



**OUTCOME ANALYSIS OF RESEARCH PROJECTS  
COMPLETED DURING 2016 TO 2017 UNDER  
COLLABORATIVE SCIENTIFIC RESEARCH PROGRAMME  
AND  
DURING 2013 TO 2017 UNDER  
INDUSTRY-ACADEMIA RESEARCH & DEVELOPMENT  
PROGRAMME**

**Indo-French Centre for the Promotion of Advanced Research (IFCPAR)**

**Centre Franco-Indien pour la Promotion de la Recherche Avancée (CEFIPRA)**

## FOREWORD FROM THE DIRECTOR



It is my pleasure to present this report which contains the outcome analysis of the projects completed under CEFIPRA's Collaborative Scientific Research Programme (CSRP) during the period 2016 to 2017, and Industry-Academia Research & Development Programme (IARDP) during the period 2013 to 2017. The CSRP is a flagship programme of CEFIPRA and has been in existence since the beginning of the Centre. The programme has been an important instrument for supporting basic and applied research between India and France in cutting edge areas of Science & Technology. Over the years, this programme has had a significant impact in promoting collaborative research for strengthening the Science & Technology ecosystem between the two countries. The IARDP, formerly known as the Industrial Research Programme, was launched in 2002 with the primary objective to promote research between the relevant Industries of both the countries. Collectively, these two programmes facilitate academic and industrial research in frontier areas of S&T between India and France.

The joint publications and outcomes emerging from the projects supported by CEFIPRA under the CSRP cover major thrust areas and highlight the research achievements of Scientists/Researchers of the two countries. This programme has also contributed towards skill development among young researchers. A short summary of significant achievements is given with this report. Likewise, some of the projects completed under the IARDP have also been successful in terms of novel processes.

I hope that the information provided in this report will have a significant impact for the policy makers in strengthening the Indo-French scientific collaboration.

**Dr. Mukesh Kumar**  
Director, CEFIPRA

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## 1. INTRODUCTION

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. Collaborative Scientific Research Programme (CSRP) 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 promoting networking of scientists & researchers between the two nations.

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 of CEFIPRA provide exposure to young researchers to the scientific, social and cultural environment of the partnering country. Targeted Programmes of CEFIPRA provide a 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. 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 various targeted 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.

In this document which is divided into two parts (A & B), we are reporting the outcome analysis of the projects completed during i) 2016 to 2017 under the Collaborative Scientific Research Programme (CSRP) and ii) 2013 to 2017 under the Industry-Academia Research & Development Programme (IARDP), respectively.

# **PART A**

COLLABORATIVE SCIENTIFIC RESEARCH PROGRAMME (CSRP)

## **2. BACKGROUND & SUMMARY OF THE COLLABORATIVE SCIENTIFIC RESEARCH PROGRAMME**

Indo-French Centre for the Promotion of Advanced Research (IFCPAR/CEFIPRA) is India's first and France's only bi-lateral organization committed to promote academic collaboration between the scientific communities of two countries across the knowledge innovation chain. 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.

The Collaborative Scientific Research Programme (CSRP) constitutes the nucleus of the various programmes 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.

Through this programme, the Centre enhances the Indo-French S&T cooperation in all the domains of Science & Technology such as Life and Health Sciences, Environmental Science, Pure and Applied Physics, Pure and Applied Chemistry, Pure and Applied Mathematics, Computational Science, Biotechnology, Earth and Planetary Sciences, Materials Science and Water. 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 Collaborative Scientific Research Programme are monitored by Scientific Council (SC) of the Centre. The SC comprises of eminent scientists of both the countries which enhances the research agenda of the Centre in view of national goals of S&T sectors.

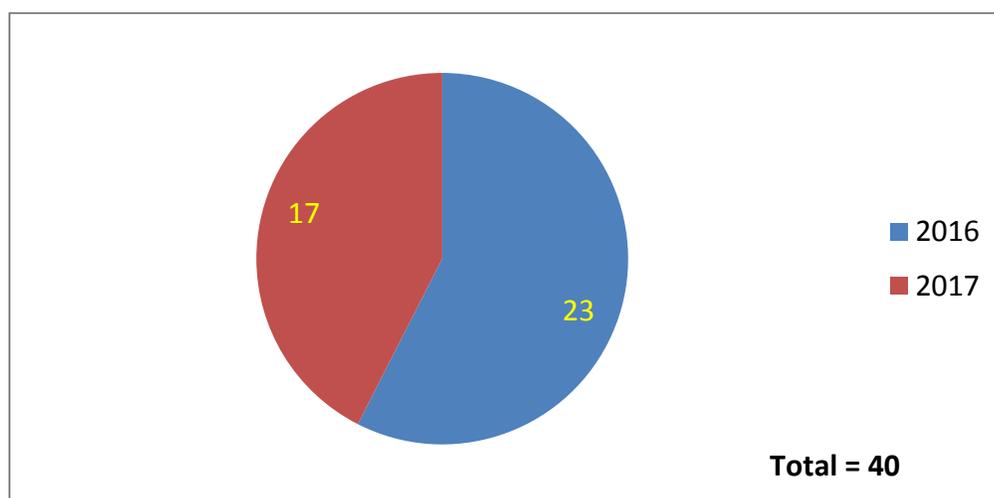
The Governing Body (GB) in its 27<sup>th</sup> and 28<sup>th</sup> meetings held on 6<sup>th</sup> March, 2014 at New Delhi & 13<sup>th</sup> April, 2015 at Paris, respectively, directed as well as suggested for measuring the impact of CEFIPRA supported projects. It was later suggested by the subsequent GB in its 29<sup>th</sup> meeting on 4<sup>th</sup> March, 2016 at New Delhi that such an analysis should be done on a periodic basis. Accordingly, the first outcome analysis report for the projects completed under the CSRP during 2011 to 2015 was presented during the 30<sup>th</sup> GB held on 6<sup>th</sup> March, 2017 at Paris. The present report contains the outcome analysis of CSRP projects completed during 2016 to 2017 and analysis of IARDP projects completed during 2013 to 2017.

Accordingly, the information received from the final reports submitted after completion of the projects as well as inputs received for annual reports of the Centre were used for analyzing the outcome of completed projects.

Based on qualitative and quantitative approaches, the present report analyses the outcome of projects, completed under Collaborative Scientific Research Programme during 2016 to 2017. During the above said period, a total of 45 projects were slated for completion. One project was pre closed. Out of the remaining 44 projects, 40 have been completed as on the date of preparation of this document (on 28/2/2018). The data obtained from the final report of the 40 completed projects was utilized for outcome analysis. The area wise list of the completed projects is given in Annexure II.

The year & thrust area-wise distribution of the projects completed during 2016 to 2017 is given as follows:

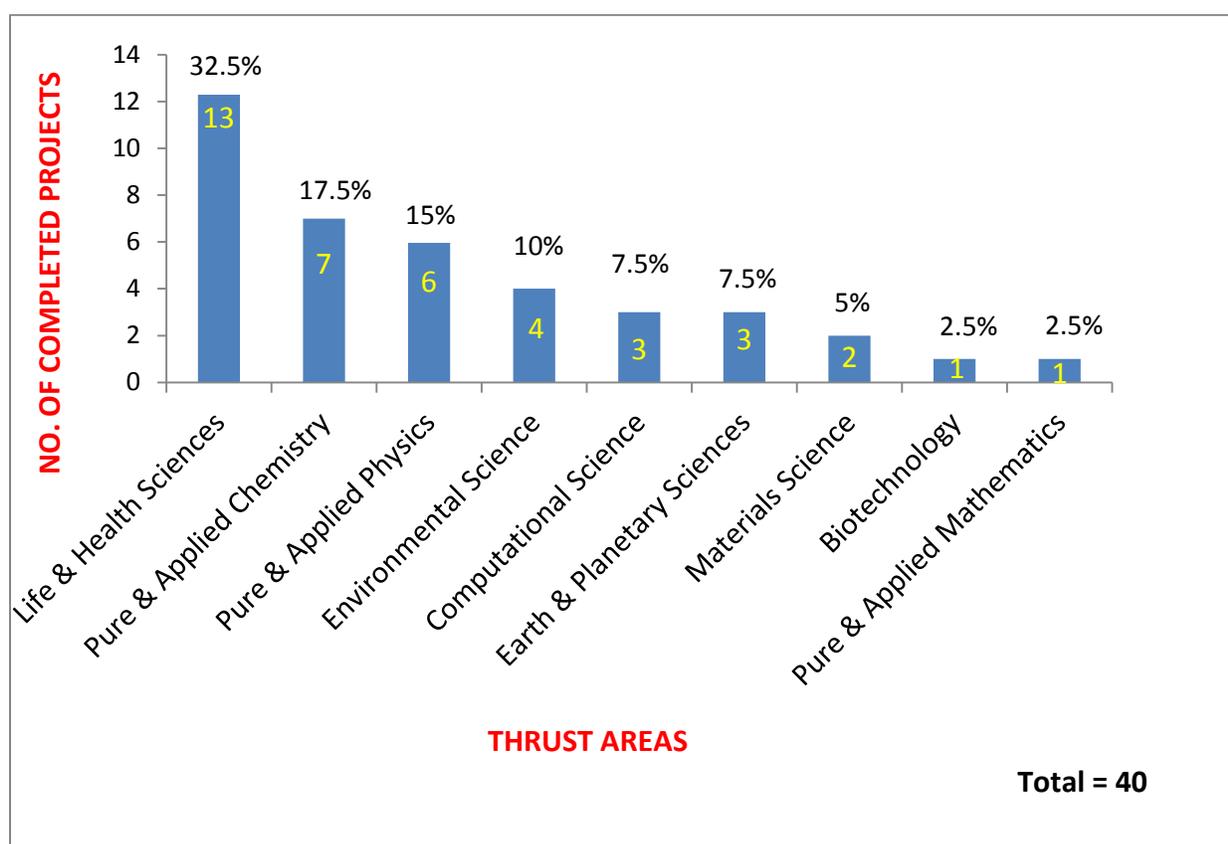
#### YEAR-WISE DEPICTION OF 40 PROJECTS



Out of 40 projects which were completed during the period 2016 to 2017 under the Collaborative Scientific Research Programme, 23 were completed in the year 2016 and 17 in 2017.

Maximum numbers of projects were funded in the domains of Life & Health Sciences, followed by Pure & Applied Chemistry and Pure & Applied Physics. In terms of percentage, these three disciplines accounted for 65% of the total completed projects. The data indicates that the maximum number of completed projects were from the areas of Life & Health Sciences (13), Pure & Applied Chemistry (7) and Pure & Applied Physics (6), during the years 2016 to 2017.

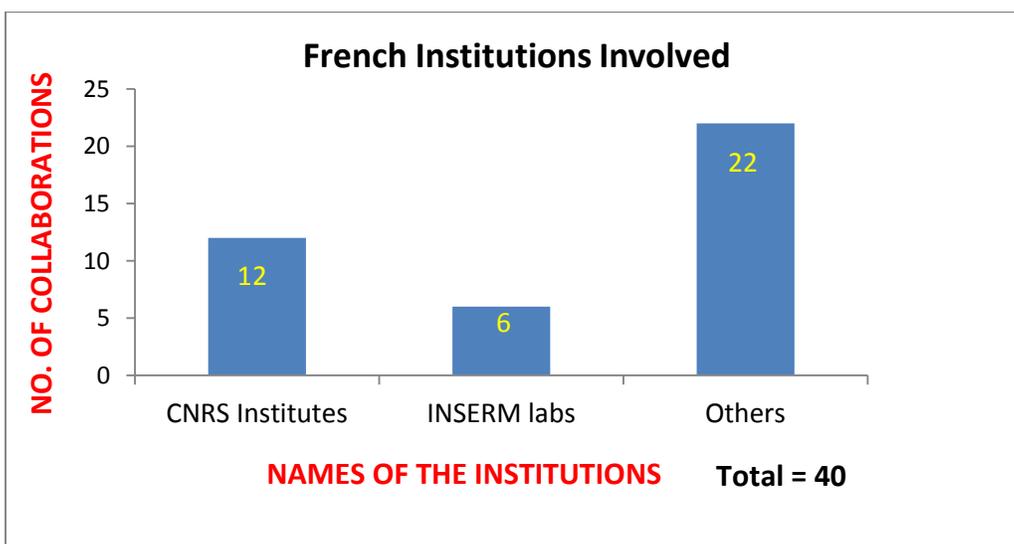
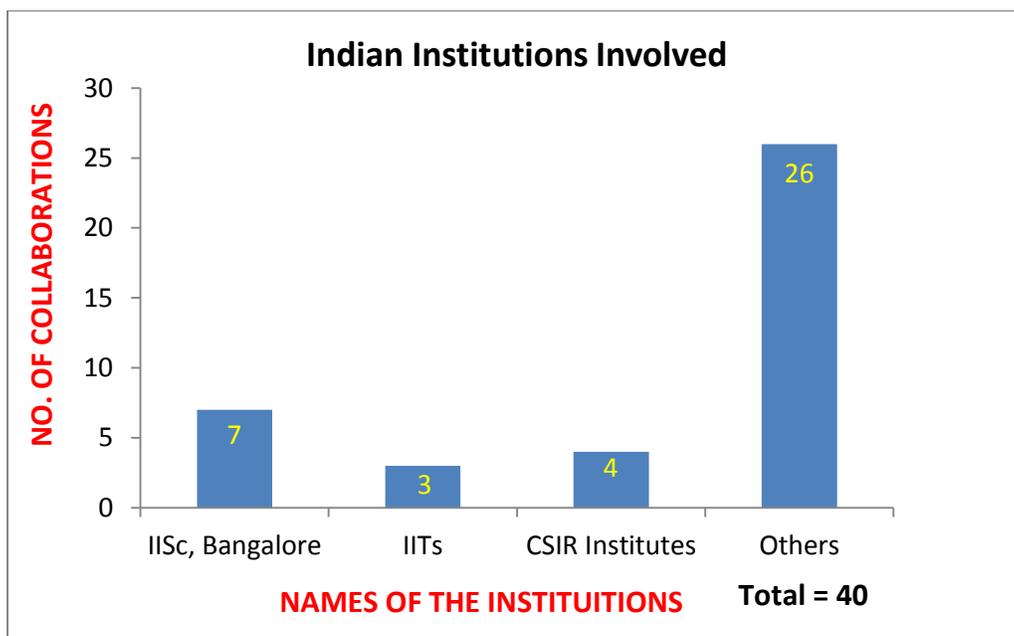
### THRUST AREA-WISE PERCENTAGE OF 40 PROJECTS



### 3. INSTITUTIONAL PARTICIPATION IN THE 40 PROJECTS

The Collaborative Scientific Research Programme involves partnership of Institutes from India and France. These partnerships, which intend to complete the joint proposal, often lead to long term academic linkages between the two groups. From the Indian side, the maximum numbers of collaborative projects were from the Indian Institute of Science, Bangalore (7) followed by 4 from CSIR Institutes/labs and 3 from the Indian Institutes of Technology (IITs). The remaining 26 collaborative projects were from other Indian Universities/Institutes. From the French side,

there were 12 collaborative projects from the CNRS Institutes and 6 from INSERM labs. The remaining 22 collaborative projects were from various other French Universities/Institutes.

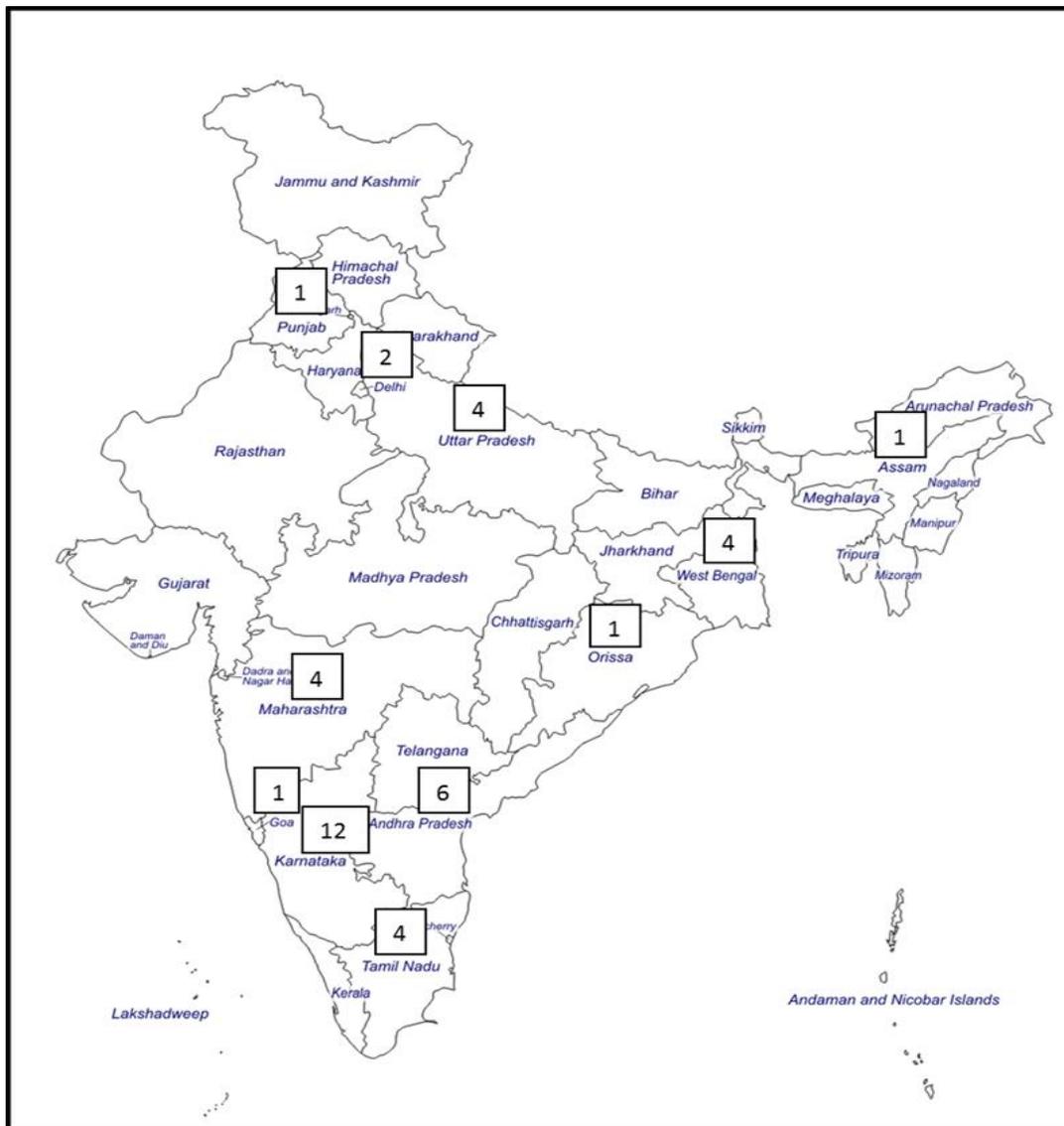


The list of participating Universities/Institutes in the “Others” section of both India and France is provided in Annexure III(a) & III(b). This list indicates that the projects supported by CEFIPRA under the Collaborative Scientific Research Programme were spread over the entire geographical regions of both the countries. It is further depicted through Indian and French maps in the following pages.

