

WOMEN IN SCIENCE



Indo-French Centre for the Promotion of Advanced Research/ Centre Franco-Indien pour la Promotion de la Recherche Avancée (CEFIPRA) is a model for international collaborative research in areas of Science & Technology. The Centre was established in 1987 being supported by Department of Science & Technology, Government of India and the Ministry for Europe & Foreign Affairs, Government of France. CEFIPRA is actively involved in supporting Indo-French Science, Technology & Innovation system through various activities. Collaborative Scientific Research Programme (CSRP) focuses on Academia-to-Academia Collaborations between Indian and French Academic Collaborators in various domains of S&T.

Industry Academia Research & Development Programme (IARDP) emphasizes to develop the linkages between Industry and Academia from France and India. Dedicated mobility support Programmes of CEFIPRA provide exposure to young researchers for the working in social and cultural environment of the partnering country. Targeted Programmes of CEFIPRA provide platform for Indian and French National Funding Agencies to implement programmes for specific areas. Innovation Programmes through PPP mode are the programmes where industries join hands with CEFIPRA as a funding partner for supporting R & D in defined priority areas.



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IN PROGRAMMES

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(1.1.2008 to 31.12.2017)

FOREWORD FROM THE DIRECTOR

It is my pleasure to present this report which contains the scientific contribution of Women in Science in programmes supported by CEFIPRA.

The Centre initially embarked upon the journey to nurture the Indo-French scientific ecosystem as a funder and in the course of its evolution, it has significantly expanded its role & programmes. While the Collaborative Scientific Research Programme (CSRP) continues to be the flagship programme, the Centre has taken numerous initiatives to enhance the scientific competency among the two countries by adding several new initiatives and programmes to its profile. With the constant support, guidance and mentorship from its Governing Body and the Vision Group, the Centre continues to shape the future of the Indo-French scientific landscape.

Women of today comprise an important part of the scientific workforce in India & France and eminent women scientists from both the countries have represented the Scientific Council and the Industrial Research Committee of CEFIPRA. The successful contribution of women in Indo-French scientific projects was earlier highlighted in a meeting at the Indian Institute of Science, Bangalore in 2015. In this context, the present meeting is an appropriate platform to provide a glimpse at the research achievements of women scientist in CEFIPRA supported projects & programmes. It is noteworthy that the scientific contribution of women has been remarkable in terms of publications, products and patents, in spite of the fact that women's participation is less in some of the programmes. I hope that the data and information provided herein will serve as a basis for affirmative action to promote gender equality in academia through CEFIPRA supported programmes.



Dr. Mukesh Kumar
Director, CEFIPRA

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Executive Summary

Scientific development is significantly benefitted from diversity and one of the important components of this diversity is the gender of the scientific manpower. The level of participation of women in the scientific disciplines is a complex phenomenon which at times, is dictated by social, cultural and economic background of the country in question. Herein, we have analyzed the participation and outcome of Indian and French women in some of the important programmes of CEFIPRA.

Indian women have made their presence felt in the scientific disciplines; the earliest documented instance is dates back to 1885, when the first Indian woman received a degree in medicine. However, the overall numbers for Indian woman in science in the pre-independence era was miniscule. This was mostly due to the fact that Indian was primarily an agrarian economy under a colonial rule. Even after Indian independence in 1947, women were mostly responsible for taking care of household related activities. The current situation is drastically different as women in India have come a long way in terms of scientific education and participation thereof. Today, they account for almost 40% of the undergraduates in science. Among the PhDs in science, about 25-30% are women (www.ias.ac.in).

In spite of a significant representation at the student level, only **14% of the current researchers in India are women** (Woman Science Congress, 18.3.2018, Manipur University, Manipur, India) Therefore, it is apparent that the above mentioned degrees could not be converted into successful careers due to certain reasons. Some of these reasons could be societal or family related pressure, gender bias, and lack of relevant opportunities or a difficulty in attaining a work-life balance and also due to the general perception that a prototypical scientist should be a male. Regardless of the precise reason, the issue needs to be addressed so that a significant amount of talented scientific manpower is utilized for societal benefit. In order to promulgate the participation of woman, several national science funding agencies of India, such as Department of Science & Technology (DST), Department of Biotechnology (DBT), University Grants Commission (UGC), Department of Health Research (DHR) and Science and Engineering Research Board (SERB) etc. have launched exclusive schemes to encourage the participation of women in science. It is expected that these schemes will

increase the share of women in the scientific workforce. As compared to the national level of 14%, the participation of Indian woman in the Collaborative Scientific Research Programme (CSRP) of CEFIPRA is marginally higher (15.42%). Though this is an encouraging data, but it must be noted that the dynamics of participation in a bilateral research programme must be very different from that of the nationwide representation.

The participation of woman in French science is dates back to the scientific revolution. French women have made their mark in the field of science through their notable contribution in several disciplines. Going by the latest report* published by French National Center for Scientific Research (CNRS)—France’s largest public research institution, 43% of all staff members—which include permanent researchers, PhD students, Post-docs and Administrative Personnel—were women. 65.1% of technicians were women, as compared with 45.4% of research engineers and 34.5% of researchers. Among permanent researchers, women accounted for 37.7% of lab members, 28.2% of team leaders, and just 18.8% of unit Directors. There is a slight deviation from this trend at the highest levels of leadership: one-third of the deputy scientific Directors of CNRS institutes were women. According to UNESCO report#, **women comprise 27% of the scientific workforce of France**. These data suggest that participation of women in science is significantly higher in France as compared to India. A factor which should be taken into account is that France became independent in the 18th century, about a hundred and fifty years before India. In addition, the societal and cultural factors might be very different in France than they are in India. Hence, the **percentage of French women’s participation in science might be at par with the other developed countries**. The participation of French women in the CSRP of CEFIPRA is 17.41%, which is below their national level data. A reason for this could be the lack of awareness about CEFIPRA among the French scientific community. Hence, the dissemination of information about CEFIPRA and its programmes among the relevant sectors would lead to a likely increase in the participation of women scientific manpower in both the countries. In view of the fact that the projects involving Indian and French women have been scientifically fruitful (**183 peer reviewed publications and 7 patents from 38 completed CSRP projects**), it may be worthwhile to consider launching a new programme to encourage participation of women.

*www.sciencemag.org/careers/2017/02/action-and-data-women-science-french-example #UNESCO, UIS Fact Sheet No. 51 | June 2018

1. About CEFIPRA

The Indo-French Centre for the Promotion of Advanced Research (IFCPAR/CEFIPRA) is a model for international collaborative research in advanced areas of Science & Technology. The Centre was established in 1987 and is being supported by Department of Science & Technology, Government of India and the Ministry for Europe & Foreign Affairs, Government of France. CEFIPRA is actively involved in supporting Indo-French Science, Technology & Innovation (ST&I) system through various activities. The Centre aligns its mandate from time to time along with the national research priorities of India and France in S&T sectors. The activities of IFCPAR/CEFIPRA are reviewed by a Governing Body comprising of two Co-chairs and other members, nominated by the respective Governments.

Collaborative Scientific Research Programme (CSRП) promotes academic collaborations between India and France in various domains. Industry Academia Research & Development Programme (IARDP) emphasizes to develop the linkage between Industry and Academia from France and India. Seminars, Workshops and Training Schools supported by the Centre help in dissemination of information and provide a platform for the promotion of networking amongst scientists & researchers.

Some of the collaborative research projects involving industry & academia partners, have resulted in products which have already come to the market and some promising technologies developed are seeing a ray of hope for commercialization.

Dedicated mobility support programmes like the Raman-Charpak Fellowship, DST/CEFIPRA-ESONN fellowship and CEFIPRA-SOLEIL Synchrotron Programme provide exposure to young researchers to the scientific, social and cultural environment of the partnering country. Targeted Programmes of CEFIPRA such as DST-ANR, DST-Inria-CNRS and Indo-French Water Network (IFWN), provide a platform for Indian and French National Funding Agencies to collaborate in specific areas of national importance.



Innovation Programmes through the Public Private Partnership mode (BIRAC-CEFIPRA-French Embassy & BIRAC-CEFIPRA-Bpifrance programme etc.) are the programmes where industries join hands with CEFIPRA as a funding partner for supporting R & D in defined priority areas. It has worked as an enabling platform for the organizations in India & France to realize their potential in terms of development of products and processes. It has facilitated innovation, risk taking for industries and also bringing in the private industry, public institutions and the government under one roof to promote the research and innovation between India & France.

The projects supported under above mentioned programmes have resulted in prominent outcomes in the form of institutional linkages, intellectual contribution through excellence in science, capacity building through training of budding scientists, knowledge advancement in basic and translational research and publications having good citations.

2. Women in Science – a Historical Perspective

Women have made significant contributions to science from the earliest times. Historians with an interest in gender and science have illuminated the scientific endeavors and accomplishments of women, the barriers they have faced, and the strategies implemented for peer-review and acceptance of their research work in major scientific journals and other publications. The involvement of women in the field of medicine occurred in several early civilizations and the study of natural philosophy in ancient Greece was open to women. Women contributed to the proto-science of alchemy in the first or second centuries AD. During the middle ages, convents were an important place of education for women, and some of these communities provided opportunities for women to contribute to scholarly research. While the eleventh century saw the emergence of the first universities, women were, for the most part, excluded from university education.

The Scientific Revolution was a series of events that marked the emergence of modern science during the early modern period, when developments in Mathematics, Physics, Astronomy, Biology (including human anatomy) and Chemistry transformed the views of society about nature. The 17th century writer Ms Margaret Cavendish (1623-1673) helped to popularise the ideas of the scientific revolution and was one of the first to argue that theology is outside the parameters of scientific inquiry. As England's first recognised woman natural philosopher, she also argued strongly for the education of women and for their involvement in science. She worked on scientific matters, including *Observations upon Experimental Philosophy and Grounds of Natural Philosophy* (1666).

Although gender roles were largely defined in the eighteenth century, women experienced great advances in science. Women's contributions began to be recognized by their admittance into learned societies during this period. In the later nineteenth century, the rise of the women's colleges provided jobs for women scientists and opportunities for education in Europe, Russia and the United States. In the early 20th century, Mme. Marie Curie, the first woman to receive a Nobel Prize in 1903 (Physics), went on to become a double Nobel Prize recipient in 1911 (Chemistry), both for her work on radiation. The later part of the 20th century (post world war II) witnessed

ground breaking discoveries by woman scientists. Forty women have been awarded the Nobel Prize between 1901 and 2010. A total of 17 women have been awarded the Nobel Prize in Physics, Chemistry, Physiology or Medicine till date. The formation of the Kovalevskaja Fund in 1985 and the Organization for Women in Science for the Developing World in 1993 gave more visibility to previously marginalized women scientists. However, on a global level, women are still underrepresented as compared to men in various domains of Science & Technology, the only exception being the domain of Life Sciences where a degree of parity has been achieved. (**Source:** *Wikipedia, InterPlanetary File System, Epigenesys, National Library of Medicine*)

The Indian and French scenario: The earliest evidence of a **woman in Indian science** dates back to Ms Lilavati, a gifted mathematician and an astrologer of the 12th century. The Lilavati Award for outstanding contribution to public outreach in Mathematics, was constituted later on in her name and Lilavati's Daughters, a collection of biographical essays on women scientists of India was published in the form of a book by Indian Academy of Sciences, Bangalore, in 2008. A few instances of woman in science are also available in the pre-independence era of India. The decades after the post-independence era of India saw the emergence of woman in different domains of Science & Technology and by the turn of the 20th century it was very common to find woman in all the domains of Science. Though the name of Mme. Marie Curie is synonymous with **woman in French science**, there have also been many French female scientists who have made significant contributions. The list includes familiar scientists such as Mmes. Sophie Germain, Irène Joliot-Curie, Fred Vargas, Audrey Mestre, Émilie du Châtelet, Marguerite Perey and Marie-Anne Paulze Lavoisier, to name a few. These women represented different domains. It is also noteworthy that some French woman scientists were also **involved in the scientific revolution** and made pioneering discoveries.

In this document, we highlight the contribution and achievements of women scientist in the projects & programmes of CEFIPRA supported under the CSRP and IARDP (in the last ten years) and the Targeted & Innovation Programme through PPP mode (since the inception of these programmes).

3. Collaborative Scientific Research Programme (CSRP)

The Collaborative Scientific Research Programme (CSRP) is the flagship programme of CEFIPRA and is keeping pace with the emerging requirement in frontier areas of Science and Technology (S&T). The programme supports high quality research groups in advanced areas of basic and applied sciences to nurture scientific competency. The projects under the CSRP constitute one Indian and one French Principal Investigator (PI).

Through this programme, the Centre enhances the Indo-French S&T cooperation in all the basic and applied domains of Science & Technology by catering to the changing scientific and research landscape of both the countries. The Centre facilitates the scientific exchange under the projects which provides an interactive interface for sharing growth of knowledge and development of human resources.

The collaborative projects have helped in establishing network of scientists as well as institutional linkages between academic institutions of India and France leading to the High Impact Scientific Network Programme.

