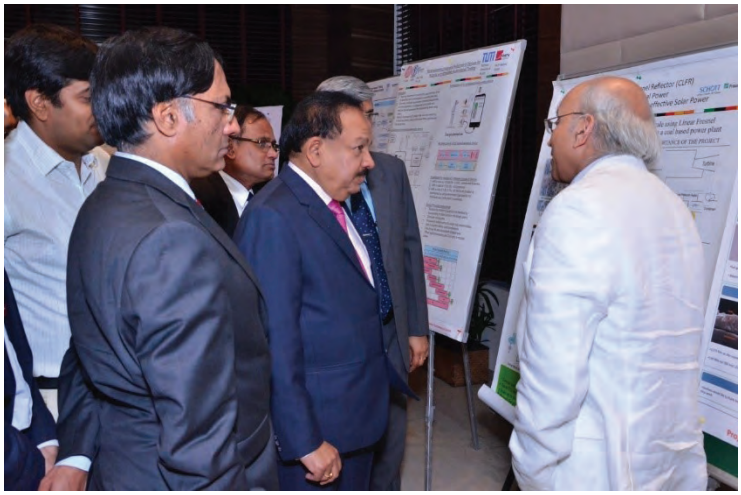
An outreach programme was organized by CEFIPRA during Annual Lecture Series in Paris & Cean in June, 2016.

Indo-German Science and Technology Centre (IGSTC)

Indo-German Science & Technology Centre (IGSTC), the binational Centre between India (DST) and Germany (BMBF) to promote industrially relevant R&D partnership on PPP mode is entering into its sixth year in 2016-17. The 2+2 model, connecting academia and industry for translation of research results into products/processes and services received widespread acceptance as a unique model of research partnership for socio-economic contribution through technological interventions.

During the year 2016-17, IGSTC continued its support to 18 joint projects in 2+2 mode in emerging areas of (i) sustainable energy (ii) advanced manufacturing (iii) biomedical devices and biotechnology (iv) water & wastewater technologies (v) nanotechnology and (vi) embedded system & ICT. Among these six are new projects from Call 2015 in the areas of energy materials, energy storage and water biosensors & wastewater technologies. The total project investment (both Indian and German) can be estimated as Rs. 100 Cr or 14 million euros and is involving 72 (seventy two) project partners from academia and industry from India and Germany.

Indo-German Science & Technology Centre (IGSTC) was recognized as a successful model and flagship initiative of Indo-German R&D partnerships. The tenure of IGSTC was extended to 2022 and beyond with increase in annual investment from 2 to 4 million euros by each side for expansion of its scope and horizon through a joint declaration signed between Govt. of India (DST) and Govt. of Germany (BMBF). In conjunction with 7th Governing Board Meeting, IGSTC organized a Partners Meeting on 15 March 2016 in Delhi. There were presentations from selected projects and all the projects were exhibited as posters in the evening session. Hon'ble Minister for Science & Technology, Dr. Harsh Vardhan inaugurated the poster session.



In endeavor to promote Indo-German Research partnership, IGSTC organized the Symposium on "Smart Cities: Challenges and Opportunities" during 27 - 29th April 2016 in Berlin, Germany in association with FICCI (India), Nexus Institute (Germany) and PTV AG (Germany). Nearly 80 participants attended the workshop from India and Germany and from both academia and industry. IGSTC continued shouldering the responsibility 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 global leaders at the Max Planck Institutes in Germany through a networked model of cooperation. Currently IGSTC is implementing ten Partner groups.

Indo-U.S. Science and Technology Forum (IUSSTF)

Established under an agreement between DST and the US State Department, IUSSTF has a program portfolio that helps to catalyse and support bilateral science, technology and innovation programs involving government, academia, enterprises and industry from both countries. During the period, IUSSTF supported six Indo-U.S. bilateral workshops. To foster linkages between the outstanding next generation of scientists and technologists from India and the U.S., the 6th Indo-American Frontiers of Science Symposium was organized at Irvine, California. Support was continued to the fifteen ongoing Indo-U.S. Joint Centers of Research. Four new R&D Knowledge Networked Centers were awarded for promoting collaborative research. Special training schools for women scientists were organized under Women in Science cooperation program.

Close to 150 Indian and US student and researcher exchanges took place through various internships and fellowship programs namely SN Bose Fellowships, Khorana Scholar Program, Viterbi-India program, Research Internship in Science and Engineering, Bhaskara Advance Solar Energy Research Fellowships, Graduate Research Opportunities World Wide (GROW)-India which is supported by DST, SERB and DBT. Eight Indian and US faculty and students exchange took place under IUSSTF funded visitation programs with the American Physical Society (APS). IUSSTF launched three new visitation programs namely, Water Advanced Research and Innovation (WARI); Building Energy Efficiency Higher & Advanced Network (BHAVAN) Fellowships Fellowship both supported by DST and Bioenergy-Awards for Cutting Edge Research (B- ACER) supported by DBT.

Initiative for Research and Innovation in Science (IRIS), a science and research based initiative for school students is a public-private partnership between DST, IUSSTF and Intel aimed at motivating the next generation student innovators. Indian team comprising of seventeen school children participated in the Intel International Science and Engineering Fair held in Pittsburgh, USA in May 2015. The team won multiple awards which also included a minor planet named in recognition of the young Indian innovators.

In the space of innovation and technology entrepreneurship, IUSSTF continued to implement the US-India Science & Technology Endowment Fund for Innovation supported by DST and the U.S. State Department. In addition to the fourteen ongoing projects, five new projects were approved under the 2015 sixth call. The ongoing projects are in the two broad categories of 'Health Citizens' and 'Empowering Citizens' and include innovative projects on affordable biomedical devices, diagnostics, clean water, sanitation, clean energy, cold chain, financial inclusion, and prosthetics. Several projects supported under this program have been successfully commercialized through establishment of start-up companies.

DST-Lockheed Martin 'India Innovation Growth Program' (IIGP), 50 Indian innovators were trained under the boot camp organized by Stanford Graduate School of Business. Visit of a team of 16 innovators and incubator managers to the Silicon Valley was organized in partnership with FICCI. The IIGP innovators got an opportunity to showcase their innovative products at the India-U.S. Startup 'Konnect' which was visited by the Prime Minister of India. Under the Stanford-India Biodesign Program for biomedical innovation in partnership with DBT, three fellowships were awarded in 2015.

The Joint Clean Energy R&D Centre (JCERDC) is a joint initiative of the Ministry of Science and Technology and the U.S. Department of Energy Partnership for Advancement of Clean Energy Research (PACE-R). The aim is to facilitate joint research and development of clean energy technologies. Support was continued to the three consortia established on Solar Energy, Second Generation Biofuels and Energy Efficiency of Buildings. The JCERDC is based on a public-private partnership model with equal funding from government and participating industries and academic institutions from both countries. The first-of-its-kind initiative has brought together more than eighty Indian and U.S. institutional and industrial partners to work jointly in the space of clean energy research and development. The Ministry of New and Renewable Energy (MNRE), Govt. of India and the U.S. Embassy announced the PACEsetter Fund which is being administered by IUSSTF. The mission of the PACEsetter Fund is to accelerate the commercialization of innovative off-grid clean energy access solutions by providing early-stage grant funding that would allow businesses to develop and test innovative products, business models and systems.

Support continued for six projects on India-U.S. Grand Challenge on Affordable Blood Pressure Measurement Technologies for Low-Resource Settings in India and the US. This program is supported by the SERB of DST and U.S. NIH.

A. INTERNATIONAL MULTILATERAL & REGIONAL S&T COOPERATION

International Multilateral Regional Cooperation Division (IMRCD) of Department of Science and Technology (DST) continued to play its mandated role in fostering India's regional and multilateral science and technology cooperation frameworks at inter-governmental level with a view to make a positive contributions, gainful consequences and spin offs in (i) Enlarging India's pursuit of influence in global arena/platforms and mainstreaming Science, Technology and Innovation (STI) into international diplomacy and foreign relations; (ii) Moving up the ranks for India's scientific excellence in the global research landscape; (iii) Leveraging foreign alliances and partnerships to accelerate key priorities and programs devoted to strengthening India's national science and technology (S&T)/ Research and Development (R&D) competencies-capabilities-access to technologies. Major programmes include S&T cooperation with EU,ASEAN, BRICS, IBSA, SAARC, BIMSTEC, ASEM, EAS; engagements vis-à-vis S&T aspects of UN and other international organizations (India's S&T engagements with NAM S&T Centre, UNESCO-TWAS-ICTP, UNCSTD, OECD, IOR-ARC); multilateral platforms such as Carnegie Group Meetings and its spin offs like GSO-GRI, Science and Technology for Society Forum.

The salient achievements during 2016 under different Regional/Multilateral framework are enumerated below.

BRICS STI Cooperation

The 4th BRICS Science, Technology and Innovation Ministerial Meeting was convened on 8 October, 2016 at Jaipur,India to further strengthen the collaboration amongst the BRICS countries in the areas of Science, Technology and Innovation (STI). The meeting was chaired by Dr Harsh Vardhan, Hon'ble Minister for Science & Technology and Earth Sciences and his counterparts Ministers/Vice Ministers from BRICS Nations. This Meeting was preceded by 6th BRICS STI Senior Official and 2nd BRICS STI Funding Working Group Meeting at Jaipur ,India on 6-7 October 2016.

4th BRICS Science & Technology Ministerial Meeting on 8 October 2016 in Jaipur

The major outcomes of the BRICS Ministerial Meeting were Jaipur Declaration on the theme ***"BRICS Science, Technology and Innovation Partnership – Building Responsive Inclusive Collective Solutions"*** and adoption of an updated BRICS STI Work Plan 2015-18. Thirty five high level BRICS events have been proposed/planned for 2017. India will coordinate and host five BRICS events namely (i) Working Group Meeting on BRICS Innovative Idea Prize for Young Scientists" within the framework of BRICS Young Scientist Forum, (ii) 1st Meeting on BRICS Science and Technology driven Entrepreneurship and Innovation Partnership (iii) BRICS Conference on Technology Foresight and STI Policy (iv) 2nd Meeting of BRICS Geospatial Working Group (v) 3rd Meeting of BRICS Astronomy Working Group.

6th BRICS Science & Technology Senior Official Meeting (SOM) on 7 October 2016 in Jaipur

BRICS Young Scientists Conclave

The 1st edition of the BRICS Young Scientist Conclave (BYS) was organized during 26-30 September 2016 at NIAS Bangalore by Department of Science & Technology (Government of India) under BRICS STI framework. The discussion of conclave were centered around three themes– Computational Intelligence, Energy Solutions and Affordable Healthcare. The event brought together more than fifty young scientists primarily in the age group of 22-35 years, drawn from science, engineering and allied disciplines. A session on "Talent Hunt" was also organized under which about 15 ideas were presented on 3 identified themes of the Conclave. They have given a set of recommendation for BRICS collaboration in Affordable healthcare, Energy solutions and Computational intelligence. Two report titled "BRICS Science and Technology Enterprise Partnership" and "Hampi: Splendours of a World Heritage Site" were released during the Conclave. **The 2nd BRICS Young Scientist Conclave will be hosted by China in 2017.**

Participants of 1st BRICS Young Scientist Conclave Sept. 26-30, 2016 at Bengaluru

1st Meeting of BRICS Geospatial Working Group March 2, 2016, Noida

The 1st Meeting of BRICS Geospatial Working Group was hosted by India as a lead country in Noida, March 2, 2016 with participation of 25 expert scientists from BRICS countries. The workshop identified the areas of BRICS collaboration Geospatial Research, Technology, Development and its Application focusing on key theme such as Geodesy, Remote Sensing data processing for People-centric Applications in Agriculture, Land Use Land Cover Study and Development of Smart Cities and BRICS Geospatial capacity building through networking, training and researchers and students mobility.

Launching of 1st BRICS Pilot Call for Proposals 2016

The Arrangement of BRICS STI Framework Programme to support of BRICS countries' joint Initiative on Multilateral Interdisciplinary Research and Innovation Funding was signed among eight Funding Agencies from BRICS countries. The funding agencies include National Council for Scientific and Technological Development(CNPq, Brazil), Foundation for Assistance to Small Innovative Enterprises (FASIE, Russia), Ministry of Education and Science (MON, Russia), Russian Foundation for Basic Research (RFBR, Russia), Department of Science and Technology (DST, India), Ministry of Science and Technology (MOST, China), National Natural Science Foundation of China (NSFC, China) and National Research Foundation (NRF, South Africa). Consequent to this arrangement, the 1st BRICS Call for Proposals was launched in May 2016 with commitment of funding in the range of 0.50-4 million US$ from each funding agencies. The proposals were sought in ten thematic priority areas: Material science including nanotechnology; Biotechnology and biomedicine including human health and neuroscience; new & renewable energy and energy efficiency; Water resources and pollution treatment Geospatial Technology Applications for development; Prevention and monitoring of natural disasters;; astronomy; ICT and High Performance Computing; Ocean& Polar Sciences Photonics. Total

321 proposals received out of which 208 proposals were found eligible for peer review consideration as per prescribed criteria. The highest interest is shown in the areas of advanced material, biotechnology and bio-medicine, energy and water sectors.

India-European Union (EU) STI Cooperation

India-EU Science, Technology and Innovation Cooperation continued on strong footing with several new programs initiated under the framework of India- EU S&T Agreement Cooperation Framework. The following are the main achievement during 2016.

i. The Union Cabinet, Government of India has approved the renewal of India-EU S&T Agreement w.e.f May 17, 2015 for further period of 5 years.

ii. India and EU has agreed to Standard Operating Procedure for co-funding of India-EU R&D Proposals in the areas of Advance Materials & Nanotechnology for High Added Value Products and Process industries and; Advance Material and Nanotechnology for Healthcare. The joint Call for Proposals were launched in August 2016 in the subtopics (a) Architectured /Advanced material concepts for intelligent bulk, (b) Improved material durability in buildings and infrastructures, including offshore and (c) Cross-cutting KETs for diagnostics at the point-of-care. India has agreed to co-invest 2 million Euro to support India-EU research and Innovation initiatives.

iii. Under India-EU Members States Inno-Indigo Partnership Program, six multi-county projects in the area of "Diagnostics and Interventions in Chronic Non-Communicable Diseases" involving Belgium, Estonia, Germany, Portugal, Norway and India have been agreed for co-funding with an investment of 1.0 Million Euro from Indian side. The thrust of these joint research proposals include non-invasive rapid diagnostics for cancer and neurodegenerative disorders; understanding the processes of calcification in chronic kidney disease; Nano platform-based drug delivery system and combinational therapy against breast and colorectal cancer; Multiple biomarker detection of Rheumatoid Arthritis etc.,

iv. An International Conference on Innovation in Sustainable Water and Waste Water Treatment System (ISWATS)- cum- Terminal Review of four India-EU water research and technology development/deployment projects was held during 21-23 April, 2016 in Pune. The conference was organized jointly by Department of Science and Technology (DST) and Directorate General Research and Innovation, European Commission. More than 200 participants including researchers, scientist, students, policy makers, industry and civic body/utilities representatives and other stakeholders from India and Europe participated in this conference. The participants discussed various facets of water and wastewater management and key issues related to implementation of water and wastewater system and adaptability and replicability of technologies to accelerate the national program (such as Swachh Bharat Mission, Smart Cities). A comprehensive Report on India –EU Coordinated projects on Water and Wastewater Treatment: Activities and Achievements was prepared.

India-ASEAN STI Cooperation

To extend and expand the ASEAN-India collaboration, ASEAN-India Science & Technology Development Fund (AISTDF) has been enhanced from existing one million USD to five million USD. The Terms of References (ToR) of AISTDF have also been revised. The scope of activities of AISTDF has been enlarged by inclusion of Innovation as priority.

The 5th Meeting of the Governing Council AISTDF was held in New Delhi during 16-18 August 2016. The Indian delegation for this Meeting was led by Prof. Ashutosh Sharma, Secretary DST whereas the ASEAN delegation was led by H.E. Houmphanh Intharath, Vice Minister, Ministry of Science & Technology, PDR Lao. The Meeting also decided to support following schemes/program under AISTDF-

- ASEAN-India Research Training Fellowship (100 Fellowships per year to ASEAN Researchers to work at Indian Research Institutes/Universities/Labs) for a period up to 6 month
- Participation of ASEAN School Children in National Children Science Congress (100 ASEAN School Children to be supported)
- ASEAN-India collaborative R&D (project/ Networking;ASEAN-India Innovation Platform (Idea to solution)
    - Inclusive Innovation (social challenges)
    - Research Innovation (technology commercialization)
    - Product Innovation (private sector)

Participants of 5th Meeting of the Governing Council AISTDF at Delhi 16-18 August 2016.

DST-G20 Cooperation on Innovation: 'G20 Innovation Action Plan 2016'

The G20 countries set up a 'Task Force on Innovation' and deliberated on the possible actions on G20 cooperation in Innovation. DST was nodalised to contribute to the Task Force through NITI Ayog. The Task Force deliberated on a 'G20 Innovation Action Plan' for adoption by the G20 Summit in 2016. The final Innovation Action Plan was adopted by the G20 leaders during G20 Leaders' Summit held on September 04, 2016 in Hangzhou, China that Hon'ble Prime Minister of India attended. DST contributed actively to the G20 Innovation Action Plan. The Action Plan among others, identified the actions such as: (i) revision of the Oslo Manual pertaining to innovation Data; (ii) Providing a G20 innovation forum; (iii) Release of 2016 G20 Innovation Report; (iv) Promoting dialogue among governments, businesses and other stakeholders; (iv) Collaboration on science and research activities, discussion on open science and access to publicly-funded research results; (v) Supporting the mobility of STI human resources; (vi) Sharing best practices on enhancing skills training for innovation and entrepreneurship, including improving access to STEM education(vii) Supporting the Technology Facilitation Mechanisms of the United Nations; (viii) Comprehensive mapping of information on existing STI initiatives, mechanisms, and programs; (ix) Discussions on STI cooperation around thematic areas for the implementation of the 2030 SDGs and in addressing global challenges.

G20 Science, Technology and Innovation Ministers' Meeting

To take forward the implementation of the G20 Innovation Action Plan, the first meeting of the G20 Science, Technology and Innovation (STI) Ministers/ Chief Science Advisors was held on November 3-4, 2016 in Beijing. Hon'ble Minister of State (MoS), Science & Technology and Earth Sciences Shri Y.S. Chowdary led the Indian delegation in the meeting.

The Ministerial Meeting deliberated upon key issues such as (i) 'Policy and Practices on Innovation-driven Growth' (ii) "Innovation & Entrepreneurship'(iii) 'Priority Areas and Modalities of STI Cooperation' and (iv)'Science and Technology Human Resources and Innovative Talent'. The participants shared their country's STI policies, programmes, challenges and future plans. They, among other, emphasised on open science, creation of new knowledge and research infrastructure, promoting PPP and building an ecosystem to support innovation and entrepreneurship and development of human resource especially skill development, and inclusion of marginalised, young and women in STI.

The meeting issued a G20 STI Ministerial 'Statement' which supports Development of a G20 Online exchange community in Innovation; Release of the '2016 G20 Innovation Report' by the OECD; Strengthening developing countries' capacity in STI; Voluntary knowledge diffusion and technology transfer; Development of fully inclusive information society, Culture and ecosystem of innovation; Exchange and cooperation between STI clusters and parks; Sharing good practices on STEM education and skill training for entrepreneurship and innovations; Investments in Basic science; , collaborative programs and projects to address global challenges and Human resource development. The statement also supported future G20 STI engagements.

Carnegie Group' Meeting of the Science Ministers/ Chief Science Advisors

Hon'ble Minister of State, (MoS) Science & Technology and Earth Sciences Shri Y.S. Chowdary participated in the 44th Carnegie Group Meeting of the Science Ministers'/ Chief Science Advisors of G8 countries and emerging economies, jointly hosed by Italy and China during 4-6 November, 2016 in Beijing, China. Hon'ble MoS shared India perspective on the three topics floated by different Carnegie group countries: (i) New technologies for healthy aging" (Preventive, nutrition and personalized medicine against cancer and neurodegenerative diseases (topic proposed by Italy) (ii) Women in STEM education" (topic jointly proposed by Canada and Japan) (iii) Executing on the Paris Agreement (COP 21) through Innovations (topic proposed by US).

Cooperation with NAM S&T Centre

The Centre for Science and Technology of the Non-Aligned and Other Developing Countries (NAM S&T Centre) is an inter-governmental organisation with 48 member countries. India is a founder member and also the host country of the Centre. DST as the designated Focal Point for the Centre in India has been paying the annual membership contribution on behalf of India and has also been nominating Indian researchers and experts to participate in various scientific activities of the Centre.

Research Training Fellowship for Developing Countries Scientists (RTF-DCS)

During 2016-17, 50 Fellowships were awarded among 30 developing countries in various fields of Science & Technology. These 50 researchers from developing countries will be attached to Indian research Institutes/Universities/Laboratories for carrying out their research work for a period of 6 months. The Government of India (through DST) is supporting entire expenses including fellowship amount, international airfare and research contingencies etc related to these 50 fellowship availed by researchers from Developing countries.

Payment of annual membership contribution on behalf of India: As a member country,

GoI (DST) has sanctioned the release of 20,000 USD in Rupee equivalents as annual membership subscription for 2016-17 to NAM S&T Centre, an intergovernmental organization hosted in India.

DST-ICTP Ramanujan Prize in Mathematics

The Ramanujan Prize for Young Mathematicians from Developing Countries, is jointly awarded by the International Centre for Theoretical Physics(ICTP), the Department of Science and Technology of Govt of India and the International Mathematical Union. The Prize money of USD 15,000 is being funded by the Govt of India (DST) for a period of 5 years from 2014 onwards. Chenyang Xu of the Beijing International Center of Mathematics Research, China was selected for the awarded of 2016 Ramanujan Prize for Young Mathematicians from Developing Countries. Xu was awarded the Prize for his work in algebraic geometry, and for creating an impressively wide range of techniques in algebraic geometry and beyond to tackle a broad spectrum of geometric problems.

India-UN STI cooperation in development of the UNDP Country Programme for 2018-2022

DST participated in the Strategic Prioritization Retreat (SPR) on 23rd November, 2016 in New Delhi, organized to align the UN Sustainable Development Framework (UNSDF) with India's development priorities and the sustainable development agenda 2020-30. DST sought Science & Technology and Innovation (STI) Cooperation under UNSDF programme in supporting the priorities of the Government of India in the next programme cycle with special emphasize on inclusion, affordable healthcare, skilling and job creation, natural resource management, energy efficiency, and building community resilience.

Global Research Infrastructure Development Cooperation

The issue of co-development and management of Global Research Infrastructures is being addressed by a Group of senior Officials (GSO)from G8, BRICS, Mexico and Australia. The Group has finalized a framework for development of Global Research Infrastructures and has identified 5 pilot research Infrastructures and facilities for future collaborations. This includes 'International Mouse Phenotyping International Mouse Phenotyping Consortium'. Department of Science and Technology from India represented in the 7th meeting of the GSO and the Research Infrastructure Forum during February 1-3, 2016 in Sydney Australia. India shared its interest in becoming member of the International Mouse Phenotyping Consortium'(IMPC). Access to such an international resource base would be of immense future value for Indian Biomedical and health research efforts. It suggested that India could explore to collaborate through an Indian Consortium for Functional mammalian Genomics by using IMPC resources and/or contributing to the IMPC resources.