#### 4. GEOGRAPHICAL DISTRIBUTION OF 40 PROJECTS

Activities of CEFIPRA have a broad spatial footprint across the S&T ecosystem and institutional landscape of India and France. This enables a significant outreach to the relevant stakeholders among the S&T sectors. The participating states & regions of India and France, with respective number of collaborations are depicted in the following maps. In terms of geographical distribution of projects in Indian and French institutions, the depiction shows a heterogeneous representation of different areas of both the countries. However, the maximum concentration of projects was observed in the southern part of both the countries.

#### GEOGRAPHICAL DISTRIBUTION OF 40 PROJECTS IN INDIA

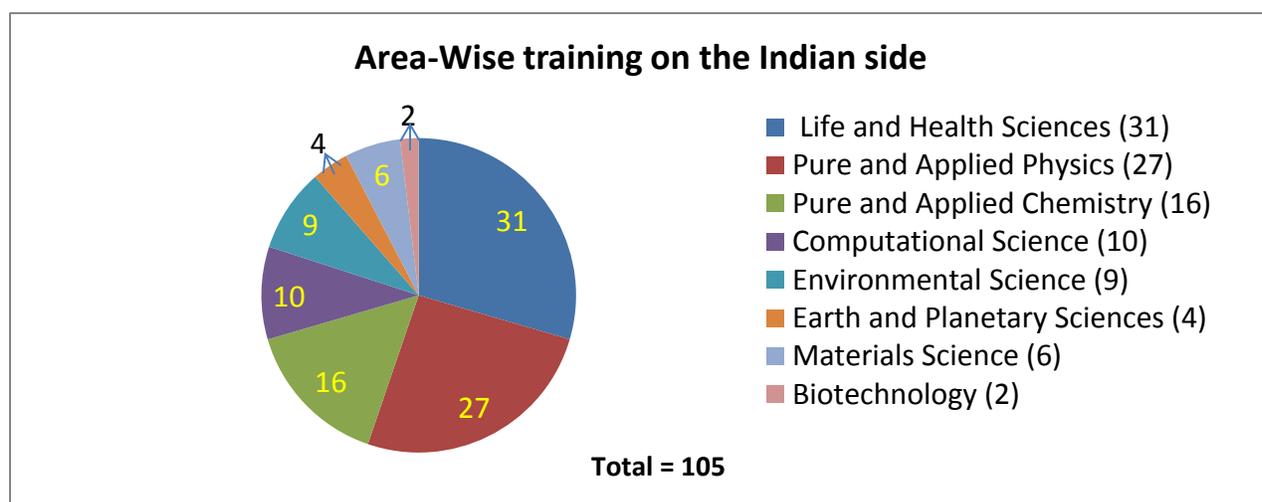
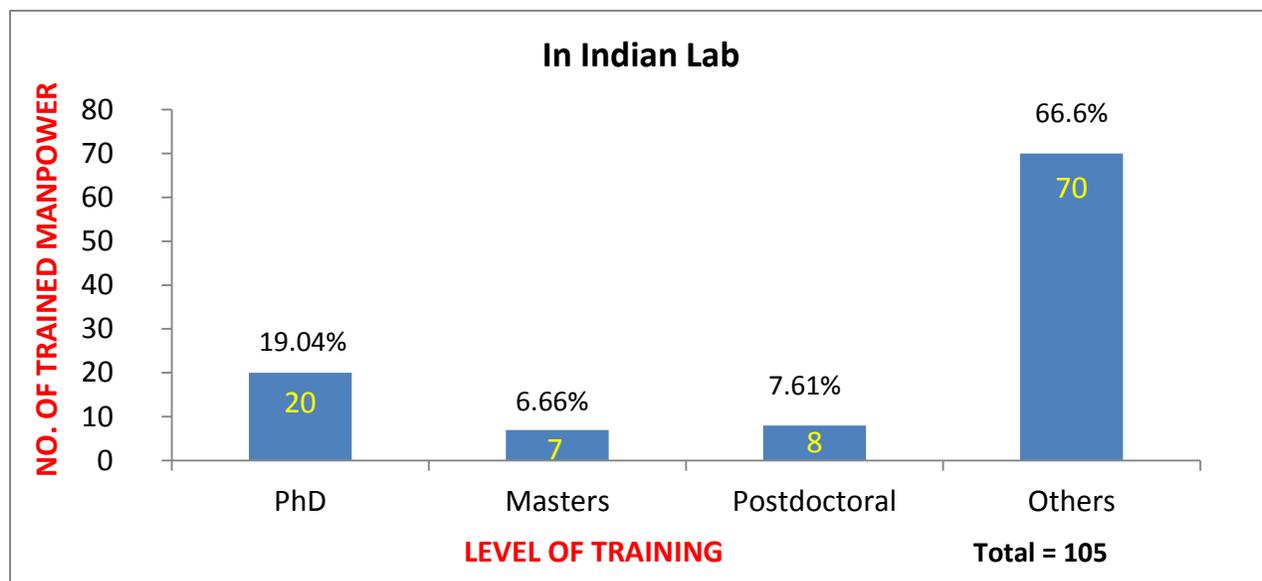


GEOGRAPHICAL DISTRIBUTION OF 40 PROJECTS IN FRANCE

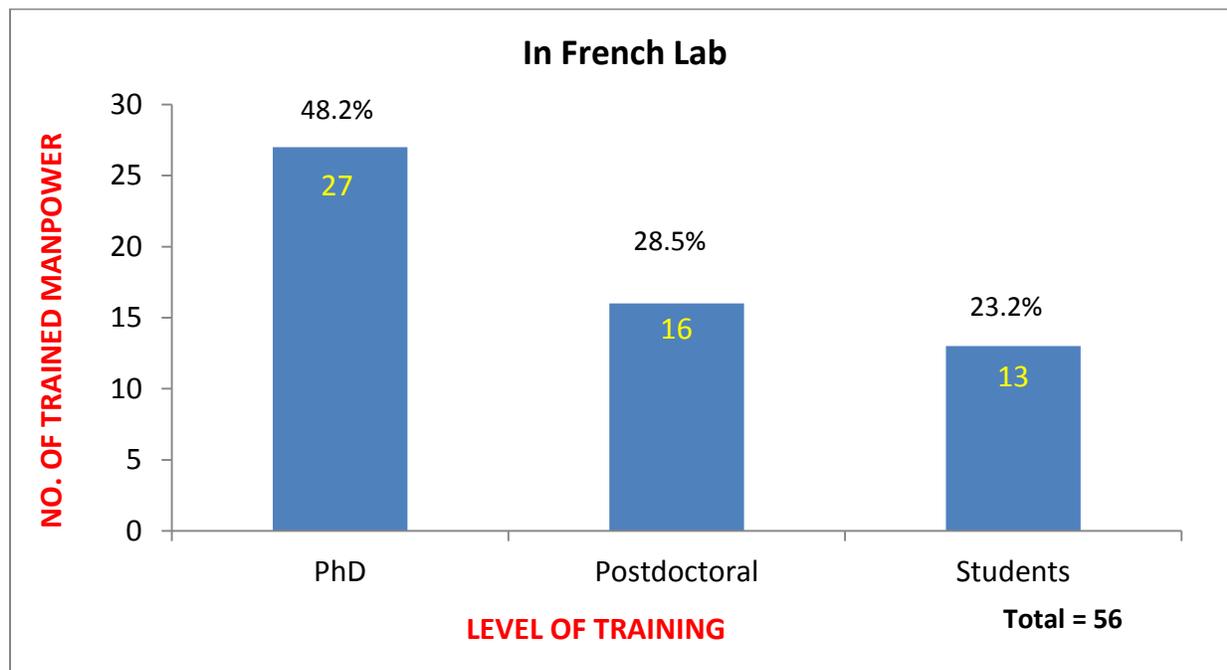


## 5. MANPOWER TRAINED UNDER THE 40 PROJECTS

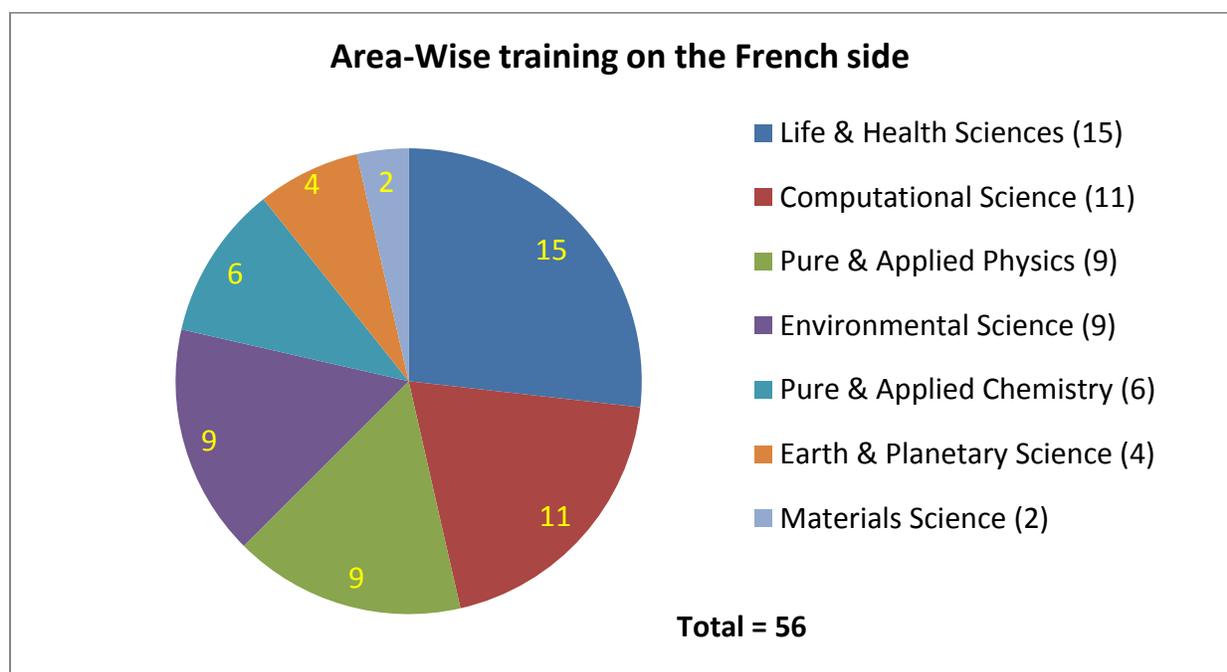
Skilled manpower in the form of students, postdoctoral researchers and young scientists are the backbone of scientific research projects and the Collaborative Scientific Research Programme provides funding support for such personnel (PhD/Postdoctoral positions for French Partners; Junior Research Fellow, Senior Research Fellow & Research Associate for Indian Partners). Manpower such as PhD students, Masters' level students and Postdoctoral Fellows are hired to carry out the objectives of the research projects. Analysis of the data reveals that from the Indian side, out of a total of 105, 19% of the trained manpower was PhD students, 6.6% were Masters' Students and 7.6% were Postdoctoral fellows. However, a significant portion of the manpower (approx. 66.6%) belonged to the category of Junior or Senior Research Fellows, Project Associates/Assistants, Interns/Students which have been classified as Others in the following chart.



From the French side, out of a total of 56, 48% of the trained manpower was PhD students, followed by 28.5% Postdoctoral Fellows and 23% Student Trainees. Therefore, based on the data, it can be concluded that a higher percentage of PhD students and Postdoctoral Fellows were trained in France as compared to India. However, the percentage in 'Others' (which also includes students at different stages of their academic career) was high on Indian side.



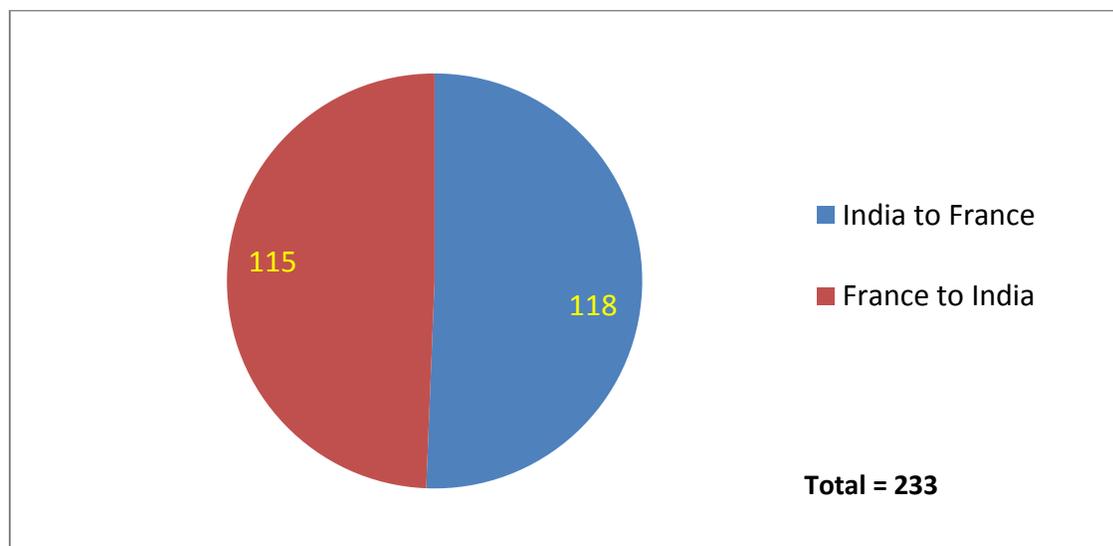
Maximum numbers of manpower trained were in the area of Life & Health Science on both sides.



## 6. EXCHANGE VISITS UNDERTAKEN BETWEEN INDIA AND FRANCE IN THE 40 PROJECTS

Exchange visits are an integral and significant part of the Collaborative Scientific Research Programme of CEFIPRA. These visits are an important aspect of scientific research project and are undertaken to carry out a designated set of experiment(s) related to the project and can also led to a transfer of experimental material, protocol or methodology and ideas across the participating laboratories. Academic interaction is significantly enhanced by these visits and the researchers/institutions are benefited through these exchange visits in a long run. In addition, exchange visits also provided an opportunity for cultural exchange. The purpose of such visits is to execute and discuss the necessary aspects of work related to scientific research under the project. These visits help in speeding up the collaborative work and also provide exposure to researchers/students. Therefore, scientific collaboration and teamwork is enhanced by these visits.

A total of 233 exchange visits took place under the 40 projects completed during 2016 to 2017. Out of these visits, 118 were from India to France and 115 were from France to India. Therefore, it can be concluded that the total number of exchange visits from both the sides were almost equivalent. The mobility programmes made significant contributions in terms of enhancing mutual scientific competency and creating futuristic networks between individual scientists and institutions of India and France leading to collaborations.

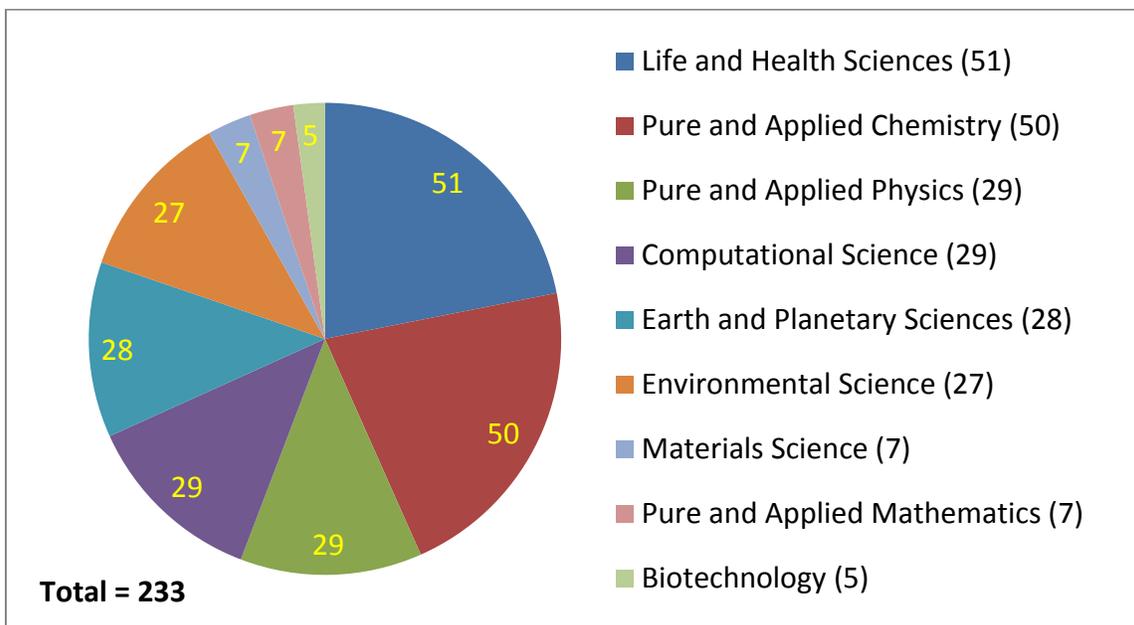


**Year-wise Exchange visits under the 40 completed projects**

Year	India to France	France to India	Total
2016	70	68	138
2017	48	47	95
<b>Total</b>	<b>118</b>	<b>115</b>	<b>233</b>

The breakup of the visits of the 40 completed projects shows that there were 138 visits for the projects completed in 2016 and 95 visits for the projects completed in 2017. The domain-wise analysis indicates that Life & Health Sciences had maximum number (51) of visits, followed by Pure & Applied Chemistry (50). This number is consistent with the fact that these two domains had the highest number of completed projects during 2016 to 2017 as compared to other domains.