Supported thrust areas for collaboration under the CSRP

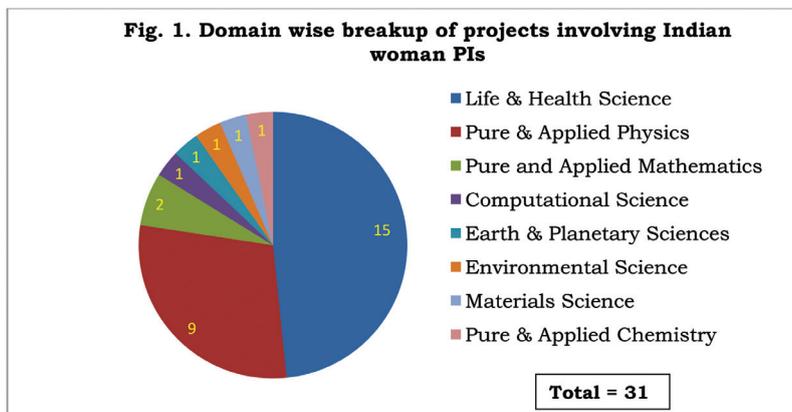
1. Pure & Applied Mathematics
2. Computational Science
3. Life & Health Sciences
4. Pure & Applied Physics
5. Pure & Applied Chemistry
6. Earth & Planetary Science
7. Materials Science
8. Environmental Science
9. Biotechnology
10. Water

The activities of CSRP are monitored by Scientific Council (SC) of the Centre. The SC comprises of five eminent scientists from each of the countries to enhance the research agenda of the Centre in view of national goals and priorities of S&T sectors.

3a. Participation of Woman Scientists in the CSRP in Last Ten Years

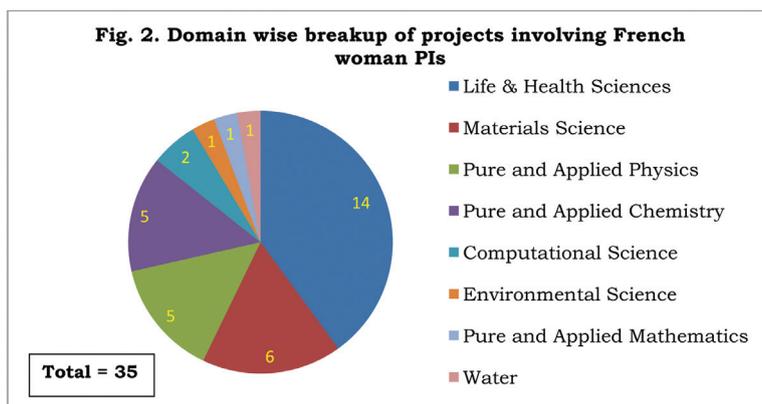
A total of 201 projects have been supported under the CSRP in the past ten years (1.1.2008 to 31.12.2017). Out of these projects, 132 have completed their stipulated duration, 68 projects are ongoing and 1 project was preclosed. A total of 31 Indian and 35 French woman PIs have been involved in these projects as collaborators.

The domain wise breakup of the projects involving Indian woman PIs (Figure 1) shows that 15 projects were in the area of Life & Health Sciences, 9 in Pure & Applied Physics, 2 in Pure and Applied Mathematics and 1 each in Computational Science, Earth & Planetary Sciences, Environmental Science, Materials Science and Pure & Applied Chemistry. This data is depicted in the following pie chart.



From the above data, it can be concluded that the domain of Life & Health Sciences accounted for 48.3% of projects which were led by Indian woman PIs.

The domain wise breakup of the projects involving French woman PIs (Figure 2) shows that 14 projects were from the area of Life & Health Sciences, followed by 6 from Materials Science, 5 each from Pure and Applied Physics and Pure and Applied Chemistry, 2 from Computational Science and 1 each from Environmental Science, Pure and Applied Mathematics and Water. The pie chart on the next page represents the above mentioned data.



The domain of Life & Health Sciences accounted for 40% of the projects which were led by French woman PIs. Based on the data for both the sides, it can be concluded that Life & Health Sciences accounted for majority of the projects led by woman PIs from India and France.

Out of the 31 and 35 projects led by the Indian and French woman PIs respectively, 21 and 20 projects have completed their duration. Three projects have woman PIs on both the sides for the completed projects. Following is the summary of achievement of these 38 completed projects:

3b. Summary of Achievements under CSRP projects

1. Project No. 3701-1

Title: Control of systems of partial differential equations

Principal collaborators (India)	(France)
Prof. Mythily Ramaswamy T.I.F.R Centre for Applicable Mathematics Bangalore	Prof. Jean Pierre Raymond Laboratoire MIP UMR 5640 CNRS-Université Paul Sabatier Université Paul Sabatier Toulouse

The project aimed at studying different models of partial differential equations and coupled systems arising from physical phenomena. The outcomes are as follows:

- Coupled system with Stokes equation for the fluid in 2 dimensional domain

- b) Helmholtz equation to model the vibrations of a coupled fluid-solid system
- c) The study of meta-materials which are electromagnetic materials having negative permittivity and/or permeability has been initiated by setting up a mathematical model and is ready for further study of control and homogenization
- d) A numerical implementation of feedback control for the important problem of fluid control modelled by Navier-Stokes equation has been initiated and is being investigated
- e) The practical problem of Data assimilation has been tried numerically for the Burgers' equation model using optimal control techniques. Further applications with models used in atmospheric sciences is now possible; and
- f) Compressible Navier-Stokes system has been taken up for the study of controllability and stabilizability and optimal control

2. Project No. 3703-2

Title: Role of immune and genetic factors in the outcome of *Plasmodium falciparum* malaria

Principal collaborators (India)	(France)
Dr. Shobhona Sharma Department of Biological Sciences Tata Institute of Fundamental Research Mumbai	Dr. Sylviane Pied Centre d'Immunologie et de Biologie Parasitaire Institut Pasteur de Lille Lille

The project aimed to implement a global approach based on field and laboratory research for a better understanding of the additive role of the host immune responses and genetic factors in malaria induced by *Plasmodium falciparum* and its severity in human population resident in Eastern (malaria endemic) and Western (urban malaria non-endemic) regions of India. The major objective was to assess a correlation of cytokine profile, antibody production and host-genetic factors with specific malaria severity, in order to ascribe certain immunological pathways for different kinds of disease. The cytokine patterns allowed to identify IL15 as a key

cytokine in malaria pathogenesis. The genetic polymorphism studies have revealed interesting results regarding TLR, iNOS and TNF-alpha and malaria susceptibility. Interesting observations are also obtained regarding genetic polymorphisms in populations of Orissa versus cosmopolitan cities such as Mumbai. The analysis of the repertoire of autoantibody against brain, liver, kidney and lung produced in malaria patients allowed to identify a discriminant response depending on the clinical manifestation. Proteins recognized by these antibodies are under identification. The parasite antigen specific antibody response revealed that generally mild malaria category gave the lowest response and multi-organ dysfunction patients showed the highest response. Responses of cerebral malaria and cerebral malaria patients exhibiting multi-organ dysfunction were statistically indistinguishable and lower than those with multi-organ dysfunction alone. The humoral response was also largely polyreactive. The results will also help consolidate the contribution of several immunological parameters that play a role in malaria disease pathology.

3. Project No. 3800-W1

Title: Enhanced processes for the removal of nitrate from water

Principal collaborators (India)	(France)
Dr. S. Vasudevan CSIR-Central Electrochemical Research Institute Karaikudi	<i>Dr. Florence EPRON</i> CNRS-Université de Poitiers Poitiers

The general purpose of the joint project was the selective reduction of nitrate in water into nitrogen by catalytic and electrocatalytic method. The experimental part consisted of (i) preparation of the bimetallic Pd-Sn catalysts, both by electrochemical and classical chemical techniques and (ii) the selective reduction of nitrate in water into nitrogen by totally avoiding the formation of ammonium ion, an undesirable product. The last part of the project was the operation of a semi-batch and continuous reactor on the (electro) catalysts presenting the best performances for nitrate reduction. A prototype portable Electrochemical Nitrate Removal Unit was developed.

4. Project No. 3803-3

Title: Neural differentiation of embryonic stem cells

Principal collaborators (India)	(France)
Dr. Shyamala Mani Centre for Neuroscience Indian Institute of Science Bangalore	Prof. Pierre Gressens INSERM U 676, IFR 02 & IFRH Hôpital Robert Debré(AP-HP) Paris

The study aimed at identifying critical pathways that extrinsic cues induce to generate any kind of neuronal subtype *in vitro* and enables to advance understanding of basic mechanisms of neuronal subtype specification and pathophysiological mechanisms underlying several neural diseases. Another significant achievement was that the group quantitatively analyzed the changes in cerebellar cortical layers in preterm infants and provided a framework for understanding the reason behind the cerebellar volume change that has been seen in preterm infants and investigators are getting ready for transplantation into animal models. It has brought new insights on the specification of mouse and human neurons *in vitro* and *in vivo*, in particular important progress in the understanding of cerebellar specification and differentiation. The project provided validated cellular models that have been used in neuroprotective studies of newly identified molecules (HIP/PAP) against excitotoxicity. The collaboration between the two labs is still ongoing and has been broadened to new topics related to neural specification, but with regard to human diseases.

5. Project No. 3808-2

Title: Atomistic studies of supported metal oxide nanosystems

Principal collaborators (India)	(France)
Dr. Satish Chandra Ogale National Chemical Laboratory Pune	Prof. Beatrice Hannoyer Université de Rouen St. Etienne du Rouvray

The project aimed to examine surface supported metal oxide nanosystems of technological interest (magnetic, electronic and/or optic) by combining the novel microbial and chemical (shape control, composite nanomaterials) synthesis at NCL (Pune) and the expertise of the French group (GPM) in the

fields of special spectroscopic and atomistic probe studies. The objectives were:

- a) Controlled chemical and biochemical synthesis of anisotropic magnetic nanostructures and functional nanocomposites, their atomistic characterizations, and the development of an understanding about the growth mechanisms
- b) Synthesis, thorough characterization and application of bi-functional magnetic and fluorescent nanoparticles of Fe_3O_4 (CdTe) Core (Shell)
- c) Synthesis, characterization and (solar cell) application of optical nanomaterials
- d) Explorations of transition element (Fe, Co) doping in TiO_2 nanoparticles
- e) Application of the novel technique of laser ablation wide angle atom probe tomography to the study of metal oxide systems (iron oxide) and elucidating the attendant mechanisms

6. Project No. 3904-1

Title: Memory effects in three-level systems

Principal collaborators (India)	(France)
<i>Prof. Rupamanjari Ghosh</i> School of Physical Sciences Jawaharlal Nehru University New Delhi	Dr. Fabien Bretenaker Laboratoire Aimé Cotton, CNRS Orsay

The project aimed at exploring memory effects in two-mode lasers and in coherent processes in metastable helium gas. The main implications of this study would be in expecting the work on slow and fast light effect to result in an improvement of the sensitivity of some optical sensors such as gyrometers or magnetometers. This also has implications in the study of the fundamental noise limit in lasers containing strongly dispersive media. Furthermore, the work on the tripod system has just started and the existence of unexpected resonance paves the way for new fundamental studies and also possible applications to quantum information processes. Finally, two-frequency VECSELs are very interesting lasers for microwave photonics applications: further fundamental studies about noise correlations between modes and applied developments such as

implementation of phase-lock loops are without any doubt very promising for societal benefit.

7. Project No. 4005-1

Title: Development of waste derived activated carbon supported oxide catalyst for low temperature VOC oxidation

Principal collaborators (India)	(France)
<i>Dr. Vidya S. Batra</i> The Energy and Resources Institute New Delhi	Prof. Jean-François Lamonier University of Lille 1 Villeneuve d'Ascq Cedex

The objective was to develop activated carbon supported oxide catalyst from waste biomass ash and red mud respectively and assess the catalytic performance during VOC oxidation. The joint project has contributed towards modification of wastes to obtain catalysts with high performances in Volatile Organic Compounds (VOC) removal. The separated carbon from bagasse fly ash has been imparted high surface area and good thermal stability. Red mud leached with oxalic acid offered a suitable iron rich solution for impregnation of the carbon support. The project has successfully developed catalysts from two different wastes namely unburned carbon from bagasse fly ash and red mud waste produced during enrichment of bauxite ore. The project has contributed towards modification of wastes to obtain catalysts whose performance is comparable to commercial activated carbon. Based on promising results from this work, TERI has done some experiments on catalytic tar removal from biomass gasifier producer gas.