STRENGTHENING S&T IN STATES/UTs

Department of Science & Technology (DST) has established 36 State Councils for S&T including those in 7 Union Territories (UT's) in the country. This programme was initiated by the Department for the promotion of Science & Technology and building strong base for providing S&T intervention in country. Department has played a catalytic role by facilitating the State Governments in establishing and developing the State Councils on S&T and by providing support for their technical secretariats. Concurrently, the Department, in collaboration with respective State Councils, has organised all India thematic seminars/workshops whose recommendations helped to identify some activity-areas for promotion by the State Councils. The Department also organized periodic review meetings to discuss the status of various S&T programmes and to plan the strategy for future. Regional meetings organized by the Department facilitated review of state S&T structures and identification of areas of mutual cooperation between States for implementation of project and programme to address the location specific challenges through Science & Technology interventions.

The support provided under SSTP can be classified as:

- Core support to S&T Councils
- Location Specific Research and Technology Development and Demonstration (LSR&TDD)
- S&T studies, surveys, information exchange and joint programming

During the year 2016-17 the Department provided core support to 28 State Councils for S&T for which Rs. 34.34 Crore was sanctioned for their technical secretariats and to implement S&T activities in the country.

- **Location Specific Research and Technology Development and Demonstration (LSR & TDD), S&T survey and studies programmes :**

25 new projects/ programme were supported to address the State specific S&T challenges through S&T intervention some are mentioned below:

Development and scale up of technology for in vitro and in vivo production of Entomopathogenic Nematodes and comparative studies of efficacy of local strains of EPN and other bio-agents including training and demonstrations programmes was initiated at Foundation for Agricultural Resources Management and Environmental Remediation (FARMER), Ghaziabad, Uttar Pradesh

Demonstration of importance of efficient AM fungi in chilli and tomato was initiated at University of Agricultural Sciences, Dharward, Karnataka.

Improving Sustainable energy access among SC/ST households in Chararajnagar district was initiated at Rural and Renewable Energy Group under Social Transformation Division, The Energy and Resource Institute, Bangalore.

Survey and investigation, pre-feasibility study preparation of DPR and detail engineering design and drawing of technology transfer based MH projects in Arunachal Pradesh was initiated at Arunachal Pradesh State Council of Science & Technology (APSCST), Itanagar, Arunachal Pradesh

Installation of SIRU RIJO Micro Hydel (2X50Kw) at Gankak in District West Siang was initiated at Arunachal Pradesh State Council of Science & Technology (APSCST), Dept. of Science and Technology, Govt. of Arunachal Pradesh.

Tribal Ethnobotanical Exploration, Identification, Documentation and Usage of Wild Edible Plants in North East India was initiated at Ardent Foundation, Ng.Ngareophung, Phungreitang, West Ukhrul, Manipur.

Some of the projects implemented in various part of the country have generated promising outcome and have potential for applications in the other parts of the country.

I. Setting up of demonstration cum prototype units at Saharanpur & Nagina for showcasing & adoption of the technology on UV curable wood coatings at Shriram Institute for Industrial Research, Delhi.

UV Curing technology is an upcoming technology in the field of coatings and has been adopted for coating of wooden handicrafts under this project. After the successful development of UV coating compositions in laboratory for wooden handicrafts, this project was sanctioned with the aim for creation of UV curing demonstration facility at handicraft clusters: Nagina and Saharanpur. A UV curing facility has been created at Nagina in association with Hast Shilp Seva Samiti, Nagina and Photo Frame Center of Export Promotion Council, Saharanpur for Handicrafts. These facilities

comprise of UV curing equipment and its accessories for providing UV coating services to the handicraft manufacturers of Nagina, Saharanpur and surrounding areas. The facilities at Nagina and Saharanpur were installed and commissioned. These facilities are now in operation and are being handed over to the respective partners: Hast Shilp Seva Samiti, Nagina and Export Promotion Council for Handicrafts, Saharanpur.

UV curing facility and developed products

II. Awareness & Training (TRG) - Capacity Building of Fabricators, Cupola Owners and their Workforce at Punjab State Council for Science Technology & Environment

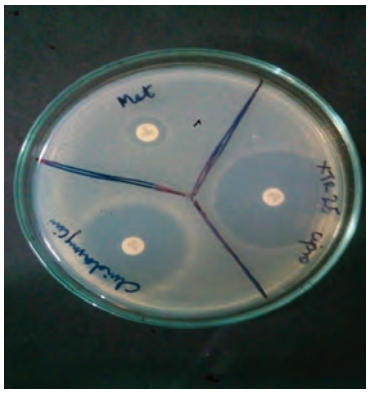
The study of 28 cupola foundry units with respect to their present metal coke ratio, melt cost, operating practices, scope of improvement in energy efficiency etc., was undertaken in different clusters of Punjab. The melt cost in these units was found to ranging between Rs 2.17 to Rs 5.76 per kg (considering fuel consumption only). After carrying out studies, recommendations were made to each unit for improving the efficiency of their cupola furnace. The beneficiary units after implementing the recommendations of Punjab State Council for Science and Technology, Chandigarh reported 10-15% fuel saving with economic gain of Rs. 1.50-2.0 lakhs/annum besides reduction in carbon footprint. Now, other cupola units in the State are following these units as benchmark to make their industry competitive in this period of recession. One industry came forward and expressed their interest to set up more number of units to boost the morale of the industry.

Awareness & Training program - Diagnostic study of Cupola operation

III. Microbiological characterization documentation, sociological insight, physicochemical analysis of hot spring's (Tatopani) of Sikkim at Sikkim University, Gangtok.

Microbiological characterization, documentation, sociological insight, physicochemical analysis of hot spring's (Tatopani), Sikkim was undertaken to assess the quality of water. The literature review suggested the presence of 8 hot springs in Sikkim, however in this study, a new Hot Spring was found in Yumesamdong area, in North Sikkim. Physical parameters and chemical analysis of seven hot springs has been done and it was found that the water from main sources of all seven hot springs is potable. More than 200 bacterial isolates have been isolated and among these isolates, 46 isolates were found to be positive for Amylase production and 6 for Protease production. One isolate was found to be resistant to Clindamycin, one to Penicillin, one to Gentamycin and 38 isolates were found to be resistant to Methicillin. DNA isolation of more than 30 isolates has been done and among them16S rDNA sequencing of 15 isolates has been done and is still in progress. Initial sequencing results suggest that most of them belong to genus GeobacillusAnoxybacillus, and Bacillus sp.

Newly found Hot Spring in Yumesamdung, North Sikkim



North Sikkim Gram Staining of Geobacillus Toebii, isolated from Yumthang Hot Spring

IV. Development and demonstration on bioremediation of indigo dye containing textile effluent using microbial biofilm with adapted microorganisms at PSG College of Arts and Sciences, Coimbatore.

Bioremediation of dyes from the textile effluent is emerging fast as an alternate method for treatment of aqueous waste. Samples were collected from denim industry dyeing unit and its physico-chemical properties were checked, Indigenous adapted microbial strains were isolated and the maximum decolorizing strains were screened, identified and developed into consortia, Effluent treated using microbial consortium fixed on polyurethane foam was then analysed for the degraded compounds using GCMS, which revealed the toxic compounds present in the raw effluent were degraded, The enzyme responsible for degradation was identified as laccase. The optimization of cultural conditions was performed and the following parameters namely pH-9, temperature - 17°C, substrate concentration - 25ml, foam concentration - 1g, incubation time- 96 hours and under shaking condition were found to be optimal conditions for degradation. Using the similar conditions, an industrial trial was performed

at KG Denim Fabrics, which also revealed the reduction in colour of about 81%, COD around 75% and TDS round 47%, treatment also revealed no sludge deposition.

V. Generation of Pony Based Animal Energy for Utilization in Agricultural Development of Manipur State at College of Agriculture, Central Agricultural University, Imphal, Manipur

The cart is designed to suit the Manipuri Pony animals of the state of Manipur for carrying agricultural commodities in and around the farm. The carrier has a seating arrangement for the operator at the front side of the cart along with foot rest to control the animal. The cart is provided with two rubber tyre wheels. For easier movement of the cart in both smooth and rough uneven road, the wheels are supported with elliptical springs. The springs will help in the absorption of shock. The wooden floor fitted on a rigid frame made of mild G.I pipe is about 2050 x 1215 mm in size including the space for the seat of the operator. The effective space for the carrier is about 1420 mm long and 1215 mm in width. All the sides of the cart except the rear side have fixed vertical wooden walls of 420 mm high for supporting the materials to be carried as well as to limit from overloading the cart with excess weight. The rear side is provided with removable wooden walls which can be fitted and removed as and when required. The cart will be fitted to the animal body with a pair beams made out of mild steel pipes. The beams are made free to rotate vertically so that the vertical movement of the animal will not affect the cart. Besides, the load on the cart will not be carried by the animal for vertical movement.



Pony cart developed for the project

VI. Comparison of Stability With Two Times Use of Platelet Rich Growth Factor Versus One Time Use of Platelet Rich Growth Factor In Immediate Placement of Dental Implant In Infected Socket at King George's Medical University, Lucknow.

Restoration of missing teeth is baffling the clinicians since time immemorial but with the advent newer technique/technologies and regenerative medicine, Immediate placement of dental Implant along with PRGF (Protein rich growth factor) is possible with predictable outcome. However immediate implantation in infected socket is very rare in clinical practice because there is impaired healing at extraction site. Thus this approach tries to produce osteoblast rich environment by PRGF use immediately and after one month of Implant placement. It also saves time and money of patient. Advantages of two time use of PRGF are-

- Clinical and radiographic findings are suggestive of enhancement of implant stability and bone healing.
- Clinical outcome is suggestive of better patient's compliance.

Important meetings:

Department organized an all India meeting of the State S&T Councils at Assam State Council for Science and Technology , Guwahati during 6th -7th September'2016. During the inaugural session of the conclave, a "Compendium on the State Specific S&T Intervention-2016 by State S&T Councils in India" was also released by the Hon'ble Minister of S&T, Govt. of Assam.

BUILDING NANO S&T CAPACITY

The Mission on Nano Science and Technology (Nano Mission) was launched in the year 2007 to promote R&D in this emerging area of research in a comprehensive fashion. The main objectives of the Nano Mission are — basic research promotion, research infrastructure development, Nano applications and technology development, human resource development, international collaborations and orchestrating national dialogues. During the year 2016-17, Nano Mission actively continued its activities which are summarized below.

Basic Research Promotion: Eighty-Eight (88) new individual scientist-centric R&D projects were funded during the year which focused scientific studies of nano-scale systems and applications in the area of drug delivery, biomedical, agricultural, energy, solar, water etc. 6 Thematic Projects in frontiers of Nano S&T have been established across the country from competent scientists/groups in one or more institution/s for carrying out investigations on one or few focused topics expected to lead to significant enhancement in scientific knowledge or useful applications and technologies

Some notable applications from ongoing projects are:-

i. Development of titania aerogel photo anode for dye sensitized solar cell (DSSC) application: titania aerogel based photoanode achieved higher dye loading capacity. This DSSC showed higher efficiency compared to standard titania powder. Titania aerogel based systems achieved efficiency of 4-4.5% which is better compared to standard powder.

ii. Dendrimeric Sunscreen cream with high SPF and less chemical sunscreen ingredient concentration with bioactive-dendrimer complex has been developed at Manipal University, Karnataka is ready for preclinical evaluations.

iii. Novel amperometric catechol biosensor based on α-Fe2O3 nano crystals (NCs) – modified carbon paste electrode was developed under the project entitled, "Development of metal-oxide hetro-structures for nano-electronics and photocatalytic applications", by sol-gel method using glycol as solvent. The biosensor gave good sensitivity with linear detection response in the range 8-800µM with detection limit of 4.28µM with a 100% response for catechol, showing enormous potential to be used in biosensors for sensitive detection of phenol derivatives

iv. Considering the large quantity of electrode materials requirement for the fabrication of battery pack for electric vehicle (EV) application, the International Advanced Research Institute for Powder Metallurgy and Advance Materials (ARCI) developed simple and cost-effective large scale processe to produce lithium titanate (LTO) through milling process. High energy Zoz milling has been identified as an ideal process to syntheisze large quantity of LTO with cheaper cost. Bench mark studies revealed that the specific capacity of LTO synthesized by high energy Zoz milling process is higher than LTO obtained by FSP and commercial LTO. More importantly, it was found that the cost required to synthesize ARCI developed 1 Kg of LTO (185 USD) is less than the cost of 1 Kg of LTO by FSP (520 USD) and with the cost of 1Kg of commercial LTO (211 USD) electrode material.

v. IIT-Madras has developed water purification systems for removal of Arsenic, Iron, pesticides and other contaminants using nanotechnology. Water filter, Amrit (Arsenic and Metal Removal by Indian Technology), has been installed in 750 locations in West Bengal, Uttar Pradesh, Bihar and Karnataka provides arsenic-free drinking water at a cost of less than 5 paisa per litre to nearly 5,00,000 people. The PI Prof T Pradeep's start up, InnoNano Research Private Limited, set up in 2008 has signed an agreement with Nanoholdings based in Connecticut, U.S. wherein Nanoholdings will provide his team venture funding of $18 million (about Rs.120 crore) to further develop its nanomaterials-based water technology that is currently used in India to remove arsenic from drinking water.

vi. India, today is placed 3rd in the world in terms of scientific publications.

Human Resource Development

1) Ongoing Programmes:

(a) Support to ongoing Post Graduate programmes [M.Sc./M.Tech in Nano Science & Technology] continued this year at several institutions.

(b) Post-doctoral fellowships to attract talented young researchers towards advanced research in Nano Science & Technology continued to be offered through Jawaharlal Nehru Centre for Advanced Scientific Research (JNCASR), Bangalore.

2) New Initiatives:

(a) Nano Science & Nanotechnology Visiting Associate-ship (NS& T-VA) (14 Institutions Pan-India have been chosen): Institutions with established research profile in Nano Science & Technology in the country shall implement this programme in a proactive fashion. Each such institution would be provided funds for managing the programme, with provisions of travel support, fellowship, board and lodging expenses and research expenses for Visiting Associates.

(b) Nano Science & Nanotechnology Overseas fellowship (NS&TOF): Under this programme fellowships for a period of one year extendable to one more year would be provided every year to the selected Indian scientists/technologists for conducting advanced research/undergoing specialised training in overseas research laboratories/institutes in area of nano science & technology.

3) Major events organized- 3 National/International conferences including the 1st Annual Conference and Workshop of Indian Society of Nano medicine, AIIMS, New Delhi, 24th to 26th November, 2016

International collaborations

- Support to the India-Japan Beamline Phase-II at the Photon Factory, KEK, Tsukuba, Japan continued.
- Initiation of collaboration with the Rutherford Appleton Laboratory (RAL), UK to access its neutron facility. This collaboration will help Indian scientists gain access to all the beam lines of ISIS neutron scattering facility at Rutherford Appleton Laboratory (RAL), UK for carrying out research in Nano Science and Technology.
- India motivated beam line has been initiated at PETRA-III Synchrotron Radiation Facility at DESY, Hamburg, Germany.

Development of Nano technologies and their applications : Support to ongoing projects in this category continued. 3 new Proof-of-Concept projects were funded during the year. IIT-Delhi, M/s RESIL Chemicals Private Limited and ARCI, Hyderabad had developed "antimicrobial nanofinish technology based on nanosilver for textiles" under Nano Mission funded joint collaborative project. This technology was successfully commercialized.

Awards / Recognition

The National Award for the successful commercialization of indigenous technology was presented to SMITA Research Lab, IIT Delhi for the commercialization of N9 Pure Silver; developed jointly with partners M/s RESIL Chemicals Private Limited and ARCI, Hyderabad who also received the award. The award was presented during the Technology Day function on 11th May 2016 by Shri Pranab Mukherjee, the Hon'ble President of India,

Prof. Ashwini K. Agrawal receiving award (on behalf of his group) on Technology Day 2016.
Award being given by Shri Pranab Mukherjee, the Hon'ble President of India

Orchestrating National Dialogues

The Nano Mission continued to forge linkages with other government agencies and industry organizations in promoting Nano Science and Technology in the country and also orchestrate national dialogues on issues which are manifestly multi-agency issues. Initiatives towards development of Standards for Nanotechnology were discussed with stakeholders in Regulatory Framework Advisory Group (RFAG) meet, early April 2016.

CLIMATE CHANGE PROGRAMME

Two national missions on climate change i.e. (a) National Mission for Sustaining the Himalayan Ecosystem [NMSHE] and (b) National Mission for Strategic Knowledge on Climate Change [NMSKCC] launched under National Action Plan for Climate Change [NAPCC] are under implementation by the department. A national programme on CO2 Sequestration Research is also being implemented by the department.

Highlights of activities of the scheme during 2016-2017

i. Establishing/Strengthening the State Climate Change Cells in the States and Union Territories

ii. A Major climate change research programme on 'Building Human and Institutional Capacities"

iii. Establishing/Strengthening new Knowledge Centres of Excellence and institutions working in climate change issues

iv. Human Capacity building programmes/Training of research professionals in climate change related areas.

v. International bi-lateral and Regional cooperation

vi. All India Coordinated programme in North East in CO_2 sequestration

Major Achievements:

A. Major Scientific Discoveries, research publications, patents granted/filed and technology developed under both the mission are given below.

Table1: Output under the projects in term of research paper new technique developed

SN	Category of project*	Number of Projects	No of research papers/ Monographs	Cumulative Impact factor	No of new techniques developed
1	CoEs	4	273	340.7	15
2	MRDPs	12	73	93.56	16
3	Network-Modeling	7	35	41.56	9
4	Network-Health	9	35	22.53	12
5	NMSHE-TFs	4	76	21.01	1
6	NMSHE-Consortium	4	15	17.09	1
7	State CC Cells	18	27	-	-
8	GTWGs	2	12	-	-
	Total	60	510	536.45	54

*CoE: Centre of Excellence; MRDP: Major R&D Programme; TFs: Task Forces
GTWG: Global Technology Watch Group

B. New Programme initiated/supported during the year:

The Climate Change Programme division of the department is coordinating two national missions under the National Action Plan for Climate Change [NAPCC]. As part of deliverables of these national missions, this division has initiated several activities during 2016-17. These include; 9 State Climate Change cells, 2 Task Forces and 6 Global Technology Watch Groups, 4 National Network programmes, 4 new Centres of Excellence, 8 Major R&D programmes, 6 Human Capacity Building Programme, Indo-Swiss Joint Collaborative Research Programme, Indo-US Fullbright-Kalam fellowship, etc. As many as 8 events were organised/supported under the programme.

Brief scientific summaries of these programmes

(i) New State Climate Change Centre/Cells

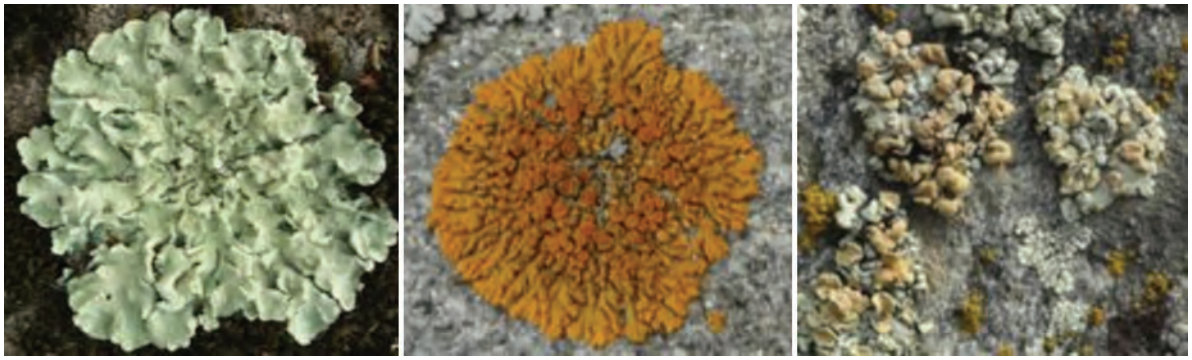
One of the deliverables of CC missions implemented by DST is to provide assistance to states for implementation of sustainable actions as outlined in their State Action Plans (SAPCCs) linked to NMSHE and NMSKCC missions. To meet this objective, DST initiated an institutional mechanism by setting up of State CC Cells. The State Climate Change cells have been established in the State Government's nodal Department designated to implement State Action Plan on Climate Change to conduct

- Vulnerability and risk analysis to important eco-systems in the state and region (district/ Block/ Village Level).
- Institutional Capacity building and R&D for data base/ Information generation as per the requirements of state and national action plan on climate change.
- Training programmes for stakeholders including Government officials, researchers, community based organizations, media, etc.
- Public awareness

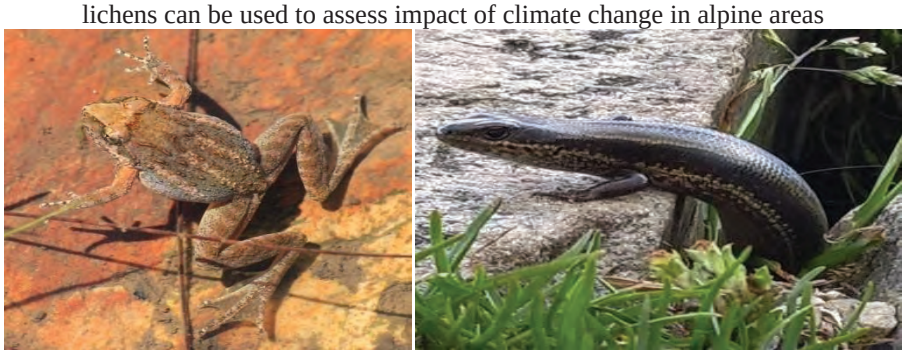
State Climate change cells have been established in 18 States/UTs. These include; Punjab, Madhya Pradesh, J&K, Himachal Pradesh, Uttarakhand, Nagaland Sikkim, Mizoram, Manipur, Tripura, West Bengal, Meghalaya, Tamil Nadu, Telangana, Chhattisgarh, Karnataka, Kerala, and Puducherry

(ii) Task force on "Micro flora and fauna and wildlife and animal population" at Wild Life Institute of India, Dehradun

The aim of this task force is to develop strategies to mitigate climate change effects on wild animal species and ecosystems in the IHR. The thematic approaches have been divided into terrestrial system, aquatic system, human ecology, and spatial ecology components. The objectives are to assess theme specific species diversity, distribution and abundance and to assess the impacts of climate change on ecosystem services. The Bhagirathi basin in Uttarakhand has been selected as the primary study area for first two years. Primary information collection is being carried covering an elevation extent from 500m to 5000m through systematic grid sampling design. Automatic weather data loggers and camera traps have been deployed in the grids and permanent sampling sites in the Basin. Secondary information collection has been completed for both terrestrial and aquatic themes. Preliminary analysis of species distribution and inventory preparation has been carried out. Research trend and knowledge gap analysis for all the terrestrial and aquatic themes has been completed. In total, 4895 literatures have been compiled into a database on fauna and micro-flora of IHR. The number of publications showed substantial rise in the last two decades and dearth of studies on climate change impacts was observed for all the taxa.