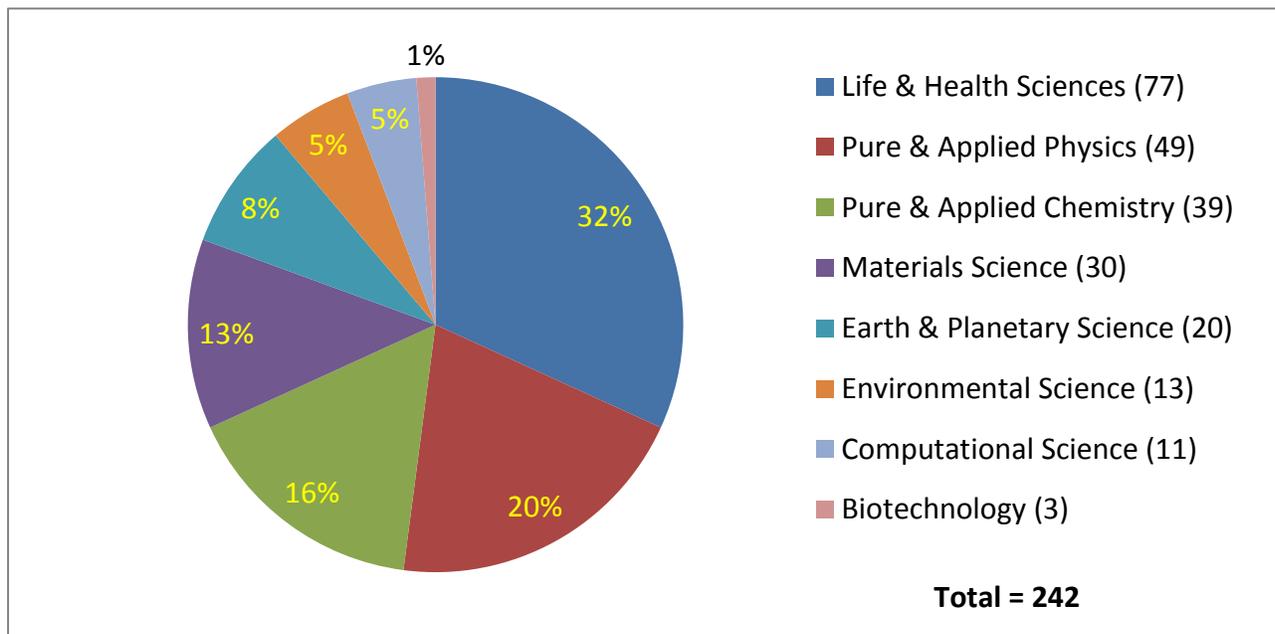
### SUBJECT AREA-WISE MOBILITY SUPPORT UNDER COMPLETED PROJECTS



### 7. ANALYSIS OF PUBLICATIONS EMANATED FROM 40 PROJECTS

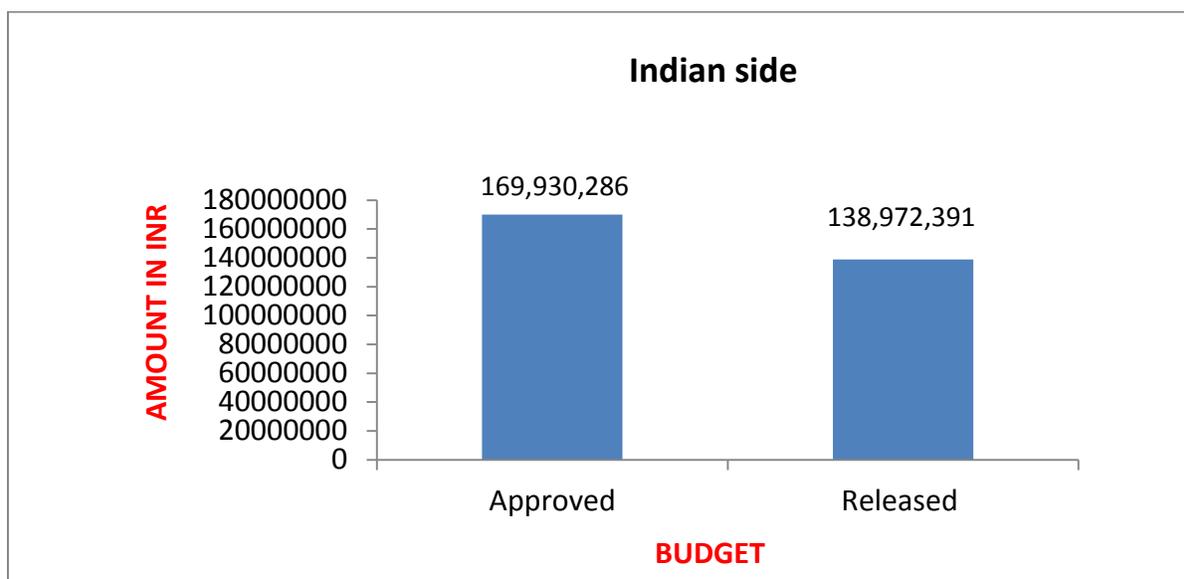
One of the most important indexes for assessing the outcome of a scientific project is the analysis of emanated publications. Therefore, it is very important to know this outcome. This number was obtained from the final report of the projects which were submitted to the centre after the completion of the projects. A total of 242 research papers were published from the 40 projects completed during 2016 to 2017. The maximum number of publications were from the domain of Life & Health Sciences (77), followed by Pure & Applied Physics (49), Pure & Applied Chemistry (39), Materials Science (30), Earth & Planetary Science (20), Environmental Science (13), Computational Science (11) and Biotechnology (3). This data is consistent with the fact that the maximum number of completed projects were also from areas of the Life & Health Sciences, Pure & Applied Physics and Pure & Applied Chemistry. The percentage representation of the publications is depicted in the pie chart.

### AREA-WISE DEPICTION OF PUBLICATIONS EMANATED FROM THE 40 PROJECTS

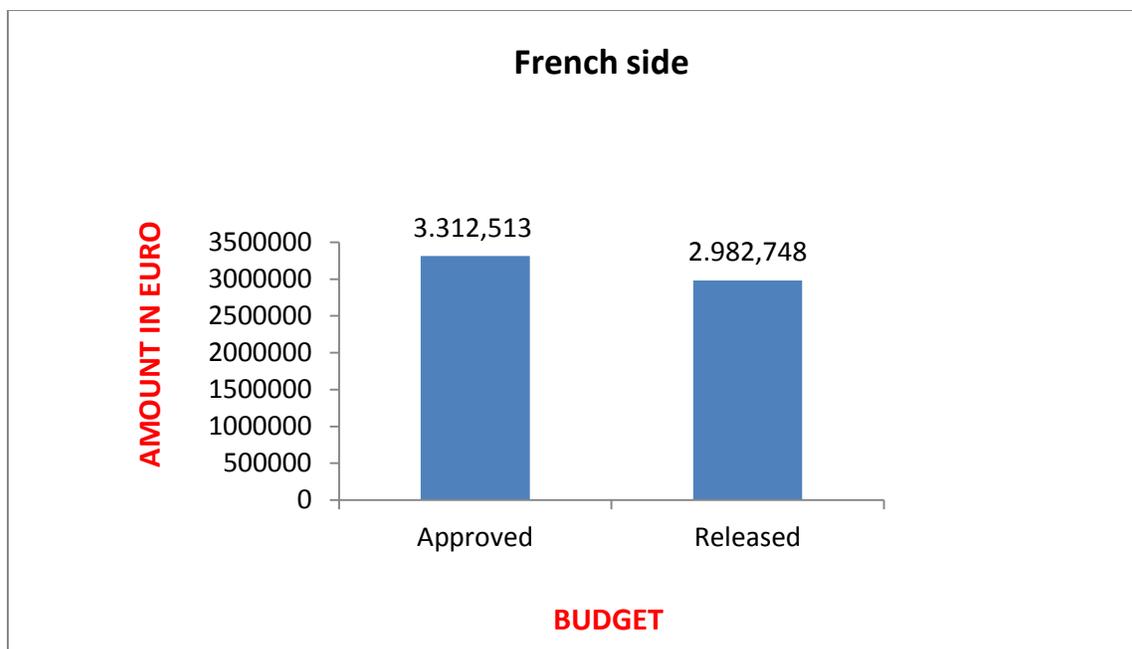


### 8. BUDGET COMPONENT (APPROVED v/s RELEASED) OF THE 40 PROJECTS

The information regarding the approved and released budget for the 40 projects completed during 2016 to 2017 is as follows:



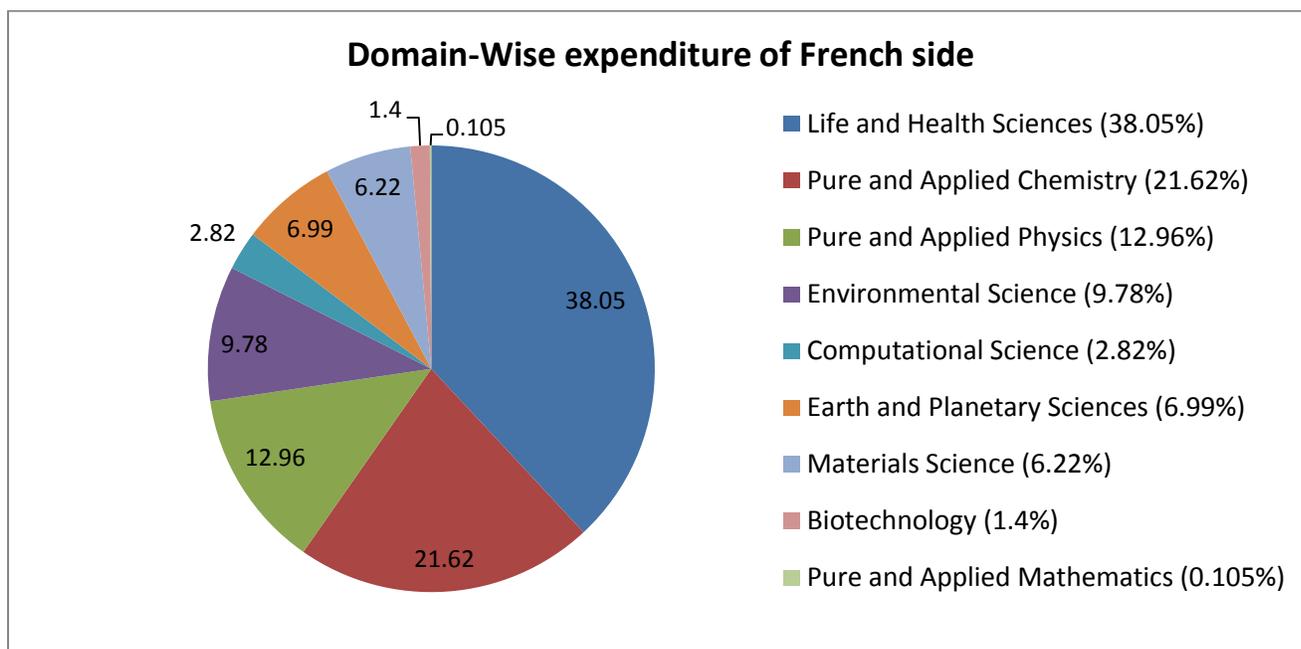
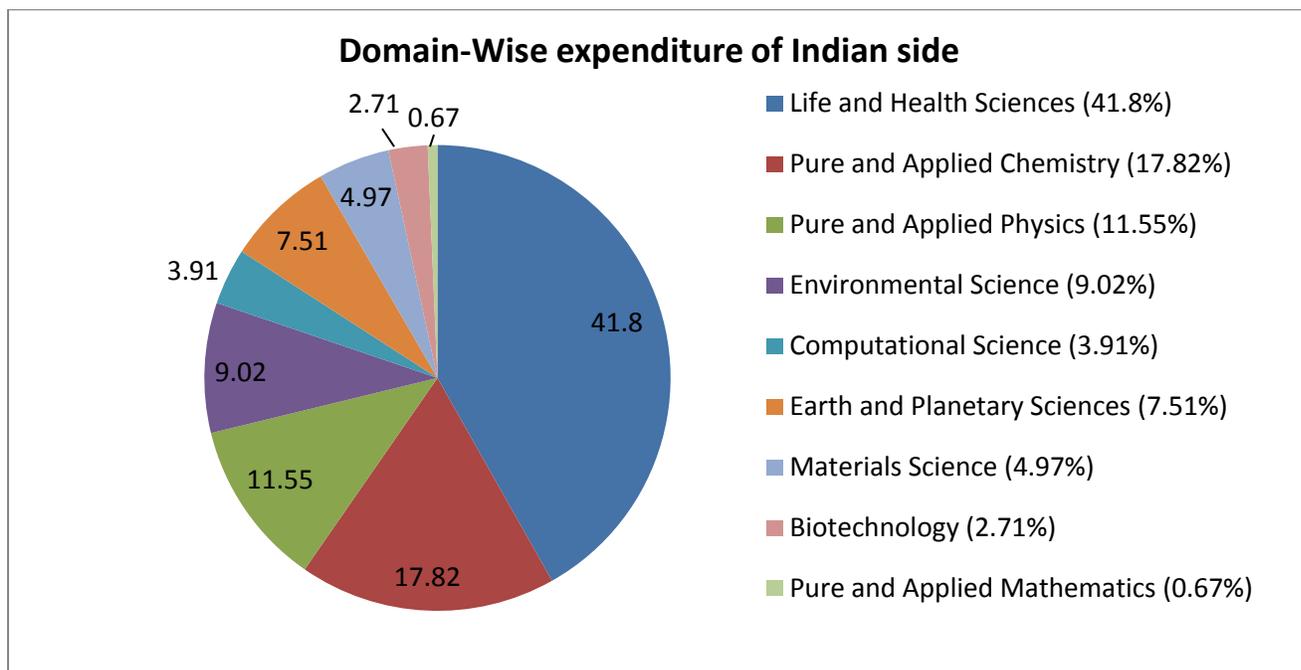
Percentage of budget released for the Indian side is 81% as compared to approved



Percentage of budget released for the French side is 90% as compared to approved

The difference between the approved and released budget for both the sides for the 40 projects is primarily due to the fact that the International travel is managed by CEFIPRA. The other factors, which might have contributed to this difference could be, i) the number of exchange visits which were eventually undertaken, might have been less than the number which was approved and ii) the utilization of funds under recurring expenses might have been less compared to the estimate given in the proposals approved by the Scientific Council. The analyses of expenditure for both the sides show that the areas of Life & Health Sciences and Pure & Applied Chemistry collectively accounted for 60% of total released budget, a data which is consistent with the fact that these two domains also accounted for maximum number of completed projects. The percentage of expenditure for each domain is represented in the pie chart.

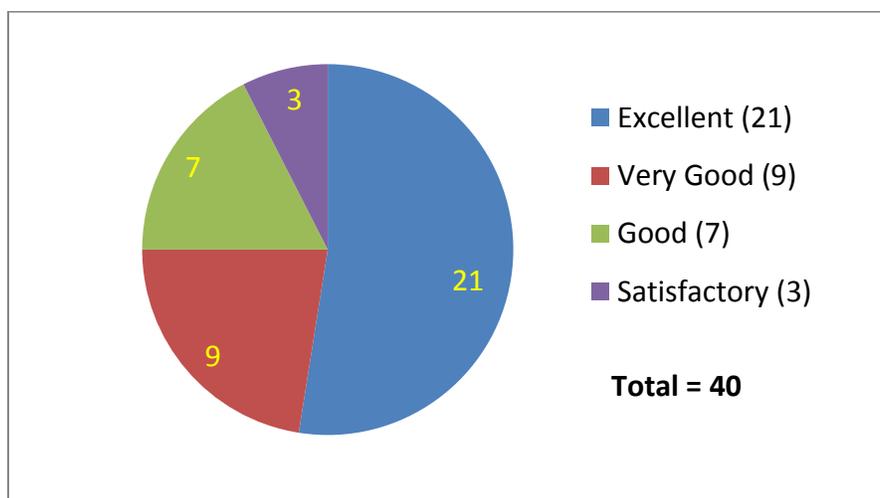
## SUBJECT AREA WISE BUDGET EXPENDITURE IN THE 40 PROJECTS



## 9. PERFORMANCE INDEX FOR THE 40 PROJECTS

The Scientific Council (SC) 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.