8. Project No. 4101-1

Title: Numerical treatment of integral operators with non-smooth kernels

Principal collaborators (India)	(France)
<i>Prof. Rekha P. Kulkarni</i> Indian Institute of Technology Bombay Mumbai	Prof. Mario Ahues Laboratoire de Mathématiques de l'Université Saint-Etienne

The joint collaboration shed light on the following:

- Asymptotic series expansions for approximate solutions of second kind Fredholm integral equations and for approximate eigen elements in the case of a kernel of the type of Green's function.
- Proof of the non-commutativity of linearization and discretization of non-linear integral equations for some discretization schemes and preference for beginning by linearization.
- Modified Projection Method for non-linear integral equations.
- Introduction of a condition number of a basis of a finite dimensional normed space to measure the possibility of its 'near linear dependence' as well as of overflow/underflow.
- Preparation of software packages for linear and non-linear integral equations

9. Project No. 4103-1

Title: Epigenetics of transcription by RNA polymerase III

Principal collaborators (India)	(France)
<i>Dr. Purnima Bhargava</i> Centre for Cellular and Molecular Biology Hyderabad	Dr. Olivier Gadal Université Paul Sabatier Toulouse Cedex 9

This project studied the link between local chromatin structure and expression level of the genes transcribed by the yeast RNA polymerase III at global scale. The highlights of the joint collaboration are as follows:

- A unique arrangement of nucleosomes is found near the yeast pol III-transcribed genes. The genes reside in a nucleosome-free region (NFR), bordered by positioned nucleosomes
- These nucleosomes change positions under repressed state, predominantly at 3'- ends of the genes. Expression of different genes shows different response to nutrient starvation
- Different pol III-transcribed genes were found in different locations within the nucleus
- Nuclear location of different genes shows different response to nutrient deprivation

- However, gene expression does not show correlation with location in nuclear space

10. Project No. 4105-1

Title: Practical methods for surface bio functionalization

Principal collaborators (India)	(France)
Prof. Amitabha Sarkar Indian Association for the Cultivation of Sciences Kolkata	<i>Prof. Michèle Salmain</i> Chimie ParisTech (ENSCP) Laboratoire Charles Friedel Paris Cedex 05

The project aimed at development of concepts which can be adapted for designing and developing nanosized bio-chips for specific application. The objectives of the project were efficient methods to immobilize biomolecules on surfaces like gold or silica, for eventual adaptation in bio-sensing, has been successfully accomplished. Fabrication of bio-chips rely on efficient, selective and mild methods to immobilize especially through covalent bond formation that leads to much greater stability and control of density of loading useful biological molecules that sense primarily through their bio recognition/affinity attributes.

11. Project No. 4403-1

Title: Collective migration in the fly nervous system

Principal collaborators (India)	(France)
Prof. K Vijay Raghavan NCBS, TIFR Bangalore	<i>Dr. A Giangrande</i> CNRS, Institut de Génétique et de Biologie Moléculaire e Cellulaire, Alsace

The objective of the project was to study collective cell migration, a widely conserved process that plays a key role in several physiological contexts, from development to homeostasis. It is also involved in pathological processes, including metastasis formation and tumor-associated angiogenesis in cancer. The project used the glial chain moving along the so-called L1 sensory nerve of the developing *Drosophila* wing, which allowed an *in vivo* analysis at unprecedented resolution. The outcomes were as follows:

- Adhesion molecule N-cadherin is an important determinant of tumor progression that acts as a molecular brake during collective migration
- An unconventional N-cadherin cascade is involved in collective migration
- Connecting intrinsic and extrinsic cues controlling collective cell migration
- The glial determinant controls the expression of the Netrin chemoattractant receptor
- Impact of a glial neuronal Semaphorin signaling on motor behaviour

12. Project No. 4409-1

Title: Mineral fluid interaction model for CO₂ sequestration

Principal collaborators (India)	(France)
Dr. Tapati Dutta St. Xavier's College Kolkata	Dr. Philippe Gouze Université de Montpellier Montpellier

The objective of this project was to develop efficient modelling tools for reproducing flow-transport and reaction at pore scale. The outcomes of the project are as follows:

- Algorithms have been developed by to study microgeometry of pore and rock phase
- A simulation platform based on Time Domain Random Walk and Kinetic Monte Carlo was developed.
- Partial validation of the Stokes solver
- The calculation of the time evolution of bulk diffusivity of the porous media has been implemented.
- The behaviour of the dissolution pattern at different values of the Peclet and Damkohler numbers was analysed for different geometries (fractures and porous media).

13. Project No. 4503-1

Title: Studying the interactome of NAD-dependent deacetylase Sirt1 in the testis

Principal collaborators (India)	(France)
Dr. Ullas Kolthur Seetharam Tata Institute of Fundamental Research Mumbai	<i>Dr. Anne Gonzalez de Peredo</i> Universite de Toulouse Toulouse Cedex 4

This project was aimed at identifying novel Sirt1 interacting partners from mouse testis using proteomic approaches. The outcome of the joint collaboration is as follows:

- Transfer of DNA plasmid vaccine and its evaluation in a mouse model
- Identified novel isoform of Sirt1 based on MS/MS analyses
- Performed high throughput analyses and identified novel Sirt1 interacting proteins (both full length and delta-E2 isoforms) from cells in culture and from tissues
- Identified novel interacting proteins of Sirt4
- Standardised and established methodologies to analyse acetyl-proteome of cells and tissues
- Unravelling the role of acetylation in regulating CDK1 functions in cell cycle progression

14. Project No. 4503-2

Title: Evaluation of cellular and immune response in mice and patients with acute promyelocytic leukemia treated with arsenic trioxide

Principal collaborators (India)	(France)
Dr. Vikram Mathews Christian Medical College Vellore	<i>Prof. Christine Chomienne</i> Hopital Saint Louis Institute of Universitaire Hématologie Paris

The overall goal of the project was to study the effects of novel agents used in treatment of APL on immune response through preclinical studies in mice models. The outcomes of the efforts of the research teams have demonstrated the following achievements.

- Development of plasmid based vaccine for promyelocytic leukemia
- Demonstrated the synergistic effect between all-transretinoic acid and a DNA plasmid vaccine in a mouse model of leukemia
- Demonstrated the absence of synergy with this vaccine when ATO was used as a single agent
- Demonstrated the upregulation of NK cell receptors and ligands on malignant promyelocytes in a direction that enhances NK cell mediated cytolytic activity against malignant promyelocytes
- Demonstrated the presence of Myeloid Derived Suppressor Cells (MDSC) in patients with acute leukemia
- Successfully transferred the mouse model of leukemia and the use of DNA plasmid vaccine to laboratory and considerably increased institutional ability to further pursue research in leukemia

15. Project No. 4508-1

Title: Mechanisms of new long-lasting Luminescence Biomarkers

Principal collaborators (India)	(France)
Dr. Kaustubh R. S. Priolkar Goa University Goa	<i>Dr. Aurélie Bessiere</i> Laboratoire de Chimie de la Matière Condensée de Paris Paris

The project was aimed at developing new persistent phosphors which emit in the red or near infrared wavelength range suitable for the application of small animal *in vivo* imaging and elucidating the Long Lasting Phosphorescence (LLP) mechanism in these red emitting phosphors. The new knowledges generated in this project are as follows:

- Developed new LLP materials, $ZnGa_2O_4:Cr_3^+$ and $MgGa_2O_4:Cr_3^+$ suitable for bioimaging
- These materials show excellent LLP not only with X-rays or UV excitation but also with visible light excitation
- This has a great implication in bioimaging as the biomarker can now be reexcited from within the animal body thereby enhancing the detection time

- The mechanism of LLP induced by visible light excitation is entirely localized around Cr₃⁺ ion with an antisite defect in its first cationic neighbour
- Presence of Cr-O-Cr linkages (Cr clusters) however, is detrimental to observation of visible light induced persistent luminescence

16. Project No. 4603-1

Title: Genome wide recruitment profiling of BLM after DNA damage

Principal collaborators (India)	(France)
Dr. Sagar Sengupta National Institute of Immunology New Delhi	<i>Prof. Gaëlle Legube</i> Laboratoire de Biologie Moléculaire et Cellulaire du Contrôle de la Prolifération Toulouse

The project studied the whole genome recruitment of the BLM helicase after DNA damage. The results of the joint collaboration are following:

- Demonstrated that BLM and H2AX are present at the double strand breaks upon DNA damage induction in U2OS-AsiSI-ER cells. Provided evidence that BLM and H2AX are present in a chromatin bound complex at the sites of double strand breaks
- Successfully carried out the genome-wide recruitment of BLM following DNA damage
- Carried out the cell synchronization studies to determine the recruitment of BLM at the DSBs at different phases of the cell cycle
- Demonstrated the recruitment of BLM in S and G1 phase of the cell cycle. Shown how BLM interacts with different repair machineries in S and G1 phase of the cell cycle. Provided evidence that the recruitment of BLM to the site of damage depends not on ATM but on MRN complex
- Mechanistically shown that the interaction between BLM and MRN complex regulates its recruitment to the DSBs

17. Project No. 4603-2

Title: Dynamics of Serotonin 1A receptors by single particle tracking

Principal collaborators (India)	(France)
Prof. Amitabha Chattopadhyay Centre for Cellular & Molecular Biology Hyderabad	<i>Dr. Laurence Salomé</i> University Paul Sabatier Toulouse

The overall objective of the proposed project was to understand the interplay between membrane organization (dynamics) and function of the human serotonin_{1A} receptor by single molecule analysis of its diffusion (single particle tracking) in live cells. A new stable cell line has been established, expressing a serotonin mutant which can be labelled on its extracellular side using antibodies. The Indian collaborator has been trained to Single Particle Tracking experiments and advanced analysis of the trajectories. The salient achievement of the projects are production of a HEK cell line expressing His-Myc-5HT_{1A} receptor, validation of the full functionality of the expressed receptors; pharmacological responses of serotonin receptors in basal state; under cholesterol depletion and destabilization of actin; SPT analysis of the Transferrin receptor as a non-raft reference, SPT analysis of serotonin receptors in basal state, under cholesterol depletion and destabilization of actin cytoskeleton.

18. Project No. 4603-3

Title: Catecholestrogens in fish reproductive endocrinology

Principal collaborators (India)	(France)
<i>Dr. Radha Chaube</i> Banaras Hindu University Varanasi	Dr. Alexis Fostier INRA, LPGP Campus de Beaulieu, 35042 Rennes cedex

The project aimed at studying the synthesis and functional role of catecholestrogens (CE) in catfish and rainbow trout oocyte maturation – catfish total RNA extraction and sequencing using next generation sequencing technologies, assembly and annotation of deduced sequences, production of an estimated 44,000 sequences homologous nucleotide array, CE effects on the transcriptome of catfish post vitellogenic ovarian

follicles and expression of enzymes involved in CE synthesis during gonadotropin-induced oocyte maturation. The completion of the project led to analysis of mRNA pools of six different Indian catfish tissues by Next Generation Sequencing and about 60,000 contigs were produced. These data are available for searching transcripts of unknown genes in this species and has been positively checked for that. Molecular cloning and characterization of *cyp1a1*, *cyp1b1* and *comt* in the catfish was successfully done and sequence submitted to NCBI database. An Agilent oligonucleotides 58K microarray has been specifically designed for any kind of, without a priori transcriptomics, studies to be developed in the Indian catfish, *H. fossilis*.

19. Project No. 4604-4

Title: Realtime Imaging Through Fog Over Long Distance (RITFOLD)

Principal collaborators (India)	(France)
Dr. Hema Ramachandran Raman Research Institute Bangalore	Dr. Mehdi Alouini Universite de Rennes 1 Rennes

This project aimed at obtaining visual images of a source despite intervening strongly scattering media. Innovative ideas on source modulation, detector synchronization and sampling, particularly suited for aircraft navigation, will be implemented in the field, in actual fog, and over — kilometer. This project also aimed at providing data on atmosphere scattering, which is lacking in literature, and will help optimize existing theoretical models. The following goals were achieved:

- a) Imaging in actual fog was performed in field over distance of 1.3 km using polarimetric imaging with a Wollaston-based snapshot polarimetric camera
- b) Using information theoretic tools and a relevant noise model accounting for possible noise correlation between the acquired polarimetric channels, an optimal and adaptive polarimetric representation was derived
- c) Real time imaging through strongly scattering media using intensity-modulated light was demonstrated by engineering a speedup of more

- than three orders of magnitude over conventional techniques with the use of a simplified algorithm enabling processing of data on the fly
- d) The efficiency of using intensity modulated light for the estimation of scattering properties of a turbid medium and for ballistic photon discrimination has been theoretically quantified and the existence of a variance-minimizing optimal modulation frequency has been shown
 - e) A new all-optical full-field and reference-free quadrature demodulation technique has been patented within this project (International PCT Patent filed on 10th May 2016). Relying on a specific optical arrangement including an electro-optic crystal, the technique is in principle capable of demodulating signals in an image in a parallel way up to frequencies above GHz
 - f) A laboratory demonstrator based on the above patent has been realized showing at low frequency the validity of the full-field and reference-free demodulation principle and opening new exciting perspectives including in the biomedical domain

20. Project No. 4608-2

Title: Research of new layered oxides for energy storage and conversion

Principal collaborators (India)	(France)
Prof. U.V. Varadaraju Indian Institute of Technology Chennai	<i>Dr. Valerie Pralong</i> Laboratoire CRISMAT ENSICAEN, CNRS Caen

The objective of the project was ‘Synthesis and characterization of new materials for energy storage’. The PIs of this joint project shed light on the following:

- a) Development of new compounds for use in energy storage devices

Discovering of new structures synthesized based on transition metal phosphate, new phases as electrode material for Na ion batteries:

- $\text{NaFe}_3(\text{SO}_4)_2(\text{OH})_6$
- TiOSO_4
- LiTiOPO_4

- Barbosalite $\text{Fe}_3(\text{PO}_4)_2(\text{OH})_2$
- Lipscombite with complete iron(III) $\text{Fe}_3[\text{PO}_4]_2\text{O}(\text{OH})$

21. Project No. 4702-1

Title: Arithmetic circuits computing polynomials

Principal collaborators (India)	(France)
Dr. Meena Mahajan The Institute of Mathematical Sciences Chennai	Dr. Guillaume Malod Université Paris Diderot Paris Cedex 13

The project aimed at Proving lower bounds for restricted computation models, capturing completeness of complexity classes (specifically, the class VP) via natural polynomial families and Exploring the complexity of enumerating monomials. The project established that the iterated matrix polynomial IMM (n,d) has no depth 4 formulas of different kinds. These results show that a recent upper bound by Tavenas (MFCS 2013) is tight and improve the lower bound of Nisan and Wigderson from 1997. The results demonstrated VP-completeness of a polynomial family that is a variant of the polynomial that generalizes counting graph homomorphism, the first known example of a natural VP- complete polynomial. The main results obtained have introduced or developed techniques and models which can be further explored.