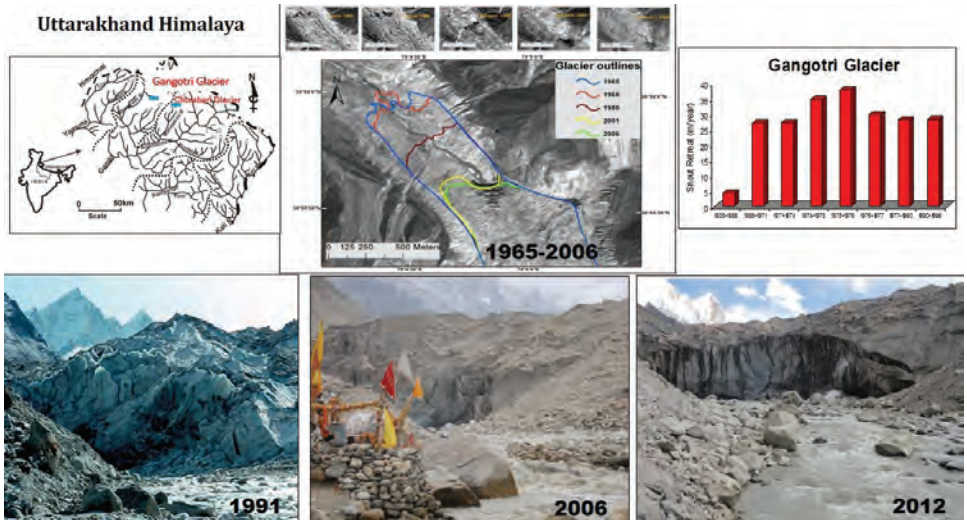
Three of the 82 species of lichens recorded from Bhagirathi Basin,
lichens can be used to assess impact of climate change in alpine areas



Nanorana minica and Asymblepharus are selected as indicator species for climate change for further study

(iii) Task force on "Natural & geological wealth" at Wadia Institute of Himalayan Geology, Dehradun

Under this Task force programme geo-resources and Impact Assessment of Geological (exogenic) Processes in NW Himalayan Ecosystem will be studied. The preparation for the database for the (i) landslides and related mass movement activities, (ii) glaciers and glacial lakes, (iii) spring and water bodies, particularly in the north-western (NW) Himalaya, have been initiated. It has been noted that during recent years, the frequency of landslides and related mass movement activities, including cloudbursts have increased significantly.



Recession trend and Surface change in the snout of Gangotri Glacier, Uttarakhand Himalaya

(iv) Global Technology Watch Groups (GTWGs)

As part of deliverables of the National Mission on Strategic Knowledge for Climate Change (NMSKCC) Global technology Watch Groups (GTWGs) were required to be set up for technology assessment, evaluation, prioritization, risk assessment and foresight in the areas of climate change adaptation and mitigation. In addition to two existing GTWGs in the areas of Renewable Energy technologies and Advanced Coal Technologies, GTWGs in 6 other areas of technologies are being launched this year. These include; Enhanced Energy Efficiency, Green Forest, Sustainable Habitat, Water, Sustainable Agriculture and Manufacturing.

(v) Establishing new National Knowledge Network programmes on

a) Climate change and human health

b) Climate modelling

c) Climate change and coastal vulnerability and

d) Climate change and agriculture

Three workshops were organized during the year to identify some broad sub-themes, potential groups of investigators and institutions who could actively and meaningfully participate in the proposed National Network Programme. Based on the recommendation of the workshop expression of interest were invited. Under the network programme on CC & human health 19 proposals were recommended out of 30 proposals. Under National network programme on Climate Modelling 13 proposals were recommended out of 22 full proposals and under the coastal vulnerability 10 proposal were recommended. More than 100 EOI are received under the National network programme Climate change and agriculture, out of which 49 have been shortlisted for inviting full proposals.

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

CCP has already initiated a number of R&D programmes on some key areas of climate change science, adaptation and mitigation. Several institutes working in these areas have been engaged in providing capacity building programmes along with involving research students leading to generate trained manpower in the area of climate change sciences and technologies.

Table 2: Outcomes of R&D projects in terms of manpower trained.

SN	Category of project	No. of projects	No of Ph.D/PG students enrolled/ Completed	No of workshops	No of personnel trained
1	CoEs	**4**	**83**	**118**	**4160**
2	MRDps	**12**	**17**	**17**	**90**
3	Network-Modeling	**7**	**12**	**13**	**110**
4	Network-Health	**9**	**6**	**5**	**88**
5	NMSHE-TFs	**4**	**1**	**43**	**1503**
6	NMSHE-Consortium	**4**	**31**	**5**	**48**
	Total		**150**	**201**	**5999**

D. Study reports produced/generated and their brief findings

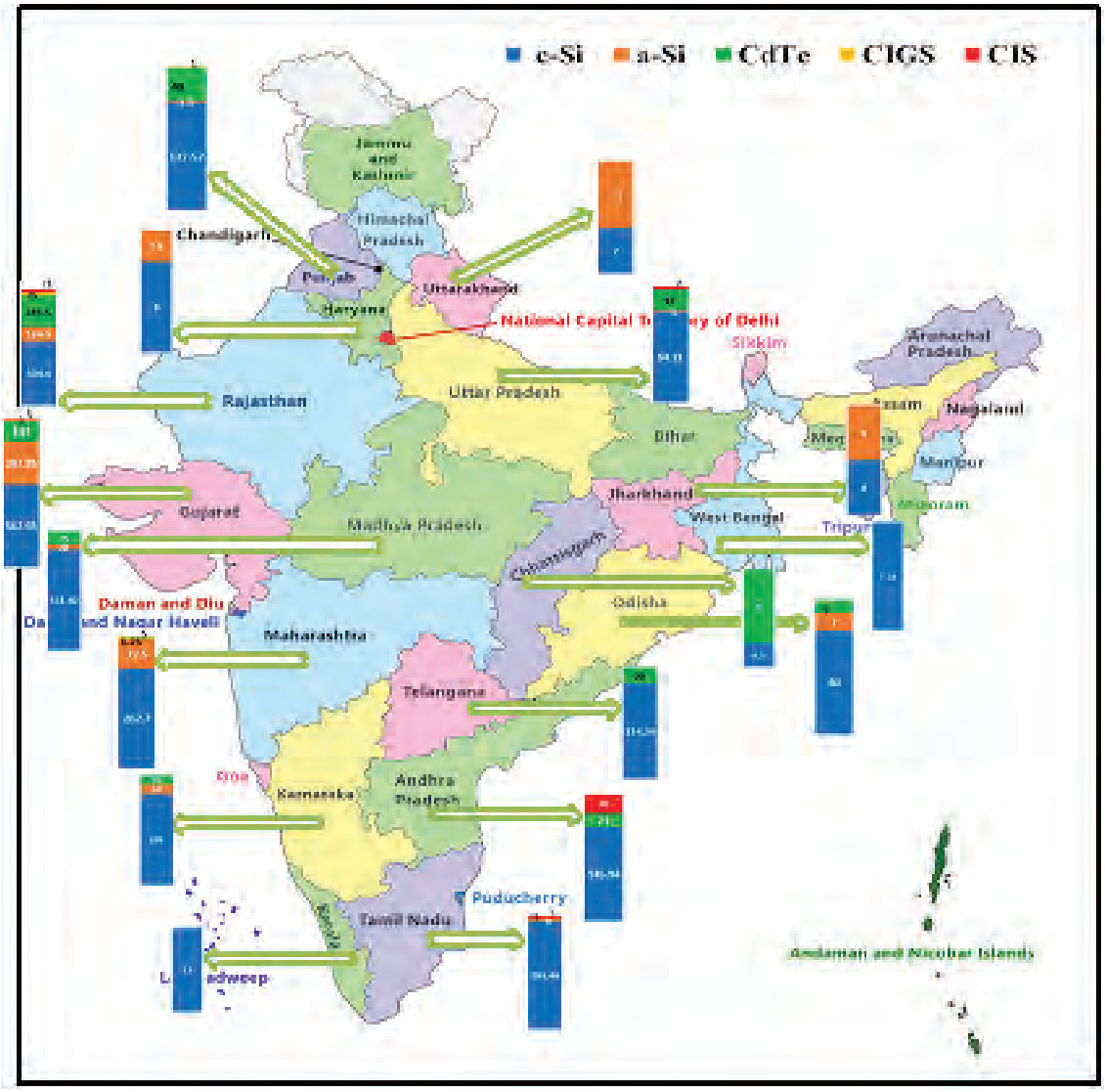
A gist of important findings/outcomes/achievements of some of the programmes supported by Climate Change programme of DST is given below:

a. Global Technology Watch Group

Under Global Technology Watch Group-Renewable Energy Technologies (GTWG-RET) the group identified state-of-the art technologies in the following renewable energy technologies: Solar Photovoltaic Technologies, Solar Thermal Technologies, Storage of Energy Management and Business Models and Policy. For each of these technologies the relevance of the technology, assessed the role of the technology in contributing to the mission goals, examine the lifecycle and progression of the technology and finally commercial applicability of the technology were studied. The following are few key findings for each of the technologies the group worked on.

i. Solar photovoltaic technologies (Divecha Centre for Climate Change, IISc)

Various solar PV technologies, relative penetration of various PV technologies in the total PV installed capacity world-wide are examined by this subgroup. For each of these cells, most recent treatment and manufacturing processes, advantages and disadvantages of these cells are presented. SPV technology status in India is represented in a map



The map of Technology wise solar PV power plants installed in India

ii. Solar Thermal Technologies (Centre for Energy Studies, IIT Delhi) Different solar thermal technologies like (Solar cooking, desalination of water, Solar dryer, solar water heater, energy efficient passive buildings) had been examined by this subgroup with respect to their current status, applications in different quarters, and few recommendations.

iii. Storage and Management (National Institute of Advanced Studies)

In the wake of increasing percentage of renewable energy in total installed capacity, the role of energy storage and management system is crucial. In this regard, different storage technologies are reviewed (international status and their applicability in Indian context)- Chemical, Thermal and Mechanical Energy Storage. As the most established bulk energy storages world wide the study is focused at Pumped Hydro Storage.

iv. Policy and Business Models (Gujarat Energy Research and Management Institute)

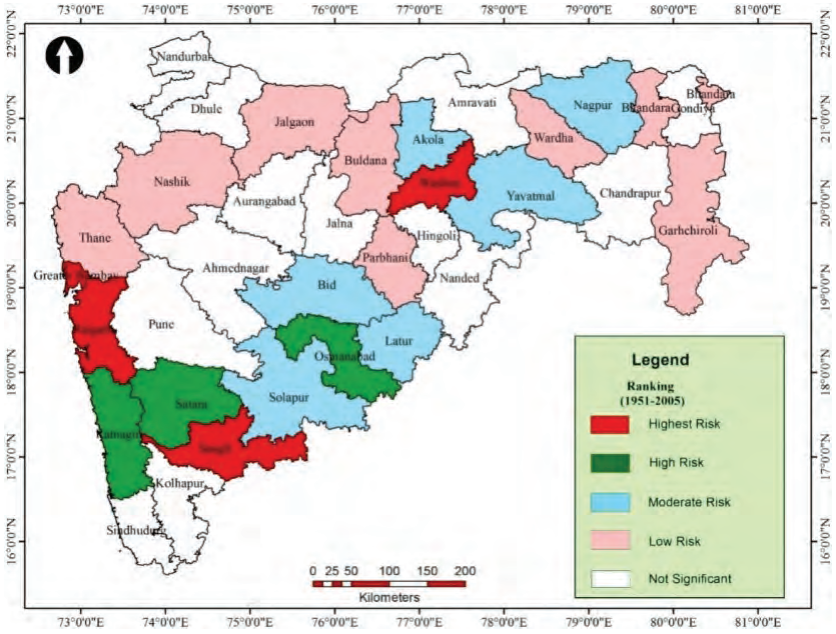
In order to provide knowledge platform for all stakeholders interested in solar developments in India and abroad, GERMI designed and developed a one-stop website that gives information on: solar energy status in various states, centre and state level policies to support and boost solar energy, business models practiced in various states, pool of knowledge generating agencies and human resources specific to solar energy technologies.

In addition to two existing GTWGs in the areas of Renewable Energy technologies and Advanced Coal Technologies, GTWGs in 6 other areas of technologies are being launched this year. These include; Enhanced Energy Efficiency, Green Forest, Sustainable Habitat, Water, Sustainable Agriculture and Manufacturing.

b. DST- Centre of Excellence in Climate Studies at Indian Institute of Technology,

Bombay, Maharashtra

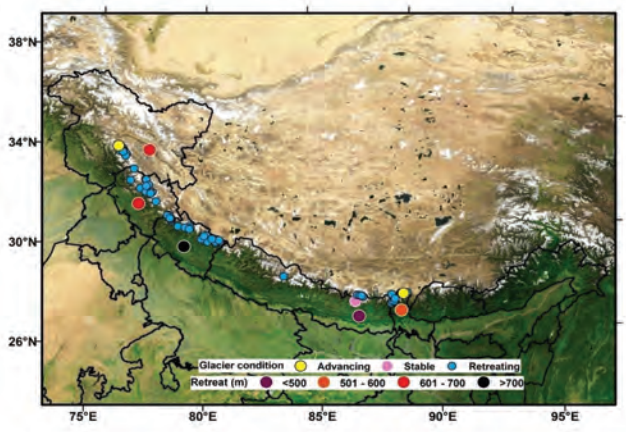
The IIT Bombay Centre of Excellence in Climate Studies seeks to develop a scientific understanding of regional climate change and connect it to impacts (socio-economic, environment, resources) and effective response (adaptation and mitigation). A doctoral programme has been established, with participation from 25 faculty and 36 current PhD students, towards building long-term scientific capacity and systems for study of regional climate change and climate futures. Ongoing research cuts across the domains of climate science, vulnerability and adaptation, and mitigation and policy. Climate Variability: A district level analysis of Maharashtra was done. Climate change has adverse impacts on crop production. A better understanding of regional climate variability is required to assess and address the impact of climate change and subsequently helping in reducing the unwanted impacts and preparedness of farmers towards future climatic variability. In this research factors such as Wet/Dry spells freak weather events such as frequency and intensity of rainfall extremes, deviation from long period mean (DLPA), and daily-scale variability (DSV) are used as measures of monsoon variability. The analysis brought out the extent of variability within districts of the same region and across regions in Maharashtra, and offers some policy recommendations based on the agricultural vulnerability assessment.



Climate Variability and Risk for all districts in Maharashtra from 1951-2005

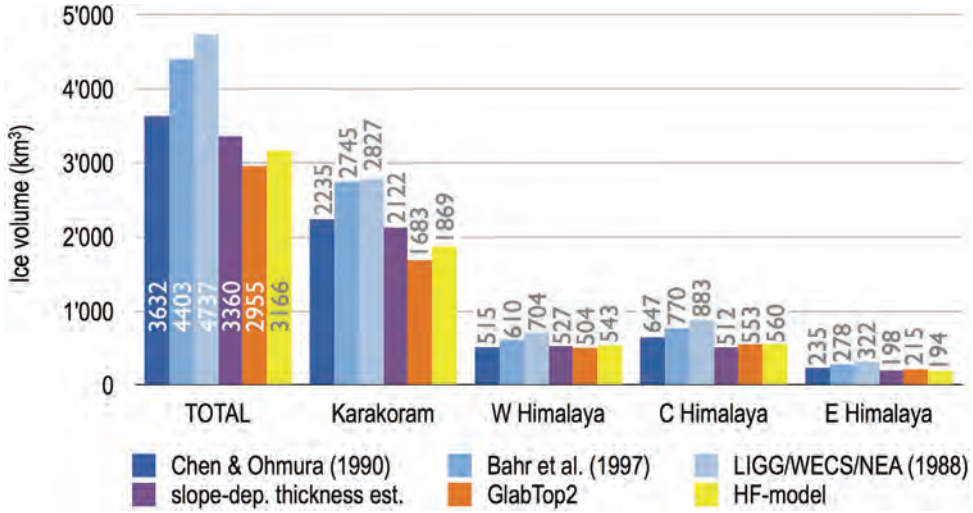
c. DST -Divecha Centre for Climate Change at Indian Institute of Science, Bangalore

The Divecha Centre for Climate Change aims to assess state of Himalayan glaciers. The retreat data based on field satellite observations is available for 83 glaciers. The observations suggest that most of the Himalayan glaciers are retreating though the rate of retreat is varying from glacier to glacier, ranging from few meters to almost 61 meters per year. Mapping of almost eleven thousand sq km of glaciated area, distributed in all major climatic zones of the Himalaya suggest an almost 13 % loss in area from year 1960 to 2000. This variation in retreat is due to factors like area altitude distribution, mass balance, slope and debris cover. In order to understand changes in rate of retreat in Indian Himalaya, Divecha centre has undertaken a program to monitor glacier changes in Baspa and Tista Basins in western and eastern Himalaya, respectively.



The rate of retreat in in Himalaya was observed to be 15 ± 11 m/a between 1960 to 2000.
Except three glaciers, all glaciers are retreating.

Ice volume estimates are crucial for assessing water reserves stored in glaciers. Centre carried out a study where different existing methodologies are used to estimate the ice reserves. Three area–volume relations, one slope-dependent volume estimation method, and two ice-thickness distribution models are applied to a recent, detailed, and complete glacier inventory of the HK region, spanning over the period 2000–2010 and revealing an ice coverage of 40 775 km2. Results of the two ice-thickness distribution models are validated with local ice thickness measurements at six glaciers. The resulting ice volumes for the entire HK region range from 2955 to 4737 km3, depending on the approach. Results from the ice thickness distribution models and the slope-dependent thickness estimations agree well with measured local ice thicknesses.



Volume of glacier stored ice in Himalaya- Karakoram region and for four sub regions

d. Sikkim State Climate Change Cell

GLOFs and South Lhonak Lake Mitigation

Studies show that, South Lhonak Lake is continuously increasing in size from last few years. The lake was around 18 ha in 1976 which increased to more than 126 ha in 2013. The lake is purely a glacial moraine dammed lake which is vulnerable in terms of GLOFs. The lake if burst may cause devastation in the downstream. With this background a multi departmental expedition to South Lhonak Lake carried out this time (September 2016) most importantly for siphoning of lake and to install Glacier Lake monitoring system in the South Lhonak Lake.

First Siphoning of South Lhonak Lake

After the scientific interventions, Sikkim State Climate Change Cell initiated the first mitigation works for GLOF in September 2016 at South Lhonak Lake. Siphoning of lake was done by using High Density Polyethylene (HDPE) quick clamp pipes during the expedition. The diameter of the pipe was 8 inches. A total of 140 pipes were used for the siphoning of lake for siphoning of water from three

sets of pipelines. The team first measured the discharge of lake (say discharge after the peak melting season) by area velocity method. The approximate discharge measured near the outlet was about 4.5 m3/s (160 cusec). The discharge from single pipeline is measured approximately 50 litres/second which ultimately gives a total of 150 -180 lit/s in three sets of pipelines. It is expected that lake would be lowered by about 2 meters at the end of winter season. This is the first of its kind, that HDPE pipes were used for siphoning the glacial lake in India and first approach towards the siphoning of such glacial lake in Indian Himalayan region.


The photos showing the siphoning of South Lhonak Lake for lowering the water level on September 2016

Installation of Lake Water monitoring system

As a part of project with Centre for Development and Advanced Computing (CDAC), Pune, the Department of Science and Technology, Sikkim has installed a Lake monitoring and information System (water level Sensor) at South Lhonak lake. The sensor gives the water level of the lake and also monitored the lake level when there is sudden fluctuation in water level. The sensor is developed by CDAC Trivandrum. The sensor provides the data to the CDAC-Pune and mobile information system is in process so that any alert message can be given at the local level. The system itself is in experimental phase. The same sensor has also been installed Kupup Lake, North Sikkim this year.



Installation of Lake Water monitoring system at South Lhonak Lake on September 2016

The Sikkim State Climate Change Cell conducted Climate Change awareness programme in 26 Block Administrative Centres (BACs) in 4 districts of Sikkim. The programme was linked with National Science Day 2015 on the Theme of “Science for Nation Building” organized by Sikkim State Council

of Science and Technology. Almost 500 people including Panchayat members, NGOs, Self Help groups, staff of BAC and students and general public were sensitized on Climate Change.

e. Manipur State Climate Change Cell

The primary objective of Cell is to "develop a resource base climate information network and sustainable capacity for continuous assessment of the ecosystem health so as to enable in policy formulation and implementation of climate sensitive activities". In collaboration with the Manipur University Working Women's Association (MUWWA), the State Climate Change Cell, Manipur organized Capacity Building Workshop on "Role of Women in Climate Change adaptation" was held on April 15, 2015 at Manipur university to establish a common understanding about the challenges faced by the State, specially the women and to bring a common framework for vulnerability assessment with traditional knowledge, new science and climate models. The workshop was participated by 65 working women s from all the districts. Many awareness programme on "Climate Change and Global Warming were conducted at village level during the year.

E. International Programme

a. Indo-US Fulbright-Kalam Fellowships in Climate Change

In pursuance of the Joint Statement, the Government of the United States of America and the Government of the Republic of India, desiring to promote further mutual understanding between the peoples of the United States of America and the Republic of India by a wider exchange of knowledge and professional talents, intend to work in partnership to build long-term capacity in the United States and India by engaging scientific and technical research scholars and professionals from both countries related to climate research and education through the launch of the Fulbright-Kalam Climate Fellowship. The United States-India Educational Foundation (USIEF) is given responsibility to administer the Fulbright-Kalam Climate Fellowship on behalf of both governments. Fulbright-Kalam Climate Fellowships are offered for Doctoral Research and Postdoctoral Research. These fellowships are designed for Indian faculty and researchers. 84 applications 47 for Doctoral Research and 37 for Postdoctoral Research were received. The first batches of six fellows have been selected.

b. 2nd phase of Indo –Swiss bilateral programme – Joint Research programme

DST and SDC have agreed to jointly fund the Indo-Swiss Collaborative Research on Climate Science and Adaptation to Climate Change in the Indian Himalayan Region (2017-20). DST in partnership with SDC has sought joint proposals from universities and research institutions in India and Switzerland to conduct collaborative research in the field of glaciology and related areas in Indian Himalayan Region (IHR). The goal of the research is to develop scientific evidence to inform and increase knowledge on impacts of and vulnerability to climate change in the Himalayan socio-ecological systems. The Indo-Swiss collaborative research is expected to enhance institutional and human capacities on climate science for adaptation to climate change in IHR and addressing major knowledge gaps in the region.

The joint call for seeking proposals has already been published. The last date of receipt of proposals is 20th December, 2016. The programme is expected to be launched by April, 2017.

F. Mega events :

a. Consultation Workshop and launch of Indo-Swiss bilateral programme Phase 2

The launch programme was organized back to back with the third Consultation Workshop of States of the Himalayan Region, under NMSHE in partnership with DST, on 10 and 11 March 2016 at New Delhi. The workshop was organized by the Indian Himalayas Climate Adaptation Programme (IHCAP) of the Swiss Agency for Development and Cooperation (SDC) in partnership with the Department of Science and Technology (DST). The aim of the consultation workshop is to foster dialogue amongst the states on climate change adaptation and sustainable development across the Himalayan region.

b. Himalayan Sustainable Development Forum (HSDF): First Regional Consultation

The consultation aimed to foster cooperation on sustainable development across Himalayan region; promote science-policy-practice connect; and identify priority sectors and needs for adaptation action in the Himalayan region. The workshop was organized by G.B. Pant Institute of Himalayan Environment and Development.

c. Regional Workshop for North Eastern Region (NER) of India on Climate Adaptation Programme and Sustainable Ecosystem

The State Climate Change Cell, Manipur in collaboration with the Ministry of Science and Technology, Government of India organized "Two Days Regional Workshop for North Eastern Region (NER) of India on Climate Adaptation Programme and Sustainable Ecosystem" at Imphal, the capital city of Manipur on 25-26th April, 2016. The objective of the workshop is development for building human capacity on climate science and integration of adaptation planning on state issues, Understanding of issues related for assessing vulnerability, risk and hazards in the Indian Himalayan Region focussing on effective implementation of SAPCC, and framing of modalities for implementation of training programme in the NE States.

NATIONAL PROGRAMME ON CO2 SEQUESTRATION RESEARCH

Under a project on "CO_2 Capture by CO_2 Selective Thin Film Composite Polymeric Membrane containing amine carrier" implemented at IIT Guwahati, a novel polymer composite membrane having potential for CO_2/N_2 separation was synthesized with 50%PVA, 25wt%PAA, 15wt%AHPD and 10wt%KOH. Characterization of the synthesized membranes using DSC, TGA, SEM, FTIR and XRD was done. The membrane showed thermal stability up to 200oC, which is impressive as far as flue gas is concerned.