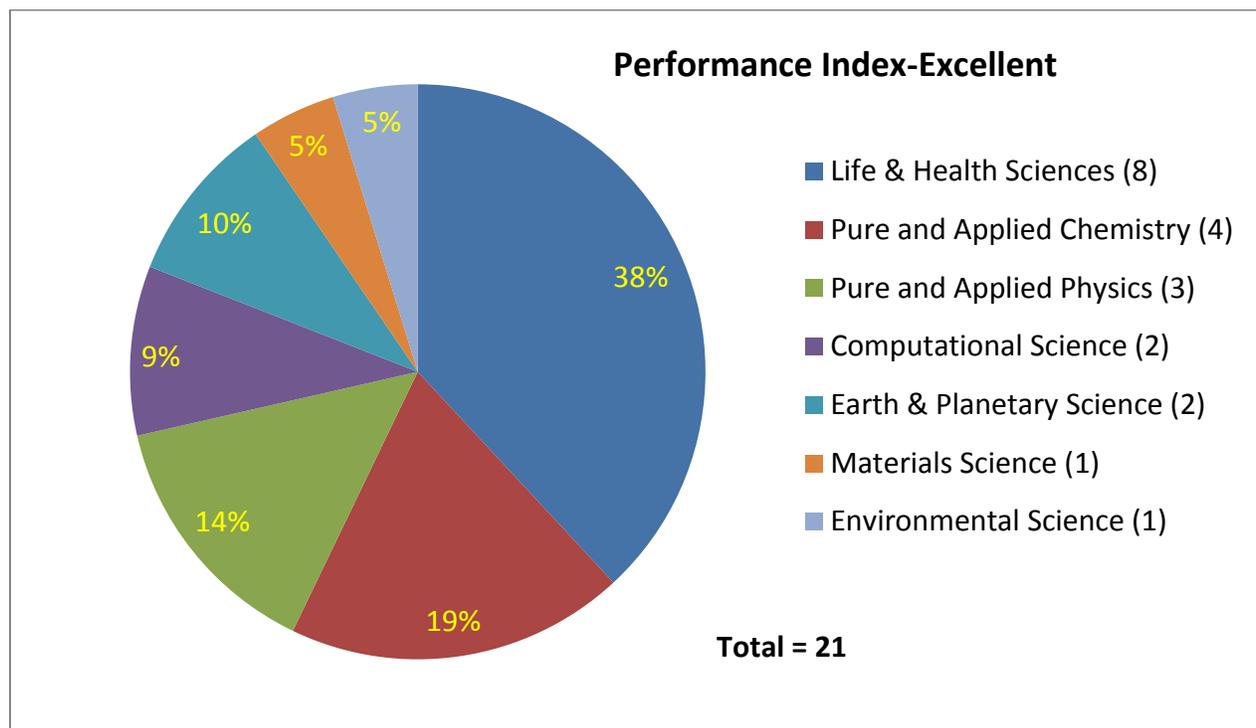
The SC developed the parameters which were used for the grading of completed projects based on the performance. Projects were graded as excellent, very good, good, satisfactory, average and poor, depending upon their adherence to the parameters. The defined criteria was based on parameters like excellence 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 40 completed projects is depicted in the following pie-chart.



A total of 21 projects were graded **excellent**, followed by 9 projects as **very good** and 7 projects were graded as **good**. 3 projects were graded as **satisfactory**.

Out of the 21 excellent projects, 19 are from the areas of Life & Health Sciences, Pure and Applied Chemistry, Pure and Applied Physics, Computational Science and Earth & Planetary

Science. In the remaining 2, one each belonged to Materials Science and Environmental Science.



In the 9 projects belonging to the **very good** category, 2 each belonged to Life & Health Sciences and Pure and Applied Physics, and one each belonged to Pure & Applied Chemistry, Environmental Science, Biotechnology, Earth and Planetary Sciences and Computational Science. In the 7 projects belonging to the **good** category, 2 each belonged to Life & Health Sciences and Pure and Applied Chemistry whereas 1 each belonged to Environmental Science, Pure and Applied Physics and Pure and Applied Mathematics.

Some significant outcomes resulted from the 40 completed projects are given in Annexure IV. Outcomes in the form of patents filed/obtained and a list of projects showing possible commercial potential are given in Annexures V(a) & V(b).

## 10. TRENDS IN COLLABORATIVE SCIENTIFIC RESEARCH PROGRAMME

The Collaborative Scientific Research Programme has been instrumental in supporting academic collaborations between India and France since inception of the Centre in 1987. As a flagship programme, this has supported research collaborations in basic as well as applied sciences by catering to the changing scientific and research landscape of both the countries. The year 2017 was a landmark for CEFIPRA as it launched its celebration of 30<sup>th</sup> year of its existence and also the simultaneous support of this prestigious research partnership. The very fact that this arrangement has existed for three decades is a testimony of its relevance to the scientific communities of both the countries. Until December 2017, a total of 507 projects have been funded under this programme. This report analyzes the outcome of projects completed during 2016 to 2017 under the CSR.

Out of the 40 completed projects, 13 were funded in the area of **Life & Health Sciences**, which indicates that issues of human health and disease control continued to be the significant areas for collaboration between the two countries. Out of these 13 projects, 8 have been graded as Excellent by the Scientific Council. Apart from Life and Health Sciences, the major thrust areas have been Pure & Applied Chemistry and Pure & Applied Physics. A total of 13 projects have been completed in these domains in which 7 have been graded as Excellent and the rest have been graded Very Good to Good. Analysis of the expenditure reveals that the percentage of released budget for the French side was higher (90%) as compared to the Indian side (81%) as per the approved budget.

Analysis of geographical distribution of projects depicts the **states/regions** that accounted for maximum number of projects for India and France. From the Indian side, the state of Karnataka accounted for 12 projects while Île de France region of France, mainly Paris had the highest concentration of projects (13) as compared to rest of the regions in France. Though most of the projects were concentrated in the southern region of both the countries, the involvement of state/regional universities and institutes spread throughout indicates the broad outreach of this prestigious programme of CEFIPRA. This is particularly significant for an emerging economy like India. It is expected that the outreach programmes organized by the Centre (last one in held in October, 2017) will help in further dissemination and visibility of programmes & activities among the relevant institutions.

A total of 233 **exchange visits** took place for the 40 completed projects during 2016 to 2017; the percentage of visits for both sides was approximately equal. Analysis of the manpower training data reveals that a total of 105 and 56 students were trained in India and France respectively, from the 40 completed projects. These trained manpower and exchange visits have yielded significant outcomes in terms of scientific competence, enhancement of skills and capacity building through collaboration. The Indian side trained 20 PhD, 7 Masters' students

and 8 Postdoctoral Fellows. The French side trained 27 PhD students and 16 Postdoctoral Fellows. These data indicate that the postdoctoral training system in France is more robust as compared to India. However, the overall number of research personnel trained was more in India. The training positions were beneficial to the students as it allowed them to learn from peers about new tools, methodology and techniques. Mobility support to students allowed them to expose themselves to different scientific ecosystems, and work in variety of environment set-ups with an enhanced understanding of the social and cultural norms. It is highly likely that the mobility support would have helped the students in exploring and furthering their research careers. Thus the rising trend in number of mobility among students/scientists under the projects is in line with CEFIPRA's role for emphasizing international competitiveness and competence.

**Regarding participating institutions** from the Indian side, the highest number of collaborations were from the IISc Bangalore, CSIR labs and the IITs, whereas from France, CNRS institutes has the highest number of projects followed by INSERM labs. Some of the collaborations have led to fruitful linkages between groups which have continued well beyond the completion of the project. The exchange visits and manpower support are, therefore, significant in nurturing scientific competency among the youth of the scientific workforce.

The scientific output in terms of **publications** suggests that 242 peer reviewed research papers were published from the 40 completed projects. The domains of Life & Health Sciences, Pure & Applied Chemistry and Pure & Applied Physics accounted for 68% of the total publications. This data is consistent with the observation that these three domains accounted for i) 65% of the completed projects during 2016 to 2017 and ii) 72% of the projects which were graded as excellent by the SC.

Though the publications emanated in peer reviewed journals is an established yardstick for assessing the outcome of projects, it is also important to analyse the outcome of projects in terms of the Intellectual Property (IP). Analysis of the data on the lines of IP reveals that there were 2 patents from the 40 completed projects during 2016 to 2017. The reason for such a miniscule outcome in terms of patents could be that the results of the experimental finding was published before hand, or there was an apparent lack of willingness or awareness among the scientists regarding the IP potential of their results or the process of filing a patent application. Alternatively, it might be possible that the patent application process may be in the pipeline just after the completion of the project. Regardless of the precise reason, this situation has to be addressed in order to carry forward the generated knowledge so that the benefits of fundamental science lead to societal benefit. The Standard Expert Panel (SEP), which was constituted by CEFIPRA in August, 2016, plays an important role in *a)* increasing awareness among the PIs regarding the IP and commercial potential of their respective projects and *b)* encouraging the PIs to analyze the results of their experimental findings in terms of

patentability and commercialization before publishing the results or presenting the same in a conference/meeting. Since its inception, the SEP has met twice and the mentoring and monitoring of the Indian PIs for the projects approved in the Scientific Council meeting of May, 2017, was held in August 2017 in the CEFIPRA office in New Delhi, India. The next mentoring session is likely to be held in May, 2018 in France, for the mentoring of the French PIs for the projects approved in May & November 2017.

Thus, CEFIPRA enables to foster economy driven innovation by addressing the above mentioned gap along with strengthening the research and technological competency of scientific communities in both the countries.

### **11. ASSESSMENT BY THE INVESTIGATORS OF THE PROJECTS**

The feedback (assessments) from PIs has indicated that the scientific complementarity is the main strength of the scientific collaborations. This complementarity is helpful in exploring new research ideas, discussing the same with the counterpart and bringing the same to realization. The following were some of the foremost quotes from PIs of CEFIPRA projects;

1. Interactions and collaborative projects are most fruitful when carried out by scientists that trust and appreciate each other and this takes time. The CEFIPRA grant has been a fantastic tool to establish longstanding interactions that we hope to consolidate further in the future. In this respect, we particularly appreciated the amendment involving the no cost one-year extension and the permission to visit the Indian institute.
2. As for any grant, science moves on between the time at which the project is written and the time at which it is funded. This implies readjusting the objectives and the approaches. We appreciate that CEFIPRA took this issue into consideration.
3. We would like to thank CEFIPRA for its help, support and for giving flexibility in the project management. Answers to questions as well as proposed solutions were very satisfactory.
4. We were very happy with the project. Implementation went very well and CEFIPRA granted us supplementary visits and time for the project which we have been able to put to good use.
5. We are grateful to the funding agency, CEFIPRA, for supporting the implementation of this project. We also thank CEFIPRA for the 3 months extension of salary given to the PhD student. Administrative work related to the project was handled most professionally and efficiently, with minimal delay in allocation and transfer of funds. The office addressed all our questions or concerns promptly, unambiguously and to our satisfaction. Support through CEFIPRA enabled successful arranging of exchange visits of investigators at both centers.

6. On the whole, we have a very positive assessment of how the project was implemented and we have appreciated the help that IFPCPAR has brought us throughout the project in human resources as well as financial.
7. We are quite satisfied with the way the project was implemented. The project has greatly benefited from the flexibility and prompt assistance from the CEFIPRA staff. Most queries and difficulties we encountered whether in the context of collaborative visits, recruitment of students, extension of project and other miscellaneous issues were quickly and sensibly resolved.
8. We have had two CEFIPRA grants awarded and the Indian and the French laboratories have benefited greatly from this interaction. In fact it must be stated that this grant was built on an earlier success which resulted in the setting up of a stem cell facility in the French laboratory because the students trained in the Indian laboratory were able to visit the French laboratory. In reverse, since an in house clinical researcher was present in France and the French laboratory was housed within the largest children's hospital in Paris, the clinical and basic research could be integrated seamlessly.
9. We are very happy with the overall experience in communicating with IFPCPAR. All our queries were promptly addressed in very less time, which made the running the project smoothly. We have been able to complete almost all the proposed work.

However, some suggestions for improvement and consideration were also received, which are given below:

1. Another point, which might be improved, is the lack of flexibility on how to use budget. Mainly, since travels (international) cannot be taken from project (except for visits related to project), it was difficult to attend to conferences related to the project. This is at the same time a problem for dissemination/publicity of the project, as well as an impediment to submission (and so to quality of PhD defended, visibility of results). We think that allowing using budget for conferences would be very useful.

**Response from CEFIPRA:** As a bilateral organisation, CEFIPRA can support only visits in India and France. For domestic and international travel, funds are approved in the projects as per the requests from the collaborators.

2. We also suffered from lack of timely fund release and excessive administrative steps, especially added in the fund utilization, in particular from the Indian side. For example, it was demanded that we must provide details of the chemicals purchased. This is very difficult as we generally several projects and almost invariably, chemical orders are clubbed. Also, very often chemicals and services used by different project are paid from any one of the project depending on factors like availability of funds. We expect CEFIPRA to maintain investigator friendly attitude.

**Response from CEFIPRA:** Demanding the details of expenditure is a normal practice followed by all the funding agencies and is required for auditor's point of view.

3. Several visits of the French P.I. to India were planned. The current procedure for visa application made it however impossible for the P.I. to organize a second visit to India within the years 2015 and early 2016. Indeed, it has to be planned that the passport can be blocked at the Indian embassy for about 4 weeks (for non-French residents). The very busy schedule of the French P.I. (not a French citizen) did not allow such a long deposit (passport was needed to travel frequently within Europe and to Asia). In addition, the newly introduced "fast last-minute procedure" for scientists is only available for French citizens, thus not applicable to the present P.I. Therefore, in the future, it would be very useful if a "three year multiple entry visa" could be given to the P.I.s for the whole duration of the project. Alternatively, another "fast procedure" would be very useful (applicable also for non-French citizens).

**Response from CEFIPRA:** The visa procedures depend upon the rules & regulations of the corresponding embassies/countries.

4. We felt that more flexibility may be allowed in hiring project staff. We had made a request to CEFIPRA on one occasion to hire more than the approved number, and despite the availability of funds, we were requested to stick to the original approved number. This could be left to the discretion of the investigators.

**Response from CEFIPRA:** Sticking to the approved number of project staff is a normal procedure being followed by the funding agencies.

5. Travel arrangements could be left to the investigators' institutions instead of CEFIPRA going through the trouble of making the arrangements. In particular, because of various teaching and administrative commitments, it is difficult for senior members to come for a long period of 2-3 weeks. Therefore, it can be more efficient to have a larger number of shorter visits of duration several days each.

**Response from CEFIPRA:** CEFIPRA follows the global envelope norm which addresses this request as a flexibility to the PIs.

6. Material transfer due to the border security. Lot of times, the samples from India was returned after the Border Security Agencies in Paris have found some problems with them. Initially, they wanted MSDS sheets and we have provided and sent again. Then, the parcel was returned saying that the sample contains chemicals. Next, the parcel was returned again for some other new form which has come up because of some terror activity in Paris. This led to decomposition of the sample.

**Response from CEFIPRA:** The security rules & regulations are beyond the control of CEFIPRA.

7. Distribution of funds. The third instalment of funds was released after several reminders that had caused us inconvenience of spending from some other projects. The salary of the Post-doc was released after six months. At one point of time, one of the personnel who were working on the project had planned to quit the Post-doc and it required a lot of persuasion to retain him in the group.

**Response from CEFIPRA:** CEFIPRA will look into the individual case. Normally, it does not take much time for release of funds, if submitted along with necessary documents/papers.

A SUMMARY OF ACHIEVEMENTS OF THE 40 COMPLETED PROJECTS DURING YEARS 2016 to 2017								
S. No	Subject Areas	Actual budget released		Exchange visit	Man power trained	No. of patents	No. of projects with commercial potential	No. of publications
		India (INR)	French (Euro)					
1.	Pure and Applied Mathematics (1)	932889	3138	7				
2.	Computational Science (3)	5440670	84185	29	21		2	11
3.	Life & Health Sciences (13)	58103422	1135176	51	46	1	2	77
4.	Pure and Applied Physics (6)	16056394	386806	29	36	1	1	49
5.	Pure and Applied Chemistry (7)	24765875	645261	50	22		6	39
6.	Earth & Planetary Sciences (3)	10450572	208649	28	8			20
7.	Materials Science (2)	6910144	185774	7	8		1	30
8.	Environmental Science (4)	12535788	291759	27	18		1	13
9.	Biotechnology (1)	3776637	42000	5	2			3
	<b>Total (40)</b>	<b>138972391</b>	<b>2982748</b>	<b>233</b>	<b>161</b>	<b>2</b>	<b>13</b>	<b>242</b>

**LIST OF 40 PROJECTS COMPLETED DURING YEARS 2016 to 2017: THRUST AREA-WISE**

**1. Life & Health Sciences (13)**

S. No	Title of Project	Project No.
1	Collective migration in the fly nervous system	4403-1
2	Catecholestrogens in fish reproductive endocrinology	4603-3
3	Anti factor H autoantibody associated hemolytic uremic syndrome	4703-1
4	Integrating Hox and chromatin mediated transcriptional regulation	4703-2
5	Molecular mechanisms of immune evasion by <i>M. tuberculosis</i>	4803-1
6	DNA encapsulated Quantum dots for Bio imaging	4803-2
7	Control of melanosome biogenesis by small GTPases	4903-1
8	Study of neural development in hiPS models of microcephaly	4903-2
9	Transcriptomics and metabolomics in patients with steroid Non-responsive severe alcoholic hepatitis	4903-3
10	Global transcriptomics of sex specific splicing	4903-4
11	Muscle SC self-renewal: A stressful matter?	5003-1
12	Decipher the symbiotic program in tropical legumes	5103-4
13	Molecular study of Rh gene variants in Indians	5203-1

**2. Pure & Applied Physics (6)**

S. No	Title of Project	Project No.
1	Research and Development of Micromegas Detector and related devices	4304-1
2	Real-Time Imaging Through Fog Over Long Distances (RITFOLD)	4604-4
3	Correlations and transport far from equilibrium in nanosystems	4704-2
4	Rotating and curved boundary-layer instabilities	4704-3
5	Reversals of a large scale field on a turbulent background	4904-1
6	Studies of spin ladder and heavy fermion systems in extreme conditions of hydrostatic or uniaxial pressure and low temperature	4904-2

**3. Pure & Applied Chemistry (7)**

S. No	Title of Project	Project No.
1	Correlated studies of response properties of Open-shell molecules in the relativistic Framework	4705-3
2	Supra molecular approach to composite materials for advanced technologies	4805-1
3	Kinetics and spectroscopy in extreme environments: Applications to Astrophysics and Astrochemistry	4905-1

4	Influence of the Resorcin[4]arene on the Catalytic Outcomes	5005-1
5	Design and synthesis of new C1- symmetric biaryl-based ligands and catalysts and their evaluation in asymmetric catalytic reactions	5005-2
6	Glycochemical Studies on Mycobacterial Arabinomycolate	5105-1
7	Phosphorus-supported multisite coordinating ligands for the assembly of polynuclear heterometallic (3d-4f) and homonuclear (3d) ensembles: Towards a new generation of molecular magnetic materials	5105-3

#### 4. Environmental Science (4)

S. No	Title of Project	Project No.
1	Controlling for upscaling uncertainty in assessment of Forest aboveground biomass in the Western Ghats of India	4509-1
2	Nutrient sensing in plants	4609-1
3	Gene resources from polluted soils	4709-1
4	Survey of soil-Si pools and contribution of Si fertilization in a sustainable rice cultivation in South India	5109-1