22. Project No. 4703-1

Title: Anti factor H autoantibody associated Hemolytic Uremic Syndrome (HUS)

Principal collaborators (India)	(France)
Prof. Arvind Bagga All India Institute of Medical Sciences New Delhi	Dr Marie-Agnès Dragon-Durey Unité INSERM UMRS 1138, Centre de Recherche des Cordeliers Paris

The aim of this project was to screen for mutations in the genes implicated in susceptibility to HUS in all patients included retrospectively and prospectively in the study, to validate the anti-factor H antibody assay in India and to establish a positive threshold appropriate to the population.

It was also aimed to study the anti-factor H cellular immune response, through constitution of a Peripheral Blood Mononuclear Cells (PBMCs) and plasma samples bank of patients with HUS and anti-FH IgG positive antibodies, to obtain genetic insights into the mechanisms of immunization against factor H and determination of the microbial triggers associated with occurrence of the disease. The collaboration provided insights in the physiopathology of HUS, on its epidemiology on its management and its treatment. It allowed the availability of facilities in complement exploration at AIIMS which remains unique in India. The collaboration of the two teams allowed an active dissemination of their experience not only in the two countries, but also to all others via international publications, poster presentations and conferences.

23. Project No. 4704-1

Title: Two dimensional electron gas physics in oxide heterostructures

Principal collaborators (India)	(France)
Dr. Anjana Dogra National Physical Laboratory New Delhi	Prof. Jérôme Lesueur Laboratoire de Physique et d'Etude des Matériaux, ESPCI Paris Cedex 05

The original aim was to study the physics of the two dimensional electron gas which takes place at the LaTiO₃/SrTiO₃ interface. The outcomes of the joint collaboration are as follows:

- Precise controlled unit cell growth of epitaxial LAO/STO and Cr doped LAO/STO using pulsed laser deposition technique with *in situ* RHEED
- Successfully grown ultra-thin (6uc) films and probed the interface with X-ray photo emission spectroscopy (XPS) in order to understand the metal to insulator transition with Cr doping
- In photo conducting investigation, increase in both photoresponse and relaxation time with Cr doping is observed. In addition an anomalous peak was observed at 690nm
- Study of the interplay between Superconductivity, Spin orbit coupling and Kondo effect on Cr-doped LAO/STO interfaces
- Role of the electrostatic doping

- Discovery of a new type of superconducting fluctuations with an anomalous dynamics driven by density fluctuations ($z=3$ and $=1/2$)

24. Project No. 4704-2

Title: Correlations and transport far from equilibrium in nanosystems

Principal collaborators (India)	(France)
Dr. Pareek Tribhu P Harish Chandra Research Institute Allahabad	<i>Dr. Mireille Lavagna</i> Institute of Nanosciences and Cryogeny, CEA Grenoble

The objectives of the project were to study non equilibrium quantum phenomena in strongly correlated nanoscale systems, like for instance quantum dots in which the central region marked by strong correlations is connected to metallic leads. The groups proposed to study various sources of non-equilibrium. They first considered the application of a time-independent bias voltage between the two leads. They studied the induced currents and more specifically the noise at finite frequency in the presence of spin independent tunneling between the central region and the leads. The discussion was then extended to the situation of a modified environment like either injection of a current in one of the leads, which may eventually lead to a spin accumulation, or application of Rashba interactions introducing a spin-flip tunneling, or presence of a spin dependent tunneling. Finally, other ways of achieving non equilibrium as the application of a time dependent bias or gate voltage was examined. The whole results were discussed in the light of recent experiments. The completion of the project led to the following:

- a) Non-equilibrium quantum transport in strongly-correlated nanosystems: methodological advances
- b) Non-equilibrium transport through a quantum dot in the presence of spin accumulation in one of the leads
- c) Fluctuations of current, emission and absorption current noise in a quantum dot

25. Project No. 4704-3

Title: Rotating and curved boundary-layer instabilities

Principal collaborators (India)	(France)
<i>Prof. Rama Govindarajan</i> International Center for Theoretical Sciences (ICTS-TIFR) Bengaluru	Dr. Benoît Pier Laboratoire de mécanique des et d'acoustique- Ecole Centrale de Lyon Ecully Cedex

The present project was aimed at studying one class of such shear flows, where two features which may be expected to co-exist, namely a curvature of the wall and a rotation of the system or parts of the system, are studied together. Instabilities in wall-bounded shear flows depend qualitatively and sensitively on the details of the geometry and external forcing. An understanding of this for each flow of physical relevance is thus very important, and forms a significant area of present-day research. The following goals were achieved:

- Boundary layer flow along a rotating cylinder – Base flow completely documented and published
- Boundary layer flow along a rotating cylinder – Stability analysis completed and published
- Rotating channel flow: study completed and submitted for publication
- Rotating rough cylinder with crossflow: two-dimensional simulations in progress
- Flow through a rotating pipe: linear and nonlinear dynamics completed and submitted for publication

26. Project No. 4709-1

Title: Gene resources from polluted soils

Principal collaborators (India)	(France)
Prof. M. Sudhakara Reddy Thapar University Punjab	<i>Dr. Laurence FRAISSINET-TACHET</i> Université Lyon1 Villeurbanne Cedex

The objectives of the project were to explore, at the gene level, the functional biodiversity of soil eukaryotic microbial communities living in stressful

polluted soil environments. This would allow the characterization of genes implicated in adaptation to these stressful conditions such as: heavy metal resistance mechanisms but also genes implicated in basic processes such as organic matter degradation under stressful conditions. A new process/protocol to construct sized eukaryotic cDNA libraries using low input of total environmental RNA from soil samples has been developed. This technique is simple and cost effective. It will facilitate the cloning of environmental expressed eukaryotic genes and will contribute to a better understanding of basic biological and/or ecological processes carried out by eukaryotic microbial communities.

27. Project No. 4803-2

Title: DNA encapsulated Quantum dots for Bio-imaging

Principal collaborators (India)	(France)
Dr. Yamuna Krishnan/Prof. Praveen Kumar Vemula National Center for Biological Sciences Bangalore	Prof. Benoit Dubertret ESPCI Paris-Tech Paris

The project aimed at preparation of non-blinking DNA-functionalized Quantum Dots (QDs) for biological applications, functionalize QDs with known stoichiometry of DNA and use these DNA-QD conjugates for biological applications.

In this project, several new types of bioimaging probes with superior properties have been developed. Additionally, the proof of principle applicability of these probes in specific contexts has been demonstrated. The most valuable outcome of this project is that all the methods and approaches developed herein have tremendous generalizability and can be tuned in context specific manner. This is aimed to benefit the highly interdisciplinary and rapidly expanding community of material scientists and biologists.

28. Project No. 4803-3

Title: Mechanisms of Lysine acetyltransferase (KAT/HAT) activation by small molecule activators and use thereof in memory

Principal collaborators (India)	(France)
Prof. Tapas Kumar Kundu Jawaharlal Nehru Centre for Advanced Scientific Research Bangalore	<i>Dr. Anne-Laurence Boutilier</i> Laboratoire d'Imagerie et de Neurosciences Cognitives UMR 7237 UdS/CNRS Strasbourg

It was proposed to study the effect of a newly-generated Histone acetyltransferase (HAT) activator in adult neurogenesis, memory formation and in Alzheimer's disease mouse model. PIs elucidated the following through this joint study:

For the first time, *in vivo* pharmacological activation of the HATs CBP/p300 is achieved in the adult mouse, with the conjugation of an activator molecule (TTK21) to a carbon nanosphere (CSP) particle. Pre-clinical studies with CSP-TTK21 HAT activator led in normal and pathological (Alzheimer's model) mice showed a benefic effect on plasticity and memory-related processes, with a clear mode of action defined at the epigenomic and genomic levels. Such molecules – or derivatives – could be of use for bringing cognitive recovery in neurodegenerative diseases. Further improvement in the drug delivery by producing shape-directed nanoparticles able to specify subcellular compartment, will help to carry molecules targeting epigenetic enzyme closer to the gene sites.

29. Project No. 4903-1

Title: Control of melanosome biogenesis by small GTPases

Principal collaborators (India)	(France)
Dr. Subba Rao Gangi Setty Indian Institute of Science Bangalore	<i>Dr. Graca Raposo</i> Institut of Curie, CNRS UMR144 Paris

The aim of this project was to investigate the role of small GTPases Rab proteins in endosomal trafficking and generation of functional melanosomes in melanocytes, investigating the function of GTPases of the Arl family in

the formation of melanosomes and investigating how GTPases dependent trafficking steps, melanosome biogenesis and transfer are influenced by interaction of keratinocytes with melanocytes. The results of the project demonstrate that several endosomal Rab GTPases that regulate different protein trafficking steps from different endosomal domains during melanosome biogenesis were characterized. The study also unraveled a previously unknown post Golgi-melanosome pathway required for melanogenesis and controlled by Rab6AA' GTPases. These studies were recently accepted in Nat. Communication. Furthermore, a role of Arf-like GTPase (ARL4A) that regulates melanosome biogenesis by controlling AP-3 dependent cargo transport to melanosomes was highlighted.

30. Project No. 4903-2

Title: Study of neural development in hiPS models of microcephaly

Principal collaborators (India)	(France)
Dr. Shyamala Mani Indian Institute of Science Bangalore	Prof. Pierre Gressens Institut National de la Santé et de la Recherche Médicale, INSERM U1141, Paris

The stated goal for this project was to create *in vitro* models of human brain developmental disorders. The particular disorder that was modelled was autosomal recessive primary microcephaly (MCPH), chosen because of the criticality of human *in vitro* models to understand the disease and the expertise of the principal investigators in this area of research. To create humanized models of MCPH, induced pluripotent stem cell technology was used. As there are no known cures for most brain disorders and therefore this approach could prove very valuable in discovering novel signaling pathways and potential drug targets. hiPSC can be used for drug discovery platforms. The outcome of this project is as follows:

- a) Generation of human induced pluripotent stem (hiPS) cell lines from normal human fibroblasts and patients fibroblasts mutated in MCPH1
- b) Differentiation normal and patients hiPS cell lines into neural progenitors
- c) Study of cell cycle and proliferation of neural progenitors

- d) Study of cortical neurons specification
- e) Study of centrosome composition, and cell polarity

31. Project No. 4907-1

Title: Tropical cyclones in the Bay of Bengal: Oceanic response and air-sea interactions

Principal collaborators (India)	(France)
Ms. S. Neetu National Institute of Oceanography Goa	Dr. M. Lengaigne Université Pierre et Marie Curie Paris

The project aimed at studying Tropical Cyclones (TCs), one of the deadliest natural hazards in coastal areas, causing huge lives and property losses. The Indian sub-continent is one of the most badly affected regions in the world. Cyclone track and intensity prediction is hence an important part of hazard mitigation programs. One of the significant constraints on TCs intensity predictions is the lack of knowledge about the ocean response to the storm forcing. TCs induce intense upper ocean mixing resulting in a surface cooling and a chlorophyll bloom. In this project, the original objectives were:

- Quantification of the oceanic control on tropical cyclones-induced surface temperature and chlorophyll response in the Bay of Bengal, with an emphasis on the role of salinity stratification using an ocean model
- Understanding how this surface cooling retroacts onto the TC characteristics in this region by using a regional coupled ocean-atmosphere model
- Development of statistical prediction schemes in this region in order to quantify the skill improvement brought by accounting for ocean-atmosphere interactions under TCs

A statistical forecast models for TCs intensity change has been developed. A non-linear architecture such as ANN models outperforms the currently used linear (MLR) models and better accounts the air-sea interactions under TCs by including more suitable subsurface oceanic information. This knowledge/tool generated can greatly benefit the agencies responsible for operational TCs forecast.