Under the project **"Discovery of novel absorbents for enhanced carbon dioxide (CO_2) capture"** implemented at Institute of Chemical Technology, Mumbai, performance of two amine blends, (AMP+HMDA) and (AMP+HMDA,N,N') using co-solvents (H_2O+TEG) was investigated. The

efficacy of the best-performing solvent (AMP+HMDA,N,N') was investigated in a bench-scale closed-loop absorption-desorption apparatus. The investigated solvents are useful for enhanced CO_2 capture, e.g., from flue gas in thermal power stations. Novel absorbent composition and method for removing acid compounds from industrial gases is patented.

Under the project **"Development of Electrochemical Reactor and Solid Electrolyte for Efficient Conversion of Carbon Dioxide into Value Added Products"** at IIT Delhi, an efficient electrochemical reactor was developed for the continuous conversion of CO_2 into value added products. It was found that the functional group effects the electrochemical reduction of carbon dioxide and in fact it helped as a co-catalyst, which is a novel finding.

Under the project **"In-situ formation of foam-gel in a thin channel for improved sequestration of CO_2 in a hydrocarbon reservoir"** implemented at IIT Kharagpur, the effectiveness of foam gel layer in sealing a subsurface fracture against the flow of carbon dioxide was studied. The flow experiments were conducted in a replica of mm-wide fracture in plexiglass. A patent has been filed on a co-flow device to make a gel matrix with embedded voids of sub-millimeter tunable dimensions. 466/KOL/2013.

Under the project **"Inorganic-Organic Hybrid Nanoporous Materials for Carbon Dioxide Capture"** implemented at IIT Roorkee, Nanoporous high surface area framework materials (both inorganic-organic hybrid and organic materials) with high nitrogen content have been synthesized. It has achieved the CO_2 capture capacity up to 40 wt % at 273 K and 1 atm and the material could capture 28 wt % at 1 atm, even at room temperature.

Under the project **"A techno-economic assessment of CO_2 capture and storage Potential in India: A Policy Perspective** implemented at IIM Ahmadabad, a techno-economic assessment of CO_2 capture and storage potential in the country was carried out in Policy Perspective. The analysis based on the mapping and clustering exercise project that India can mitigate around 766 million ton of CO_2 annually below $60 per ton involving only 10 storage locations with a total CO_2 storage potential of 23 billion tons. The study has identified that initial low-cost opportunities for CCS can be in basins with EOR possibilities and coal seams with considerable ECBM potential such as the Cambay Basin and Barmar Sanchor Basin. The revenue from EOR and ECBM will more than off-set the cost of CCS.

NATIONAL SUPERCOMPUTING MISSION (NSM): Building Capacity and Capability

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. This will be the first step in the direction to have a supercomputer machine in the top 20 list by the end of 6 years. 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. A couple of these facilities would have petascale computers which will be in the range above 8 petaflops (PF), with next level of mid-range supercomputers with 1 petaflop capacity. In addition, the entry-level supercomputer will be between 300 to 500 teraflop capacity. Peta-scale computing refers to the capability to add at least a quadrillion (1,000 trillion) real numbers in a second.

During the year, with the constitution of the NSM-Expert Groups on Infrastructure (INFRA), Research & Development (R&D), Applications (APPNS), and Human Resources (HR), the progress of NSM has accelerated. Under the guidance of NSM-Technical Advisory Committee (TAC), the Implementation Strategies for NSM was finalised. The Executive Board under the Co-Chairmanship of Secretary, DST and Secretary, DeitY had approved the first set of supercomputers under "build" and "buy" approach.

The Mission is going to be transformative since high-end training is being planned as a part of HR efforts from understanding and developing indigenous applications to cater to our needs in basic science & engineering and in applications in medicine, agriculture, and technology. Applications in typical complex problems such as in aerospace and automobile engineering; weather and climate modelling; digital agriculture; engineering application; computational physics, computational biology, computational chemistry; cyber-physical systems; Big Data application; and their interfaces with other areas have been identified for initial thrust. Similarly, the HR Expert Group has designed the course content for short term, mid-term and long-term courses in HPC and related areas in close coordination with Department of Higher Education, GOI.

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.

CHAPTER 5

SCIENCE AND TECHNOLOGY FOR SOCIO-ECONOMIC DEVELOPMENT

Three pronged Socio-economic Development programmes are implemented by the Department which include (a) S&T based initiatives for societal benefits; (b) S&T led Entrepreneurship and Innovation promotion; and (c) Developing Scientific Temper in Society. Major activities and achievements of societal programmes are described in the following sections.

SCIENCE FOR EQUITY, EMPOWERMENT AND DEVELOPMENT

Technological Advancement for Rural Areas (TARA)

Technological Advancement for Rural Areas (TARA) is a unique scheme under societal programme of DST to provide Long Term Core Support to S&T based/driven Voluntary Organizations. Core support enables these agencies in development/adaptation, field testing and delivery of appropriate technologies for rural application to address location-specific needs and is not "institutional support". Currently, 25 such organizations are being provided facilitated on technology innovations/modulation, incubation and delivery in respective geographical coverage area to train and empower local community in field based technologies and packages.

For instance, Centre for Indian Knowledge Systems (CIKS), Chennai, Tamil Nadu has developed neem oil soap, pongam oil soap and neem pungam oil mixed soap and tested its efficacy in controlling pests in Paddy (Leaf folder, stem borer), Vegetables (Aphids, hoppers, mealy bug, white fly, fruit borer), Pigeon pea (Helicoverpa, pod borer), Cotton (Mealy bug) and Pulses (Army worm). During the impact analysis it is inferred that for cultivation of cotton crop, a farmer can save Rs.308 per acre by following these organic pest control measures. Similarly, in case of paddy, farmer can save Rs.773 per acre by implementing and Rs. 313 per acre by using soil fertility management technique.

WWF-India, another Core supported organization has developed/disseminated technology package for alternative livelihoods to address conservation issues around protected areas involving tribal community. Its geographical coverage area is Terai landscape spread over 30,000 sq. kms, 50 per cent of which comprises of ecologically rich forests and wetlands in the States of Uttar Pradesh and Uttarakhand. WWF-India has successfully demonstrated effective management of grasslands, fire management, reduced dependency on forest for firewood collection through need-based technological interventions like biogas plants, energy efficient cooking devices, fabrication of solar domes, design modifications for looms and shuttles by engaging local communities for less carbon footprint and improved livelihoods.

In the area of waste management, Vigyan Ashram, a Core group based in Pune has developed Incinerator for efficiently and effectively used sanitary pads and is under commercialization stage, while hand operated balling press has been developed for bundling recycled dry plastic waste. Vigyan Ashram has been accredited under Agriculture Skill Council of India (ASCI) and Electronics Sector Skill Council (ESSC) under National Skill Development Corporation (NSDC) of Skill-India Mission

for providing skill training in advanced techniques.

To revamp traditional pottery practices, Integrated Rural Technology Centre, Palakkad, has modernize the processing and production technology by introducing mechanized potter's wheel and pug mill besides product diversification, value addition techniques. Technique for construction of energy efficient wood-fired kiln (height 4', dia') has been developed by providing a lining of ceramic wool on the inner side of the kiln wall. On scientific measurement, it was found that 25% energy efficiency can be achieved by this method. Besides, product diversification with value addition has been achieved through Decoupage, Glazing, Mural work and Ornament making. Development of Terracotta pot for microwave cooking is another achievement of this Group. Such innovative technological interventions made by these organizations are being integrated with the national programs/schemes such as Skill India, Swachh Bharath Abhiyan, Unnat Bharat Abhiyaan, and so on.

Incinerator for used Sanitary pads

Microwavable Terracotta Pot

Secretary, DST during Review Workshop of TARA held at Pune in May, 2016

Technological Interventions for Tribal Empowerment (TITE)

SEED Division is operating Technological Interventions for Tribal Empowerment (TITE) programme under Tribal Sub Plan (TSP) to support and implement technology-led demonstration projects for improving quality-of-life and empowerment of Scheduled Tribe (ST) communities based on sustainable Science and Technology (S&T) activities/application. Major focus of the scheme is to promote research, development and adaptation of S&T for better living conditions with enhanced livelihood opportunities, and initiation of location- specific and need-based programmes. Projects are being implemented mainly by S&T driven/based voluntary organizations and Universities/R&D institutes as part of their extension/research activities mostly in difficult geographical areas.

Under TITE, for instance, improvised drying-cum-storage technology for large Cardamom has been successfully introduced and demonstrated by Take Bogo Multipurpose Co-operative Society in Ziro, Arunachal Pradesh. They introduced a modern technology flue pipe system dryer that provides good colour to the capsules and perfect drying in short span of time. Now, Cardamom farmers of Ziro are getting better economic returns through the introduction of this improved drying technology as compared to traditional system.

In another project implemented by Association for Social & Humanize Action (ASHA), in Chinturu Block, Andhra Pradesh, machinery tools and equipment have been introduced for improved processing and packing of UNR (Untapped Natural Resources) Palmyrah Fronds and Bamboo sheaths at the household level to make value-added products locally. Trained tribal families are now able to make biodegradable cups using Bamboo sheaths and extraction of fiber from Palmyra fronds in sustainable way. A group of 2 women are able to make 400 cups fetching Rs.360/- per day by engaging themselves for 4-5 hrs besides performing household activities. Such intervention for value addition at local level with capacity building has enabled tribal families to get additional income without disturbing their routine work.

Bamboo Sheath Cup Making

Extraction of Palmyra Fiber

Towards forest resource centric interventions for diversified sustainable livelihood opportunities in tribal regions of Central India (Betul District, Madhya Pradesh; Gadchiroli District, Maharashtra), action research project is being implemented by BAIF Development Research Foundation, Pune.

Some of the resources available in the project areas are NTFPs like honey, gum, lac, chironji, mahua, tendu, etc. The major activities promoted through appropriate technology interventions for NTFP are systematic/improved practices of Lac cultivation, gum harvesting and inland fishery. Lac cultivation is being introduced in the project area with the involvement of tribal community on Palas (Butea monosperma), Kusum (Schleichera oleosa) and Ber (Zizyphus mauritiana) plants to supplement their incomes.

To have larger impact and outreach of technology-led demonstration, a Network programme to address migration and malnutrition in tribal communities (i.e. Kolam, Korku, Katkari, Mahadeokoli, Gond and Bill) through appropriate technologies is being implemented in 11 locations in the tribal pockets of Maharashtra covering 50 villages and around 3000 beneficiaries. Efforts are being made to reduce the malnutrition by building local capacities in kitchen gardens, revamping the use of wild vegetables and fruits through establishment of nurseries, development of value added products having nutritive value and scientific practices of livestock management. To improve the food & nutrition security and reduce malnutrition through collective farming and promotion of Forest Home Gardens (FHGs), Medicinal Plants Conservation Centre & Trust, Pune has set up a central nursery having 22 varieties of species of fruit plants (57 families), vegetable saplings like Tomato, Brinjal and Chilly (215 families).

Bamboo Sheath Cup Making

Extraction of Palmyra Fiber

In another field based project, Sahyadri Wildlife and Forest Conservation Trust (SWIFT), a partner project implementing agency in the network programme “People & Protected Areas: Conservation and Sustainable Livelihoods in Partnership with Local Communities” has been working to improve livelihood security in villages around Dandeli-Anshi Tiger Reserve, Uttara Kannada, Karnataka. Tubers and roots are an important source of nutrition for many poor tribal communities in this area, which can withstand fluctuating weather conditions and are projected as food security crops when the productivity decline due to climate change. SWIFT with technical support of Central Tuber Crops Research Institute (CTCRI) is making efforts to introduce techniques to grow better varieties of tubers. They are also exploring the possibility of producing flour from tubers which could help in increasing income of the Kunbis tribe. In addition, energy efficient cooking devices have been introduced to reduce local dependency on fuel wood with reduced indoor pollution.

Technological Interventions for Addressing Societal Needs (TIASN)

TIASN primarily involves technology development and adaptive R&D for the benefit of the society. Projects are mainly supported in the area of Agriculture, Health, Nutrition and activities related to Non-Farm sector. Some of the noteworthy achievements are:

1. A project "Krishi Utthan- Development and promotion of eco-friendly low external input agriculture technology for small & marginal farmers", is being implemented in Sarahasbah and Tikuliha villages of District Deoria, U.P. Due to erratic rainfall in Kharif season and groundwater depletion, last few years were trying for the farmers resulting in serious damage to paddy crop. To address this, appropriate variety of seeds and package of practices (PoP) were identified. Narendra-97 (N-97), "Extra, Early Paddy" with 90 days of cultivation period- from nursery to harvest- was procured from Narendradeo University of Agriculture and Technology (NUAT), Faizabad, for promotion among the farmers. The selected variety can be cultivated on upland and sandy loam and has substantial benefits such as shorter cultivation duration and minimal requirement of water besides being less sensitive to photoperiod. Breeder seed of N-97 was provided along with Package of Practice (PoP) mustard cake, neem oil coated urea and micronutrients to be used as manure to 77 farmers. N-97 required only 2-3 irrigations as compared to 6-7 irrigations given to longer duration varieties cultivated earlier also in line with the "More Crop Per Drop" maxim. It was found to be disease free and therefore did not need pesticides. Average yield recorded was 14-18 quintals per acre as compared to 12-14 quintals of long duration varieties. This variety is being sold at Rs.40-50 per Kg at local festival Jiutia. This paddy, even which was planted late, got harvested early from first week of September and the vacant plot thus was available for cultivation of short to long duration mustard, rabi onion, vegetable and fodder leading to extra income generation and food and fodder security. The successful cultivation of this Extra Early Paddy has been covered extensively in print and electronic media including DD Kisan channel and ETV News.

2. In another project funded to Dr. YS Parmar University of Horticulture and Forestry Himachal Pradesh for "Standardization and commercialization of apple cider vinegar production technology for sustainable livelihood of weaker sections of society", optimization of the traditional method of cider vinegar production has been achieved in order to promote indigenous knowledge for the benefit of the society. Traditionally apple cider vinegar is used as a condiment and is produced at home/cottage scale using natural fermentation process which takes 6-7 months. Therefore, efforts were made to standardize the protocol for (i) Production of alcoholic liquid /fermented juice (cider/ base wine) involving various parameters and (ii) Factors involved in acidification of alcoholic liquids (cider/ base wine). Three methods of vinegar production using natural vinegar fermentation in bottles/drums, bioreactor and

vinegar generator were compared for small scale production of vinegar. Vinegar generator method was found to be best as it produced good quality of vinegar (4.5% acidity) in short duration (68-70 days as compare to 150 days of natural fermentation) and is cost effective. Acidic flavor was suppressed by addition of herbs and spices extract (seasoning). Out of different recipes tried, the recipe consisting of 70% vinegar (4.5% acidity), 10% Honey, 1% Black Salt, 3% Black Pepper, 4% Cumin Seed, 1% Large Cardamom, 2% Pudina, 4% Ginger Powder, 5% Lemon Juice was adjudged to be the best by the panelists based on better sensory score for taste and flavor, hence was optimized. The technology developed has been compiled in the form of a technical booklet. The developed technology has been disseminated among the farmers/apple growers, entrepreneurs and Self Help Groups (SHGs) through trainings and the process of transfer of technology.

Location-Specific Interventions

SEED Division also addressed issues related to Livelihood, Health & Nutrition, Drudgery and Local Resource Management in the lower Shivaliks through its *"Sustainable Agriculture Rural Transformation Holistic Initiative (SARTHI)"*. Some of the specific interventions made under this initiative are:

1. Under the project *"Management and utilization of Lantana Camara to improve livelihood in Kandi region of Punjab"* Punjab Agriculture University, Ludhiana, in collaboration with Forest Research Institute, Dehradun has developed a technology package to collect the biomass and its effective usage in making handmade paper. A modified bush cutter for harvesting lantana effectively and use its biomass for preparation of handmade paper and charcoal was developed (Fig) in order to effectively eradicate lantana from private and forest lands thus leading to its economic utilization reduction and reduction in the cases of forest fires. The biomass is used to improve the livelihood of people through direct employment generation in handmade paper unit and using the cleared land for agriculture activities. A field demonstration was conducted to evaluate the performance of two types of bush cutters developed under the project- one with straight shaft and another with flexible shaft for cutting Lantana Camara in May 2016. The bush cutter with straight shaft weighs 7.5 kg and is powered by 4-Stroke, air cooled, 1.2 kW petrol engine whereas one with flexible shaft is 11.1 kg in weight and is powered by 2-Stroke, air cooled, 1.5 kW petrol engine with fuel consumption 0.8 l/ha and 0.7 l/ha with a field capacity of 0.171 ha/day and 0.141 ha/day and labour requirement 47 man-hrs/ha and 57 man-hrs/ha respectively as compared to 320 man-hrs/ha for manual cutting, thus saving 260 man-hr/ha. The cost of operation was found to be Rs.4638/-ha and Rs.5140/-ha respectively, whereas with manual cutting, the cost of operation was Rs.10000/- per ha.

In order to remove the *lantana* completely from roots, an ergonomically effective and safe manual

root puller-cum-transporter was developed (Fig) on the principle of clamping/pipe wrench (used for domestic plumbing). The device consists of two small but sturdy wheels for free movement from one place to another, rectangular frame, clamping jaw and handle to pull the root of the bush. Clamping jaw is supported by angle iron at the bottom or base, so that it can easily move back and forth. Two small wheels are provided for easy transportation. The handle height is around 120cm from the ground, dimension of rectangular frame is approx. 40cm x70cm, and diameter of wheel is around 15cm. The weight of the machine is around 18-20 kg. The root is pulled and plucked out from the ground completely with the help of clamping jaw. Three training programs were also conducted on handmade paper manufacturing from Lantana biomass for 15 potential entrepreneurs at FRI, Dehradun. Trainees will be able to generate income of Rs.10000/-pm.

2 Under the project entitled "Ensuring Sustainable Agricultural Development and Livelihood Security in Lower Shivalik Range of Uttarakhand" identified challenges of the community in Roorkee, Laksar and Narsan blocks of Haridwar district, relating to low yield of major crops and vegetables including paddy and wheat, compared to national average were addressed by providing technological packages at site. Interventions were designed for rabi 2015-16 season with on-farm demonstrations of improved IARI wheat varieties HD 2967 (11) and HD 3086 (22). Wheat varieties (HD-2967) and (HD-3086) recorded yield of 52q/ha and 45q/ha respectively with yield increase of 14% and 2% than the local ones (PBW-226, PBW-292) with an estimated increased profit of Rs.40,000/- from 1ha of land. Three improved paddy varieties (P-1121, P-1612, and P-2511) were also introduced in the farmer's field. Introduced varieties gives yield 50.13 qt/ ha as compared to local variety which gives 45.60qt/ha with increased yield of 6.57, 14.69 and 8.55%, respectively as compared to local check (Sarbati) leading to an estimated increased profit of Rs.10,800/- per ha.

Introduction of short duration paddy variety (120 days) as compared to local variety (135 days), gives a chance to sow another crop i.e., mustard with increased net return and crop diversification for the farmers. Application of bio-fertilizer (Azolla) in paddy field was promoted to reduce weed infestation. In addition, farmers were instructed how to store seeds for multiplication and production for future use. Vegetable demonstration for summer season on bottle gourd (Pusa Naveen) were also laid out. Pusa Naveen resulted in 112.5 q/ha yield as compared to local variety which gives 65.3q/ha and estimated increased profit of Rs.50,000/- per ha. As per the feedback, Pusa Naveen variety has more market acceptability due to its big fruit size (550-700 g) and better taste as compared to the desi variety.

Table 1: Comparison of yield performance between IARI improved Wheat, Paddy and Bottle Gourd with local variety

Variety	Demonstration Yield (q/ha)	Yield of local Check (q/ha)	Proportionate change in yield (in %age)
Wheat			
HD 2967	52.09	45.72 (PBW 292)	13.93
HD 3086	45.05	44.14 (PBW 226)	2.06
Rice			
Pusa-1121	48.6	45.6 (Sarbati)	6.57
Pusa-1612	52.3		14.69
Pusa-2511	49.5		8.55
Bottle Gourd			
Pusa Naveen	112.5	65.3 (Desi)	72.3

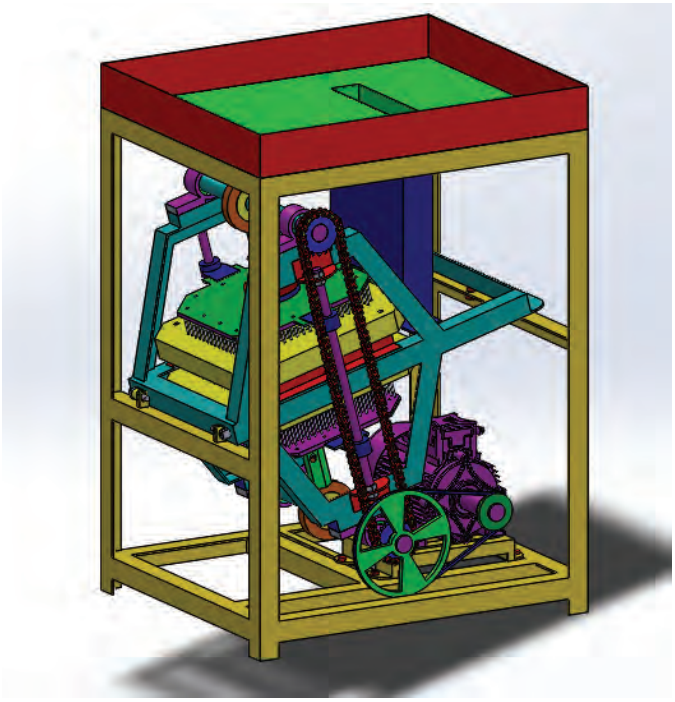
Shaft Cutter ▲

Root Puller ►

Scheme for Young Scientist and Technologists (SYST)

The scheme nurtures young scientists to take up S&T based projects of societal relevance with lab-to-land approach. DST has recommended 33 projects under SYST scheme in 2016-17 for support. Some highlights are given below:

1. Under a project "Design, Development and Testing of a Continuous Aonla Pricking Machine" various challenges related to its processing and value addition have been addressed through the development of the continuous pricking machine (Fig). Aonla murrabba is one of the desired products and for preparing it. Fruits are traditionally pricked with wooden or stainless steel needles manually which are not uniform in number and depth, and result in spoilage of stored murabba due to insufficient penetration of sugar syrup deep into the fruit. The continuous Aonla pricking machine supported under the project is designed based on processing capacity of 80 kg/hr. The machine will reduce drudgery, spoilage and time of processing and will enhance the income of the locals during the process.



Aonla Pricking Machine

2. In the project "Design and Development of Manually Operated Equipment for Bamboo Stripes Manufacturing", drudgery related issues in bamboo product manufacturing faced by artisans, have been addressed through development of hand operated equipment for manufacturing bamboo stripes. To get the bamboo stripes from bamboo culm, the whole process was divided into 5 stages 1) Splitting, 2) Inner node removal, 3) Side node removal, 4) Slicing and 5) Stripping.