#### 5. Computational Science (3)

S. No	Title of Project	Project No.
1	Multilingual word spotting for degraded documents	4700-IT-1
2	Arithmetic circuits computing polynomials	4702-1
3	Monte Carlo and Learning Schemes for Network Analytics	5100-IT-1

#### 6. Earth & Planetary Sciences (3)

S. No	Title of Project	Project No.
1	Deep structure of the Indian continent	4707-1
2	Tropical cyclones in the Bay of Bengal: Oceanic response and air-sea interactions	4907-1
3	Cenozoic denudation of South India	5007-1

#### 7. Materials Science (2)

S. No	Title of Project	Project No.
1	High anisotropy molecular magnets: Synthesis & Modelling	4808-1
2	Synthesis of Photocatalytic Porous Silicon-Containing Nitride and Oxynitride Nanocomposites	5108-1

### 8. Pure & Applied Mathematics (1)

S. No	Title of Project	Project No.
1	Hypergeometric functions: harmonic analysis and representation theory	5001-1

### 9. Biotechnology (1)

S. No	Title of Project	Project No.
1	Studying the role of rpoN, the alternative sigma factor, in the pathogenicity of <i>R. solanacearum</i> , the causal agent of bacterial wilt in plants	4800-B1

**LIST OF OTHER INDIAN UNIVERSITIES/INSTITUTES INVOLVED IN PROJECTS**

<b>S. No</b>	<b>Names and location of Universities/Institutes</b>	<b>No. of Collaborations</b>
1	All India Institute of Medical Sciences, New Delhi	1
2	Amity University, Noida, Uttar Pradesh	1
3	Banaras Hindu University, Varanasi, Uttar Pradesh	1
4	Bharathidasan University, Tiruchirappalli, Tamil Nadu	2
5	Centre for DNA Fingerprinting and Diagnostics, Hyderabad, Andhra Pradesh	1
6	Indian Association for the Cultivation of Sciences, Kolkata West Bengal	1
7	Indian Institute of Science Education and Research, Pune, Maharashtra	1
8	Institute for Stem Cell Biology and Regenerative Medicine, Bangalore, Karnataka	2
9	University of Hyderabad, Hyderabad, Andhra Pradesh	1
10	Indian Statistical Institute, Kolkata, West Bengal	1
11	Institute of Liver and Biliary Sciences, New Delhi	1
12	Institute of Mathematical Sciences, Chennai, Tamil Nadu	1
13	National Institute of Science Education and Research, Bhubaneswar, Orissa	1
14	National Institute of Immunohaematology, Mumbai, Maharashtra	1
15	National Remote Sensing Centre, Hyderabad, Andhra Pradesh	1
16	Saha Institute of Nuclear Physics, Kolkata, West Bengal	1
17	Raman Research Institute, Bangalore, Karnataka	1
18	Tata Institute of Fundamental Research, Hyderabad, Andhra Pradesh	1
19	Thapar University, Patiala, Punjab	1
20	Tezpur University, Tezpur, Assam	1
21	Tata Institute of Fundamental Research - National Centre for Biological Sciences, Bangalore, Karnataka	1
22	University of Agricultural Sciences, Bangalore, Karnataka	1
23	University of Calcutta, Kolkata, West Bengal	1
24	Harish Chandra Research Institute, Allahabad, Uttar Pradesh	1
	<b>Total</b>	<b>26</b>

**LIST OF OTHER FRENCH UNIVERSITIES/INSTITUTES INVOLVED IN PROJECTS**

<b>S. No</b>	<b>Names and location of Universities/Institutes</b>	<b>No. of Collaborations</b>
1	CEA-Saclay IRFU, Gif sur Yvette	1
2	CEA, Grenoble Cedex	2
3	Ecole Nationale Supérieure de Chimie de Rennes, Rennes Cedex	1
4	Ecole Normale Supérieure, Paris	1
5	Institut National de la Recherche Agronomique, Rennes Cedex	1
6	Institut National de la Recherche Agronomique, Montpellier Cedex	1
7	Institut National de la Recherche Agronomique, Castanet Tolosan Cedex	1
8	Inria Sophia Antipolis, Nice	1
9	Institut de Physique du Globe, Paris	1
10	Laboratoire des Symbioses Tropicales & Méditerranéennes (IRD), Montpellier Cedex	1
11	UMR AMAP, Botanique et bioinformatique de l'Architecture des Plantes, Montpellier	1
12	Université de Lorraine – Metz, Metz	1
13	Université de Rennes, Rennes	1
14	Université François Rabelais Tours Polytech, Tours	1
15	Université de Toulouse, Toulouse	1
16	Université Pierre et Marie Curie, Paris Cedex	1
17	Université de Strasbourg, Strasbourg Cedex	2
18	University Bordeaux, Pessac	1
19	CEREGE – Aix Marseille University, Aix-en-Provence	1
20	CEREGE-Université d'Aix-Marseille III, Marseille	1
	<b>Total</b>	<b>22</b>

**SOME SIGNIFICANT OUTCOMES OF 40 COMPLETED PROJECTS****Life and Health Sciences**

- Identification of adhesion molecule N-cadherin as an important determinant of tumour progression that acts as a molecular brake during collective migration
- 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*
- Insights in the physiopathology of HUS, on its epidemiology, management and its treatment
- Discovery and characterization of Hox associated PTMs and protein domains: functional and structural characterization
- Identification of biomarker and therapeutic molecules important in therapy of tuberculosis
- A novel method to conjugate DNA to Quantum dots directly
- Characterization of several endosomal Rab GTPases that regulate different protein trafficking steps from different endosomal domains during melanosome biogenesis
- Using hiPSC for drug discovery platforms
- Identified gene sets that correlated significantly with mortality in SAH patients, irrespective of whether the patient was a responder or non-responder to steroid therapy
- Given evidence for the first time for the existence of sex chromosome dosage compensation in *Bombyx mori*
- Established a new model for understanding and addressing Selenoprotein N related muscle disease pathology
- Generation of transcriptome data in tropical legumes
- Development of a multiplex PCR-based, Indian population specific, RHD genotyping test

**Pure & Applied Physics**

- Micromegas detector operation, tracks distortion calculation in in homogeneous electric and magnetic fields
- Imaging in actual fog was performed in field over distance of 1.3 km using polarimetric imaging with a Wollaston-based snapshot polarimetric camera
- Developed an equation of motion approach for the single-impurity Anderson model in non-equilibrium conditions

- Boundary layer flow along a rotating cylinder - Base flow completely documented and published
- Flow reversals and condensate states in Kolmogorov flow in two-dimensional geometry; excellent agreement between the simulations and experiments
- Design and fabrication of the Diamond Anvil Cell for electrical resistivity and magnetization measurements suitable for PPMS and VSM

### **Pure and Applied Chemistry**

- New state-of-the-art theories (MRCC) at the frontier of electron correlation theories and relativistic quantum chemistry
- The potential application of single-nanorod fluorescence polarization microscopy was demonstrated for the first time for the imaging of finely nano-structured surfaces
- A novel high enthalpy flow reactor was established at the University of Rennes
- A new glycosidation methodology was identified; a series of arabinofuranosyl lipids present on the cell surface of the *Mycobacterium tuberculosis* were synthesized
- Important role of magnetic anisotropy in determining the overall magnetic behavior is being clearly understood which will allow new design of more efficient molecular magnets
- Discovery of homogeneous catalysts operating in a confined environment
- A new methodology in terms of use of C-1 symmetric ligands especially for quick access of C-N bond formation assisted by microwave was developed

### **Environmental Science**

- Potential to develop an image processing scheme for inferring forest parameters from Very High Spatial resolution satellite imagery produced in India (IRS Cartosat-1 and IRS LISS-4)
- Identification of protein involved in regulation of nitrate transport
- Characterization of metal resistant genes and their role in metal tolerance
- Establish a relationship between bioavailability of Si on growth and metabolism of rice in South India

### **Computational Science**

- Definition of a global retrieval process based on a hash table of word signatures
- Production of lower bounds for arithmetic computations and obtaining natural complete problems for the class VP

- Developed a theoretical framework for the analysis of Whittle index based policies in continuous-space models and applied this to crawling ephemeral content in web search engines, scheduling in the cloud, and in resource allocation

### **Earth & Planetary Sciences**

- Assembled teleseismic data registered at all the Indian broadband seismological stations; Characterized the seismic structure and deformation through application of recent methodologies
- A statistical forecast models for TCs intensity change has been developed which can greatly benefit the agencies responsible for operational TCs forecast
- Major periods of lateritic weathering identified by radiometric ( $^{40}\text{Ar}/^{39}\text{Ar}$ ) dating of K-Mn oxides, and paleomagnetism of Fe-oxides

### **Materials Science**

- Preparation of heterometallic compounds with these Ni and Fe building units; Modeling of the magnetic behaviour by novel VB technique
- Production of nanocomposites in which titania/zirconia and titanium/zirconium nitride were *in situ* crystallized in an amorphous matrix (silicon oxycarbide/nitride)

### **Pure & Applied Mathematics**

- Study of the Heckman-Opdam hypergeometric functions on the root system BC for some natural classes of non-positive multiplicities: positivity, estimates, asymptotic expansions

### **Biotechnology**

- Successfully establishment of a molecular genetics laboratory for doing research in *Ralstonia solanacearum* at Tezpur University, Assam under the mentorship of the French collaborator

**OUTCOME IN THE FORM OF PATENTS FILED/OBTAINED FROM THE 40 PROJECTS DURING 2016 to 2017:**

<b>S No.</b>	<b>Discipline</b>	<b>Project Details</b>	<b>Patent Summary</b>	<b>Application Status</b>
1.	Pure and Applied Physics	Project No. 4604-4 Title: Real time imaging through for over long distance (RITFOLD)	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.	(International PCT Patent, filed on the 10th May 2016, Identification number: PCT/FR2016/051086)
2.	Life and Health Sciences	Project No. 5203-1 Title: Molecular study of Rh gene variants in Indians	Development of a multiplex PCR-based, Indian-specific RHD genotyping test	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.

**POSSIBLE COMMERCIAL POTENTIAL FROM THE 40 PROJECTS COMPLETED DURING 2016-17:**

<b>S No.</b>	<b>Discipline</b>	<b>Project Details</b>	<b>Commercial Potential</b>
1.	Life & Health Sciences	Project No. 4603-3  Title: Catecholestrogens in fish reproductive endocrinology  Prof. K.P.Joy/ Dr. Alexis Fostier	A 58K nucleotides microarray has been specifically produced for the Indian catfish. It can be used for any, without a priori transcriptomics, study and gives the opportunity to discover unsuspected regulation mechanisms in this species. Till now, such a tool was not available.
2.	Computational Science	Project No. 4700-IT1  Title: Multilingual Word spotting for Degraded Documents  Prof. Umapada Pal/ Dr. Nicolas Ragot	A word-spotting software prototype has been developed. The GUI (Graphical User Interface) allows integrating several word-spotting engines such as FSM and ESC developed inside the project, but also others. A toolbox in C++ dedicated to elastic matching algorithms as also been developed. It has been used to produce word-spotting engines integrated to the GUI.
3.	Pure and Applied Chemistry	Project No. 4705-3  Title: Correlated studies of response properties of Open-shell molecules in the relativistic Framework  Dr. Ankan Paul/ Prof.Trond Saue	The theories and codes developed as a part of this project have vast potential for understanding and predicting molecular spectra and properties. High accuracy of predicted quantities is the primary strength of the work. Extensions are eminently possible both theoretically and computationally for increasing the viability of these approaches to larger systems and more varieties of properties.
4.	Environmental Science	Project No. 4709-1  Title: Gene resources from polluted soils  Prof. M. Sudhakara Reddy/ Dr. Laurence FRAISSINET-TACHET	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.

5.	Life and Health Sciences	<p>Project No. 4803-2</p> <p>Title: DNA encapsulated Quantum dots for Bio imaging</p> <p>Prof. Praveen Kumar Vemula/ Prof. Benoit Dubertret</p>	<p>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.</p>
6.	Pure and Applied Chemistry	<p>Project No. 4805-1</p> <p>Title: Supra molecular approach to composite materials for advanced technologies</p> <p>Prof. Uday Maitra/ Prof. André Del Guerso</p>	<p>The potential application of single-nanorod fluorescence polarization microscopy was demonstrated for the first time for the imaging of finely nano-structured surfaces. Materials, imaging technique and NP fabrication process can be further developed for potential applications.</p>
7.	Materials Science	<p>Project No. 4808-1</p> <p>Title: High anisotropy molecular magnets: Synthesis &amp; Modelling</p> <p>Dr. S Ramasesha/ Dr. J. P. Sutter</p>	<p>The demonstration of large anisotropy magnetic systems is a way forward for obtaining molecular systems with large blocking temperatures which could be useful in developing applications involving molecular materials.</p>
8.	Pure and Applied Physics	<p>Project No. 4904-2</p> <p>Title: Studies of spin ladder and heavy fermion systems in extremen conditions of hydrostatic or uniaxial pressure and low temperature</p> <p>Dr. S. Arumugam/ Dr. Daniel Braithwaite</p>	<p>Development of Uniaxial Pressure cell for magnetization measurements</p>
9.	Pure and Applied Chemistry	<p>Project No. 4905-1</p> <p>Title: Kinetics and spectroscopy in extreme environments: Applications to Astrophysics and Astrochemistry</p> <p>Prof. Elangannan Arunan/ Dr. Robert Georges</p>	<p>A new experimental set-up has been developed, aided by modeling studies, to probe hypersonic flows using the ultra-sensitive Cavity Ring-down Spectroscopy technique. A novel high enthalpy flow reactor was established at the University of Rennes following the collaboration.</p>

10.	Pure and Applied Chemistry	<p>Project No. 5005-2</p> <p>Title: Design and synthesis of new C1 symmetric biaryl-based ligands and their evaluation in asymmetric catalytic reactions</p> <p>Dr. Pradeep Kumar/ Dr. Frédéric LEROUX</p>	<p>A new methodology in terms of use of C-1 symmetric ligands especially for quick access of C-N bond formation assisted by microwave has been developed. This is certainly a useful addition to the existing knowledge in the area of catalysis and organic synthesis. The application of these ligands can be extended to some other useful reactions such as multicomponent reaction, industrially useful reduction of dehydroamino acids to amino acids, allylic substitution and epoxidation reactions.</p>
11.	Computational Science	<p>Project No. 5100-IT-1</p> <p>Title: Monte Carlo and Learning Schemes for Network Analytics</p> <p>Dr. Vivek S. Borkar/ Dr. Konstantin Avrachenkov</p>	<p>The iterative Bayesian update rule developed as part of this project has already been used by other French researchers in a machine learning context of identifying an odd arm with minimal delay and vanishing probability of error. Inria team has also applied for the industrial grant suggesting further studies of Whittle index based and stochastic approximation based techniques for optimization of several technological processes in a search engine.</p>
12.	Pure and Applied Chemistry	<p>Project No. 5105-1</p> <p>Title: Glycochemical Studies on Mycobacterial Arabinomycolate</p> <p>Dr. Srinivas Hotha/Dr. Thierry Benvegnu</p>	<p>A new glycosidation methodology was identified. A series of arabinofuranosyl lipids present on the cell surface of the <i>Mycobacterium tuberculosis</i> is synthesized and shared with ENSCR, France. The protocol that is developed during the course of the project has long term ramifications as this philosophy can be applied to the synthesis of wide range of glycolipids.</p>
13.	Pure and Applied Chemistry	<p>Project No. 5105-3</p> <p>Title: Phosphorus-supported multisite coordinating ligands for the assembly of polynuclear heterometallic (3d-4f) and homonuclear (3d) ensembles: Towards a new generation of molecular magnetic materials</p> <p>Prof. Vadapalli Chandrasekhar/ Dr. Hab. Rodolphe Clérac</p>	<p>The understanding obtained from this project should lead to the design of better systems. For example, the important role of magnetic anisotropy in determining the overall magnetic behavior is being clearly understood. This will allow new design of more efficient molecular magnets.</p>

**1. Project No. 4304-1**

<b>Principal Collaborators</b>	
<b>Prof. Supratik Mukhopadhyay</b> <b>Saha Institute of Nuclear Physics</b> <b>Kolkata</b>	<b>Dr. Paul Colas</b> <b>CEA/IRFU Saclay,</b> <b>Gif sur Yvette cedex</b>

The objective of this project was to gain an in-depth understanding of intrinsic properties of a Time Projection Chamber (TPC) based on Micromegas detectors, optimizing the design and operational parameters of the TPC by means of detailed detector simulation of the Micromegas-based TPC, study of the effect of field distortion within Micromegas modules placed in an inhomogeneous magnetic field and Refinement of the neBEM (nearly exact Boundary Element Method solver as and when necessary. The achievements were:

- a) Simulation and measurements of gain, resolution, ion back-flow, etc. for various geometries and operational parameters
- b) Setup of an entire lab at SINP
- c) Calculation of distortions
- d) Study of distortions in a Large Prototype with tracks from a beam
- e) Training of several students, including 2 PhDs

**2. Project No. 4403-1**

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

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:

- a) Adhesion molecule N-cadherin is an important determinant of tumor progression that acts as a molecular brake during collective migration
- b) An unconventional N-cadherin cascade is involved in collective migration

- c) Connecting intrinsic and extrinsic cues controlling collective cell migration
- d) The glial determinant controls the expression of the Netrin chemoattractant receptor Frazzled
- e) Impact of a glial neuronal Semaphorin signalling on motor behaviour

**3. Project No. 4509-1**

<b>Principal collaborators</b>	
<b>Dr. Chandra Sekhar Jha</b> <b>Prof. Vinay K. Dadhwal (2013-2015)</b> <b>National Remote Sensing Centre</b> <b>Hyderabad</b>	<b>Dr. Pierre Couteron</b> <b>UMR AMAP</b> <b>Montpellier</b>

The main objective of the project was to assess uncertainty in evaluation of forest aboveground biomass (AGB) at critical steps of the upscaling process from local forest data (i.e. field plots) to regional extrapolations using remote-sensing, in order to improve largescale biomass and carbon stock assessments. The project focused on the forests of the Western Ghats (WG) of India, which are a biodiversity hotspot and for which field data from forest sample plots, satellite images at various spatial and spectral resolutions, as well as reference vegetation maps were available at the beginning of the project. The project led to the following results:

- a) A consistent set of field plots (established by the team) and satellite image data was built in the Yellapur pilot landscape harboring different forest types. Lidar data were also acquired and processed by NRSC.
- b) The proof of concept of the main steps for upscaling biomass (AGB) from field, to landscape and region scales was achieved.
- c) The relevance of IRS Cartosat-1 images (2.5 m resolution) and texture analysis of canopy images (FOTO method) as central tools to predict AGB in the context of the WG was demonstrated. Airborne Lidar also proved relevant though to be expected of more limited availability for large scale applications.
- d) Predictions and associated errors assessment covered the three main types of forests, i.e. evergreen, moist and dry deciduous, though the latter type requested prior identification and specific treatment.
- e) Prospects for using LISS-4 images (5 m resolution) to address regional scale were encouraging

#### 4. Project No. 4603-3

Principal collaborators	
<b>Prof. K.P.Joy</b> <b>Banaras Hindu University</b> <b>Varanasi</b>	<b>Dr. Alexis Fostier</b> <b>INRA, LPGP</b> <b>Campus de Beaulieu, 35042</b> <b>Rennes cedex</b>

The project aimed at studying the synthesis and functional role of catecholestrogens 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*.