32. Project No. 5001-1

Title: Hypergeometric functions: harmonic analysis and representation theory

Principal collaborators (India)	(France)
Dr. E. K. Narayanan Indian Institute of Science Bangalore	<i>Dr. Angela Pasquale</i> Université de Lorraine 57045 Metz Cedex 1

The general goal was to develop the Heckman-Opdam theory of hypergeometric functions in several directions. In the original setting, this group hoped to continue the study of hypergeometric functions root systems in a systematic manner and develop the L_p harmonic analysis. A detailed study of hypergeometric functions was a natural continuation. This larger class of special functions associated with roots systems is geometrically motivated by the extension of spherical harmonic analysis to the non-compactly causal symmetric spaces. There are several new features that emerge when one deals with hypergeometric functions, such as their singularities. In another direction, developing a similar theory for the root systems of Lie super-algebras and super-symmetric spaces seems to be an exciting project. The following are salient achievements of the project:

- a) Study of the Heckman-Opdam hypergeometric functions on the root system BC for some natural classes of non-positive multiplicities: positivity, estimates, asymptotic expansions
- b) Study of the radial parts of the invariant differential operators on homogenous line bundles over non-compact Hermitian symmetric spaces G/K associated with one dimensional representations of K
- c) Construction of a 1-parameter family of (multivariable) hypergeometric functions as analytic continuation of the spherical functions on the homogeneous line bundles as in b)
- d) Study of the hypergeometric functions of the 1-parameter family of 3) and characterization of the bounded ones (under natural restrictions on the parameter)
- e) Paley-Wiener theorem, Plancherel and inversion formulas for the hypergeometric transform associated to the above hypergeometric functions

33. Project No. 5003-1

Title: Muscle SC self-renewal: A stressful matter?

Principal collaborators (India)	(France)
<i>Prof. Jyotsna Dhawan</i> Institute For Stem Cell Biology and Regenerative Medicine, NCBS Bangalore	<i>Prof. Ana Ferreiro</i> UMR 8251 Université Paris Diderot/CNRS Paris cedex 13

The project aimed at studying Selenoprotein N (SEPN1), one of the rare selenoproteins linked to a monogenic muscle disease, SEPN1-related myopathy, which presents with severe skeletal muscle weakness and wasting, leading to respiratory failure (due to impact on the diaphragm muscles) and premature death. Increase of intracellular oxidant activity in the absence of SEPN1 suggests an antioxidant role, but SEPN1 interactions and functions are poorly understood. Loss of muscle stem cells (satellite cells; SC) and regenerative capacity in SEPN1 KO mice has recently revealed SEPN1 as a potential novel actor in maintaining muscle stem cell function. Using a combination of *in vitro* and *ex vivo* expertise and models, this project aimed for the first time to clarify the role of SEPN1, associated oxidative stress and epigenetic modifications in SC self-renewal, and their response to pharmacological intervention. Overall, this study has established a new model for understanding and addressing SEPN1 disease pathology. These findings represent a major step forward towards finding a treatment for SEPN1-related myopathy, which is currently a rare, incurable disease. Most importantly, they will facilitate using this rare disease as a model paradigm to assess the potential for therapeutic interventions which can modulate myogenic regeneration and regulation of the stem cell pool in regenerative medicine for other prevalent conditions, such as age-related muscle loss or cachexia, which represent major public health concerns.

34. Project No. 5103-2

Title: Olfactory Modulation of Insect Flight

Principal collaborators (India)	(France)
<i>Prof. Gaiti Hasan</i> National Centre for Biological Sciences, TIFR Bangalore	Dr Jean-François Ferveur Université de Bourgogne Bourgogne

The project aimed at mapping the developmental pattern of neural structures underlying motor aspects of walking and flying and establishing the adult pattern of the central neural region(s) receiving the wing chemosensory modulatory inputs. Dr. Gaiti Hasan's group has identified a set of central dopaminergic neurons (PAM neurons) required during free flight for normal response to an odor-stimulus in the wind tunnel. They have identified an Octopamine receptor on the dopaminergic neurons as required for successful landing on the odor source in the wind tunnel. Dr. Jean-Francois Ferveur's group has completed response in the wind tunnel to a single odorant stimulus (food) and to a dual choice between food and pheromones. Experiments included manipulation of wings and of pheromonal perception.

35. Project No. 5103-4

Title: Decipher the symbiotic program in tropical legumes

Principal collaborators (India)	(France)
Prof. Maitrayee DasGupta University of Calcutta Kolkata West Bengal	Dr. Fabienne Cartieaux Laboratoire des Symbioses Tropicales & Méditerranéennes (IRD) Montpellier cedex 5

This project aimed at profiling the transcriptome involved in early global responses associated with inception of symbiosis in *Arachis hypogaea* and *Arachis evenia* and allowed comparison of results obtained for each plant in order to discover common and/or divergent molecular actors implicated in such tropical symbiosis. To this end, massive transcriptomics resources have been constituted by the Indian team for *A. hypogaea* and French team for *A. evenia*. These resources are used to identify genes activated during the early steps of the interaction with Bradyrhizobium.

The peanut base resource is developed by International peanut researchers and breeders, with support from many contributors that have made the Peanut Genomics Initiative possible. The transcriptome data would be more visible and usable if it can be accessed in data bases like <https://peanutbase.org/> which is a sister site of LIS – Legume Information System. The database administrators have agreed to host the data in these databases and the process is ON. The data on *Aeschynomene evenia* is being put up in a new database by french initiative in LSTM.

36. Project No. 5104-1

Title: Magnetic nanoparticles for hyperthermia and spintronics

Principal collaborators (India)	(France)
<i>Dr. Varsha Banerjee</i> Indian Institute of Technology Delhi	Dr. Julian CARREY INSA Toulouse Toulouse Cedex

The project had the following objectives:

- To develop theoretical frameworks to study equilibrium and non-equilibrium properties of assemblies of magnetic nanoparticles (MNPs) in the form of suspensions, powders, gels and 2D and 3D arrays within the two-level approximation
- To develop numerical techniques especially suited to handle long-range dipolar interactions ubiquitous in MNP assemblies to understand the morphological organization of the moments
- To identify model systems for efficient experimental and theoretical comparisons for hyperthermia and spintronics
- To study very precisely the structural properties of the model systems using electron microscopy
- To study experimentally the magnetic properties of the model systems using i) standard magnetometry, high-frequency hysteresis loops and heating power

Several types of nanoparticles have been developed for this project. Moreover, several types of numerical programs or procedures have been developed: i) kinetic Monte-Carlo simulations adapted to study the relaxation properties in assemblies of nanoparticles, ii) micromagnetic simulations adapted to calculate the TMR properties in assemblies of nanoparticles. Iii) Development of Ewald sum techniques for dipolar assemblies. Finally, model systems have been identified where joint experimental and theoretical work can yield convergence.

37. Project No. 5203-1

Title: Molecular study of RH gene variants in Indians

Principal collaborators (India)	(France)
Dr. Swati Kulkarni National Institute of Immunohematology Mumbai	Dr. Yann FICHOU Etablissement Français du Sang – Bretagne, Inserm UMR1078, BREST Cedex 2

The project studied the Rh gene variants in India. The Rh blood group system, which involves the homologous RHD and RHCE genes, has been widely studied in the Caucasian, African and Asian populations. Although Rh phenotype data have been reported in the Indian population, little is known about the genetic variants driving Rh phenotype. By studying the Rh gene variants in the Indian population, this project aimed to provide a molecular pattern of distribution of both the RHD and RHCE gene variants in the Indian population, to define potential novel population-specific variants/clusters and to delineate correlation between phenotypes and genotypes by functional studies.

A multiplex PCR-based, Indian-specific RHD genotyping test was developed. The findings will be valuable to biologists/clinicians for the clinical management of transfusion and pregnancies at risk in India.

38. Project No. 5303-1

Title: Deciphering the role of *Mycobacterium tuberculosis* Serine/Threonine protein phosphatase PstP

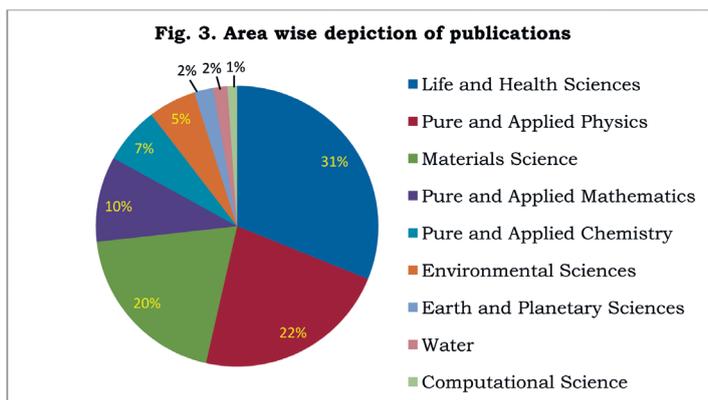
Principal collaborators (India)	(France)
Dr. Vinay Kumar Nandicoori National Institute of Immunology New Delhi	Dr. Virginie Molle Université Montpellier 2, Rhone-Alpes

Here, the group aimed to comprehensively investigate the role played by the sole serine/threonine protein phosphatase PstP. Specifically, the objective was to generate conditional gene deletion mutant of PstP in *M. smegmatis* and *M. tuberculosis*. The mutants generated would be used to delineate its impact on phosphorylation status of protein kinases PknA, PknB and some of their substrates. The data generated suggests an important role for PstP

in establishing and maintaining infection, possibly via the modulation of cell division events. The group has identified 150 novel interacting proteins of PstP and they overlaid this on phosphoproteomic data and are pursuing multiple essential and non-essential candidates to delineate the role of PstP in mycobacteria.

3c. Publications from the Completed CSRP projects

One of the most important indices for assessing the outcome of a scientific project is the analysis of emanated publications. Therefore, it is very important to know this outcome. This number was obtained from the final report of the projects which were submitted to the Centre after the completion of the projects. A total of 183 research papers were published from the above mentioned 38 completed projects. Life and Health Sciences accounted for maximum number (57) of publications, followed by Pure and Applied Physics (41), Materials Science (36), Pure and Applied Mathematics (18), Pure and Applied Chemistry (12), Environmental Sciences (10), Earth and Planetary Sciences (4), Water (3) and Computational Science (2). The percentage representation is depicted in the pie chart (Figure 3) below.



The list of projects with average impact factor (IF) and a total citation (TC) for the above mentioned 183 papers is given in Table 1:

Table 1: Impact Factor and Total Citation for the Publications from the Completed Projects

Project No.	No. of Papers	Sum of IF	Average IF	TC	Average TC/paper
3701-1	10	9.487	0.949	53	5.3
3703-2	9	31.956	3.551	102	11.333
3800-W1	3	8.437	2.812	76	25.333
3803-3	7	43.355	6.194	137	19.571
3808-2	15	59.716	3.981	356	23.733
3904-1	12	28.95	2.413	125	10.417
4005-1	2	6.188	3.094	18	9
4101-1	8	5.068	0.634	14	1.750
4103-1	4	22.952	5.738	49	12.250
4105-1	10	63.219	6.322	289	28.900
4403-1	3	13.699	4.566	15	5.000
4409-1	7	19.464	2.781	51	7.286
4503-1	1	4.886	4.886	39	39.000
4503-2	2	9.419	4.710	3	1.500
4508-1	10	70.905	7.091	516	51.600
4603-1	5	33.526	6.705	70	14.000
4603-2	0	0	0	0	0
4603-3	1	2.823	2.823	1	1
4604-4	3	9.413	3.138	5	1.667
4608-2	11	44.723	4.066	118	10.727
4702-1	2	0.841	0.421	1	0.500
4703-1	5	13.958	2.792	33	6.600
4704-1	17	63.348	3.726	143	8.412
4704-2	4	10.136	2.534	6	1.500
4704-3	1	0	0	0	0
4709-1	3	9.986	3.329	12	4.0
4803-2	2	7.193	3.597	17	8.5
4803-3	5	26.558	5.312	86	17.200
4903-1	4	23.13	5.782	33	8.25
4903-2	3	13.859	4.620	18	6.0

Project No.	No. of Papers	Sum of IF	Average IF	TC	Average TC/paper
4907-1	4	24.591	6.148	41	10.250
5001-1	0	0	0	0	0
5003-1	0	0	0	0	0
5103-2	3	17.32	5.77	3	1
5103-4	1	4.332	4.332	1	1
5104-1	4	19.95	4.988	5	1.25
5203-1	1	3.423	3.423	0	0
5303-1	1	4.125	4.125	3	3

3d. Patents from the Completed CSRP Projects

While the performance in terms of scientific publication is an established yardstick for measuring the outcome of a project, it is also important to assess the outcome in terms of Intellectual Property (IP). A total of 7 patents were filed/generated from the 38 completed projects involving woman PIs from India and France. The details of the patents are listed below:

1. Project No. & domain: 3803-3; Life and Health Sciences (Dr. Shyamala Mani)
Project title: Neural differentiation of embryonic stem cells
Patent summary/title: “Novel applications of HIP/PAP or derivatives thereof”
Application Status: The application is undergoing examination. European Patent, (No. 09290437.4 – 1521).
2. Project No. & domain: 4105-1; Pure and Applied Chemistry (Prof. Michèle Salmain)
Project title: Practical methods for surface bio functionalization
Patent summary/title: “A visual detection method of a protein using gold nanoparticles generated <i>in situ</i> and a kit thereof”
Application Status: A Patent (294/KOL/2010) entitled ‘A visual detection method of a protein using gold nanoparticles generated <i>in situ</i> and a kit thereof’ filed on 23.3.2010 and under examination at Indian Patent Office.
3. Project No. & domain: 4503-2; Life and Health Sciences (Prof. Christine Chomienne)

Project title: Evaluation of cellular and immune response in mice and patients with acute promyelocytic leukemia treated with arsenic trioxide

Patent summary/title: Not available

Application Status: The French group has already a patent on the vaccine.