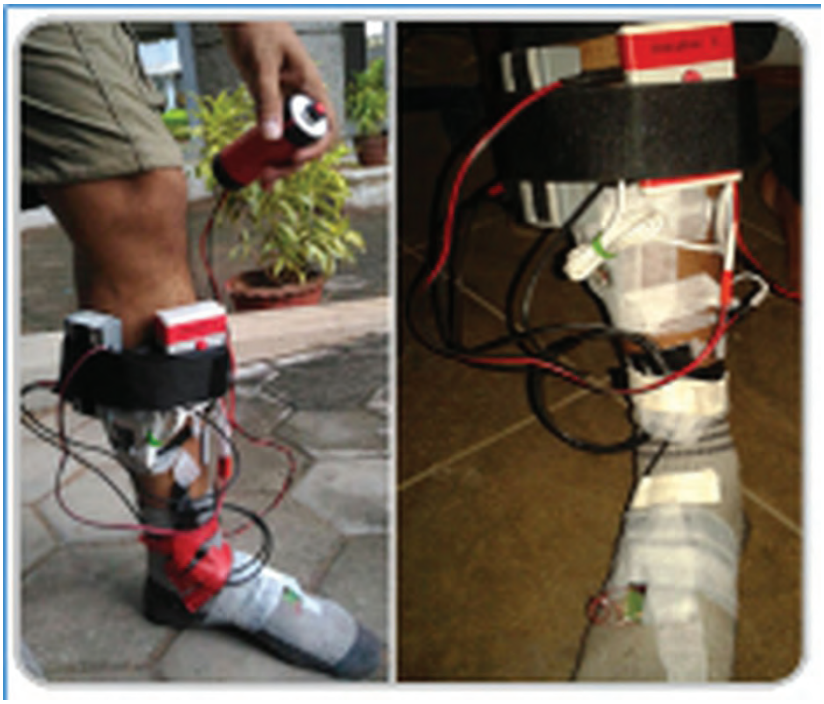
Technology Interventions for Disabled and Elderly (TIDE)

Technology Interventions for Disabled and Elderly (TIDE) is a unique initiative aimed at "promoting basic research, development and adaptation of technology for improving quality-of-life of Elderly population and Disabled People in the country through application of Science and Technological inputs". This initiative also complements the Accessible India Campaign (Sugamya Bharat Abhiyan), a nation-wide campaign for achieving universal accessibility for Divyangjan launched by the Hon'ble Prime Minister.

A wide array of technology prototypes/products for elderly and PwDs to gain access for equal opportunity, live independently and participate fully in all aspects of life in an inclusive society were developed. Some noteworthy achievements are as follows:

Functional Electrical Stimulation (FES) Devices for Neuromuscular Rehabilitation: The project is aimed at developing a device for the assistance of persons suffering paralysis following a cerebrovascular stroke. The incidence of stroke in India is approximately 1.5 M annually, and the common result of stroke in surviving people is neuromuscular paralysis (hemiplegia). Patients with hemiplegia can use a passive orthosis to prevent foot drag, but the resulting gait is slow and awkward. Such passive orthoses provide a small amount of functional improvement.

Under the project, indigenous FES stimulators for partially paralyzed lower limb including sensors for semi¬automatic control of the functional neuromuscular stimulators for foot drop correction and multi-¬electrode stimulators for partially paralyzed upper limb had been developed and designed at CMC-Vellore. The stimulator can be controlled by a manual switch. The picture shows a subject wearing the FES stimulator, the inertial sensor circuitry, and holding the manual switch. Ankle dorsiflexion was measured on all the test subjects and the range of flexion was about 20 degrees which is sufficient for ground clearance during the swing phase of walking. Data from the inertial motion sensors was recorded to develop an algorithm for detecting the phase of gait cycle for administering the stimulation.



While the idea of FES to help in moving the paralyzed leg has been around for a long time, only in recent years some commercial devices have become available. These being expensive and less reliable are rarely used in India. Indigenous sensors (below picture) for assessment of spatial movement and planning of control strategies are also developed.



The stimulators are being extensively tested on stroke patients in the Rehabilitation Institute of CMC-Vellore along with comparison (features and functions) of the developed FES systems with selected commercial systems. Other applications of FES including control of paralyzed upper limbs and an FES system for partial restoration of function of such paralyzed muscle are also being developed under this project.

Automatic generation of sign language from Hindi Text for communication and education of hearing impaired people: There are around 0.5 million hearing impaired children in India and only 5% of them get any education with Indian Sign Language (ISL). This project taken up by Thapar University will play a major role in improving the literacy rate of hearing impaired and will facilitate their communication and learning. The proposed automatic generation of Sign Language from Hindi Text will help to improve the literacy rate of hearing impaired people. This system will generate the animation in ISL for text given in books/websites and will act as a powerful tool for their effective education and communication. It will also facilitate hearing impaired to communicate effectively with others as well as the other hearing impaired people. In the proposed system input Hindi sentence will be processed by shallow parser to identify the higher syntactic and functional information of the sentence. It will perform the tasks of tokenization, morph analysis, part-of-speech tagging and chunking for the processing of an input sentence. The root words of input sentence will be mapped with HamNoSys notations with eSIGNEditor tool to pick signed sentences sign by sign from the lexicon and apply morphological changes to individual signs or strings of signs where necessary. After writing signs in HamNoSys, it will be converted into Signing Gesture Mark-up Language (SiGML), a form of XML. Generated SiGML file will finally be processed by Signing Avatar like “”, which will play sign animation for the input text. The system has several advantages over video based generation systems like flexibility and scalability, higher download speeds and dynamic generation of sign language. It can be made available to public through web based and mobile based solutions where a user can input any simple sentence in Hindi language/whole document/website to get its corresponding Indian Sign Language animation played by a virtual human character. It was tested at Bhagat Puran Singh School for Deaf, Pingalwara, Amritsar by 8 sign language experts and the field trails to understand the teaching practices followed in the school of hearing impaired people was also be conducted.

S&T LED ENTREPRENEURSHIP AND INNOVATION PROMOTION

National Science and Technology Entrepreneurship Development Board (NSTEDB) aims to foster knowledge based and technology driven entrepreneurship among S&T persons through its programmes and activities. The institutional programmes and other facilitating mechanisms of the Board are structured to foster ideas and innovations into successful start-ups and to create techno-entrepreneurs among the S&T persons. In line with the Startup India movement, department has strengthened ongoing programs and initiated various programs to support creation of conducive ecosystem of innovation, incubation and entrepreneurship.

The programmers of the Board and the related achievements during F.Y. 2016-17 are summarized below.

National Initiative for Developing and Harnessing Innovations (NIDHI)

NSTEDB, DST has conceived, develop and is implementing a new umbrella initiative 'National Initiative for Developing and Harnessing Innovations (NIDHI)'. NIDHI is developed keeping in line the new national aspirations and on the basis of DST's experience of three decades, in promoting innovative start-ups. Under NIDHI, several programs have been designed and are being implemented for nurturing ideas and innovations (knowledge-based and technology-driven) into successful startups. The TBI program has been restructured as 'NIDHI-Technology Business Incubator (TBI)' with enhanced infrastructure, facility and funding support. Enhanced support has also been provisioned for Seed support for incubatees. The key components of NIDHI are –

- NIDHI-PRomoting and Accelerating Young and ASpiring innovators & startups (NIDHI-PRAYAS) - Support from Idea to Prototype;
- NIDHI- Entrepreneur-In-Residence (NIDHI-EIR) - Support system to reduce risk;
- NIDHI-Accelerator - Fast tracking a start-up through focused intervention;
- NIDHI Centres of Excellence (NIDHI-CoE) - A World class facility to help startups go global;
- NIDHI-GCC - Grand Challenges and Competitions for scouting innovations;

New programs launched under NIDHI initiative

In the idea to market innovation chain, the early stage prototyping support is currently lacking. To setup Idea to Prototype support, NIDHI-PRomoting and Accelerating Young and ASpiring innovators & startups (NIDHI-PRAYAS) program has been launched. NIDHI-PRAYAS is positioned as a pre-incubation initiative. Under NIDHI PRAYAS, 10 PRAYAS Centres have been setup at various TBIs along with support for establishing PRAYAS Shala and Proof of Concept Grant support for innovators/ entrepreneurs as Prayasee.

To inspire the best talents to be entrepreneurs, minimise the risk involved in pursuing start-ups and

to partially set off their opportunity costs of high paying jobs, NSTEDB has introduced NIDHI-Entrepreneurs-in-Residence (EIR) Programme. Under the program subsistence grant for a period of one year is provided through a TBI to an aspiring or budding entrepreneur of considerable potential for pursuing a promising technology business idea. Ten TBIs have been extended support for further disbursement of EIR grants to the entrepreneurs. The NIDHI-PRAYAS and NIDHI EIR programs are being managed through online portals developed specifically for these programs.

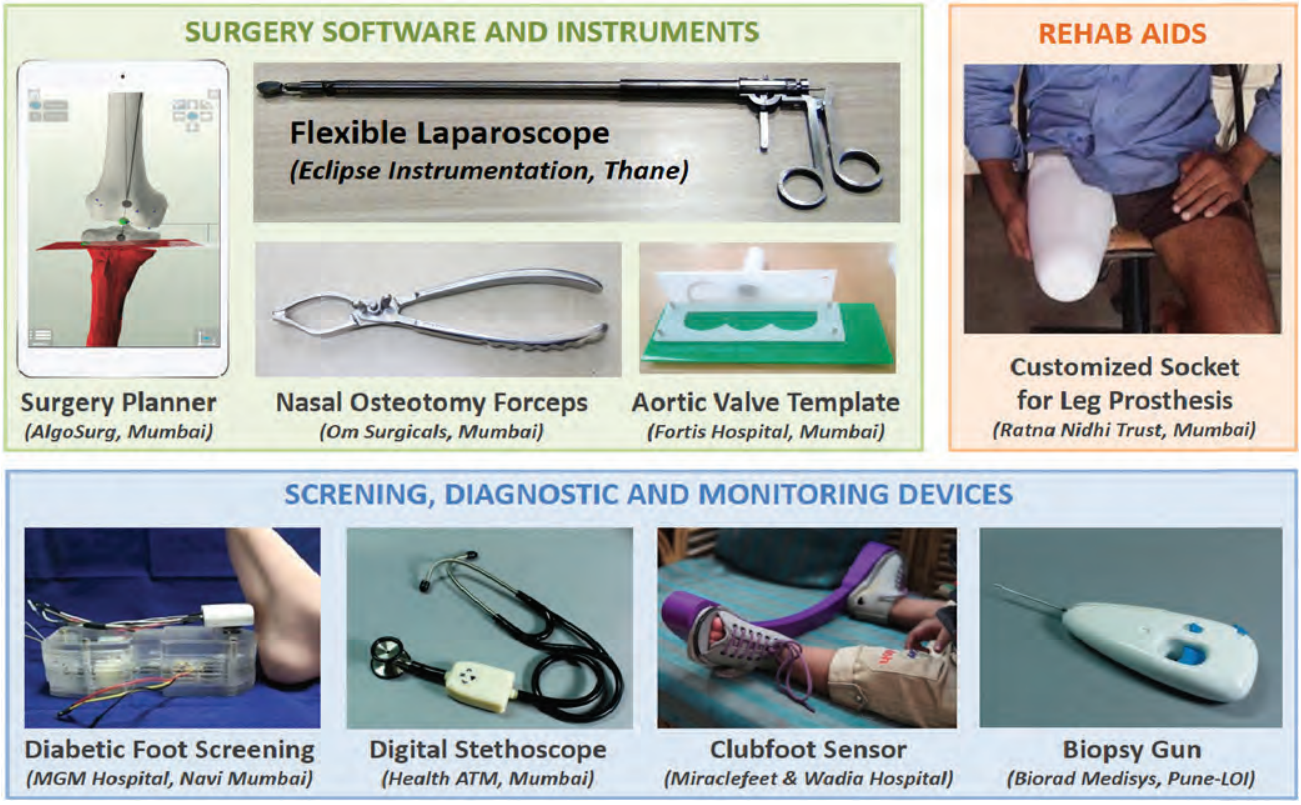
NIDHI Accelerator programme is a successful mechanism to enable fast tracking the seed and early stage start-ups through deep and intensive engagement model. In F.Y. 2016-17, 9 TBIs/STEPs have been recommended for support under the recently launched programme "National Initiative for Developing and Harnessing Innovations- Accelerator (NIDHI-Accelerator". These include CIIE Initiatives, Centre for Innovation Incubation and Entrepreneurship (CIIE), Gujarat, KIIT -Technology Business Incubator (KIIT-TBI), Odisha, EDEN, Bangalore under IKP Hyderabad, Startup Oasis, Rajasthan, IIM Calcutta Innovation Park, Kolkatta, Amrita Technology Business Incubator, Kerala, Ahmedabad University Support Foundation (AUSF), Gujarat, NAARM-TBI a-iDEA, Telangana and Zone Startups India, Maharashtra.

The NIDHI-CoE (Centre of Excellence) proposes to strengthen and scale up existing capacities of STEP/ TBIs and support potential start-ups with different pursuits and practices in transferring technological innovations into marketable products/high-growth companies. Six TBIs have been recommended for scaling up as Centre of Excellence.

Technology Business Incubators:

Department of Science and Technology has been supporting establishment of Technology Business Incubators primarily in and around academic, technical and management institutions to tap innovations and technologies for venture creation by utilizing expertise and infrastructure already available with the host institution. Under this flagship program, department has established more than 100 Technology Business Incubators (TBI) and Science and Technology Entrepreneurs Parks (STEP) and several among them have matured and developed competence to become state-of-art Incubators. During the year 2016-17, TBI have been established at Entrepreneurship Development Institute (EDII) of India, Ahmedabad; Fr. Conceicao Rodrigues Institute of Technology (FCRIT), Mumbai; Coimbatore Institute of Engineering and Technology, Coimbatore; Gujarat Law Society (GLS University), Ahmedabad; IIT Gandhinagar; IIT, Hyderabad; National Innovation Foundation, Ahmedabad; Dayanandsagar College of Engineering, Bangalore; Deshpande Foundation, Hubli; Somaiya Vidyavihar, Mumbai; Tata Trusts, Bangalore; Indian Society of Agribusiness Professionals (ISAP), New Delhi; Indian Institute of Management (IIM), Kozhikode; Indian Institutes of Management (IIM), Udaipur; Indian Institute of Technology, Mandi, IIT Roorkee; NIT Raurkela, IT UPVAN, Indian Institute of Information Technology Design and Manufacturing Kancheepuram (IIITDM Kancheepuram; Malaviya National Institute of Technology (MNIT), Jaipur; Dr. B R Ambedkar National Institute of Technology, Jalandhar.

Some of the achievements of the TBIs and its incubatees:



Products Licensed to Industry, Hospitals and Institutions by the TBI at IIT Bombay - BETiC (Biomedical Engineering & Technology (Incubation) Centre)

Ather Energy wins ET Startup Awards 2016. Ather Energy is one of the incubate of TBI at IIT Madras – 'Incubation Cell' and is building first of its kind Smart Electric Scooter.

World's largest capacity food waste processing plant at Pune developed by "NobleExchange Environment Solutions Pvt Ltd" by one of the Incubatees at Venture Centre TBI at NCL Pune

Forus Healthcare is an innovation led social enterprise incubated by TBI-CIIE,IIM Ahmedabad and has designed and developed -'3nethra'. This device is a single, portable, intelligent, non-invasive, non-mydriatic eye pre screening device that can detect 5 major ailments of eye automatically - cataract, glaucoma, diabetic retina, cornea problems and refractive error measurements.

"Coolectrica" designed and developed by 'Promethean Power' a startup at TBI- Villgro Innovations Foundation, Chennai, is the world's first rapid milk chilling machine for smaller villages. It is designed to work in areas with unreliable grid power.▼

"BabyChakra.com" at TBI-Zone Startups, BSE, Mumbai is a platform that helps mothers find maternity & children related products & services. BabyChakra connects user (new parents) with other mothers, experts or child care services. The platform currently helps the 30 Million Mums (and Dads) online.

Seed Support to Incubators

The Seed fund provided by the Department equips the STEP/TBI withthe much needed early stage financial assistance to be provided timely to deserving start-ups underincubation in a relatively hassle free manner. 2 TBIs/STEPs namely, Science and Technology Park, Pune and Kalinga Institute of Industrial Technology (KIIT) Technology Business Incubator, Odisha, were provided seed funding during 2016-17.Total grant of Rs. 300.00 lakh has been sanctioned to these 2 TBIs as seed support which will be disbursed to them in phases. In F.Y. 2016-17, 11 TBIs/STEPs have been recommended for Seed support under the new launched programme "National Initiative for Developing and Harnessing Innovations- Seed Support System (NIDHI-SSS)". These include, CIIE Initiatives, Centre for Innovation Incubation and Entrepreneurship (CIIE), Gujarat, KIIT -Technology Business Incubator (KIIT-TBI), Odisha, Entrepreneurship Development Center (Venture Center), Maharashtra, Startup Oasis, Rajasthan, IIM Calcutta Innovation Park, Kolkatta, Amrita Technology Business Incubator, Kerala, Ahmedabad University Support Foundation (AUSF), Gujarat, i-Create, Gujarat Foundation For Entrepreneurial Excellence, Gujarat, Coimbatore Institute of Engineering and Technology-TBI, Tamil Nadu, Shri Mata Vaishno Devi University Technology Business Incubator Center Society (SMVDU TBIC), Jammu & Kashmir and GLS University Incubator, Gujarat.Grant of Rs. 1000 lakh has been recommended for 10 of these TBIs and Rs. 200 lakh for the remaining one TBI. This seed support will be disbursed in instalment after the financial approval of the Seed support.

Joint initiative of DST with MHRD to promote Innovation and Incubation at National Institutes of importance.

Department of Science & Technology (DST) and Ministry of Human Resource Development (MHRD) have launched a joint initiative of promoting Start-up Ecosystem in institutes of repute. DST has been promoting establishment of Technology Business Incubators and MHRD has been establishing Research Parks in the country. Under this joint initiative, it is proposed to establish a 'Start-up Centre', a

'Technology Business Incubator' or a 'Research Park' depending on the preparedness of the institution in commercialization of technologies, supporting industrial research and mentoring start-ups. Under this joint initiative, 6 Research Parks, 15 TBIs and 14 Startup Centres are being established at various IITs, NITs, IIITs and IISERs etc. During 2016-17, DST has supported establishment of Research Park at IIT Gandhinagar.

National Award for Technology Business Incubators for the year 2015

In order to recognize and reward the remarkable work done in the area of techno-entrepreneurship development through value added business support by specialized facilities such as Technology Business Incubators and Technology Parks, Department has established a National Award for Technology Business Incubators. During 2016, a new category of award was introduced as 'National Award for Emerging Technology Business Incubator. The National Award for Technology Business Incubators for the year 2015 was presented to the "Entrepreneurship Development Center, National Chemical Laboratories, Pune on the Technology Day, 11th May 2016. " During 2016, a new category of award was added as 'National Award for Emerging Technology Business Incubator. For the year 2015, the National Award for Emerging Technology Business Incubator was presented to '91 Springboard, New Delhi.

The National award for "Technology Business Incubator" being presented
to Entrepreneurship Development Center, National Chemical Laboratories, Pune

DST supports First Women Start-up Accelerator programme "-empoWer " by Zone Start-ups, Bombay Stock Exchange Institute , Mumbai

Empower is positioned as the **1st women entrepreneur centric accelerator program in India.** This 6 weeks program for accelerating 15 women entrepreneurs was successfully conducted which resulted in promoting the gender diversity/equality and providing an opportunity to women entrepreneurs for building business and scaling up, and being job creators.

A Decade of DST-Lockheed Martin India Innovation Growth Program (IIGP)

DST-Lockheed Martin India Innovation Growth Program (IIGP) is a unique public private partnership initiated in 2007 between Government of India's Department of Science and Technology; Lockheed Martin Corporation; Indo-US S&T Forum; FICCI; Stanford Graduate School of Business; IC2 Institute, University of Texas at Austin and TiE Silicon Valley. Each partner brings a distinctive value to the programme with a common objective of fostering innovation driven entrepreneurship in the country. Through a wide outreach campaign spreading over 100 cities across India, the Programme has received and evaluated over 7000 ideas so far and nurtured over 350 startups. In addition to building entrepreneurs, more than 50 incubation managers from India have been trained in the US on global best practices on incubation and commercialization.

Some of the innovations awarded in the year 2016-17 included an innovative computer aided catheter reprocessing machine which is fully automatic and provides quality assurance as well as eliminates human error; a service innovation in automatic defect identification on live power transmission lines using unmanned aerial vehicle, imagery sensors and its data analytics and a unique disease resistance & health-care system for crops that will reach 500,000 farmers within 3 years, among others.

Roundtable of Hon'ble Minister Dr. Harsh Vardhan with Ms. Marillyn A. Hewson, Chairman, President and Chief Executive Officer, Lockheed Martin Corporation marking the 10th Year of successful Partnership under IIGP, July 6, 2016, New Delhi

PLUGIN – A collaborative Incubation Program for Hardware & Systems Startups by DST, Intel, & SINE, IIT Bombay

DST,SINE and Intel have collaborated to conduct a first of its kind incubation program to support hardware& systems-based startups in India. While entrepreneurial ecosystem is maturing in the country, there are still many gaps to support hardware product based start-ups in terms of lack of funding,

hardware equipment, design expertise, manufacturing support, and market access. The program aims to address these gaps in the start-up ecosystem that hardware companies face for product development and commercialization.

This would be first of its kind program in India where industry, academia and Government are coming together to support over 15 hardware product based start-ups.. The 1-year incubation is designed to help startups to develop their products and assist in go-to-market strategies and scaling up. There startups are provided with cash grants, add on equity funding, intensive training periods, one-on-one mentoring, technical support from Intel experts, business service support, as well as prototyping and manufacturing support. There will be a demo day after 6 months where the start-ups are showcased to investors and industry players.

DST-Texas Instruments "India Innovation Challenge 2016"

DST has partnered with the Texas Instruments to scoute, motivate, validate and incubate Engineering students driven innovative design ideas with commercial potential in the Electronics, semiconductor and embedded systems domain under Make in India , anchored by MyGov platform and implemented through Indian institute of Management , Bangalore.

"India Russia Bridge Program (IRBI)" for Indian hi tech start-ups 17-29 Sept 2016, Moscow

With the active engagement of Indian High Commission at Moscow, Russia DST implemented a first of its kind bilateral initiative i.e. India Russia Bridge Program (IRBI) which was conceived and formulated subsequent to the Hon'ble PM's visit to Russia to explore the possibility of supporting and accelerating cross border innovation and technologies promoted by Indians start-up into the Russian market. The program was implemented by Society for Innovation and Entrepreneurship, SINE –IIT-Bombay in consultation with Global Venture Alliance (GVA) Launch Guru, a private start up accelerator having its operations in Moscow, Russia . 10 Start ups in healthcare, education, solar energy, IOT underwent this 2 week duration experiential learning cum capacity building programme from 17-29th September 2016 in Moscow. The key outcomes included understanding of the Russian ecosystem, business culture, environment, geographical challenges and opportunities etc. and identify and establish networks with potential corporate and government partners and entrepreneurs to initiate working/penetration in the Russian market. Also the participants gained through sharing of best practices with Government, Policymakers, Industries, Startups and Investors .

DST-Intel partners for Innovate for Digital India Challenge 2.0'

The Intel & DST - Innovate for Digital India Challenge (IFDC) 2.0 aims to foster local innovation and encourage the creation of intuitive, easy to use and scalable solutions in the IoT and / or Datacenter / Cloud space in ***Agritech, Healthtech, Fintech , Sustainability including resources as water, energy etc. The innovation being targeted are that*** enables and drives access to services imperative for development and help in building a Digital India. It is anchored by T-Hub, with support from MyGov and Department of Electronics and Information Technology ("DeitY").

DST supports an exclusive Mentorship Program: "Women Entrepreneurship and Empowerment (WEE) ' to IIT Delhi during Oct. 2016 to Jan. 2017.

WEE (Women entrepreneurship and empowerment) Mentorship program is an initiative (By IIT Delhi through FITT, IIT Delhi and WEE Foundation) to empower and encourage 30 women entrepreneurs by training them in entrepreneurship skills and enabling them to convert their idea(s) into a successful business models. The 4 month program was conducted free of cost. Program Curriculum entailed idea identification, understanding business Eco system, strategic women - women networking, understanding value proposition of the business idea, scaling the idea, technology enablement and finally starting the business.