#### 5. Project No. 4604-4

Principal collaborators	
<b>Dr. Hema Ramachandran</b> <b>Raman Research Institute</b> <b>Bangalore</b>	<b>Dr. Mehdi Alouini</b> <b>Universite de Rennes 1,</b> <b>Rennes</b>

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, and the utilisation of task and data parallelization capabilities of typical desktop computers
- 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

**6. Project No. 4609-1**

<b>Principal collaborators</b>	
<b>Dr. Narendra Tuteja</b> <b>Amity University</b> <b>Noida</b>	<b>Dr. Benoit Lacombe</b> <b>CNRS/INRA/SupAgro/UM2</b> <b>Montpellier</b>

The aim of this project was to understand the signaling network that exists between these two ions to increase the knowledge of salinity tolerance in plants. The objective is to understand the mechanisms by which plants sense the concentration of sodium and nitrate in the media and integrate downstream signaling pathway to adapt their developmental processes (especially root developmental response). The project led to the observations that salinity stress induces reduction in primary root length in all genotypes. *cbl9* and *cipk23* mutants (KO) were identified as most salt sensitive mutant due to its higher sodium ion (Na<sup>+</sup>) accumulation, high reactive oxygen species (ROS) level; unbalanced calcium level and higher cell death as compare with wild type (Columbia) under salinity stress. CBL1 (calcium sensor) and ABI2 (protein phosphatase 2C family member) were involved in regulation of nitrate transport, sensing and signaling. Co-

expression studies in *Xenopus* oocytes and analysis of plants deficient in ABI2 indicated that ABI2 enhanced NPF6.3-dependent nitrate transport, nitrate sensing, and nitrate signaling.

### 7. Project No. 4700-IT-1

<b>Principal collaborators</b>	
<b>Prof. Umapada Pal</b> <b>Indian Statistical Institute</b> <b>Kolkata</b>	<b>Dr. Nicolas Ragot</b> <b>Université François Rabelais Tours</b> <b>TOURS</b>

The main objective of the project was to design a new word spotting framework to allow searching and retrieval of documents using visual query words. Word spotting is an interesting alternative to OCR for specific documents (degraded, historical, graphics, handwritten etc.). The project achieved the following goals:

- a) Definition of a global retrieval process based on a hash table of word signatures
- b) Definition and conception of a local matching approach based on sequence matching able to skip outliers (noise) and to operate partial matching
- c) Definition of a text/graphic separation approach handling lines touching text components
- d) Definition of a scheme for localisation and matching of characters, independently from their orientation
- e) Elaboration of a GUI framework for spotting inside image collections (including preprocessing, visualization and querying interface, matching approach between query and images of words)

### 8. Project No. 4702-1

<b>Principal collaborators</b>	
<b>Dr. Meena Mahajan</b> <b>The Institute of Mathematical Sciences</b> <b>Chennai</b>	<b>Dr. Guillaume Malod</b> <b>Université Paris Diderot</b> <b>Paris Cedex 13</b>

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.

### 9. Project No. 4703-1

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

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 cell (PBMC) 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.

### 10. Project No. 4703-2

<b>Principal collaborators</b>	
<b>Dr. Rakesh K Mishra</b> <b>Centre for Cellular and Molecular Biology</b> <b>Hyderabad</b>	<b>Dr. Yacine Graba</b> <b>IBDM, Campus Universitaire de Luminy</b> <b>Marseille Cedex 09</b>

The goal of this project was to better understand how the evolutionary conserved Hox transcription factors, with broadly recognized functions in development and disease, control gene expression by investigating the interplay with chromatin features and regulators. The project led to the following outcomes:

- a) Characterization of Hox chromatin interplays for gene regulation in Drosophila S2 cells
- b) Discovery and characterization of Hox associated PTMs and protein domains: functional and structural characterization

- c) Discovery and characterization of a Hox generic function in the Drosophila fat body: repression of autophagy
- d) Defining the chromatin landscape for Hox generic functions
- e) Functional relevance of abdA in the posterior domain where identity is determined by AbdB

**11. Project No. 4704-2**

<b>Principal collaborators</b>	
<b>Dr. Pareek Tribhu P</b> <b>Harish Chandra Research Institute</b> <b>Allahabad</b>	<b>Dr. Lavagna Mireille</b> <b>Institute of Nanosciences and Cryogeny, CEA</b> <b>Grenoble Cedex 9</b>

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

**12. Project No. 4704-3**

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

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:

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

### 13. Project No. 4705-3

<b>Principal collaborators</b>	
<b>Dr. Ankan Paul</b> <b>Indian Association for the Cultivation of Science</b> <b>Kolkata</b>	<b>Prof. Trond Saue</b> <b>Université de Toulouse 3 (Paul Sabatier)</b> <b>Toulouse</b>

The overall objective of this project was to develop computational tools for the study of reactivity and properties of molecules containing heavy elements. More precisely, it was aimed at developing state of the art electron correlation methods (coupled-cluster) providing highly accurate results for molecules displaying relativistic effects, on par with what has been achieved for light elements. The project led to development and implementation of a suite of many-body theories to treat strong electron correlation, both for studying potential energy surfaces and precision spectroscopy in a spin-free manner, generalization of the above theories to include scalar relativistic effects for systems with medium heavy atoms and development and implementation of relativistic many-body theory for understanding and interpreting core-ionization and core-excitation spectroscopy, dovetailing the formulations from both the Indian and the French sides. The theories and codes developed as a part of this project have vast potential for understanding and predicting molecular spectra and properties. High accuracy of predicted quantities is the primary strength of the work.

#### 14. Project No. 4707-1

<b>Principal collaborators</b>	
<b>Prof. M. Ravi Kumar</b> <b>National Geophysical Research Institute</b> <b>Hyderabad</b>	<b>Prof. Jean-Paul Montagner</b> <b>Institut de Physique du Globe de Paris</b> <b>Paris</b>

This proposal was primarily aimed at investigating the causative factors that determine the unique nature of the Indian continent, with emphasis on its origin, deformational history, interactions with Asia and its tectonic evolution, in order to constrain the thermal structure of the Indian shield lithosphere. Upon its completion, it led to assembly of teleseismic data registered at all the Indian broadband seismological stations, characterization of the seismic structure and deformation through application of recent methodologies (P- and S- receiver functions, SKS splitting and obtained a 3-D anisotropic, heterogeneous mantle model of the Indian continent and surrounding oceans, mapped lateral variations in the lithosphere-asthenosphere boundary.

#### 15. Project No. 4709-1

<b>Principal collaborators</b>	
<b>Prof. M. Sudhakara Reddy</b> <b>Thapar University</b> <b>Punjab</b>	<b>Dr. Laurence FRAISSINET-TACHET</b> <b>Université Lyon1</b> <b>Villeurbanne Cedex</b>

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.

#### 16. Project No. 4800-B1

<b>Principal collaborators</b>	
<b>Dr. Suvendra Kumar Ray</b> <b>Tezpur University</b> <b>Assam</b>	<b>Dr. Stephane Genin</b> <b>INRA/CNRS, Laboratoire des Interactions</b> <b>Plantes-Microorganismes</b> <b>UMR441, F-31326 Castanet-Tolosan</b>

The aim of this project was to understand the role of sigma-54 in the bacterium *Ralstonia solanacearum*, which causes a lethal bacterial wilt disease in many plants including eggplant, chilli, potato, tomato, banana, groundnut etc. In the Indian laboratory, which was new to start the research on this bacterium, standardization of novel pathogenicity assays were done in tomato seedlings. With the support from the French collaborators, molecular techniques were standardized to study the association as well virulence factors of *R. solanacearum*. In the French laboratory, transcriptome data were generated to know the role of Sigma-54 as well as PehR, regulators in this bacterium. A molecular genetics laboratory for doing research in *R. solanacearum* at Tezpur University, Tezpur, Assam was successfully established, under the mentorship of the French collaborator Dr. Stephane Genin. During the visit of the French scientist to Tezpur University, two national seminars on plant associated bacteria were conducted.

**17. Project No. 4803-1**

<b>Principal collaborators</b>	
<b>Dr. K. N. Balaji</b> <b>Indian Institute of Science</b> <b>Bangalore</b>	<b>Dr. Jagadeesh Bayry</b> <b>Institut National de la Santé et de la</b> <b>Recherche Médicale</b> <b>Centre de Recherche des Cordeliers</b> <b>Paris</b>

This project focused on integrating cellular immunology and signaling events to dissect immune evasion strategies of *M. tuberculosis* and to conceive novel therapeutic strategies.

From the above mentioned investigations, several molecular regulators that orchestrate immune evasion mechanisms of *M. tuberculosis* have been identified.

*Biomarkers:* In terms of biomarkers, several miRNA signatures such as miR-155, miR-31, miR-150 and miR-146a which regulate significant evasion strategies have been identified. These miRNAs including identified the host signaling pathways can be analysed for host directed therapies (HDT) of tuberculosis.

*Therapeutic molecules:* Immunogenic antigens of *M. tuberculosis* like PE\_PGRS 17 (Rv0978c), PE\_PGRS 11 (Rv0754), Rv1917c (PPE34) and PE\_PGRS 62 (Rv3812), have been identified. They could be utilized as novel vaccine antigens which can be combined with currently used BCG vaccines to boost the vaccine efficacy or can be used as a subunit vaccine. Also, the studies identified potential therapeutic utility of PD-L1 inhibitors and IL-1 beta to boost Th1 and Th17 responses to *M.tuberculosis*.

### 18. Project No. 4803-2

Principal collaborators	
<b>Prof. Praveen Kumar Vemula</b> <b>National Center for Biological Sciences</b> <b>Bangalore</b>	<b>Prof. Benoit Dubertret</b> <b>ESPCI Paris-Tech</b> <b>Paris</b>

The project aimed at preparation of non-blinking DNA-functionalized quantum dots 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.

### 19. Project No. 4805-1

Principal collaborators	
<b>Prof. Uday Maitra</b> <b>Indian Institute of Science</b> <b>Bangalore</b>	<b>Prof. André Del Guerso</b> <b>Université de Bordeaux</b> <b>Talence</b>

The aim of the project was to use composite and hybrid materials for application in synthesis. The combination of organic and inorganic components is a challenge that is addressed using supramolecular chemistry. Novel combinations of gelators and bridging ligands are designed for intimate intermixing and structuring into gels of organic self-assembled nanofibers, inorganic nanoparticles and metal salts. Besides the synthetic effort performed both at the IISc, Bangalore and at the ISM, Bordeaux, original supercritical fluids techniques are developed at the ICMCB-Bordeaux to prepare original nanoparticles. The achievements of this project were:

- a) Composite organic/inorganic nanofibers displaying dual-color dual-polarization emission were obtained using CdSe-CdS nanorods and 2,3-didecyloxyanthracene (DDOA)
- b) Alignment of nanorods in space was achieved exploiting supramolecular interactions with gel nanofibers
- c) High quality CdSe QDs showing narrow distribution in sizes and high photoluminescence efficiencies were synthesized in microfluidic supercritical fluids at gram scale

- d) Original CdSe-CdS nanocubes and high quality CdSe-CdS nanorods with narrow distribution in sizes and high photoluminescence efficiencies were synthesized using micro-millifluidic supercritical fluid technology and in conventional batch reaction
- e) The potential application of single-nanorod fluorescence polarization microscopy was demonstrated for the first time for the imaging of finely nano-structured surfaces

## 20. Project No. 4808-1

<b>Principal collaborators</b>	
<b>Dr. S Ramasesha</b> Indian Institute of Science Bangalore	<b>Dr. J. P. Sutter</b> Laboratoire de Chimie de Coordination du CNRS Toulouse

The objectives of this project were synthesis of low dimensional (discrete, 1-D) molecular magnets based on complexes with unusual coordination to enhance magnetic anisotropy, study of structure-property relations of the synthesized magnets. Both static and dynamic magnetic properties were studied, besides other properties such as optical properties, heat capacities and related thermodynamic properties. Besides, the development of theoretical tools to model magnetic systems with strong anisotropy and exchange interactions for systems with assorted spins was done and application of these techniques to model the compounds synthesized by the French group. The project led to synthesis of heptacoordinated Ni(II) and Fe(II) complexes in D<sub>5h</sub> surrounding, demonstration of their substantial magnetic anisotropy, and effect of ligands on it, preparation of heterometallic compounds with these Ni and Fe building units, novel hetero-trispin (2p-3d-4f) chain compounds and modeling of the magnetic behaviour by novel VB technique.

## 21. Project No. 4903-1

<b>Principal collaborators</b>	
<b>Dr. Subba Rao Gangi Setty</b> Indian Institute of Science Bangalore	<b>Dr. Graca Raposo</b> 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.

**22. Project No. 4903-2**

<b>Principal collaborators</b>	
<b>Prof. Naren Ramanan</b> <b>Indian Institute of Science</b> <b>Bangalore</b>	<b>Prof. Pierre Gressens</b> <b>Institut National de la Santé et de la</b> <b>Recherche Médicale, INSERM U1141,</b> <b>Paris</b>

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 (hiPS) 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

**23. Project No. 4903-3**

<b>Principal collaborators</b>	
<b>Dr. Shiv K Sarin</b> <b>Institute of Liver and Biliary Sciences (ILBS)</b> <b>New Delhi</b>	<b>Dr. Richard Moreau</b> <b>Centre de Recherche biomédicale Bichar</b> <b>Beaujon CR3</b> <b>INSERM U773</b> <b>Paris</b>

The first aim of the project was to identify baseline molecular mechanisms that predict the subsequent response or non-response to corticosteroids. For this, gene/exon-expression profiling in the liver and peripheral blood mononuclear cells (PBMCs) as well as metabolomic profiling of liver, plasma and urine will be performed at baseline (i.e., day 0, before starting corticosteroids). The second aim was to identify molecular mechanisms associated with the response to corticosteroid therapy. For this, gene/exon-expression profiling in PBMCs and metabolomics profiling of plasma and urine will be performed at day 4 and day 7 of corticosteroid therapy. Results were compared between responders and non-responders to treatment. It was found that urine metabolome profile for the baseline samples in severe alcoholic hepatitis was distinct as compared to post therapy urine metabolome profile. Total metabolome profile of the plasma samples at baseline was different to the post therapy metabolome. Transcriptomics analysis of the liver biopsies was able to determine the genes that were significantly and differentially expressed. Gene sets were identified that correlated significantly with mortality in SAH patients, irrespective of whether the patient was a responder or non-responder to steroid therapy. The comparative French cohort analysis revealed that marked differences in baseline gene expression between livers and PBMCs, identifying for example chemokines that are specifically expressed in the liver.

**24. Project No. 4903-4**

<b>Principal collaborators</b>	
<b>Dr. Arun Kumar K P</b> <b>Centre for DNA Fingerprinting &amp; Diagnostics</b> <b>Hyderabad</b>	<b>Dr. Leonard Rabinow</b> <b>Univ. Paris Sud</b> <b>91400 Orsay</b>

The objectives of this project were to characterize and compare the sex specific splicing of pre-mRNAs via high throughput sequencing of cDNAs (RNA-Seq), in two insect species, a male heterogametic system (*Drosophila melanogaster*) and a female heterogametic system (*Bombyx mori*) and analyze the novel molecular players involved in sex determination in these two insect model systems. There are many interesting research leads coming out of this project. The group would like to pursue them further in their lab. This project especially helped to share the knowledge generated in collaborating labs in respective model organisms and thereby led to increased pace of research. Several new insights have been obtained both in *Drosophila* as well as *Bombyx* sex determination systems and the influence of sex specific splicing in determining the sex of the individual.

## 25. Project No. 4904-1

Principal collaborators	
<b>Dr. Mahendra K. Verma</b> <b>Indian Institute of Technology</b> <b>Kanpur</b>	<b>Dr. Stephan Fauve</b> <b>Ecole Normale Supérieure</b> <b>Paris</b>

The overall aim of the project was to determine why a small number of large-scale modes accurately capture the dynamics of the reversals although these systems are strongly turbulent. It also studied how reversals are triggered and determine their correlation with the fluctuations of the energy flux that drives the large scale modes.

This project involved fundamental aspects of field reversals and led to very interesting insights into reversal dynamics. The group has constructed symmetry-based arguments to classify the reversing and non-reversing modes in thermal convection and dynamo. It was also showed that large-scale modes play a crucial role in reversal dynamics. These results are very useful to the community working in dynamo and turbulent flows. In addition, major fraction of the simulations of the project was executed using our code TARANG and Parody, where various diagnostics of dynamo and convection reversals have been implemented and tested. TARANG, which is an open-source code, will be useful to the community. This open-source code is equivalent to IPR.