4. Project No. & domain: 4604-4; Pure and Applied Physics
(Dr. Hema Ramachandran)

Project title: Realtime Imaging Through Fog Over Long Distance (RITFOLD)

Patent summary/title: A new all-optical full-field and reference-free quadrature demodulation technique has been patented within this project (International PCT Patent filed on 10th May 2016). Relying on a specific optical arrangement including an electro-optic crystal, the technique is in principle capable of demodulating signals in an image in a parallel way up to frequencies above GHz.

Application Status: (International PCT Patent, filed on the 10th May 2016, Identification number: PCT/FR2016/ 051086).

5. Project No. & domain: 4803-3; Life and Health Sciences
(Dr. Anne Laurence BOUTILLIER)

Project title: Mechanisms of Lysine acetyltransferase (KAT/HAT) activation by small molecule activators and use thereof in memory

Patent summary/title: “A Nanosphere-Histone Acetyltransferase (HAT) Activator Composition and Process Thereof”

Application Status: European Patent Application No: 13731163.5; Status: Received Communication under Rule 71(3) EPC-Intention to Grant Patent.

6. Project No. & domain: 4803-3; Life and Health Sciences
(Dr. Anne Laurence BOUTILLIER)

Project title: Mechanisms of Lysine acetyltransferase (KAT/HAT) activation by small molecule activators and use thereof in memory

Patent summary/title: “A Nanosphere-Histone Acetyltransferase (HAT) Activator Composition and Process Thereof”

Application Status: US Patent Application No: 14/397,561; Status: Received Notice of Allowance.

7. Project No. & domain: 5203-1; Life and Health Sciences
(Dr. Swati Kulkarni)

Project title: Molecular study of Rh gene variants in Indians

Patent summary/title: “Development of a multiplex PCR-based, Indian-specific RHD genotyping test”

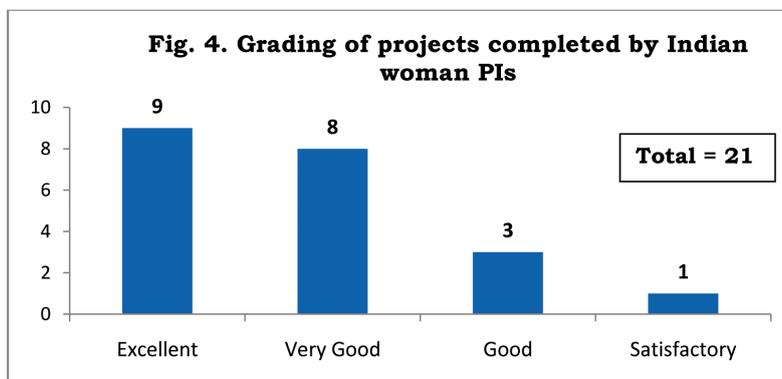
Application Status: Deposit date (Europe): 08.03.2017 – Application No: 17 305 246.5
Inventors : Dr. Yann Fichou, Dr. Swati Kulkarni
Owners: Indian Council of Medical Research (ICMR), National Institute of Immunohematology (NIIH), Etablissement Français du Sang (EFS), Institut National de la Santé et de la Recherche Médicale (Inserm), Université de Bretagne Occidentale (UBO). Status: abstract and title approved.

3e. Performance Index of the Completed CSRP Projects

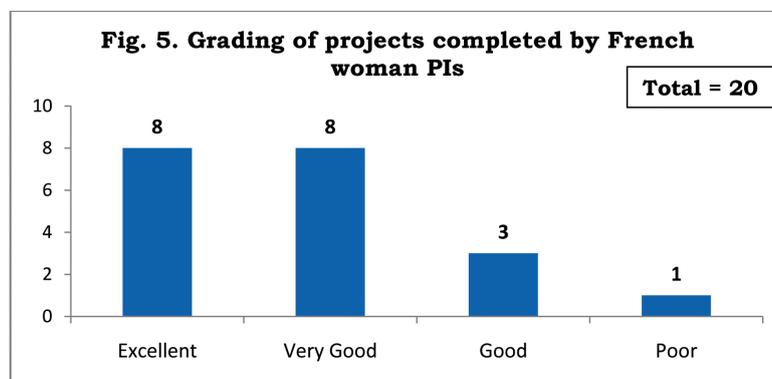
The Scientific Council of CEFIPRA consists of five eminent scientists from each country, which are nominated by the respective governments. The SC identifies thrust areas of research, selects research themes for support by the Centre and evaluates joint project outcome and other scientific activities as may be desired by the Governing Body.

The SC developed the parameters which were used for the grading of completed projects based on the performance. Projects were graded as excellent, very good, good, satisfactory, average and poor, depending upon their adherence to the parameters. The defined criteria was based on parameters like excellence in science through collaboration, training of young Doctoral/Postdoctoral students, potential output for knowledge forward chain and long term partnership between the collaborating investigators and their groups. Moreover, the achievements against the objectives of the projects, scientific publications, development of resources (libraries, new methods, data collections etc.) and innovation/resulting patents or potential of application/commercialization (new technology/products/process) were also assessed. For the projects, which are graded as 'excellent', both the French and Indian Principal Collaborators are eligible for an additional exchange visit of 15 days, which has to be undertaken within a year of review of the project.

The grading for the 21 completed projects, led by Indian woman PIs is given below in Figure 4:



The grading for the 20 completed projects, led by French woman PIs is given in Figure 5 below:



From the above mentioned data, it can be concluded that almost **43% and 40%** of the projects led by Indian and French woman PIs, respectively, were graded as **excellent**.

Out of the 9 excellent projects from the Indian side, 5 were from the area of Life & Health Sciences, 2 from Pure and Applied Physics and 1 each from Computational Science and Earth and Planetary Science. From the very good category, 3 were from the area of Life and Health Sciences and 2 each from Pure and Applied Physics and Pure and Applied Mathematics and 1 from Environmental Science.



Out of the 8 excellent projects from the French side, 6 were from the area of Life & Health Sciences and 2 from Materials Science. From the very good category, 4 were from the area of Life & Health Sciences and 1 each from Pure and Applied Physics, Environmental Science, Materials Science and Pure and Applied Chemistry. From the above mentioned data, it is apparent that the completed CSRP projects led by Indian and French woman PIs were scientifically rewarding.

4. Industry-Academia Research & Development Programme (IARDP)

The Industry-Academia Research & Development Programme (IARDP), formerly named as Industrial Research Programme (IRP) of CEFIPRA was launched in 2002 to support collaborative research programme involving Industry & Academia of both the countries. Since its inception, this programme has worked as an enabling platform for the organizations in India & France to realize their potential in terms of product and process development and has facilitated innovation, competitiveness for industries and also brought the private industries, public institutions and the government under one umbrella. The projects supported under the programme have resulted in some prominent outcomes in the form of products which have already come to the market and some promising research leads seeing ray of hope for commercialization.

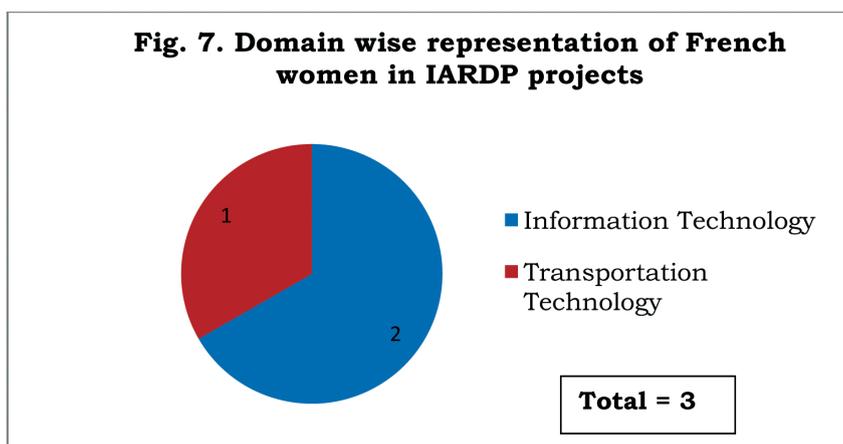
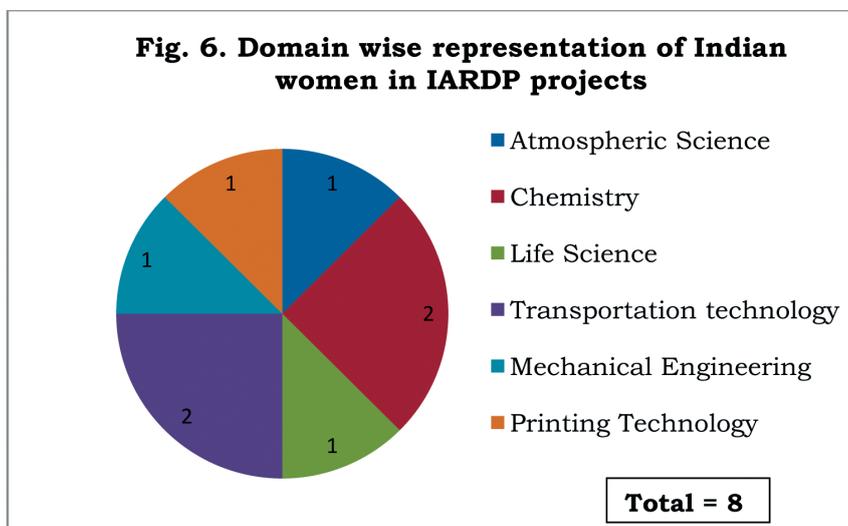
The primary objective of this programme is to promote the development of new processes or products or the improvement of existing processes or products, thus offering the industrial partners to enhance competitiveness at the international level. Therefore, all the areas of Science & Technology which are of interest to the industry are supported under this programme.

The projects undergoing under this programme are monitored by the Industrial Research Committee (IRC) which comprises of eminent representatives from academia and industry from India and France, nominated by the respective governments. The project proposals that can be submitted in the framework of this programme should preferably involve at least one industrial partner and one research institute each from India & France. However, project proposals not fulfilling this model are also eligible, if appropriately justified.

4a. Participation of Woman Scientists in the IARDP in Last Ten Years

A total of 28 projects have been supported in the IARDP in the last ten years (1.1.2008 to 31.12.2017). Nine out of these 28 projects involve Indian and French women as PIs/Co-PIs. In these nine projects, there have been 8 women from the Indian and 3 from the French side. The domain wise

representation of Indian and French women in IARDP projects is depicted in the following pie charts (Figures 6 & 7):



The above mentioned pie charts for the projects involving Indian and French woman PIs indicated scientific and technological heterogeneity of the IARDP.

Out of the 9 projects involving woman PIs from India and France, five have completed their duration. The outcome summary of these five projects is listed below:

4b. Summary and Scientific Outcome under IARDP projects

1. Project No. 7113

Title: Friedel crafts acylation of 2,4-Dichloro-5-Fluoro Acetophenone (DCFA) for Ciprofloxacin production

Principal collaborators (India)	(France)
<i>Dr. Lakshmi Kantam</i> Indian Institute of Chemical Technology (IICT) Hyderabad	Dr. Michel Vaultier Université Bordeaux 1 Talence
Industry partner from India Dr. P Ravi Neuland Laboratories Limited Hyderabad	
Duration of the project: April 2011 to March 2014 (preclosed in 2013)*	

The project aimed at devising an environmental friendly method for the synthesis of DCFA, an intermediate in the synthesis of Ciprofloxacin. The antibiotic Ciprofloxacin is used to treat a broad spectrum of bacterial infections caused by Gram negative and Gram positive bacteria. In addition, the project also aimed at an alternative synthesis of DCFA or a substitute for Ciprofloxacin. The investigators were successful in designing an alternative method for the synthesis of DCFA from 3-chloro 5-phenyl. However, in spite of the several efforts, the intended objectives of the project could not be met.