DST-ABI-IUSSTF supports Women Entrepreneurship Quest (WEQ) 2016

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 in the founding or leadership team of early stage startups driven by technology in innovative ways to solve meaningful business problems. WEQ 2016 organized by Anita Borg Institute offers an excellent platform for women entrepreneurs to showcase business ideas and receive feedback from an eminent panel of judges, who evaluate the viability of the plan and advise and mentor on how best to strengthen the proposals for implementation. The finals were conducted on 8-9th December in 2016 in Bangalore and top 10 women led technology startups were selected for an all paid experiential learning visit to Silicon valley.

Innovation and Entrepreneurship Development Centres (IEDCs)

Innovation and Entrepreneurship Development Centre (IEDC) have been promoted in education institutions to develop institutional mechanism to create entrepreneurial culture in academic institutions to foster growth of innovation and entrepreneurship amongst the faculty and students. The IEDCs aim to promote innovation and entrepreneurship amongst the students of S&T. The students are encouraged to take up innovative projects as a part of their curriculum and are supported to develop a working prototype. During 2016-17, 36 IEDCs have been operation in the country.

i-STED (Innovation, Science and Technology led Entrepreneurship Development) Programme:

In F.Y. 2016-17, under the i-STED programme aimed at inculcating strongentrepreneurial orientation in people to translate already developed innovative /S&T solutions in themarket., a total of 7 new i-STED

projects have been recommended for support. Out of these, 4 projects that have been sanctioned in F.Y. 2016-17to following organization/institutes: Tamil Nadu Veterinary and Animal Science university, Tamil Nadu, Institute of Rural Management Anand, Gujarat, Peermade Development Society, Kerala, and TANSTIA-FNF Service Centre, Tamil Nadu in the areasof food technologies,creating a Social Entrepreneurial Ecosystem through an Incubator, rural enterprises based on proven grassroots technological innovations in high risk areas of Kerala, energy, water and sanitation/waste management by way of organic fertilisers from leather waste, terafill water filters, briquetted fuel for microenterprise development. 3 proposals of Centre of Technology and Entrepreneurship (CTED), U. P, R.K.Santhan, Rajasthan, and Kerala Forest Research Institute (KFRI), Kerala, focussing on various technologies i.ebamboo and cane craft/utilization, Renewable Energy, Food and Dairy Technologies and Farm Machinery, food processing, metal brassware, leather and footwear, etc. recommended in F.Y. 2015-16 for financial support have also been sanctioned during F.Y.2016-17.Support to four ongoing i-STED projects was continued. A total of 317 direct jobs were generated through the 4 i-STED projects supported so far.

Science & Technology Entrepreneurship Development (STED) Programme:

The programme on Science & Technology Entrepreneurship Development(STED) is now phased out, however support to the existing STED project was continued. A total of 11ongoing STED projects were supported in FY 2016-17 which have helped in nurturing 447 new micro-enterprises, 143 existing micro-enterprises, trained 2010 manpower by capacity building programmes and generated 1758 jobs.

Service Tax Concessions Initiative for TBIs/STEPs

NSTEDB has been active towards promoting the culture of S&T based entrepreneurship ecosystem in the country. As per the Notifications issued by the Ministry of Finance, NSTEDB has been recognising and notifying Technology Business Incubators (TBI) and Science & Technology Entrepreneurs Parks (STEPs) from levy of Service tax. The total Taxable Value Added Services provided by the 46 recognized TBIs/STEPs for F.Y.2014-15 is –Rs.117.5 lakhs and Rs.257.90 lakhs by the incubatees in various sectors.

NSTEDB TRAINING PROGRAMMES

The training programmes supported by NSTEDB on entrepreneurship development are able to generate an eco-system and technology-based entrepreneurial culture in S&T institutions in the country covering more of tier 2 and tier 3 towns. The training programmes were able to train 15725 number of students/ potential entrepreneurs across the country during 2016-17

DEVELOPING SCENTIFIC TEMPER IN SOCIETY

National Council for Science and Technology Communication (NCSTC) has been actively engaged in popularizing science amongst the masses. One such flagship initiative is **'Science Express'**- an innovative mobile science exhibition mounted on a custom-built 16 coach AC train, specially fabricated DST by Indian Railways. Science Express is a mega outreach programme and this unique mobile exhibition has completed 8 phases of its journey which includes 4 phases of 'Science Express',

3 phases of 'Biodiversity Special' and the recently concluded phase of 'Climate Action Special'. In 2015-16, Science Express was redesigned on the theme 'Climate Change' and travelled as 'Science Express Climate Action Special (SECAS)' from 15 October 2015 to 07 May 2016. It was a unique collaborative initiative of DST, Ministry of Environment, Forest & Climate Change (MoEFCC) and Department of Biotechnology (DBT). This programme was a great success with excellent cooperation from the Ministry of Railways. The state-of-the-art exhibition aboard SECAS aimed to create awareness among various sections of society, especially students, as to how Climate Change can be combated through mitigation and adaptation.

SECAS travelled across the country halting at 64 locations covering 19,800 km. It received an overwhelming response, with a total of 23,24,240 visitors, including about 6 lakh students and over 30,000 teachers. The complementary activities of SECAS also registered good participation with more than 80,000 students conducting hands-on activities in Joy of Science Lab and another 80,000 children in Kids Zone. The on-board team also reached out to about 28,000 students in schools that could not visit the train. Further, 1,782 teachers were also oriented on different aspects of hands-on methods of teaching science and maths. A team of well-qualified, trained and highly motivated Science Communicators travelled with the train explaining and interpreting the exhibition, answering queries, facilitating the visitors and conducting the complementary activities.

SECAS in Media

During its entire journey, SECAS has been extensively covered by both print and e-media.

Science Express Milestones (since inception in 2006)

Total Visitors~ 1.56 crore

- Total number of Schools/Colleges ~ 38,000
- Total number of Students ~ 34 lakh
- Total number of Teachers ~ 18.5 lakh
- Student's participants in

  JOS Lab ~ 4.2 lakh

  Kids Zone ~1.78 lakh

  Platform Activities ~ 5.7 lakh

  Outreach Activities ~ 1.6 lakh
- Total number of participants in Teachers Orientation Program ~ 7500
- Distance travelled ~1.4 lakh km
- Total number of Halts ~ 455
- Total number of exhibition days ~ 1,602
- 6 Limca Book of Records
- Over 250 trained Science Communicators
- Extensive Media Coverage

STEM Demonstration

An expert committee has been constituted for S&T Communication on "STEM (Science, Technology, Engineering & Mathematics) Demonstration and a meeting organized to address various S&T Communication media/formats like Chaupals, film screening, folk media, debates, lec-dem workshops, technology appreciation trainings, celebration of events of significance, etc. Science exhibitions were held at various places on themes such as Environmental Quality, Clean & Green Technologies, S&T solutions for rural sector, Home grown technologies, Low cost Innovation. Both static and mobile exhibitions were organized in several States focussing on science in toys, puppetry, activity stalls where children solve a puzzle or do mathematical games/activities, ask a good question, design/ redesign, spot-the-odd one, draw a future, quizzes, painting and skits and street plays, and expose them to science in daily life.

Students participating in Science Fair

Children's Science Congress- 2016

A burning desire to understand "How" and "Why" of any process occurring in nature has motivated many a young students to choose Science as their career path. To fuel their aspirations further, Department of Science and Technology (DST), Government of India, had initiated organization of Children's Science Congress (CSC) in 1993 through National Council of Science & Technology Communication. CSC prompts a child scientist, in the age group 10-17 years, to identify and ponder upon a significant societal problem and arriving at possible solution. The children, working in a team and under the mentorship of a teacher, try to understand the causes and solve the same using method of science. This thematic event provides encouragement to the Child's process of thinking, analyzing and resolving the pertinent issue through innovative thinking and ideas. Every year, over 500,000 students from all States & UTs participate first at the district level. Emphasis is laid on hands-on science and presentation of results and its analysis. Some teams present working prototypes or models. After due & stringent evaluation, some of the more promising ideas are then presented at State level and only about 650 projects, selected through a exhaustive process make it to the National Level. An Activity Guide Book is prepared after interaction with experts which enables the participants to develop their ideas and models.

Focal theme for CSC-2016, 24th edition in this NCSC series, was Science, Technology and Innovation for Sustainable Development with special emphasis on Accessibility for Persons with Disability. It's finals or the National Children's Science Congress (NCSC) as it is popularly known, was held during 27-31 December, 2016 at Vidyapratisthan's Institute of Information Technology (VIIT), Baramati

(Maharashtra). Hon'ble Minister of Science & Technology inaugurated the event in the august presence of several eminent personalities including Smt. Supriya Sule, Hon'ble Member of Parliament and Shri Ajit Pawar besides well known academics and science communicators. Eminent scientists from agencies like Bhabah Atomic Research Centre, Homi Bhabha Centre for Science Education, and National Institute of Training in Industrial Engineering, Mumbai interacted with the participants for quenching their thirst for scientific knowledge through Q&A sessions.

Intel International Science and Engineering Fair (ISEF)

Indian team comprising of 16 school students (IX to XII grade), who were selected as winners at the Initiative for Research and Innovation in Science (IRIS) National Science Fair, represented India at the Intel International Science and Engineering Fair, held in Phoenix, Arizona, USA during 8-13 May 2016. Indo-US Science & Technology Forum (IUSSTF) in partnership with DST also organized a special visit for 9 students from the IRIS Partner Fairs to join Team India on an exposure site visit to places of scientific interest. Team India, in ISEF 2016, has done the Nation proud by winning a total of 6 Awards and one Honorable Mention at ISEF. The students of Team India also met with Maya Ajmera CEO, Society for Science and the Public and shared their experiences about ISEF and also listened keenly to her advice and anecdotes. A meeting with student delegates and officials from India, Indonesia, Sri Lanka and Pakistan was also organized who exchanged fun facts and information about their respective cultures and to share what their projects were all about. Society for Science & the Public, in partnership with the Intel Foundation, announced Grand Awards of the Intel ISEF 2016, of which special mention is to be made of the Intel and IUSSTF- Visit to India Award. Thus 3 Best of Intel ISEF Subject Category Award winners from USA will Travel to India to present their projects during the IRIS National Science Fair 2016.

Rashtriya Kishore Vaigyanik Sammelan and Science Communicators' Meet

To provide an opportunity to child scientists to sharpen scientific temperament and knowledge and to quench their thirst for creativity by conducting scientific experiments, the best projects selected at the NCSC 2016 participated in the Rashtriya Kishore Vaigyanik Sammelan, held at Sri Venkateswara University (SVU), Tirupati as part on 104th Indian Science Congress. Number of students, teachers, Scientists interacted with the students. In the meet with the scientists, the children had an opportunity to listen to eminent scientists and academics from across the globe who participated in ISC-2017. 10th Science Communicators' Meet was also held during 5-6 January 2017 simultaneously and during the deliberations, several eminent invited speakers attended panel discussion and also delivered their talks

on the different subjects of science communication, and the participants presented over 30 technical papers and posters.

Women's Health & Nutrition

NCSTC supported fourteen more Community Radio Stations after doing need assessment and capacity building with them. These were (i) Vayalagam Vanoli, Kottampatti Village, Madurai District, Tamil Nadu, (ii) Radio Vishnu, Shri Vishnu Engineering College for Women, Bhimavaram, Andhra Pradesh, (iii) Radio Deccan, Abid Ali Khan Educational Trust, Hyderabad, Telangana, (iv) Radio Snehi, Snehi Lokottan Sansthan, Siwan, Bihar, (v) Yeralavani, Yerala Projects Society, Jalihal Budruk Village, Sangli District, Maharashtra, (vi) Alfaz-e-Mewat, SM Sehgal Foundation, Mewat, Haryana (vii) Kumaon Vani, The Energy and Resources Institute (TERI), Muktheshwar, Uttarakhand, (viii) JanVani, GB Pant University of Agriculture and Technology, Pantnagar, Uttarakhand and (ix) Voice of Azamghar, Mirza Ahsanullah Beg Institute, Azamghar, Uttar Pradesh, (x) Radio Mewat, Mewat, (xi) Hamara Solan, Solan, (xii) Lait Lokvani, Lalitpur (xiii) Punjab University, Punjab, (xiv) Radio Luit, Guwahati. All these stations are producing and broadcasting radio programmes on science for women's health & nutrition. Apart from broadcasting, they are doing outreach activities also involving community.

National Science Day (NSD):

NCSTC acts as a nodal agency to support catalyze and coordinate celebration of the National Science Day (NSD) throughout the country in scientific institutions, research laboratories and autonomous scientific institutions of DST. NCSTC celebrated NSD on 28 February. The theme of NSD-2017 was 'Science and Technology for Specially abled Persons' which was chosen for the purpose of raising public appreciation of the scientific issues involved. Hon'ble Minister for Science & Technology graced the occasion and honored those who were awarded for their outstanding contribution in communication of S&T and promoting scientific temper. As celebration of important Scientific Days with associated events brings scientific awareness in the community, many institutions organized Open House for their laboratories to appraise students about career opportunities. NCSTC supported various programmes countrywide by giving grants to State S&T Councils & Departments for organization of lectures, quizzes, Science Essay Writing Competition, etc.

National Mathematics Day (NMD):

To popularize Mathematics among students, women and general public NCSTC supports celebration of NMD with activities spread over a day to a month or longer. These include organization of debates, quizzes, exhibitions, lectures, training programmes, hands-on activities, Math-lab, etc. in schools, colleges, universities in various States through State S&T Councils.

Perfect Health Mela:

Perfect Health Mela was organised by Heart Care Foundation, New Delhi during 25-29 October 2016 at Talkatora Indoor Stadium, New Delhi, in which **318** organizations including schools, colleges, took part in various activities. Over **40000** people from all walks of life visited in which representatives

from various organizations were deputed by to display cum demonstrate their people oriented scientific activities like Vermi-composting, Nature Study, Soil & Water Testing, Explaining Science behind Miracles, Detection of Food Adulteration, Low Cost Teaching Aids, Hydroponics, etc.

A view of hands-on activity

Visit to S&T Establishments:

S&T encompasses every important sector like agriculture, housing, environment, defense, health, transport, industry, communication, etc. and establishment like, research organization, telephone exchange, steel plant, power station, milk plant, railway control room, TV Kendra, dam, hospital, refinery, bakery, printing press, automobile workshop, farm, poultry farm, etc. The main objective of visit of students to such establishments is to expose young minds to S&T, create their interest in new subjects and develop their curiosity as well as creativity. Such tours were organized at several places across India, particularly Bihar, U.P. J&K, Andhra Pradesh.

Taramandal (Mobile Planetarium):

Taramandal (Mobile Planetarium) is an inflatable dome of plastic-coated fabric. It is also motor-driven to show the apparent motion of the sky as the Earth rotates. It brings 360° experience about cosmic world to children for whom it has been specially designed . The dome is set up in a school premises and is handled by an astronomy expert who can present live planetarium shows and/or play 360° full dome films on a variety of topics. Inside, a simulation of the night sky is projected onto the dome. During the shows, he manages the show using the manuals and materials available and encourages children to be inquisitive and ask questions Taramandal's mobile set up is low-cost and easy. It does not require permanent investments, therefore it works as a low-cost but exciting teaching aid for these schools and students. NCSTC is promoting this activity across the country.

Vermin Composting:

To manage domestic solid waste using vermin composting and doing simple experiments by way of understanding the life cycle of earthworms, composting different kinds of waste, effect of different manures on yields, etc. a programme on vermi-composting gives appropriate knowledge. Modules for developing experimental skills equipping the teachers & students with better knowledge and understanding various facts of vermin-composting were held at many locations.

Farmers getting training in vermi-composting

National Awards for Science & Technology Communication:

Outstanding efforts in S&T communication are recognized through National Awards under six categories given below and each year these Awards are presented during celebration of National Science Day in Technology Bhavan.

A. National Award for Outstanding Efforts in Science & Technology Communication in general: The award comprises of Rupees two lakhs, a memento and a citation.

B. National Award for Outstanding Efforts in Science & Technology Communication through Print Media including Books and Magazines: The award consists of Rupees one lakh, a memento and a citation.

C. National Award for Outstanding Efforts in Science & Technology Popularization among Children: The award consists of Rupees one lakh, a memento and a citation.

D. National Award for Outstanding Efforts in Translation of Popular Science & Technology Literature in Languages Mentioned in the Eighth Schedule of Constitution of India and in English: The award consists of Rupees one lakh, a memento and a citation.

E. National Award for Outstanding Efforts in Science & Technology Communication through Innovative and Traditional Methods: The award comprises of Rupees one lakh, a memento and a citation.

F. National Award for Outstanding Efforts in Science & Technology Communication in the Electronic Media:

"Eco Media" & "Eco Next" Initiatives:

The initiatives engage youth to develop Science Media & Eco Next Youth leadership. Capacity, Skill/ Competence Building through Youth Engagement Workshops and location-specific Resource Creation by Youth are in focus and real-time responsiveness and eco-media leverage for promoting integrated efforts for conservation of natural resources are being added to raise a dedicated & competent generation of Young Change Makers, promote Youth Eco-Media development in the country, Knowledge-led motivation of youth for leadership and enhancing of quality-of-life and converge with national priorities. 22nd Meeting of Technical Advisory Committee (TAC) for "Jal Sutra" programme and 1st TAC meeting for Ëco Media & Eco Next Initiatives were held respectively at Indira Gandhi National Tribal University, Amarkantak on 3-4 March 2016 and Dr BR Ambedkar University of Social Sciences, Mhow, on 17-18 November 2016 followed by Youth Meet & Eco Media Lab on Scientific Temper & Ecological Justice was held on 19 November 2016 for media students. A charter of Young Change makers for Scientific Temper & Ecological Duties was adopted.

School in Eco-media & WaSH Science Communication:

The Eco-Media School, which has been set up at Madurai Kamraj University, Madurai, with new outreach methodologies including media-ready information on the scientific facts behind the eco-site, has created young leaders with skills of media productions with deep sense of ecological science communication. Learning by action at eco sites has created eco-realization within themselves and the reflexivity felt in their productions. The trainees engaged with common-man tool of mobile cams where actions for restoration, revival and conservation of natural resources attract local communities. Visiting hotspots sharing scientific knowledge with locals, youth, students and media persons, and the news publications of scientific information enhanced the reach and impact of ecological messages.

Eco Media Fellows at work at Kirudhumal River bed

Eco Eureka Workshops, Building WaSH Educators, and Eco Studios for Eco Creatives with post-trainings engagements, Water Clinics, Eco Smart School Modules, are a series of latest initiatives whereby scores of young leaders have been trained. Stress has been placed on model interventions for remote, inaccessible, marginalized, and challenging areas and populations. Improvement of quality-of-life of target groups is attained with an approach of 'Being-on- their-Own'/ 'Do-it-Yourself' and 'Collective response' to challenges and location specific developmental/socio-scientific problems. A few notable Flag-ups are,

An innovative initiative- Promoting Eco-WaSH Literacy through Community Informatics and Participatory S&T Communication- Chittoor district, Andhra Pradesh aims to promote use of participatory GIS/IT tools by farmers and school children to model and understand their problems and arrive at solutions. Farmers understood that they should nourish their soil in a holistic way and make it 'alive' again, and not just 'fertilize' crops. School children learnt about their environment using a game based approach combining fun and education.

At Satyabhama University, Chennai, NSS volunteers undergoing Engineering degree course were exposed to the entire lake system under "Adopt a Lake"- Renewable Water Source for Societal Sustenance. The ability of youths on data collection, analysis, mapping, etc. were utilized along with exposure to local issues relating to water.

Familiarizing spot level survey

Under the initiative- Capacity building of rural youth in Scientific Outlook and Approach through Participatory Science Communication in the context of Eco & WaSH for ecological balance, livelihoods & way of living- youth trained as WaSH Creatives have made short films to create awareness and sensitivity towards Eco-systems and Archaeological Water Installations. They also have documented 60 Baoris in Bundi, Rajasthan, which were either neglected or not known to community. The capacity building Trainings for Youth have led to micro-planning of eight remote villages with cooperation of Wild Life Sanctuary, Ramgarh and the Forest Department, Bundi. Trained Young Science Communicators have achieved success in catalysing the construction of one small and one large pond in village Singhari, Block Hindoli with small financial help from the Forest Department.

School children and college students from Kerala and Karnataka were given training by NIAS, Bangalore, in the method of science and social sciences to study various dimensions of WaSH in their surroundings. Members of this 'student-network' observed and recorded the impact of the last summer on their environment and society and chosen narratives were compiled. Student-scientist interaction meetings were conducted to enhance scientific temper.

Neer Naari Vigyan": A country-wide programme, involving School Children and Teachers focusing on the role of Women in Water Conservation is being implemented with Eco Roots Foundation, New Delhi. Workshops in 180 schools in 10 selected cities were held. The teachers mentor students to prepare a theatrical skit, musical play on the role of women in water conservation and earning water credits through innovative tool "Jal Bahi".

Eco Eyes, an initiative with INCLEN Trust, Faridabad, focusses on developing youth as change agent to conserve water ecologies and promote WaSH in rural areas of Haryana through utilizing scientific evidence based Geomedia communication tools. The developed Eco-WaSH maps will enable local functionaries to understand the contextual ecological issues and their cross-sectoral linkages to develop more strategic district wide planning for improving WaSH.

Science Media Research Initiatives

Conceptualizing Science Media as a niche domain, NCSTC has realized the need to innovate, augment, synergize and harness science media research in keeping with the emerging trends like transdisciplinary imaging & science media, including eco media, geo media, cloud media, computational media, etc. A Science Media Centre has come up at Indian Institute of Science Education & Research (IISER) Pune. It is involved in the conception and production of media for science, scientific research as well as science popularization.

In order to intensify the culture of research in Science Media, support would now be forthcoming 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 need strategic support so as to assess the impact, especially on youth, and defining the innovative models for replication and/or scale up. It is also aimed to identify "Lead Institutions" for piloting the mechanisms like 'Incubation & Learning Exchanges' (ILE) in Science Media Research, so that path-breaking innovative concepts & researches are nurtured and shared especially for young practitioners in science media. The successful models would be candidates for upgradation as Science Media Centres.

The initiatives hinge upon a priority set of thrust areas, which are Environmental Health Sciences, Public Health- Medicine Sciences, Food –Biosciences-Agricultural Sciences, Energy Science and Technology, Information Sciences, Science Fiction, Computational Media, and Animation & Gamification for Scientific Literacy & Temper. Institutions and professional associations, dedicated to science education & research, information science studies, computational research, transdisciplinary studies, along with science museums, science centres, and science cities, are key players. As the initiatives are largely focused on data centric imagery in science & media, they serve and leverage the national missions especially 'Digital India'.