## 26. Project No. 4904-2

Principal collaborators	
<b>Prof. S. Arumugam</b> <b>Bharathidasan University</b> <b>Tiruchirappalli</b>	<b>Dr. Daniel Braithwaite</b> <b>INAC/PHELIQS/IMAPEC</b> <b>CEA Grenoble</b> <b>Grenoble Cedex 9</b>

This project aimed at gaining further understanding of the physics of the novel and competing orders that exist in two different families namely, spin ladder and heavy fermion systems. It also aimed at growing single crystals of  $Sr_3Fe_2O_7$  and heavy fermion compounds and design and fabrication using expertise from Grenoble the Diamond Anvil Cell for electrical resistivity and magnetization measurements suitable for PPMS and VSM respectively. The Diamond anvil cell technique used extensively in CEA Grenoble was implemented in CHPR. A diamond anvil cell was fabricated in Grenoble and transferred to CHPR. All necessary instrumentation was set up. Uniaxial pressure and pressure measurements in pulsed magnetic fields were initiated in Grenoble. Large single crystals of  $Sr_3Fe_2O_7$  and  $YbNi_3Al_9$  were grown, characterised, oriented and cut in CEA Grenoble suitable for uniaxial pressure measurements in CHPR. Further, Spin

ladder single crystals of  $\text{Sr}_1\text{Ca}_{13}\text{Cu}_{24}\text{O}_{41}$ ,  $\text{Sr}_{1.4}\text{Ca}_{12.6}\text{Cu}_{24}\text{O}_{41}$  and  $\text{Sr}_3\text{Ca}_{11}\text{Cu}_{24}\text{O}_{41}$  were grown under pressure in floating zone technique, cut and oriented at PSI and characterized at CHPR. The results of the project have strong potential for future high pressure studies on multiple systems.

### 27. Project No. 4905-1

Principal collaborators	
<b>Prof. Elangannan Arunan</b> <b>Indian Institute of Science</b> <b>Bangalore</b>	<b>Dr. Robert Georges</b> <b>Université de Rennes 1</b> <b>Rennes</b>

The project aimed at Shock tube experiments coupled with *ex situ* characterization of gases and carbon particles, Microwave spectroscopic investigations on molecular complexes including propargyl alcohol complexes towards understanding intermolecular interactions, development of a new High Enthalpy Source for Cavity Ring-down Spectroscopy in hypersonic flows, high Temperature infrared emission spectroscopy of small hydrocarbons and development of a new flow reactor for high temperature kinetics studies. Following were the outcomes from this project:

- a) The studies on shock-wave processing of  $\text{C}_{60}$  in hydrogen confirmed the role played by the  $\text{C}_2$  radical as a major product of  $\text{C}_{60}$  fragmentation and less expectedly highlighted the existence of a single C atom loss channel
- b) Based on microwave spectroscopy results on argon-propargyl alcohol complex, a carbon bond was proposed in Bangalore and a joint proposal to SOLEIL was submitted to investigate  $\text{H}_2\text{O}-\text{CH}_3\text{F}$  complex. This led to the observation of a new catalytic effect of substituted methane molecules ( $\text{CH}_3\text{F}$  and  $\text{CH}_3\text{Cl}$ ) on the nucleation of water
- c) A novel high enthalpy flow reactor was established at the University of Rennes following the collaboration

### 28. Project No. 4907-1

Principal collaborators	
<b>S. Neetu</b> <b>National Institute of Oceanography</b> <b>Goa</b>	<b>Dr. M. Lengaigne</b> <b>Université Pierre et Marie Curie</b> <b>Paris Cedex</b>

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:

- a) 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
- b) Understanding how this surface cooling retroacts onto the TC characteristics in this region by using a regional coupled ocean-atmosphere model
- c) 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.

**29. Project No. 5001-1**

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

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 homogeneous 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

### 30. Project No. 5003-1

Principal collaborators	
<b>Prof. Jyotsna Dhawan</b> <b>Institute For Stem Cell Biology and Regenerative Medicine</b> <b>NCBS, Bangalore</b>	<b>Prof. Ana Ferreiro</b> <b>UMR 8251 Université Paris Diderot/CNRS</b> <b>4 Rue Marie-Andrée Lagroua Weill-Hallé</b> <b>75205 Paris cedex 13</b>

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.

### 31. Project No. 5005-1

Principal collaborators	
<b>Dr. Rengan RAMESH</b> <b>Bharathidasan University</b> <b>Tiruchirappalli</b>	<b>Dr. David SEMERIL</b> <b>Université de Strasbourg</b> <b>67070 Strasbourg Cedex</b>

The present project aimed at producing catalytic reactions taking place inside a molecular cavity. Six types of ligands based on the resorcin[4]arene platform were considered, all having either carbon, nitrogen or phosphorus atoms connected to the larger rim of a conical resorcinarene backbone. The presence of a cavity able to host a catalytic centre was mainly expected to favour an elemental step of the targeted catalytic reactions. Moreover, the confinement of the catalytic centre should introduce a high regioselectivity of the formed products. There also, resorcinarenyl-complexes will be assessed in carbon-carbon bond forming reactions and other organic transformations. The present research was a fundamental contribution to the discovery of homogeneous catalysts operating in a confined environment.

### 32. Project No. 5005-2

Principal collaborators	
<b>Dr. Pradeep Kumar</b> <b>CSIR-National Chemical Laboratory</b> <b>Pune</b>	<b>Dr. Frédéric LEROUX</b> <b>University of Strasbourg</b> <b>Strasbourg</b>

The project aimed at design of a new class of C1 symmetric ligands based on a biaryl backbone. First, ortho, ortho'-dibromobiaryls were synthesized and further functionalized by means of regio- and chemoselective halogen-metal interconversions in order to access the asymmetric ligands. In the project, novel C1-symmetric ligands such as P,P- or P,S-ligands were synthesised. The ligands prepared in this way with or without metal complex were screened for their catalytic activities. The catalytic reactions studied involved multi-component C-C bond forming reactions, C-N bond forming reactions, epoxidation and asymmetric hydrogenation, etc.

A new methodology in terms of use of C-1 symmetric ligands especially for quick access of C-N bond formation assisted by microwave has been developed. This is certainly a useful addition to the existing knowledge in the area of catalysis and organic synthesis. The application of these ligands can be extended to some other useful reactions such as multicomponent reaction,

industrially useful reduction of dehydroamino acids to amino acids, allylic substitution and epoxidation reactions.

### 33. Project No. 5007-1

<b>Principal collaborators</b>	
<b>Dr Mudlappa Jayananda</b> <b>University of Hyderabad</b> <b>Hyderabad</b>	<b>Dr Anicet Beauvais</b> <b>CEREGE</b> <b>Aix en Provence</b>

The project aimed at defining the nature, age, distribution and elevation of such lateritic paleosurfaces on either side of the Western Ghats escarpment to reconstruct the topography of three major lateritic paleosurfaces since Deccan traps 65 Ma ago, for evaluating the relative contributions of epeirogeny and climatic regime change (or their interference) in the post break-up evolution of Peninsular India over the Cenozoic. High elevation (i.e., escarpment bearing) divergent continental margins result from continental break-up and may have supplied offshore basins with significant sedimentary fluxes. Constraining the denudation history of passive margins is crucial to decipher their post-rift topographic evolution that has major implications for unravelling source-to-sink systems. Current evolution models of passive margins topography predict contrasted denudation patterns across the escarpments but generally fail in providing precise denudation rates histories mostly because of the lack of absolute dating of well-characterized geomorphic markers. In the tropical belt, the passive margin upwarps and adjoining platforms bear planation lateritic paleolandscapes. The following outcomes were achieved:

- a) Major periods of lateritic weathering identified by radiometric ( $^{40}\text{Ar}/^{39}\text{Ar}$ ) dating of K-Mn oxides, and paleomagnetism of Fe-oxides
- b) The Western Ghats escarpment is stabilized since at least 50 Ma ago
- c) Since then, the denudation and surface incision at the foot of the escarpment are low ( $\leq 5\text{-}6\text{ m/My}$ )
- d) Reconstructions of topographies of paleolandscapes on traps and across the Western Ghats Escarpment
- e) Geochemistry and mineralogy of bauxites and ferricretes

### 34. Project No. 5100-IT-1

<b>Principal collaborators</b>	
<b>Prof. Vivek S. Borkar</b> <b>Indian Institute of Technology</b> <b>Mumbai</b>	<b>Dr. Konstantin Avrachenkov</b> <b>INRIA Sophia Antipolis</b> <b>Sophia Antipolis</b>

The aim of the project was to design efficient computational methods for centrality measures and decentralized algorithms on networks. The iterative Bayesian update rule developed as part of this project has already been used by other French researchers in a machine learning context of identifying an odd arm with minimal delay and vanishing probability of error. Inria team has also applied for the industrial grant suggesting further studies of Whittle index based and stochastic approximation based techniques for optimization of several technological processes in a search engine.

### 35. Project No. 5103-4

<b>Principal collaborators</b>	
<b>Prof. Maitrayee DasGupta</b> <b>University of Calcutta</b> <b>Kolkata</b> <b>West Bengal</b>	<b>Dr. Fabienne Cartieaux</b> <b>Laboratoire des Symbioses Tropicales &amp; Méditerranéennes (IRD)</b> <b>Montpellier cedex 5</b>

This project aimed at profiling the transcriptome involved in early global responses associated with inception of symbiosis in *A. hypogaea* and *A. 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 *Arachis hypogaea* and French team for *Aeschynomene 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. 5105-1

<b>Principal collaborators</b>	
<b>Dr. Srinivas Hotha</b> <b>Indian Institute of Science Education &amp; Research</b> <b>PUNE</b>	<b>Dr. Thierry Benvegnu</b> <b>Ecole Nationale Supérieure de Chimie de Rennes</b> <b>Rennes cedex 7</b>

The objectives of the project would enable the PIs to develop a cell free model of mycolyl arabino-galactan architecture of *M.tb* cell wall. Physicochemical analysis would give an insight into the impact of furanoses over pyranoses, cyclopropanes over other functional groups, length of lipidic chains. *In vitro* biological evaluations of these glycol-conjugates might pave way to new medicines to *M.tb*. A new glycosidation methodology was identified. A series of arabinofuranosyl lipids present on the cell surface of the *Mycobacterium tuberculosis* is synthesized and shared with ENSCR, France. New knowledge in selective enzymatic esterification of arabinofuranoside and trehalose substrates, extraction of mycolic acid from *M. Smegmatis*, chemistry of arabinose in the D series (instead of the standard L series) were acquired during the project. A series of products corresponding to methyl D-arabinofuranoside/pyranoside (Araf, Arap) and trehalose esterified with linoleic acid, erucic acid and mycolic acid derivatives were produced.

### 37. Project No. 5105-3

Principal collaborators	
<b>Prof. Vadapalli Chandrasekhar</b> <b>National Institute of Science Education &amp; Research</b> <b>Odisha</b>	<b>Dr. Hab. Rodolphe Clérac</b> <b>Centre de Recherche Paul Pascal (CRPP)</b> <b>Pessac</b>

The aim of the project was to design and assemble novel phosphorus-supported multi-site coordinating multicompartamental ligands. It also aimed at synthesis and structural characterization of polynuclear homo- (3d, 4f) and heterometallic (3d-4f) complexes with an emphasis on varying the transition metals and to utilize discrete magnetic building blocks and connect with paramagnetic linker for the construction of novel 1D network and to study their Single Chain Magnets (SCMs) behavior. The understanding obtained from this project should lead to the design of better systems. For example, the important role of magnetic anisotropy in determining the overall magnetic behavior is being clearly understood. This will allow new design of more efficient molecular magnets.

### 38. Project No. 5108-1

Principal collaborators	
<b>Dr. Ravi Kumar N. V</b> <b>Indian Institute of Technology</b> <b>Chennai</b>	<b>Dr. Samuel Bernard</b> <b>European Membrane Institute</b> <b>34095 Montpellier, Cedex 05</b>

The objective of the project was to synthesize (photo) catalytic (which means catalytic and photocatalytic) porous Silicon-Containing Nitride and Oxynitride nanocomposites via the

Polymer-Derived Ceramics (PDCs) route. The idea behinds this project was to prepare nanocomposites in which titanium and/or zirconium oxide/oxy-nitride/nitride nanocrystals are formed during the synthesis of the silicon nitride and oxy-nitride matrices with (photo)catalytic activity & adsorbent capacity (by immobilizing adsorbents in the porosity of materials) concomitantly being stable in severe conditions. One of the final objectives was to prepare porous silicon nitride-based materials such as ordered mesoporous powders and mesoporous monoliths as supports of catalysts or co-catalysts for hydrogen (H<sub>2</sub>) production. The second and third objectives focused on the synthesis of porous silicon-containing nitride nanocomposites (nc-MN (M=Ti, Zr, Ta)@a-Si<sub>3</sub>N<sub>4</sub> nanocomposites) to be used for photodegradation of dye and photoassisted H<sub>2</sub> production. Performing thermodynamic calculations and combining experiments with computational approaches provide a comprehensive picture to exhibit immense scientific potential & industrial applications.

Through precursor route chemistry, the collaborators produced nanocomposites in which titania/zirconia and titanium/zirconium nitride was *in situ* crystallized in an amorphous matrix (silicon oxycarbide/nitride).

### 39. Project No. 5109-1

Principal collaborators	
Dr. N. B. Prakash University of Agricultural Sciences GKVK, Bangalore	Dr. Jean Dominique Meunier CEREGE, UM 34 Aix Marseille Universite Aix en Provence

The major objective of the project was to understand the relationship between bioavailability, speciation of Si in soils and growth and performance of rice in South India. The approach used various methods for the estimation of soil Si bioavailability that are combined to agronomical, mineralogical, geochemical and isotopical studies for the determination of the key factors that control the biogeochemical cycle of Si in these ecosystems. Three objectives were planned:

1. To characterize variation in Si status in the South Indian rice soils
2. To assess the Si budget in a wetland rice ecosystem with and without Si application
3. To assess the bioavailability of different sources of Si (pot experiment)

A study of 200 samples of cultivated soils showed that the lowest values of plant available Si (PAS) are located in the ultisols and alfisols which are common along the coastal zone. The positive correlation of pH with PAS is also compatible with the adsorption of Si which depends ultimately on the amount of Si source available in the soil. We suggest that pH measurements may be useful as a proxy for PAS. The field experiment on budgeting of silicon in rice field was a great success. The application of Si only slightly increased the yields, but <sup>30</sup>Si signatures revealed that the soil ASi pool was the main source of Si to the rice. Pot experiment at UAS

showed that DE application may contribute to additional Si for improving plant growth but its specific texture also likely aided in improving the water retention locally.

#### **40. Project No. 5203-1**

<b>Principal collaborators</b>	
<b>Dr. Swati Kulkarni</b> <b>National Institute of Immunohematology</b> <b>Mumbai</b>	<b>Dr. Yann FICHOU</b> <b>Etablissement Français du Sang – Bretagne,</b> <b>Inserm UMR1078,</b> <b>BREST Cedex 2</b>

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.

## **PART B**

### **INDUSTRY-ACADEMIA RESEARCH & DEVELOPMENT PROGRAMME (IARDP)**

## **1. BACKGROUND AND SUMMARY OF THE 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, risk taking 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. In the present report, we analyse the outcome of the projects completed under the IARDP during 2013 to 2017.

## **2. SUMMARY AND ANALYSIS OF PROJECTS COMPLETED UNDER THE IARDP DURING 2013 to 2017**

A total of six projects were slated for completion during 2013 to 2017 under the IARDP. These projects were broadly related to the areas of Materials Science, Pharmaceutical Science, Atmospheric Science, Chemical Science, Digital Economics and Life Science. Out of the six projects, one project was preclosed based on the recommendations of the IRC. The summary and outcome analysis of each project is given below.

### **i. Project No. 7112**

**Title: Shaping of durable, thermal shock resistant high volume ceramic containers**

<b>Principal collaborators</b>	
Dr. Y. Srinivasa Rao Dr. Roy Johnson International Advanced Research Centre for Powder Metallurgy and new Materials (ARCI),	

Hyderabad		
<b>Industry partner from India:</b> Dr. Rajiv Verma Ceramdecor, New Delhi		<b>Industry partner from France:</b> Mr. G Rosenblat Pierre Arqueie Ceramique Technique (PACT), Limoges
<b>Duration of the project:</b> April 2011 to March 2014		
<b>Budget</b>	Indian side (Rs)	French side (Euro)
Approved	15,00,000	6300
Released	13,50,000	6300
<b>Exchange visit:</b> India to France - 1		

**Background:** Thermal shock occurs when a thermal gradient causes different parts of an object to expand by different amounts. This differential expansion can be understood in terms of stress or of strain, equivalently. The susceptibility of ceramic materials to thermal stresses has been recognized for a long time, since derivation of equations for thermal stresses arising from temperature gradients in a cylinder by J M C Duhamel in year 1838. The Centre for Ceramic Processing at International Advanced Research Centre for power Metallurgy and New Materials (ARCI) have expertise in formulating ceramic compositions for engineered properties. M/S Pierre Arqueie Ceramique Technique (PACT) have their capacity for shaping high volume ceramic containers. CeraDecor India is a well-known supplier of ceramic frits, pigments, third fire colors, mediums and decoration material for tiles, sanitary ware, tableware and glassware industry.

Considering the huge commercial potential of durable ceramic crucibles, the three organizations proposed to collaborate in the area of their respective expertise to optimize the established slip casting process develop at PACT extending to a wide range of thermal resistant formulations developed at ARCI into various configurations such as large crucibles, nozzles and other ceramic articles looking at various applications.

**Objective:** To develop a process for casting high volume, thermal shock resistant ceramic containers with improved life time. The proposal envisaged the fabrication of crucibles with enhanced life cycles by the French industry based on the composition and design specified by the Indian partner.

**Salient achievements:**

- a) Development of thermal shock resistant formulations
- b) Optimization of the slip properties suitable for casting
- c) Sintering schedule to obtain thermal shock resistant containers of approx. dimensions  $\emptyset$  210 x H170 x th 20 mm

- d) Demonstration of lab and pilot scale technology
- e) Development of the casting process by the French industry partner
- f) Indian industry partner evaluated the prototypes as fabricated by the French partner and the results supported enhanced life cycle (upto 7 cycles) of the prototypes

**Outcome analysis:** The objective of this project was to develop novel ceramic formulations with an improved lifetime which could withstand thermal shock. The prominent outcome of this project was the development of thermal shock resistant ceramic containers and optimized parameters suitable for casting. Furthermore, the technology was validated in the laboratory as well as a pilot scale. This outcome has significant commercial implications, given the widespread use and applications of crucibles in making pigments as well as other applications. The outcome of the project was graded as satisfactory as the technical objectives had been achieved.