*It was noted that the collaborators had carried out a large number of experiments for the acylation of 2-4-Dichloro Benzene for the synthesis of DCFA but without success. It was also noted that the collaborators had come out with an alternative synthesis of DCFA starting from 3-Chloro 5- Phenyl. However, in spite of the efforts put in by the investigators, the desired catalyst could not be developed. Hence, the project was preclosed.

2. Project No. 7114

Title: Design & Scientific Validation of an Operational Protocol Allowing Real Time & Dynamic Mapping of Particulate Pollution Using Quantitative Indicators in the Vicinity of Intense Sources

Principal collaborators (India)	(France)
Dr. Chandra Venkatraman Indian Institute of Technology-Bombay Mumbai	Prof. Herve Delbarre Universite du Littoral-Cote d'Opala, Dunkerque Dr. Jean-Francois Leon Laboratoire d'Aerologie, Observatoire Midi-Pyrenees, Toulouse Industry partner from France: Dr. Benjamin Guinot Leosphere
Duration of the project: May 2011 to June 2014	

The project aimed at measurement of air quality to map the pollution, through Light Detection and Ranging (LIDAR) and complementary systems. This was expected to lead to design and scientific validation of an operational protocol allowing real time and dynamic mapping of particulate pollution using quantitative indicators. The objective was to have an integrated process that will provide to the air quality market, an innovative solution to experimentally map the particulate pollution distribution using quantitative indicators and provide an alternative to the *in situ* measurements. For achieving this objective, the investigators employed the LIDAR technology. By the use of this technology, the parameters affecting the conversion of raw data to a definite concentration were understood. The results of this project were reviewed and it was observed that the project can lead to a marketable product in the future. This product can be of immense help to agencies involved in public health and/or environmental protection.

3. Project No. 7116

Title: Selective oxidations with Hydrogen Peroxide: Development of new catalysts and process conditions

Principal collaborators (India)	(France)
<i>Dr. Subhangi Umbarkar</i> National Chemical Laboratory Pune	Dr. Markus Brandhorst Arkema Centre de Recherche Rhone-Alpes Dr. Edmond Payen Universite Lille 1 Lille Industry partner from France: Dr. Jean-Luc Dubois ARKEMA, Paris
Duration of the project: January 2013 to December 2015	

This project was aimed at the development of new catalysts which could be used for oxidation with hydrogen peroxide. The project focused on activation of the green oxidant hydrogen peroxide and its use as a reagent in reactions with biomass. Different selective oxidations with hydrogen peroxide were studied based on the various molybdenum complexes. To achieve these objectives, a total of 14 catalysts samples were prepared and subsequently characterized by spectroscopic methods. It was found that the optimized oxidation parameters showed better activity in the neutral medium. The outcome of this project has implications for use in several industrial and chemical processes.

4. Project No. 7117

Title: Screening for K-Ras and B-Raf Mutations in Tumor Tissues & Circulating Nucleic Acids present in Plasma and Urine in Patients with colorectal cancers in India

Principal collaborators (India)	(France)
Dr. C. Mohan Rao CCMB, Hyderabad Industry partner from India <i>Dr. Rama Mukherjee</i> ARA Healthcare, Gurgaon	Industry partner from France Dr. Alain Thierry Sysdiag, Montpellier
Duration of the project: February 2013 to January 2015	

The above mentioned pilot project aimed at devising a minimal to noninvasive methodology for the isolation and characterization of nucleic acids circulating in the biological fluids of patients suffering from colorectal cancer. A novel methodology was developed, which allowed the isolation of nucleic acids and their molecular characterization. The project has implications for the development of a diagnostic kit. It was suggested to involve the industrial partner to take the project further. Concerns were raised about the inadequate number of urine & blood samples used by the investigators and also non-involvement of industrial partners in the project. It was also suggested for addition of external fragment DOPE DNA and checking the efficacy of Intplex technology.

5. Project No. 7120

Title: Device to Device Communication for LTE Advanced Cellular Network

Principal collaborators (India)	(France)
Prof. Ketan Rajawat IIT Kanpur	Dr. Marceau Coupechoux, <i>Dr. Michele Wigger</i> Institut Mines-Telecom Ecole Normale Supérieure des Télécommunications Telecom Paris Tech, Paris
Prof. Neelesh B. Metha & Prof. Chandra R. Murthy IISc., Bangalore	Dr. Cedric Adjih/ Dr. Paul Muhlethaler INRIA Pairs –Rocqencourt
Dr. Rahul Vaze TIFR, Mumbai	Industry partner from France <i>Ms. Amira Alloum</i> Alcatel Lucent Bell Labs France (ALBLF) Now: Nokia Bell Labs, Nozay
Duration of the project: April 2015 to March 2018	

The project, which was aimed at the designing of parameters, algorithms and novel protocols related to Device to Device (D2D) network was highly fruitful. The technology developed on D2D is relevant for the 5G communications standard, which is currently being standardized. It also has relevance for vehicular communications. Furthermore, there were 2 patents and 17 publications from this project. The level of interaction between the Industry and Academia partners was very high. They all brought good results with two joint patents between Nokia Bell Labs & TIFR and another between Nokia Bell Labs & IMT with more than 18 publicatios.

5. DST-Inria-CNRS Targeted Programme

Department of Science and Technology (DST), Govt. of India and Institut National de Recherche en Informatique et en Automatique (Inria) jointly with the Centre National de la Recherche Scientifique (CNRS), France launched a Targeted Programme under the name of DST-Inria-CNRS Targeted Programme in October 2013, to foster collaboration between scientific Communities of two countries in the area of Information and Communication Technology (ICT). The sub-areas for collaboration under this programme are:

1. Big Data
2. Computer science for Biology and Life Sciences
3. Artificial Intelligence
4. Cyber Physical Systems
5. Any other proposal in ICST and Applied Mathematics may also be considered

5a. Participation of Woman Scientists in DST-Inria-CNRS Targeted Programme

A total of 21 projects have been supported under this programme since its inception and 6 projects have completed their duration. Out of these six projects, two involved Indian woman PIs. The summary of these two projects is listed below:

1. Title: Post-stroke Tele-neurorehabilitation using an Operant Conditioning Paradigm under Volitionally driven Transcutaneous Neuromuscular Electrical Stimulation

Principal collaborators (India)	(France)
<i>Dr. Uttma Lahiri</i> Indian Institute of Technology Gandhinagar	Dr. Mitsyhiro Hayashibe Research Scientist of the DEMAR team of INRIA
Duration of the project: September 2014 to August 2017	

The project objective was to develop, a simple to use, clinically valid home-based tool for post-stroke neurorehabilitation, that can be used both in rural and urban setting. Specifically, the group aimed at developing a cyber physical system for tele-neuro-rehabilitation by integrating biosignal sensors, eye tracker, and motion capture to deliver volitionally-driven multi-channel neuromuscular electrical stimulation. They also intended to develop gaze interaction with biofeedback as the human-machine interface for the cyber physical system to enforce active supraspinal participation for operant conditioning. The PIs developed *SmartEye*: a cost-effective, simple to use, clinically valid tool for screening one’s probable neurological disorder from oculomotor signature. Apart from the remarkable output for the detection of neurological disorders, the project led to nine publications and one Indian patent [Patent filed (Appln. No.: 3959/MUM/2014) on “Eye Tracking System”; Also applied for PCT application (PCT/IN2015/000448)].

2. Title: Algorithmic Verification of Real time systems (AVeRTS)

Principal collaborators (India)	(France)
Dr. S. Krishna Indian Institute of Technology, Bombay Mumbai	Dr. Frederic Herbreteau Institut Polytechnique de Bordeaux Talence
Duration of the project: September 2014 to August 2017	

The project AVeRTS aimed at developing formal methods for the automatic design and analysis of real-time systems. Digital systems control most of the devices that surround us. Timing constraints are often crucial for cyber-physical systems that are designed to interact with the physical world. Correctness of cyber-physical systems that work under time-constraints is an ongoing challenge since traditional methods based on testing are no longer applicable in a safety-critical setting. This project aims at enlarging the applicability of formal verification for certifying correctness of timed systems. In the last years, the group has been working on improving state of the art algorithms for the verification and synthesis of timed cyber physical systems. The results have opened a way to new approaches to algorithmic verification of timed systems. The goal of this project is to explore these new possibilities, and to make them accessible to industrial designers. Besides the above mentioned achievements, there were 16 publications from the project and three workshops were organized.

6. DST-ANR Targeted Programme

Department of Science and Technology (DST), Govt. of India and Agence Nationale de la Recherche (ANR), France signed a MoU in March, 2012 to launch the DST-ANR Targeted Programme with the aim to foster the Indo-French collaboration in scientific research and to fund joint research projects conducted by teams from both countries. The areas for collaboration under this programme are:

1. Infectious Diseases
2. Engineering Sciences
3. Neurosciences

6a. Participation of Woman Scientists in DST-ANR Targeted Programme

A total of six projects have been supported in this programme since its inception; one project involved a woman Co-PI from India. The details of the project are given below:

Title: Soluble mediators of the immune system against *Aspergillus fumigatus*

Principal collaborators (India)	(France)
Dr. Arvind Sahu NCCS, Pune	Dr. Vishukumar Aimanianda Institut Pasteur, Paris
Co-PI <i>Dr. Taruna Madan</i> NIRRH, Mumbai	
Duration of the project: April 2014 to December 2017	

The project was focused on the interaction between *Aspergillus fumigatus* and the soluble mediators of the innate immune system. The specific goals were to i) decipher the influence of *Aspergillus fumigatus* morphotypes and their cell wall components on the activation of the soluble mediators of the immune system ii) analysis the role of *A. fumigatus* secreted proteins on the complement system and collectins and iii) the study of the antifungal



effect of host defense (antimicrobial) peptides – alone or in combination with other drugs. The PIs were able to demonstrate the interaction of the secreted metalloprotease, Mep1p with the host innate immune system. The results of this project which were published in six peer reviewed journals, have implications for designing interventional strategies against the pathogen.

7. Indo-French Water Network (IFWN) Programme

The IFWN is a targeted programme in which the Indian and French governments joined hands in order to reinforce scientific collaboration for addressing the prevalent and emerging challenges in the field of Water. This programme, which is funded by the Dept. of Science & Technology (DST), Govt. of India and the French Embassy in India, has the following objectives:

1. To form dedicated networks of Indian and French research groups & industries to address identified water issues
2. To strengthen and expand the quality and potential of water research in both countries by building greater interaction between France and India
3. To build stronger relationships between industry and academic communities in France and India coupled with better knowledge exchange, to form the basis for future collaborations, research projects, and joint endeavor related to water technology, research & innovations

The proposals are encouraged in the areas of Waste water treatment (Industrial/Domestic) and Natural water treatment systems. The programme was launched in 2015.

7a. Participation of Woman Scientists in IFWN

Two projects were supported in the first call of this programme and both have completed their duration. A woman Co-PI from France was involved in both the projects, details of which are given below:

1. Title: SWACHH NEER – UNE VIE MEILLEURE: Combating water issues through Indo-French networking

Principal collaborators (India)	France)
Indian partner Dr. Jitendra K. Pandey University of Petroleum and Energy Studies Dehradun	French partner Dr. Benoit Teychene Université de Poitiers, Poitiers French Co-PI <i>Dr. Julie Mendret</i> Institut Européen des Membranes (IEM), UMR Université Montpellier
Duration of the project: May 2016 to May 2018	

The SWACHH NEER – UNE VIE MEILLEURE project aims at developing, through networking between India and France teams, in-house technology for treating water. First of all, specific contaminant will be evaluated through a careful analysis of available water resources and wastewater in France and India. Thereafter, a technology based on filtration and nanoparticles engineering will be evaluated to treat the identified pollution. The group has been able to generate the data for existing water availability in the selected regions. Waste water generation and projection has been done in Uttarakhand (India) and Aquitaine (France). In addition, an inventory of existing wastewater management practice was developed along with the French and Indian scenario for water quality management.

2. Title: GreyWatNet: Network on Decentralized Grey / Waste Water Treatment & Recycle

Principal collaborators (India)	(France)
Indian partner Dr HN Chanakya Institute of Science, Bangalore	French partner Dr. Michel Torrijos INRA, Narbonne French Co-PI (Industry) <i>Dr Joëlle Paing</i> Company Jean Voisin
Duration of the project: June 2016 to June 2018	

The aim of this project was to put together a network of expertise that can address the issue of grey-water treatment and recycling as also evolve a

few demonstrable technology options that are sustainable and can be run on 'hands-free' mode coupled with long mean times between maintenance and failures (MTBF). Specifically, the group attempted to evolve a network of experts who can address the emerging challenge of decentralized greywater treatment technologies comprising of engineers, biologists, technologists and industry to facilitate availability and access to greywater treatment and recycling options. They also assessed, standardized and demonstrated two proof-of-concept streams for anaerobic-aerobic mode of greywater treatment options possessing low sludge and low maintenance characteristics. To achieve this, the project has put together two routes namely: (i) Natural fiber supported biofilm based 4-zone anaerobic-aerobic treatment process and; (ii) AnSBR in combination with constructed wetlands to address the technology gap. Constructed wetland alone and aerobic SBRs were used as appropriate controls. The group has been meeting periodically to specify the goals, tasks and agreements. They have developed an integrated system of vertical flow wetland (with *Canna indica*) and use of electrochemical treatment.