CHAPTER 6

SCIENCE, TECHNOLOGY AND INNOVATION (STI) POLICY

STRENGTHENING STI INFORMATION SYSTEM

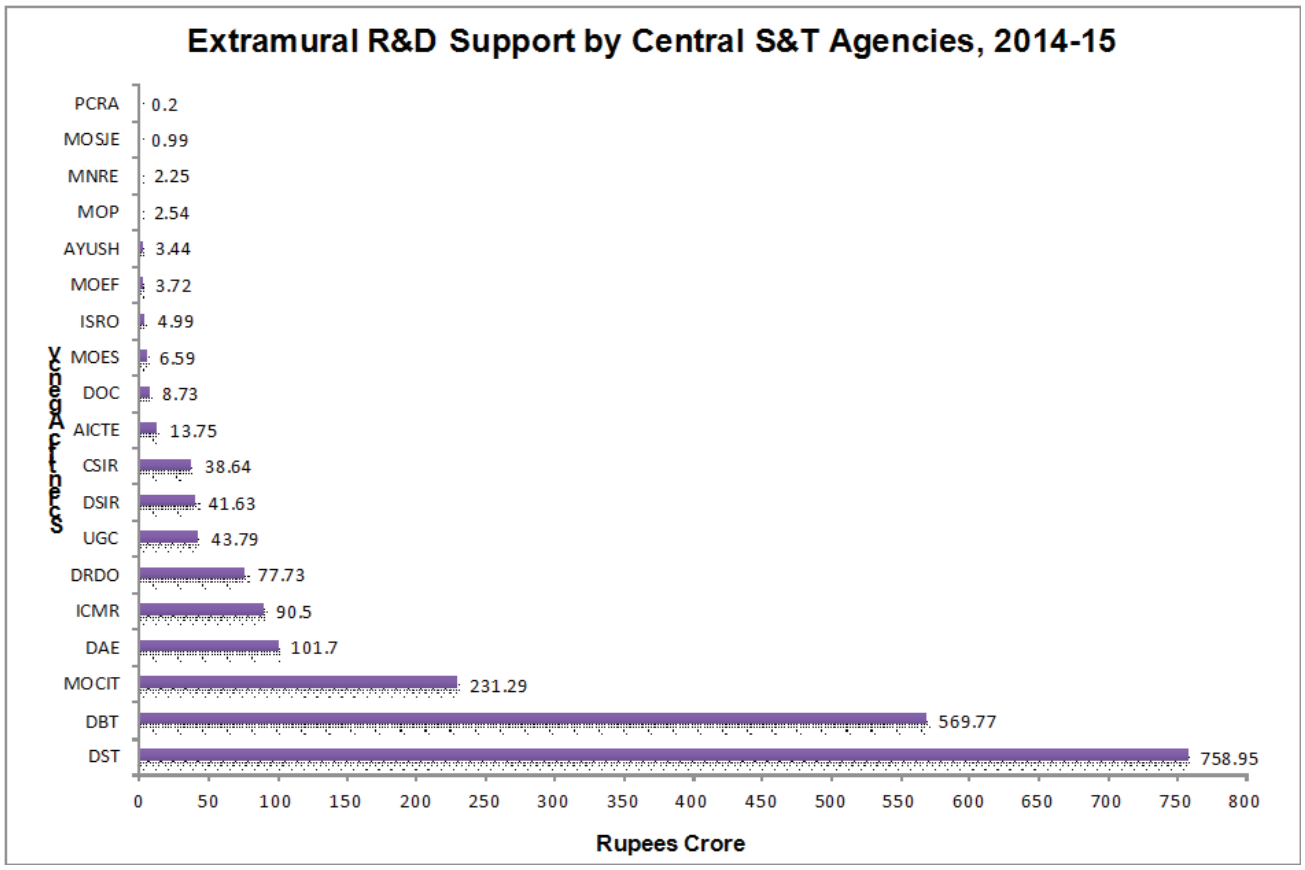
The National Science & Technology Management Information System (NSTMIS) continued its efforts of generating and making available information on resources both manpower as well as financial devoted to scientific and technological (S&T) activi¬ties by conducting national surveys both through in-house as well as sponsored studies.

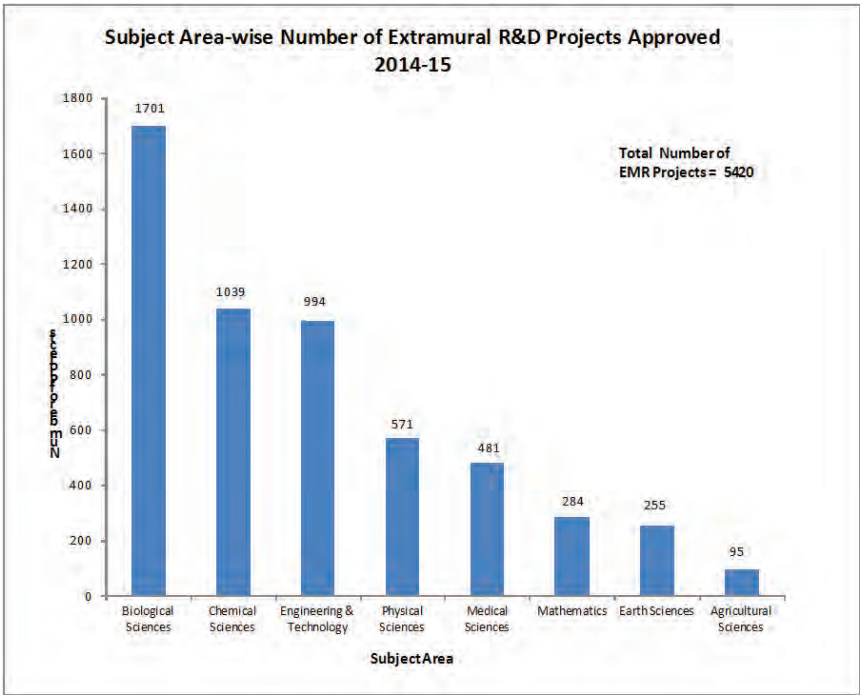
(i) S&T Resources Studies

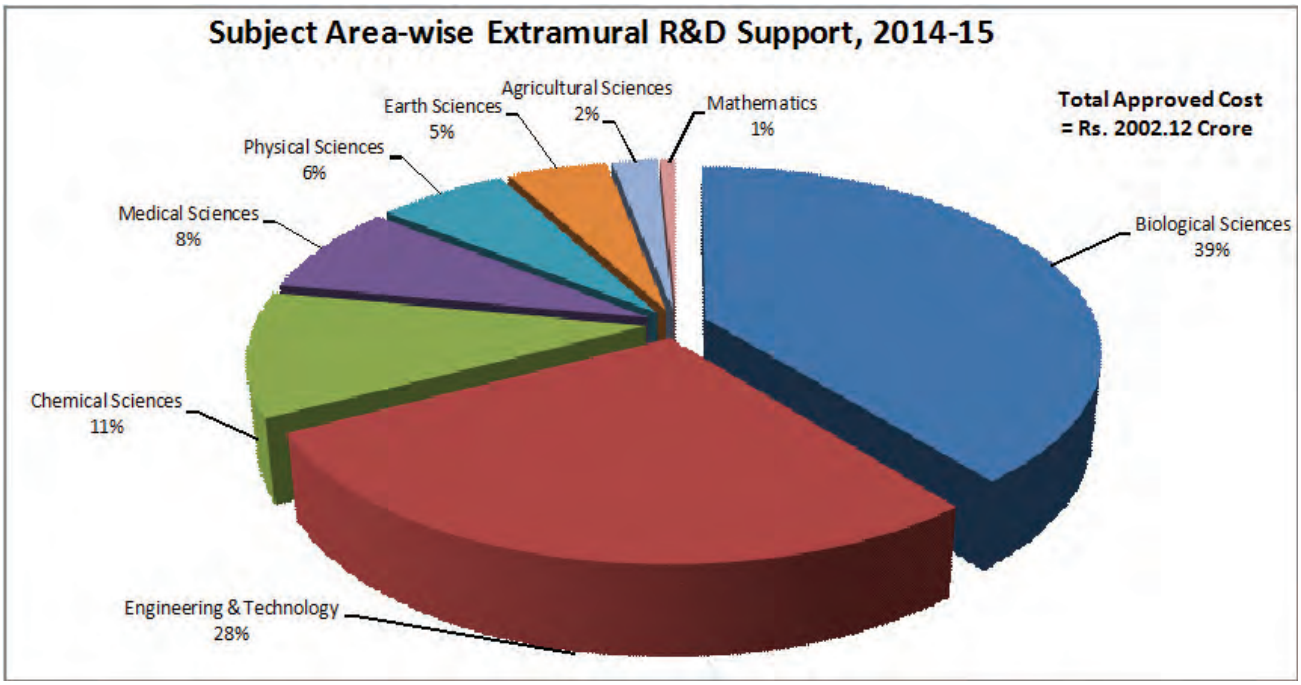
The data collection for National Survey 2015-16 on resources devoted to research and development activities is in progress. So far the survey response rate is a little over 40% out of around 5000 R&D organizations comprising of public sector, private sector, MNCs, higher education, SIROs and NGOs spread 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. Further, discussions with stakeholders were held to bring out advanced estimates based on the present national R&D survey for developing a set of indicators for inclusion in the country profile of India for the forthcoming report Global Innovation Index 2017.

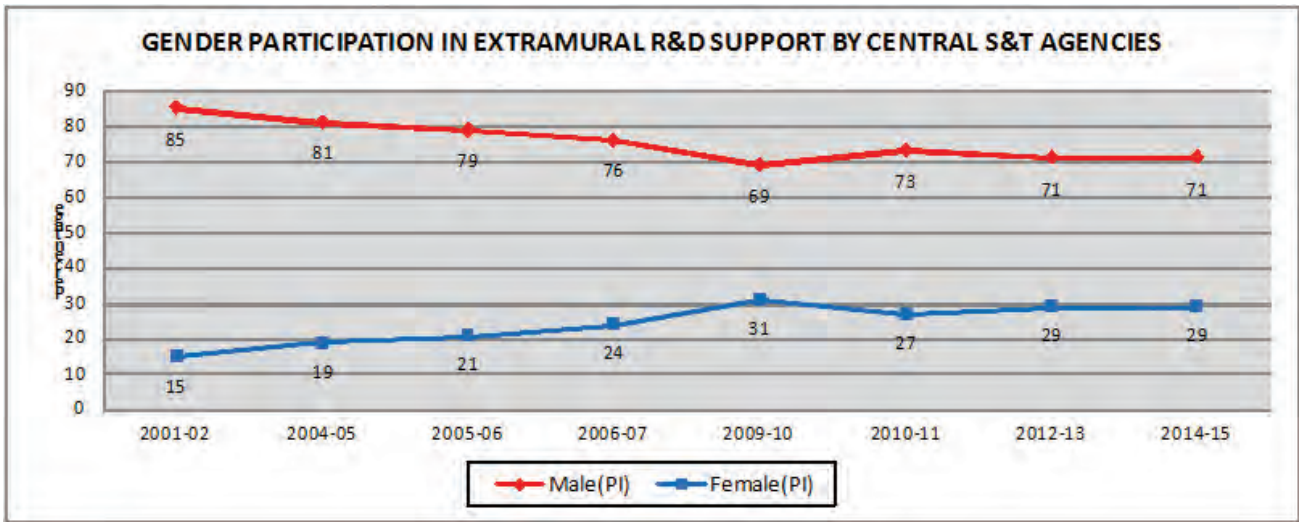
(ii) Information System/Database Activities

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 **"Directory of Extramural R&D Projects"** for the years 2013-14 and 2014-15 are being compiled and would be published together. In addition, the report entitled **"Analysis of Outcome of Extramural R&D (EMR) Projects 2005-10"**, third in the series would also be brought out simultaneously. A snapshot of the Extramural R&D Projects Directory, 2014-15 is depicted below:


Extramural R&D Support by Central S&T Agencies, 2014-15
PCRA 0.2
MOSJE 0.99
MNRE 2.25
MOP 2.54
AYUSH 3.44
MOEF 3.72
ISRO 4.99
MOES 6.59
DOC 8.73
AICTE 13.75
CSIR 38.64
DSIR 41.63
UGC 43.79
DRDO 77.73
ICMR 90.5
DAE 101.7
MOCIT 231.29
DBT 569.77
DST 758.95
0 50 100 150 200 250 300 350 400 450 500 550 600 650 700 750 800
Rupees Crore


Subject Area-wise Number of Extramural R&D Projects Approved 2014-15
Total Number of EMR Projects = 5420
1701
1039
994
571
481
284
255
95
0 200 400 600 800 1000 1200 1400 1600 1800
Biological Sciences
Chemical Sciences
Engineering & Technology
Physical Sciences
Medical Sciences
Mathematics
Earth Sciences
Agricultural Sciences
Subject Area





A Stakeholders' Workshop on **'Development of Database of Scientific Equipments'** supported under Extramural R&D Projects and other S&T infrastructure schemes of Central Government was organized on 30th August 2016 at India Habitat Centre, New Delhi. The workshop was organized on the initiative of NSTMIS, DST by TERI, New Delhi.

Prof. Ashutosh Sharma, Secretary, DST delivered the inaugural address, the workshop opened a dialogue with various stakeholders namely scientists, researchers, young scholars from universities and various scientific laboratories apart from officials from the central government funding agencies.

The workshop discussed on issues related to strengthening, access, sharing, optimal usage, maintenance and disposal of scientific equipments underlining the need to evolve a comprehensive national scientific equipment policy to foster the advancement of scientific research and collaboration in the country.

Further, a **web based digital repository,** of all the NSTMIS research publications brought out till now, has been successfully developed. The repository is available in public domain through NSTMIS website (http://www.nstmis-dst.org/NSTDRepository.aspx) and updated regularly

(iii) NSTMIS Sponsored Studies

As a part of its sponsored research programme, NSTMIS has sponsored over 200 projects in the last three decades. The sponsored research studies have imparted backward and forward linkages with the in-house research activities of NSTMIS by providing the much needed evidence base for policy actions in the S&T sector. NSTMIS research sponsorship has been availed by over 100 organizations including research institutions, universities, colleges, NGOs and consultancy organizations spread across the country.

The newly constituted **Program Advisory Committee (PAC)** of experts for implementation of NSTMIS Scheme met on 23-24 August 2016 to consider the projects submitted under the scheme for funding. A select list of projects approved by the PAC for support is as below:

i) Industrial research, development and innovation in public sector enterprises

ii) Information and communication technology adoption by micro small and medium enterprises in Punjab: Status, impacts and constraints,

iii) Agriculture research and development infrastructure in select Indian states.

iv) A comparative study of India's research performance in scientific and technology areas of clean energy and water (2007-16): A scientometric analysis.

v) An empirical study of B.Tech Students in Delhi and UP with special reference to their perception towards S&T.

vi) Technology business incubators in India: An exploratory study on their contribution to national R&D efforts.

Further efforts are being made by the division to evolve and catalyse network projects involving multiple agencies on the themes such as commercialisation of public funded research, impact of policies on women in S&T etc.

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

i) 'Critical non-fuel mineral resources for India's Manufacturing Sector: A Vision for 2030'

ii) Status, system and strategies of innovation in SMEs in equipment and machinery sector

iii) Organisational practices for innovation in Indian industries: A firm level case study on human resources and work culture

iv) Assessing industrial innovation process and suggesting Policy support framework in India

v) Study on impact of MNCs R&D in India

(iv) International Collaboration

The Division represented in the OECD Blue Sky III Form at Ghent, Belgium during 19-21 September, 2016. The Forum discussed the novel elements towards the next generation of data and indicators for informing Science and Innovation Policies. It laid specific focus on the measurement perspectives from emerging economies. 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.

A meeting on "Indian National Innovation Survey and CIS Survey in France and Europe: International Comparison and potential research synergies" was held with Dr. Fabrice Galia, Associate Professor, Burgundy School of Business, Dijon, France and other domain experts on 8th November, 2016 at DST, Technology Bhavan. In view of the importance of the area recognised globally, the following areas of mutual interests for partnership and research collaboration were identified:

- Obstacles to Innovation
- Innovation in large firms and start-ups including TBIs
- Organizational and Marketing Innovations
- Innovation eco-system and best practices

The outcome of the above would help in taking forward the best practices for strengthening the innovation eco-system apart from advancing the research frontiers in this area of global importance and cooperation.

Academy for Science, Policy Implementation and Research (ASPIRE)

ASPIRE being incubated in project mode at the Administrative Staff College of India (ASCI), Hyderabad aims to provide a common platform for interconnecting and enhancing competencies in policy development and implementation emphasizing Science Technology and Innovation across various stakeholders and arms of the Government leading to evidence based decision making.

A series of workshops on STI for 'Make in India': Promoting Manufacturing at District Level were organized at Sikkim, Guwahati and Uttarakhand. The workshop opened a dialogue with various stakeholders such as DICs, technical institutes, research laboratories, universities, financial agencies, innovators, industry experts and think tanks for better understanding of issues related to strengthening of Science, Technology and Innovation (STI) inputs for enhanced industrial activities at district/ regional level in light of the new initiative 'Make in India' announced by the Prime Minister.

As an outcome of the NSTMIS-TERI Stakeholders' Workshop, ASPIRE team has initiated work on National Scientific Equipment Policy having important policy implications in strengthening the national S&T infrastructure by linking it with the 'Skill Mission' and 'Make in India' Programme of the Government. Draft Policy would be put up for nation-wide consultation before it is finalised.

Apart from this, the policy studies such as Innovation in Large Firms in India, Study on Identification of Constraints to Growth of Technology based Start-ups in Technology Business Incubators and Technology Parks of India etc would be completed. Further efforts are on to upscale the level of engagement of socio-economic ministries and public sector industries apart from international organisations in ASPIRE for R&D management, Innovation and Policy including capacity building

FORMULATION OF ENABLING POLICIES FOR S&T

The Department of Science and Technology is mandated to develop and deliver public policy support for the promotion of research and development in the country. Major objectives of the Policy Research include preparation of study reports on Science, Technology and Innovation. The Department is engaging itself with stakeholders, national and international experts and others to develop policy related papers. The policy environment is expected to give a major push for the country to gain global leadership in S&T.

Five Policy Research Centres (PRCs) have been established in the country, located at Indian Institute of Technology Delhi, Panjab University, Chandigarh, Babasaheb Bhimrao Ambedkar (Central) University (BBAU), Lucknow, Indian Institute of Science, Bangalore and Entrepreneurship Development Institute of India (EDII), Ahmedabad. The above Centres are expected to serve as a knowledge partner of DST in the development of (a) Human capacity for science policy research, (b) Policy papers for wider study among the stake holders and (c) Enabling tools for the implementation mechanism of STI policy.

The Division has organized one discussion cum review meeting of the above Centres at Indian Institute of Technology, New Delhi (August 29, 2016). During the meeting, all the Centres presented their ongoing work and future plans before the Expert Advisory Committee. Centres have already published their annual reports for 2015-16. Centres have generated 8 working Papers, 10 study reports, 20 Research papers/book chapters to their credit during the past one year.

To disseminate findings of the study among the stakeholders involved in creating and supporting hi-technology based entrepreneurship in the country, a one-day Workshop on "Problems and Issues faced by Hi-Technology Entrepreneurs in Launching, Managing and Growth of their Ventures was organised at Indian National Science Academy (INSA) New Delhi by the Policy Research Centre at EDII, Ahmedabad. The Centre has also prepared draft for two research studies namely;

1. Role of S&T for Success of the 'Make in India initiative' and
2. Study on "Effectiveness, Efficacy and Sustainability of Incubators in India and benchmarking them with Global Best Practices in the Incubation Space"

Centre at Panjab University, Chandigarh has published a book titled "Industry-Academia R&D Ecosystem in India....an evidence based study". Centre at BBAU Lucknow has published an edited book "Bridging the Science-Policy Gap for Inclusive Growth in India". Round Table Meets (four) on Industry-Academia interaction were organised by Centre at Institute of Chemical Technology (ICT), Mumbai and Panjab University Chandigarh.

Centre at IISc Bangalore has developed model for scientometric analysis of data including the National Institutional Ranking Framework. Centre has published 6 reports/research studies. The Centre's is developing relevant metrics that would be useful for university leaders and policy makers in their discussion of tailoring and fine tuning their priorities. Policy Research Centre at IIT Delhi is preparing a draft Policy on Technology led Innovation. The Centre has organised a one-day workshop on Workshop on "Strengthening Publicly Funded Incubators on 4thDecember, 2016.

Policy Research Cell has initiated DST-STI Fellowships at post-doctoral level to generate a critical mass of policy researchers. This will provide an opportunity to develop the skills for young scientists and engineers who are interested in engagement with the STI policy domain and/or as STI policy researchers. Initially, 5 candidates were selected for the post-doctoral fellowship. Apart from this, two comprehensive training programmes on Science, Technology and Innovation Policy were granted to Zaheer Science Foundation, New Delhi and National Institute of Advanced Studies (NIAS) Bangalore.

Release of DST-CPR Brochure at Industry-Academia Meet at Panjab University, Chandigarh on 28th April, 2016.

CHAPTER 7

ADMINISTRATION 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.

STAFF POSITION

Department has a total number of 199 Group 'A' and Group 'B' (Gazetted) officers as per the break-up given below:-

Group 'A'	General	SC	ST	OBC	PH	Total
Scientific	91	07	02	-	04	104
Non-Scientific	30	03	01	-	-	34
Group 'B'						
Scientific	07	01	01	01	-	10
Non-Scientific	42	09	-	-	-	51
Grand Total	**170**	**20**	**04**	**01**	**04**	**199**

Department has a total number of 271 non-gazetted staff on its rolls as per the break-up given below:-

Group 'A'	General	SC	ST	OBC	PH	Total
Group 'B' (Non-Gazetted)	70	07	05	09	04	95
Group 'C'	77	64	13	17	05	176
Grand Total	**147**	**71**	**18**	**26**	**09**	**271**

PARLIAMENTARY WORK

The Parliament Unit 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 schedule and procedures. The Unit maintains liaison with the Ministry of Parliamentary Affairs, Secretariats of Lok Sabha/Rajya Sabha, 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 the visits of the Parliamentary Committees to various scientific institutions which are under the administrative control of this Department. During 2016-17 various Parliamentary Committees made eight visits to various institutions of the Department.

IMPLEMENTATION OF OFFICIAL LANGUAGE POLICY

The Department of Science and Technology 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 thereunder 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 consisting of a Joint Director (O.L.) assisted by an Assistant Director (O.L.) and other supporting staff which caters to the need of the Department of Science & Technology and also its Subordinate offices / Autonomous Institutions. 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 Hindi translation of the material received from various Sections / Desks of the Department from time to time.

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.
- The officers of Hindi Section conducted inspections of 6 Autonomous Institutions under the Department regarding progressive use of Hindi during the year.
- Hindi Section also coordinated the visits of the Parliamentary committee on official language to D.S.T. and its scientific institutions which are under the administrative control of the Department and achieved the targets of fulfilling the assurances given to the committee at the time of its visit.
- 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 do their maximum work in Hindi.
- The Hindi Advisory committee has been reconstituted.

Cash Awards and Incentive Schemes: An incentive scheme to encourage officers and employees to do their maximum official work in Hindi is in vogue in the Ministry. Under the scheme, cash awards are given for doing noting and drafting in Hindi.

Celebration of Hindi Pakhwara: Hindi Pakhwara was organized from 14 to 28 September, 2016 in the Ministry of Science and Technology. Various competitions with Hindi as medium of communication e.g. Essay, noting drafting, debate and translation etc. were organized and the successful participants were given cash awards and certificates.

RIGHT TO INFORMATION (RTI)

A total of 1480 applications and 125 appeals were received by the Department during 1st April 2016 to 5th Jan. 2017. All applications have been responded to within the timelines prescribed under the RTI Act, 2005. All appeals were also disposed off after issuing the requisite speaking orders on each one of them by the First Appellate Authority of the Department.

PUBLIC GRIEVANCES

A total of 1537 public grievances were received by the Department during 1st April 2016 to 5th Jan. 2017. Out of these, 1192 (i.e. 77.55%) stand cleared as on 5th Jan. 2017.

CITIZEN'S CHARTER

Department has prepared a Citizen's Charter in consultation with the Performance management Division of the Cabinet Secretariat and uploaded on the department's website in December 2013.

VIGILANCE

Vigilance Unit consolidates reports/returns received from the subordinate offices and aided institutions on vigilance matters and furnishes them 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, a close liaison with Vigilance Officers of all attached and subordinate offices is maintained to ensure timely completion of various vigilance tasks. Other miscellaneous activities, viz. identification of sensitive posts, implementation of rotational transfer policy in the Department and its subordinate offices are being done on regular basis.