**Concluding summary:** The progress of the project was found to be satisfactory. Considering that the collaborators had achieved the technical objectives initially envisaged on a near commercial scale, it was recommended to close the project.

**ii. Project No. 7113**

**Title: Friedel crafts acylation of 2,4-Dichloro-5-fluoro acetophenone for Ciprofloxacin production**

<b>Principal collaborators</b>		
Dr. Lakshmi Kantam Indian Institute of Chemical Technology (IICT), Hyderabad	Dr. Michel Vaultier Université Bordeaux 1 Talence	
<b>Industry partner from India</b> Dr. P Ravi Neuland Laboratories Limited Hyderabad		
<b>Duration of the project:</b> April 2011 to March 2014 (preclosed in 2013)		
<b>Budget</b>	Indian side (Rs)	French side (Euro)
Approved	21,92,800	8000
Released	7,12,000	6066.64
<b>Exchange visit:</b> One visit from both sides		
<b>Manpower:</b> Indian side - 1 Research fellow, French side – 1 Postdoctoral fellow		

**Background:** It has been estimated that the total annual worldwide consumption of antibiotics is somewhere between 100,000 and 200,000 tons. Among all known antibiotics, the ciprofloxacin has taken an important place because of its broad spectrum of activity including

most strains of bacterial pathogens responsible for respiratory, urinary tract, gastrointestinal, and abdominal infections, including Gram (-) and Gram (+) bacterial pathogens. Ciprofloxacin also plays an important role in excellent tissue penetration, and for its availability in both oral and intravenous formulations. CIP is one of the most prescribed antibiotics in the world and is a type of Fluoroquinolone (FQ), a wide-ranging class of antibiotic used on both human and animals.

**Objectives:** The main goals of this project were to:

- a) Develop an environmental friendly industrial method for the synthesis of DCFA
- b) Provide a process for high yield synthesis of 2, 4-dichloro-5-fluoro acetophenone
- c) Find a substitute of  $AlCl_3$  or find a method to recover catalyst
- d) Make acylation step catalytic in order to reduce cost and environmental wastage.
- e) Develop an alternative industrial synthesis for DCFA or a substitute for the synthesis of Ciprofloxacin

**Salient achievements:**

- a) Alternative synthesis method of DCFA starting from 3-Chloro 5-Phenyl

**Outcome analysis:** The antibiotic Ciprofloxacin is used to treat a broad spectrum of bacterial infections caused by Gram negative and Gram positive bacteria. Taking into account the importance of Ciprofloxacin, the project aimed at devising an environmental friendly method for the synthesis of 2, 4-dichloro-5-fluoro acetophenone (DCFA), an intermediate in the synthesis of Ciprofloxacin. 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. Keeping this observation into account, the project was preclosed.

**Concluding summary:** In the review, 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.

### iii. 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**

<b>Principal collaborators</b>		
Dr. Chandra Venkatraman Indian Institute of Technology Mumbai	Prof. Herve Delbarre Universite du Littoral-Cote d'Opala, Dunkerque Dr. Jean-Francois Leon Laboratoire d'Aerologie, Observatoire Midi- Pyrenees, Toulouse  <b>Industry partner from France:</b> Dr. Benjamin Guinot Leosphere	
<b>Duration of the project:</b> May 2011 to June 2014		
<b>Budget</b>	Indian side (Rs)	French side (Euro)
Approved	11,38,800	68000
Released	11,95,498 (extended duration)	68000
<b>Exchange visit:</b> India to France – 1, France to India – 2		
<b>Manpower:</b> Indian side – 1 Research associate, French side – 1 Postdoctoral fellow		

**Background:** Needs in air quality management are evolving from *in situ* measurements to spatially resolved observations in real time. Two key points motivated the will of LEOSPHERE to support dedicated research resources to air pollution monitoring. The first one was the growing importance attached to particles by research groups and institutional health agencies, since their impacts on visibility and health are now evidenced. The second is the growing concern about local pollution and individual exposition to pollution. The aerosol scanning Light Detection and Ranging (LIDAR) technology from LEOSPHERE can contribute to explore both aspects. Market applications mainly include local air pollution mapping in the vicinity of an intense source, like an urban highway for instance, and impact assessment studies on the neighboring environment of industrial point sources.

Key developments were however necessary to efficiently tackle such markets, which are traditionally driven by standards and certified monitoring tools. It was the aim of the present research project, which could propose the design and the scientific validation of an operational protocol allowing real time and dynamic mapping of particulate pollution, using quantitative indicators. Indeed, one of the challenges definitely sits on the capacity for a LIDAR signal to be expressed into aerosol mass concentrations in  $\mu\text{g}/\text{m}^3$ .

**Objective:** The project aimed at measurement of air quality to map the pollution, through 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.

**Salient achievements:**

- a) The validation of the retrieval method of aerosol properties from the backscattered LIDAR signal
- b) Understanding of parameters which affect the conversion of LIDAR raw data to mass concentration of aerosols
- c) The definition of the instrumental package to be used along with LIDAR to predict particulate matter with high accuracy
- d) Four test campaigns had been organized which led to the development of new algorithms to retrieve extinction from the LIDAR signal. Ability to predict particulate matter accurately even if some instruments malfunction.

**Outcome analysis:** This project, which was related to atmospheric sciences, aimed at the development of a real time & dynamic mapping of particulates from the sources of air pollution. For achieving this objective, the investigators employed the Light Detection and Ranging (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.

**Concluding summary:** The modeling work needed for the UV–LIDAR had been completed and integrated into the system. It was also noted that there had been a shift in the focus of the industrial partner, based on market requirements, to move to a IR-LIDAR system. The challenges that such a system poses would be different from the one they were pursuing earlier. It was hoped that the work carried out on the project would help in the development of a new marketable instrument in the near future.

**iv. Project No. 7115**

**Title: Financial Inclusion based upon Rural Mobiquitous Services Technological (FIRST) Platform**

<b>Principal collaborators</b>	
Prof. C.E. Veni Madhavan Indian Institute of Science Bangalore	Prof. Serge Miranda Université de Nice Sophia Antipolis

<b>Industry partner from India</b> Mr. Debi Prasad Pati Tata Consultancy Service Kolkata  Dr. Sundeep Oberoi Tata Consultancy Services Mumbai		<b>Industry partner from France</b> Prof. Jean Pierre Tual GEMALTO Paris	
Duration of the project: September 2012 to August 2015			
<b>Budget:</b>	Indian side (Rs)		French side (Euro)
Approved	24,32,680		108660
Released	8,10,890		103500
<b>Exchange visit:</b> India to France – 6, France to India – 4			
<b>Manpower:</b> French side – 1 PhD			

**Background:** Financial exclusion has been a major problem for India and other developing countries with most of the rural population excluded from banking and other financial services. In India, Government has taken major initiatives for ‘Bottom of Pyramid’ to use smartcards in the Rural Inclusion scenarios like FI (Financial Inclusion), PDS (Public Distribution System), RSBY (Rastriya Swathya Bima Yojana – insurance scheme) and NREGA (National Rural Employment Guarantee Act). However success of such initiatives largely depends on the selected technology and presence of an integrated platform/ecosystem. At the same time, Government is aggressively pursuing unique identification program (UIDAI) for citizen of India which is valid for his/her life. The unique identification program has a strong impact on the security and accountability of all services offered by Government and all other sectors like Banks and Private/Public organization. But, all of the noble initiatives are facing the following serious problems to be sustainable in future.

- a) Implementations of the initiatives in silos
- b) Right business model, technology and infrastructure to reach rural community
- c) Lack of integrated common security and accountability infrastructure
- d) Lack of adequate standards and ecosystem
- e) Need of very high capital and operational cost

**Objectives:** The primary objective of F1RST Project is to develop a unified and integrated platform as well as to create/offer a sustainable ecosystem having variable business models with low-cost, secured services involving Banks, MNOs and other stakeholders to support rural initiatives in India. The proposed technology can be put to use in next generation smart phones

to enable financial transactions in rural areas. To demonstrate FI and PDS scenario using FIRST platform, this can be taken to next level in addressing the digital initiatives in India.

**Salient achievements:**

a) FIRST Platform – FIRST Service Integration Hub

The F1RST platform and ‘F1RST Service Integration Hub’ will offer an integrated platform for easy plug-in of the rural inclusion based services like FI, PDS, NREGA, RSBY etc. thereby allowing faster, low-cost and convenient implementation of the Government initiatives.

b) Rural Services (FI,RSBY,NAREGA,PDS etc.) with Virtual Coins

Rural Services like Financial Inclusion with virtual coins offers multi-fold benefits to the rural population. Firstly, it offers easy banking services for the unbanked people and secondly it provides a small community money exchange ecosystem based on virtual coins eliminating the need of any physical cash. As part of the virtual coin integrated FI solution, Android mobile applications have been developed for bank agents, FI beneficiaries and merchants for coin exchange and other banking transactions. The pilot scale of this system was launched in India in Nov. 2014.

**Outcome analysis:** This project aimed to address the issue of financial exclusion in India; i.e the exclusion of certain sectors of population (e.g. rural, semi urban) from the mainstream banking and financial services. The digital economy initiatives necessitate the use of smartcards to avail certain services. As a result, the presence of a selected technology and/or integrated platform becomes important. Therefore, the project aimed at the development of a unified and integrated platform as well as to create/offer a sustainable ecosystem having variable business models with low-cost, secured services involving Banks, MNOs and other stakeholders to support rural initiatives in India. The resulting outcome of this project was the FIRST platform and virtual coins, which allow for a cost effective method for implementation of digital initiative in rural settings. As a result, the rural population can be merged in the mainstream services as the project outcome offers user friendly banking services.

**Concluding summary:** The project was rated as Good.

**v. Project No. 7116**

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

<b>Principal collaborators</b>	
Dr. Subhangi Umbarkar National Chemical Laboratory	Dr. Markus Brandhorst Arkema Centre de Recherche

Pune	Rhone-Alpes	
	Dr. Edmond Payen Universite Lille 1 Lille	
	<b>Industry partner from France:</b> Dr. Jean-Luc Dubois ARKEMA, Paris	
<b>Duration of the project:</b> January 2013 to December 2015		
<b>Budget</b>	Indian side (Rs)	French side (Euro)
Approved	23,17,000	52000
Released	12,81,410	47000
<b>Exchange visit:</b> India to France 3		
<b>Manpower:</b> Indian side – 1 Postdoctoral fellow		

**Background:** Hydrogen Peroxide is a well-known green oxidant that produces water and oxygen as by products. It is considered extremely useful compound for use in environmentally friendly industrial processes. CSIR-NCL has good knowledge of activation catalysts for hydrogen peroxide. ARKEMA is a producer and distributor of Hydrogen Peroxide whose skills in oxidation reactions are widely recognized. UCCS is an organization renowned for its competencies in catalysis and spectroscopic characterization of catalysts. It works on the oxidation of organic molecules. 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 developed by NCL.

**Objective:**

- a) Development of new catalysts and process conditions for selective activation of hydrogen peroxide and its use as an oxidizing agent for delignification
- b) Promotion of oxidation processes using the green oxidant hydrogen peroxide, accessible to a large number of end-users

**Salient achievements:**

- a) 14 catalysts samples prepared
- b) Catalysed were characterized directly after synthesis and showed the presence of ligands
- c) Several catalysts were characterized by Raman, 95Mo NMR and UV-Visible spectroscopy using high and low concentration of Mo species in peroxide solution
- d) Oxidation of veratryl alcohol in neutral medium was found better than in basic medium

- e) Recycling tests of the catalysts were successful
- f) Optimised parameters showed promising oxidation activity in neutral medium compared to conventional Kraft process which needs highly basic medium
- g) High efficiency of the catalyst for delignification of pulp without sacrificing degree of polymerization in neutral conditions

**Outcome analysis:** This project was aimed at the development of new catalysts which could be used for oxidation with hydrogen peroxide. To achieve this objective, a total of 14 catalysts samples were prepared and subsequently characterized by spectroscopic methods. It was found that 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.

**Concluding summary:** It was noted that the progress of the project is satisfactory.

**vi. 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**

<b>Principal collaborators</b>		
Dr. C. Mohan Rao CCMB, Hyderabad		
<b>Industry partner from India</b> Dr. Rama Mukherjee ARA Healthcare, Gurgaon	<b>Industry partner from France</b> Dr. Alain Thierry Sysdiag, Montpellier	
<b>Duration of the project:</b> February 2013 to January 2015		
<b>Budget</b>	Indian side (Rs)	French side (Euro)
Approved	37,44,600	20000
Released	20,72,300	20000
<b>Exchange visit:</b> One visit from both sides		
<b>Manpower:</b> Indian side – 1 Postdoctoral fellow		

**Background:** Cancer affecting colon and rectum (colorectal cancer, CRC) is one of the leading causes of cancer-related deaths in several parts of the world. Incidence of colorectal cancers in India is considerably low (4.3 Male and 3.4 Female per 100, 000), but has been rising over three decades. Significant quantities of tumor specific Nucleic Acids (NAs) are found in the biological fluids of patients with cancer. Development of a diagnostic method for the detection of nucleic acids in biological fluids such as blood-plasma/urine patients will represent a technological breakthrough in semi-invasive or non-invasive diagnosis of cancer. Institut de Rechercheen

Cancérologie de Montpellier, France is collaborating with research teams devoted to cancer research. The methodology for detecting the mutations in biological fluids of CRC patients in France has been developed at Institut de Recherche en Cancérologie de Montpellier by Dr. Alain R. Thiery. The Centre for Cellular & Molecular Biology (CCMB) is a premier research organization of CSIR, involved in high quality basic research and training in frontier areas of modern biology. Considering the relevant expertise of both the institutions, it was agreed to develop a proposal where the methodology developed by the French industry was employed to detect the presence of the K-Ras and B-Raf gene mutations in CRC patients in India. In addition, it was proposed to develop the methodology for isolation of nucleic acids (DNA/RNA) from Urine of CRC patients. Based on the results, a non-invasive theranostic tool, useful to detect tumor specific nucleic acids present in plasma/urine, was to be developed.

**Objective:** To detect mutations in the proto-oncogenes, K-RAS and B-RAF in colorectal tumors of Indian patients and to develop methodology to isolate and concentrate circulating nucleic acids from urine and also from plasma.

**Salient achievements:**

- a) Isolation of nucleic acids from biological samples such as plasma and urine has been standardized by conventional methods and also by novel method using modified silica matrix and magnetic nano-particles.
- b) Detection of mutations of K-Ras and B-Raf in tumor DNA/plasma and urine of patients with colorectal cancers in India using real time PCR based Intplex methodology has been standardized.
- c) A total of 39 tumor samples were evaluated out of which 64% of the samples tested positive for the wild type K-Ras and 36% tested positive for mutation in K-Ras. Some of tumors had heterogeneous mutations. One novel and silent mutation was detected in the samples.
- d) 2 of the tumor samples tested positive for B-Raf V600E mutations.
- e) A new methodology for isolation of nucleic acids from urine was standardized.

**Outcome analysis:** The above mentioned pilot project aimed at devising a minimal to non-invasive 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 thereof. The project has implications for the development of a diagnostic kit. It was suggested to involve the industrial partner to take the project further.

**Concluding summary:** 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.

### **3. CONCLUDING SUMMARY**

The IARDP aims at promoting collaboration between the Indian and French industries in the frontier areas of Science & Technology, relevant to the needs of both the countries. This programme, which was initiated in the year 2002 as the Industrial Research Programme, was subsequently revamped in 2015 to IARDP with the inclusion of small industries, i.e. SMEs, MSMEs and Start-ups. IARDP therefore, led to dynamism in Indo-French technological partnerships with the involvement of industry from both the countries. Thus, this programme is a unique platform for the industries of both the countries to come together and address the unmet technological needs to bring about socio-economic benefit. The six projects reported herein under the IARDP belong to different domains, thereby indicating scientific and technological heterogeneity. Apart from the one project which was preclosed, the remaining five projects were by and large fruitful with respect to the development of a product, process or a methodology. This is also evident from the fact that the comments on the performance of these projects were good. It is noteworthy that some outcomes can be extended and used to develop a product. Furthermore, the mentoring of the IARDP PIs from the Standard Expert Panel (SEP) is likely to add a new dimension to the outcome of the projects. It is expected that such a mentoring would lead the projects towards more beneficial outcomes as a product oriented approach to generate significant and enthusiastic participation from the industries. It is highly likely that the mentoring by the SEP would lead to commercialization of the project outcomes.

This report analyses the projects completed under the IARDP during the period 2013 to 2017. Though the outcome in terms of products & processes is a favorable sign, it must be noted that during the reported period, the number of projects funded is minimal (as compared to the Collaborative Scientific Research Programme), given the fact that the IARDP was initiated in the year 2002 and has been in existence for a decade and a half. The apparent reason for such a small number could be the lack of awareness about the existence of this programme among the relevant industrial sectors of India and France. Therefore, it becomes significant to disseminate the information about the IARDP in order to increase the number of proposals in the future. Upon the directives of the Industrial Research Committee (IRC), CEFIPRA has undertaken an initiative to disseminate the information about the IARDP among the relevant sectors of academia and industry in India. Furthermore, as directed by the Governing body, CEFIPRA has proactively disseminated the information on industry relevant programmes to the relevant clusters in India (30) and France (70). It is expected that such an initiative is likely to increase the number of relevant proposals in the future and lead to fruitful and high impact

collaborations. Recently, the IRC deliberated on the eligibility criteria of industry partners & recommended that if a start up is incubating in a Technology Business Incubator, which is recognized by Department of Industrial Policy & Promotion (DIPP) and affiliated with an University, it may be looked upon with some flexibility from Indian side after due diligence.

**Disclaimer:** This outcome analysis was done 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.



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 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 of Europe and Foreign Affairs, Government of France. CEFIPRA is actively involved in supporting Indo-French Science, Technology & Innovation system through various activities. Collaborative Scientific Research Programme focuses on Academia-to-Academia Collaborations between Indian and French Academic Collaborators in various domains. Industry Academia Research & Development Programme emphasizes to develop the linkage between Industry and Academia from France and India. Dedicated mobility support programmes of CEFIPRA provide exposure to young researchers of the working, 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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