8. Innovation Programme through PPP Mode

In the Innovation Programme through PPP mode, the industries join hands with CEFIPRA as a funding partner for supporting R & D in defined priority areas. This programme, which is primarily aimed at innovation, product & process development, is funded by the respective Indian and French stakeholders and facilitated by CEFIPRA.

CEFIPRA & Biotechnology Industry Research Assistance Council (BIRAC), Govt. of India: With a joint intent to promote industry-academia collaboration and enhancement of international linkages, CEFIPRA and BIRAC, Govt. of India, entered into a Memorandum of Understanding (MoU) in February 2014. The objective of this MoU was to establish a collaborative framework for supporting challenge oriented, bilateral innovative research projects towards new concepts and technological breakthrough in the area of human health (Red Biotechnology). The following two programmes are in progress under this MoU:

- ***BIRAC-CEFIPRA-French Embassy programme:*** BIRAC and the French Embassy in India, represented by the Science and Technology Service (SST) have joined hands to support Indian and French collaborative projects involving academic actors, biotech start-ups and SMEs for promoting the innovation ecosystem in both the countries.
- ***BIRAC-CEFIPRA-French Bpifrance programme:*** Under the framework of the MoU signed between BIRAC and CEFIPRA, Bpifrance, a public investment bank from France, joined hands with CEFIPRA and BIRAC. The partnership aims to improve the competitiveness of both Indian and French biotech industries and academia.

8a. Participation of Woman Scientists in BIRAC-CEFIPRA Programme/s

A total of three projects have been supported in the BIRAC-CEFIPRA-French Embassy programme. Two projects (both of which have woman PIs from India and France) have completed their duration and one project is in progress. The outcome summary of the two projects is as follows:

1. Title: Oxidized HDL-Apolipoprotein A1 as a risk predictor of cardiovascular disorders and development of novel diagnostics

Principal collaborators (India)	(France)
<p>Indian academic partner Dr. Krishnan Venkataraman Associate Professor VIT University Vellore</p> <p>Indian Industry partner <i>Ms. Supriya Kashikar</i> General Manager GeNext Genomics (GNG) Private Ltd Nagpur</p>	<p>French academic partner Prof. Xavier Santarelli Professor Université de Bordeaux Bordeaux</p> <p>French Industry partner <i>Dr. Daniela Balvay</i> General manager/R&D Director SPAN Diagnostics S.A.R.L. Parc Technologique des Rives de l'Oise, 60280 Venette</p>
Duration of the project: April 2015 to March 2018	

Summary: The project was aimed at studying the biochemical properties of a protein implicated in mediating the protective effects of High Density Lipoprotein (HDL) in cardiovascular disorders. Cardiovascular disease (CVD) is a leading cause of morbidity and mortality worldwide. Atherosclerosis is one of the major causes of cardiovascular disease due to chronic inflammation. It is generally believed that the High-Density Lipoprotein (HDL) helps to reduce the risk of cardiovascular diseases via reverse cholesterol transport and anti-inflammatory effects. These protective effects of HDL are believed to be mediated by Apolipoprotein A-I (ApoA1), which is the major protein component of HDL. Furthermore, recent studies have suggested that the Myeloperoxidase-mediated oxidation of apoA1 particularly chlorination and nitration of tyrosine at positions 166 and 192 of ApoA1 impairs the quality of HDLs. This project was focused on developing immunological methods to detect the nitration and chlorination of tyrosine at positions 166 & 192 of ApoA1 from myocardial infarct/stroke patient sera and validate the quality of HDL in addition to existing quantitative estimation of HDL-Cholesterol for the diagnosis CVD risks in humans. The results of this project are likely to have a diagnostic value. There were two publications from this project.

2. Title: AMIR-PepKit IVD: R&D of a peptide-based – diagnostic kit for an early detection of immune response in acute myocardial infarction patients

Principal collaborators (India)	(France)
<p>Indian academic partner <i>Prof. Savita Yadav</i> Department of Biophysics All India Institute of Medical Sciences, New Delhi</p> <p>Indian Industry partner Dr. Arjun Surya President & CEO Curadev Pharma Private Limited Noida, UP</p>	<p>French academic partner <i>Prof. Anna Maria Papini</i> PeptLab@UCP- Université de Cergy-Pontoise Cergy-Pontoise</p> <p>French Industry partner Elian Lati SAS GENEX – Director 1 Chemin de Saulxier 91160 Longjumeau</p>
<p>Duration of the project: April 2016 to May 2018</p>	

The idea of this proposal was to investigate the expression of proteins and/or aberrantly modified proteins that could have antigenic properties in Acute Myocardial Infarction (AMI) and subsequently correlate the possible antibody response to them with disease activity. Recognition of specific antibodies present in sera of patients affected by diseases involving a dysregulated immune response is a relevant goal because these antibodies may have a diagnostic as well as a prognostic value. Therefore, a relevant technical goal is to identify differential expression of autoantibodies in MI with heart failure in comparison to other groups viz: MI without HF, healthy controls and HF without MI and also to develop simple immunoassays using specific peptides to detect them. The advantage of using peptides compared to proteins as antigens to detect antibodies is that it offers a higher specificity of recognition. Using proteomic approaches, antigenic markers have been identified and the identified autoantibodies have the potential to be used as biomarkers. This study may enhance the body of knowledge to contribute to understanding the molecular mechanisms of myocardial infarction and heart failure.

9. Participation of Woman Scientists: Trends and Outcome

For more than three decades, CEFIPRA has been the corner-stone for the promotion of scientific collaborations between India and France. The CSRP has been in existence since inception of the Centre and is instrumental in supporting academic collaborations in basic as well as applied sciences. During the course of its evolution in thirty years, the Centre has expanded its mandate by adding many new programmes to its basket. The programme, which aims at promoting Industry Academia collaborations was initiated in the year 2002 as the Industrial Research Programme (IRP) and subsequently revamped in 2015 as IARDP with the inclusion of small industries, i.e. SMEs, MSMEs and Start-ups. Thus, this programme is a unique platform for the industries of both the countries to come together and address the unmet technological needs. In the current decade, Targeted programmes were initiated which focused on specific thematic areas, keeping in mind the national research priorities of India and France. The Innovation Programme through the PPP mode was started to bring the Industry and Academia on a collaborative platform.

Since the CSRP is the oldest programme of the Centre, it is reasonable to expect the highest number of projects under this programme. Indeed, a total of 201 projects have been supported in the CSRP during the last ten years. Since the model of this programme involves one PI each from India and France, a total of 402 PIs have been involved in CSRP during all these years. Out of these 402 PIs, there have been 31 Indian and 35 French woman PIs. Therefore, in terms of percentage, **16.41% of PIs in the CSRP in the last ten years have been women. Country wise**, the percentage of woman PIs in these projects is **15.42% for India** and **17.41% for France**. The domain of **Life & Health Sciences accounts for 48.3% and 40% of the supported projects, involving Indian and French women, respectively**. This indicates a strong preference for this domain among the women PIs of India and France.

On the basis of a recent study done by NISCAIR on behalf of CEFIPRA, there have been **183 research papers** from the **38 completed projects involving**

Indian and French women. The highest percentage of publications has been in the domain of Life & Health Sciences, a data consistent with the fact that this domain accounted for highest number of supported projects. However, the most remarkable feature from the completed projects is the outcome in terms of Patents. **Seven patents** have been filed/obtained from the 38 completed projects, which mean that **18.42% of the completed projects had a patentable outcome.**

Grading of the projects done by the Scientific Council indicates another encouraging feature of these completed projects as almost **43% and 40% of projects led by Indian and French women** respectively were graded as **excellent**. These data suggest that the 38 CSRP projects completed in the last ten years, which involved Indian and French women, have been overall very fruitful in terms of scientific excellence.

The IARDP is relatively a new programme as compared to CSRP. Therefore, the number of projects (28) supported in the last ten years is less under this programme. The five completed projects involve women PIs from Indian and France. By and large, these completed projects have been successful in terms of generation of products or processes and have been accordingly rated by the Industrial Research Committee (IRC).

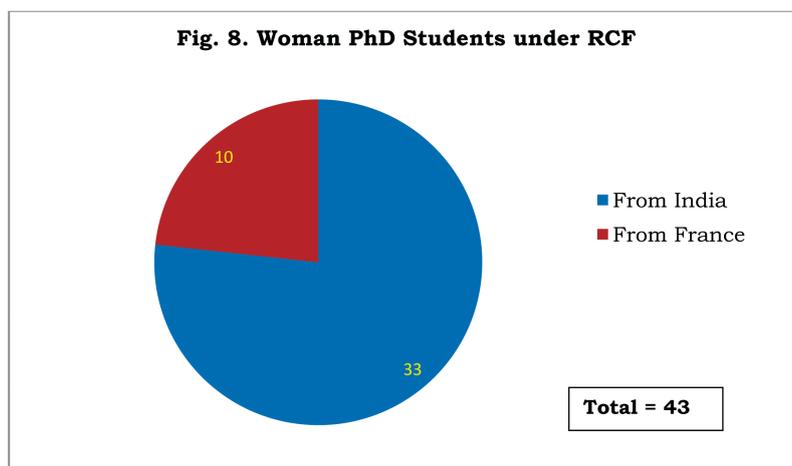
The Targeted and the Innovation Programmes began in the current decade and are just 4-6 years old. Moreover, these programmes cater to highly specific & advanced research areas. The DST-Inria-CNRS is notable among these programmes as 21 projects have been supported. Moreover, it is also noteworthy that nine women have been involved in the Targeted and Innovation programmes which have been supported within a short span of few years. By and large, it can be said that the scientific outcome of projects involving women has been significant and fruitful, based on the common quality indicators.

10. Dedicated Student Fellowship Programmes/ Mobility Support

The mobility of researchers/scientists is an important component for any international research collaborations. However, when mobility of young researcher is being connected with a dedicated Fellowship Programmes, it provides the base for longer interaction and building new collaborations. In view of this importance, CEFIPRA has dedicated fellowship programmes like Raman-Charpak Fellowship, DST-CEFIPRA Fellowship for ESONN and CEFIPRA-SOLEIL Synchrotron Programme.

10a. Raman-Charpak Fellowship

The Raman-Charpak Fellowship (RCF) Programme is in honour of two Nobel Laureates in Physics, Prof C.V. Raman, Indian Nobel Laureate, 1930 and Prof Georges Charpak, French Nobel Laureate, 1992. It is a bilateral Fellowship programme initiated in 2013 & jointly funded by the Department of Science and Technology (DST), Government of India and the Service for Science and Technology (SST), French Embassy in India, Ministry for Europe & Foreign Affairs, Government of France. CEFIPRA implements this fellowship programme with a goal to improve the doctoral skills of students by providing them an opportunity to carry out part of their research work in a University/ Research Institute based in France or India. A total of 118 PhD students (93 Indian and 25 French) during 2013 to 2017 have been supported under this programme, in which 43 (approx. 36%) were woman scholars. Out of these 43 students, 33 from India and 10 from France were selected, as depicted in Figure 8 on the next page.



10b. DST-CEFIPRA Fellowship for ESONN Programme

CEFIPRA along with DST has joined hands with Université Joseph Fourier (now Université Grenoble Alpes), Grenoble, France for supporting participation of Indian doctoral students to European School on Nano-sciences and Nano-technologies (ESONN) in Grenoble, France. ESONN is a three-week course held annually in Aug.-Sept., aimed at providing training for graduate students, postdoctoral and junior scientists from universities and laboratories in the field of nano-sciences and nano-technologies in Physics, Biology and Chemistry. The academic and practical courses cover the elaboration, functioning and characterization of nano-objects. A total of 46 Indian PhD students have been supported out of which 21 (approx. 46%) were woman.

10c. CEFIPRA-SOLEIL Synchrotron Programme

The objective of the CEFIPRA-SOLEIL Synchrotron Programme was to provide financial support to successful Indian scientists/researchers who have been allocated beam time experimental facility at SOLEIL. It provides unique opportunities to learn and acquire knowledge in the field of Synchrotron Science with an international context. The programme helps in gaining practical experience and skills from experiments performed in this facility which will increase the scientific outcome of research in India. The Programme is envisaged as a source of strengthening collaborations

between India and France in the field of Synchrotron science. A total of 29 visitors (comprising of Scientists, Students and Researchers) during 2014 to 2017 have been supported from India and France. Out of 29, two were woman.

Disclaimer: This data in this document is based on the final and periodic progress reports submitted by the Principal Investigators (PIs) of the projects. Any opinion, finding, and achievement expressed in this document are as per the information provided by the PIs. Discrepancies, if any, may be reported to CEFIPRA and acknowledgement would be appreciated, if any reference/quote is made.