During 2016, Vigilance Unit dealt with the following number of complaints:

Source	Opening Balance	Recd. during the year	Total	Disposed	Balance
CVC	25	61	86	76	10
Others	17	125	142	123	19

Vigilance Awareness Week was observed in the Department during 31st October to 5th November 2016. Besides the oath, an Integrity Pledge was also taken by the employees of the Department. During this occasion, several competitive events were organized and Shri Praveen Sinha, Addl. Secy., CVC delivered a speech on this year's theme on "Public participation in promoting integrity and eradicating corruption".

Shri Y S Chowdary, Minister of State (S&T and ES)
Administering Integrity Pledge to DST Officials

EXHIBITION

The Exhibition Cell is responsible for organization of exhibitions, participation in science exhibitions at national and international level. In addition, it has also been assigned responsibility of coordinating the work related to participation of Department of Science & Technology along with its organisations in the exhibitions.

The Exhibition Cell coordinated participation of DST in India International Trade Fair (IITF)-2016 from 14th to 27th Nov. 2016 and participation in 104th Session of Indian Science Congress 2017 during 3rd to 7th Jan. 2017 at Tirupati by setting up DST's pavilion. The cell has also played an active role in INSPIRE Exhibition during 10th to 11th Dec. 2016 which was organized during India International Science Festival in Delhi. The Cell also coordinated with subordinate offices and autonomous institutions of the Department to participate in a number of exhibitions in various states.

AUDIT OBSERVATIONS

Detailed position of Action Taken Notes (ATNs) for the year 2015-16 is as following:

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)	
2	5 of 2005(SD)			1(5.1)	
3	1 of 2006(SD)DST			1(3.1 to 3.8)	
4	PA 13 of 2007			1(5.3.1 to 5.3.8)	
5	CA 3 of 2008(SD)DST			1(5.1)	
6	CA 3 of 2008(SD)DST			1(5.2)	
7	CA 16 of 2008-2009(SD)DST			1(5.1)	
8	CA 16 of 2008-2009(SDs)	1(5.2)			
9	CA 16 of 2008-2009(SDs)			1(5.3)	
10	CA 16 of 2011-12(Civil)			1(15.1)	
11	22 of 2013(Compliance Audit),Union Government Scientific and Environmental Ministries/Departments			1(5.1)	
12	22 of 2013(Compliance Audit),Union Government Scientific and Environmental Ministries/Departments			1(5.2)	
13	27 of 2014(Compliance Audit),Union Government Scientific and Environmental Ministries/Departments			1(3.1)	

14	27 of 2014(Compliance Audit),Union Government Scientific and Environmental Ministries/Departments			1(3.2)	
15	30 of 2015 (Compliance Audit), Union Government Scientific and Environmental Ministries/Departments		1 (3.1)		
16	30 of 2015 (Compliance Audit), Union Government Scientific and Environmental Ministries/Departments		1 (3.2)		

(*)ATNs have been delivered to O/o PDA (SD) on 14.08.2015 (Sl. No.4), 16.11.2015 (Sl. No. 5), 09.02.2016 (Sl. No. 10), 12.01.2016 (Sl. No. 11) respectively for vetting.

Significant audit points printed in Audit Reports of 2015

Audit Report no. 30 of 2015-Union Government, Scientific Ministries/ Departments

Department of Science and Technology

1) Para No. 3.1 of 30 of 2015 - Implementation of Drugs and Pharmaceutical Research Programme

Deficiencies in selection, financial management and monitoring of projects sanctioned by Department of Science and Technology under Drugs and Pharmaceutical Research Programme led to non-realization of outstanding loans and interest of Rs.73.68 crore, non-receipt of final project completion reports and consequent lack of information on outcome generated from the projects. The objectives of enhancing capabilities of Indian Pharmaceutical industry and promoting them to develop new drugs at lower costs were not achieved.

(Paragraph 3.1)

2) Para No. 3.2 of 30 of 2015 -Avoidable expenditure due to poor management of land and delayed construction of office complex

Department of Science and Technology delayed executing lease deed in respect of land acquired from Noida for 21 years and failed to complete construction of office complex within permissible time period. Consequently, it incurred avoidable expenditure of Rs.1.81 crore besides recurring liabilities towards penalties till completion of the construction.

(Paragraph 3.2)

FINANCIAL SUMMARY

DEPARTMENT OF SCIENCE AND TECHNOLOGY SUMMARY OF FINANCIAL REQUIREMENTS													
Sl. No.	HEAD OF DEVELOPMENT PROJECTS / PROGRAMMES / SCHEMES	ACTUALS 2014-2015			BE 2015-2016			RE 2015-2016			BE 2016-2017		
		Plan	Non-Plan	Total	Plan	Non-Plan	Total	Plan	Non-Plan	Total	Plan	Non-Plan	Total
1	2	3	4	5	6	7	8	9	10	11	12	13	14
		(Rs. in crores)											
1	SECRETARIAT ECONOMIC SERVICES												
1.1	SECRETARIAT, EXHIBITION & FAIRS & Pr. ACCOUNTS OFFICE	0.00	57.95	57.95	0.00	69.91	69.91	0.00	64.41	64.41	0.00	79.82	79.82
	TOTAL - SECRETARIAT ECONOMIC SERVICES	0.00	57.95	57.95	0.00	69.91	69.91	0.00	64.41	64.41	0.00	79.82	79.82
2	R&D SUPPORT												
2.1	RESEARCH AND DEVELOPMENT SUPPORT	259.54	0.67	260.21	330.00	0.75	330.75	330.00	0.75	330.75	360.00	1.00	361.00
2.2	DRUGS AND PHARMACEUTICALS RESEARCH	18.97	0.00	18.97	25.00	0.00	25.00	23.00	0.00	23.00	20.00	0.00	20.00
2.3	NATIONAL MISSION ON NANO-SCIENCE & NANO-TECHNOLOGY	64.92	0.00	64.92	85.00	0.00	85.00	85.00	0.00	85.00	95.00	0.00	95.00
2.4	SWARAN JAYANTI SCHOLARSHIP FOR OUTSTANDING SCIENTISTS	0.00	11.99	11.99	0.00	15.00	15.00	0.00	15.00	15.00	0.00	15.00	15.00
	TOTAL - R&D SUPPORT	343.43	12.66	356.09	440.00	15.75	455.75	438.00	15.75	453.75	475.00	16.00	491.00
	TOTAL - R&D PROMOTION PROGRAMMES	343.43	12.66	356.09	440.00	15.75	455.75	438.00	15.75	453.75	475.00	16.00	491.00
3	TECHNOLOGY DEVELOPMENT PROGRAMME	130.59	0.00	130.59	154.00	0.00	154.00	152.16	0.00	152.16	200.00	0.00	200.00
	TOTAL - TECHNOLOGY DEVELOPMENT PROGRAMME	130.59	0.00	130.59	154.00	0.00	154.00	152.16	0.00	152.16	200.00	0.00	200.00
4	S&T PROGRAMMES FOR SOCIO-ECONOMIC DEVELOPMENT												
4.1	SCIENCE AND SOCIETY PROGRAMME	9.80	0.00	9.80	13.93	0.00	13.93	13.93	0.00	13.93	17.00	0.00	17.00

DEPARTMENT OF SCIENCE AND TECHNOLOGY
SUMMARY OF FINANCIAL REQUIREMENTS

Sl. No.	HEAD OF DEVELOPMENT PROJECTS / PROGRAMMES / SCHEMES	ACTUALS 2014-2015			BE 2015-2016			RE 2015-2016			BE 2016-2017		
		Plan	Non-Plan	Total	Plan	Non-Plan	Total	Plan	Non-Plan	Total	Plan	Non-Plan	Total
1	2	3	4	5	6	7	8	9	10	11	12	13	14
4.2	SCIENCE AND TECHNOLOGY ENTREPRENEURSHIP DEVELOPMENT												
	AND EMPLOYMENT GENERATION	44.00	0.00	44.00	40.00	0.00	40.00	60.00	0.00	60.00	180.00	0.00	180.00
4.3	SCIENCE AND TECHNOLOGY COMMUNICATION AND POPULARISATION	19.88	0.00	19.88	20.00	0.00	20.00	24.00	0.00	24.00	25.00	0.00	25.00
	TOTAL - S&T PROGRAMMES FOR SOCIO ECONOMIC DEVELOPMENT	73.68	0.00	73.68	73.93	0.00	73.93	97.93	0.00	97.93	222.00	0.00	222.00
5	SPECIAL COMPONENT PLAN FOR SCHEDULED CASTES												
5.1	S&T COMMUNICATION AND POPULARISATION	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5.2	S&T ENTREPRENEURHSIP DEVELOPMENT	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5.3	SPECIAL COMPONENT PLAN FOR THE DEVELOPMENT OF SCHEDULED CASTES	9.99	0.00	9.99	18.04	0.00	18.04	18.04	0.00	18.04	19.00	0.00	19.00
5.4	AUTONOMOUS SCIENTIFIC INSTITUTIONS	16.00	0.00	16.00	18.00	0.00	18.00	18.00	0.00	18.00	20.00	0.00	20.00
5.5	TECHNOLOGY DEVELOPMENT PROGRAMME	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5.6	STATE SCIENCE & TECHNOLOGY PROGRAMME	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5.7	SCIENCE & ENGINEERING RESEARCH BOARD	5.00	0.00	5.00	25.00	0.00	25.00	25.00	0.00	25.00	37.50	0.00	37.50
5.8	DISHA PROGRAMME FOR WOMEN IN SCIENCE	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5.9	ALLIANCE AND R&D MISSION	15.00	0.00	15.00	24.00	0.00	24.00	24.00	0.00	24.00	23.50	0.00	23.50
5.10	SUPER COMPUTING FACILITY & CAPACITY BUILDING	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5.11	NATIONAL GEOGRAPHIC INFORMATION SYSTEM	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5.12	TECHNICAL RESEARCH CENTRES	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	TOTAL - SCSP	45.99	0.00	45.99	85.04	0.00	85.04	85.04	0.00	85.04	100.00	0.00	100.00
6	SCHEDULED TRIBE SUB-PLAN												
6.1	S&T COMMUNICATION AND POPULARISATION	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6.2	S&T ENTREPRENEURHSIP DEVELOPMENT	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6.3	TRIBAL SUB-PLAN	16.90	0.00	16.90	62.04	0.00	62.04	62.04	0.00	62.04	59.00	0.00	59.00
6.4	AUTONOMOUS SCIENTIFIC INSTITUTIONS	9.30	0.00	9.30	15.00	0.00	15.00	15.00	0.00	15.00	33.00	0.00	33.00
6.5	TECHNOLOGY DEVELOPMENT PROGRAMME	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6.6	STATE SCIENCE & TECHNOLOGY PROGRAMME	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6.7	SCIENCE & ENGINEERING RESEARCH BOARD	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6.8	DISHA PROGRAMME FOR WOMEN IN SCIENCE	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6.9	ALLIANCE AND R&D MISSION	10.00	0.00	10.00	8.00	0.00	8.00	8.00	0.00	8.00	8.00	0.00	8.00

DEPARTMENT OF SCIENCE AND TECHNOLOGY
SUMMARY OF FINANCIAL REQUIREMENTS

Sl. No.	HEAD OF DEVELOPMENT PROJECTS / PROGRAMMES / SCHEMES	ACTUALS 2014-2015			BE 2015-2016			RE 2015-2016			BE 2016-2017		
		Plan	Non-Plan	Total	Plan	Non-Plan	Total	Plan	Non-Plan	Total	Plan	Non-Plan	Total
1	2	3	4	5	6	7	8	9	10	11	12	13	14
6.10	SUPER COMPUTING FACILITY & CAPACITY BUILDING	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6.11	NATIONAL GEOGRAPHIC INFORMATION SYSTEM	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6.12	TECHNICAL RESEARCH CENTRES	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	TOTAL - TSP	36.20	0.00	36.20	85.04	0.00	85.04	85.04	0.00	85.04	100.00	0.00	100.00
7.	INTERNATIONAL COOPERATION PROGRAMMES												
7.1	INDO-FRENCH CENTRE FOR THE PROMOTION OF ADVANCED RESEARCH	12.50	0.00	12.50	14.50	0.00	14.50	14.50	0.00	14.50	12.50	0.00	12.50
7.2	SCIENCE COUNSELLORS ABROAD	0.00	7.74	7.74	0.00	9.95	9.95	0.00	8.95	8.95	0.00	13.40	13.40
7.3	INDO-US SCIENCE AND TECHNOLOGY FORUM	9.50	0.00	9.50	10.50	0.00	10.50	10.50	0.00	10.50	10.00	0.00	10.00
7.4	INDO-GERMAN SCIENCE & TECHNOLOGY CENTRE	6.00	0.00	6.00	10.00	0.00	10.00	10.00	0.00	10.00	13.00	0.00	13.00
7.5	S&T COOPERATION WITH OTHER COUNTRIES	50.68	0.00	50.68	64.00	0.00	64.00	64.00	0.00	64.00	114.50	0.00	114.50
	TOTAL - INTERNATIONAL COOPERATION PROGRAMMES	78.68	7.74	86.42	99.00	9.95	108.95	99.00	8.95	107.95	150.00	13.40	163.40
8	STATE SCIENCE AND TECHNOLOGY PROGRAMME	32.32	0.00	32.32	35.00	0.00	35.00	45.00	0.00	45.00	60.00	0.00	60.00
9	TECHNOLOGY DEVELOPMENT BOARD	0.00	6.75	6.75	0.00	10.00	10.00	0.00	30.00	30.00	0.00	10.30	10.30
	TOTAL- OTHER SCIENTIFIC RESEARCH	740.89	27.15	768.04	972.00	35.70	1007.70	1002.16	54.70	1056.86	1307.00	39.70	1346.70
10.	SCIENTIFIC SURVEYS (MODERNISATION OF MAPPING ORGANIZATIONS (SoI & NATMO)												
10.01	SURVEY OF INDIA	17.80	305.75	323.55	27.16	331.01	358.17	27.00	311.48	338.48	4.93	350.54	355.47
10.02	NATIONAL ATLAS AND THEMATIC MAPPING ORGANISATION	1.53	10.54	12.07	2.84	14.70	17.54	2.84	13.70	16.54	25.07	16.62	41.69
	TOTAL - SCIENTIFIC SURVEYS	19.33	316.29	335.62	30.00	345.71	375.71	29.84	325.19	355.02	30.00	367.16	397.16
11	AUTONOMOUS SCIENTIFIC INSTITUTIONS	675.70	8.10	683.80	830.50	9.00	839.50	857.50	9.00	866.50	1007.00	9.64	1016.64
	TOTAL - SCIENTIFIC INSTITUTIONS	675.70	8.10	683.80	830.50	9.00	839.50	857.50	9.00	866.50	1007.00	9.64	1016.64
12	SYNERGY PROJECTS (O/o the PRINCIPAL SCIENTIFIC ADVISER) (including CHAIN)	23.23	0.00	23.23	26.00	0.00	26.00	26.00	0.00	26.00	26.00	0.00	26.00
	TOTAL	23.23	0.00	23.23	26.00	0.00	26.00	26.00	0.00	26.00	26.00	0.00	26.00
13	INFORMATION TECHNOLOGY	0.36	0.00	0.36	5.00	0.00	5.00	5.00	0.00	5.00	3.00	0.00	3.00
	TOTAL	0.36	0.00	0.36	5.00	0.00	5.00	5.00	0.00	5.00	3.00	0.00	3.00

DEPARTMENT OF SCIENCE AND TECHNOLOGY
SUMMARY OF FINANCIAL REQUIREMENTS

Sl. No.	HEAD OF DEVELOPMENT PROJECTS / PROGRAMMES / SCHEMES	ACTUALS 2014-2015			BE 2015-2016			RE 2015-2016			BE 2016-2017		
		Plan	Non-Plan	Total	Plan	Non-Plan	Total	Plan	Non-Plan	Total	Plan	Non-Plan	Total
1	2	3	4	5	6	7	8	9	10	11	12	13	14
	NEW SCHEMES (Eleventh Five Year Plan)												
14	SCIENCE & ENGINEERING RESEARCH BOARD	530.00	0.00	530.00	635.00	0.00	635.00	635.00	0.00	635.00	712.50	0.00	712.50
15	MEGA FACILITIES FOR BASIC RESEARCH	61.93	0.00	61.93	99.00	0.00	99.00	69.00	0.00	69.00	120.00	0.00	120.00
	TOTAL	591.93	0.00	591.93	734.00	0.00	734.00	704.00	0.00	704.00	832.50	0.00	832.50
	NEW SCHEMES (Twelfth Five Year Plan)												
16	POLICY RESEARCH CELL	7.94	0.00	7.94	17.00	0.00	17.00	7.00	0.00	7.00	16.00	0.00	16.00
17	DISHA PROGRAMME FOR WOMEN IN SCIENCE	43.85	0.00	43.85	53.00	0.00	53.00	58.00	0.00	58.00	60.00	0.00	60.00
18	ALLIANCE AND R&D MISSION	392.46	0.00	392.46	512.50	0.00	512.50	528.00	0.00	528.00	518.50	0.00	518.50
19	SUPER COMPUTING FACILITY & CAPACITY BUILDING	0.00	0.00	0.00	84.00	0.00	84.00	84.00	0.00	84.00	120.00	0.00	120.00
20	NATIONAL GEOGRAPHIC INFORMATION SYSTEM	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
21	FUND FOR INCLUSIVE INNOVATIONS FOR COMMON MAN	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
22	TECHNICAL RESEARCH CENTRES	1.00	0.00	1.00	137.50	0.00	137.50	100.00	0.00	100.00	80.00	0.00	80.00
	TOTAL	445.25	0.00	445.25	804.00	0.00	804.00	777.00	0.00	777.00	794.50	0.00	794.50
	GRAND TOTAL	2496.69	409.49	2906.18	3401.50	460.32	3861.82	3401.50	453.30	3854.80	4000.00	496.32	4496.32

ABBREVIATIONS

AMRIT	-Affordable Medicines & Reliable Implants for Treatment
APIN	-Asia Pacific Incubation Network
ARI	-Agharkar Research Institute
AZO	-Aluminum Doped Zinc Oxide
BARC	-Bhabha Atomic Research Centre
CAETS	-International Council of Academies of Engineering and Technological Sciences
CAT	-Centre for Advanced Technology
CCD	-Charged Couple Device
CERES	-Crop Environment Resource Synthesis
CIGS	-Copper Indium Gallium Selenide
CII	-Confederation of Indian Industry
CIIE	-Centre for Innovation, Incubation and Entrepreneurship
CMPDI	-Central Mine Planning and Design Institute
CRNS	-Centre National de la Recherche Scientifique (French National Centre for Scientific Research
CS	-Chemical Science
CSIR	-Council of Scientific and Industrial Research
CURIE	-Consolidation of University Research for Innovation & Excellence
DAE	-Department of Atomic Energy
DBT	-Department of Biotechnology
DIPP	-Department of Industrial Policy and Promotion
DNA	-Deoxyribonucleic Acid
DOPT	-Department of Personnel and Training
DPMS	-District Planning Map Series
DST	-Department of Science and Technology
EAC	-Entrepreneurship Awareness Camp
EAS	-Earth and Atmospheric Science
EDII	-Entrepreneurship Development Institute of India
EDP	-Entrepreneurship Development Programme
EEG	-Electroencephalogram
EFS	-Encrypting File System
EPR	-Electron Paramagnetic Resonance

ES	-Earth Science/Engineering Science
FAIR	-Facility for Antiproton Ion Research
FDP	-Faculty Development Programme
FIST	-Fund for Improvement of S&T Infrastructures in Universities and Higher Educational Institutions
FSSAI	-Food Safety and Standards Authority of India
GBPIHED	-GB Pant Institute of Himalayan Environment and Development
GHG	-Green House Gas
GIS	-Geographical Information System
GISTDA	-Geoinformatics and Space Technology Development Agency
GITA	-Global Innovation and Technology Alliance
GLP	-Good Laboratory Practices
GMS	-Golden Map Service
GOI	-Government of India
GPS	-Geographical Positioning System
HCT	-Himalayan Chandra Telescope
HESP	-Hanle Echelle Spectrograph
HYSAF	-Hybrid Submerged Aerated Filter
ICAR	-Indian Council of Agricultural Research
IC-IMPACTS	-India-Canada Centre for Innovative Multidisciplinary Partnerships to Accelerate Community Transformation and Sustainability
ICMR	-Indian Council of Medical Research
ICPMS	-Inductively Coupled Plasma Mass Spectrometry
ICT	-Information and Communication Technology
ICTP	-International Centre for Theoretical Physics
ICZM	-Integrated Coastal Zone Management
IDC	-Infiltrative/Invasive Ductal Carcinoma
IGSTC	-Indo-German Science and Technology Centre
IHC	-Immunohistochemistry
IIGP	-India Innovation Growth Programme
IISER	-Indian Institute of Science Education and Research
IIT	-Indian Institute of Technology
IITF	-India International Trade Fair
IMPRINT	-Impacting Research Innovation and Technology

IMU	-International Mathematical Union
INSPIRE	-Innovation in Science Pursuit for Inspired Research
IPR	-Intellectual Property Rights
ISRO	-Indian Space Research Organisation
IRHM	-Intelligent Remote Health Monitoring
JRF	-Junior Research Fellow
MEA	-Ministry of External Affairs
MEMS	-Micro-Electro-Mechanical Systems
MFP	-Mercury Free Plasma
MNRE	-Ministry of New and Renewable Energy
MSBR	-Multi-spouted Bed Roaster
MSME	-Ministry of Micro, Small and Medium Enterprises
NABL	-National Accreditation Board for Testing and Calibration Laboratories
NASA	-National Aeronautics and Space Administration
NEHU	-North Eastern Hill University
NET	-National Eligibility Test
NCSTC	-National Council for Science & Technology Communication
NGCMA	-National GLP Compliance Monitoring Authority
NIF	-National Innovation Foundation
NIMHANS	-National Institute of Mental Health and Neurosciences
NIMR	-National Institute of Malaria Research
NLST	-National Large Solar Telescope
NMR	-Nuclear Magnetic Resonance
NSDI	-National Spatial Data Infrastructure
NSTEDB	-National Science & Technology Entrepreneurship Development Board
NUIS	-National Urban Information System
OECD	-Organisation for Economic Cooperation and Development
OSM	-Open Series maps
PAC	-Programme Advisory Committee
PFC	-Patent Facilitation Centre
PLGA	-Poly Lactic-co-Glycolic Acid
PMS	-Physical and Mathematical Science
PURSE	-Promotion of University Research and Scientific Excellence

QCD	-Quantum Chromo Dynamics
RC-UK	-Research Council-United Kingdom
R&D	-Research and Development
SERB	-Science and Engineering Research Board
SHG	-Self Help Group
SIRO	-Scientific and Industrial Research Organisation
SRF	-Senior Research Fellow
S&T	-Science and Technology
SSTP	-State Science and Technology Programme
STI	-Science, Technology and Innovation
ST-Radar	-Stratosphere Troposphere Radar
TDB	-Technology Development Board
TEDP	-Technology Entrepreneurship Development Programme
TIFR	-Tata Institute of Fundamental Research
UASB	-Upflow Anaerobic Sludge Blanket
UG	-Under Graduate
UGC	-University Grants Commission
UKIERI	-United Kingdom India Education and Research Initiative
UT	-Union Territory
UV	-Ultra Violet
UVIT	-Ultra Violet Imaging Telescope
WEDP	-Women Entrepreneurship Development Programme
WFA	-Web Feature Service
WMS	-Web Map Service
WSN	-Wireless Sensor Network

सत्यमेव जयते

Department of Science and Technology
Ministry of Science and Technology
Technology Bhawan, New Mehrauli Road
New Delhi-110016, INDIA