Criteria–wise Inputs

CRITERION I: CURRICULAR ASPECTS

1.1 Curriculum Design and Development

1.1.1 Reflection of the institutional vision and mission in the academic programmes

To recapitulate, the mission and vision of the Institute are reproduced here.

Mission

- To encourage pursuit of excellence in sciences (including engineering sciences) and mathematics in a manner that has major significance for the progress of indigenous nuclear technological capability.

Vision

- To provide an academic framework for integrating basic research with technology development.
- To encourage inter-disciplinary research.
- To nurture an environment for attracting high quality manpower in the sciences including engineering sciences to take up a career in nuclear science and technology and related areas.

Emphasis on human resource development and basic research has been the key factor in the successful development of indigenous technological capability in the field of nuclear science and engineering. Excellence in the human resource development is emphasized at all levels viz., during the selection for recruitment, during training at the entrance level and while in service, and during the process of appraisal leading to promotions. The programme to train young scientists and engineers prior to joining is done at BARC Training Schools and this training has been singularly responsible for induction of high quality manpower in the institutions of DAE. Training School recruited its first batch in 1957. Though it is a Graduate School, the name given in the beginning was Training School as it was not a part of any university. With the setting up of HBNI, it has become a part of a university, but for historical reasons the name Training School has been retained. For engineers, Training School programme has been converted to a M.Tech. programme by adding one year project work. Scientists are given three options, (i) getting a M.Phil by doing one year of project work, (ii) using the credits earned during the one year at the Training School towards course work for a Ph.D. from HBNI, and (iii) getting a M.Tech. by doing one year of project work. The third option is available only to those who work in applied areas such as lasers, accelerators, radiological safety engineering, material science,

exploration geosciences.

Project work for M.Tech. or topic of research chosen for Ph.D. is such that it has relevance of development of indigenous capability. This also follows from the fact that expertise of faculty and research infrastructure that is available for research is oriented towards nuclear science and engineering, and mathematics.

Application areas of nuclear science are quite broad and include application to health sciences and cover diagnostics, therapy as well as sterility assurance. Accordingly programmes being pursued under health sciences cover these aspects in detail.

Apart from health care, application areas of radiation cover industry, agriculture and research. Use of radiation in research establishments, industry and hospitals has to be in a manner that is safe for the health of radiation workers, patients, members of the public and the environment. This requires that competent radiation safety professionals are associated with planning and use of radiation, and subsequent monitoring of radiation safety practices. To train human resource necessary for doing this job, HBNI also conducts a Diploma in Radiological Physics as well as M.Tech. in Radiological safety Engineering.

The DAE has pursued a science based approach for nuclear power development and this has resulted in indigenization of nuclear power programme including associated fuel cycle facilities. This approach has also given India confidence to construct reactors based on technology development in the country. This is demonstrated by the ongoing construction of Prototype Fast Breeder Reactor, which is now nearing completion. India's participation in the international venture ITER has been possible only because of robust basic research in plasma physics done on the country over the past three decades. DAE institutions continue to pursue basic research in areas such as high energy physics, accelerator physics, laser physics, plasma physics, astrophysics, string theory, quantum information and computation, number theory, theoretical computer science, organo-metallic materials, nano and soft condensed matter, atomic/ molecular clusters, catalysis, generation and storage of hydrogen, molecular mechanisms of abiotic stress tolerance, molecular marker techniques for marker assisted selection, development and characterization of transgenic plants and many other similar areas including several areas which may be classified as blue sky research.

Programmes being conducted by HBNI have been designed with this background and are listed below.

Ph.D. in varied disciplines is offered at all CIs. HRI and IMSc also offer an integrated Ph.D. programme where students study for **M.Sc.** as well as Ph.D.

M.Tech. in engineering sciences, and **M.Phil.** in physical sciences, chemical sciences and life sciences. These programmes consist of one year of course work and one year of project work. The course work is offered at all campuses of BARC Training School and project work is offered at BARC, IGCAR, RRCAT VECC and some other units of DAE. Those who are not interested in project work get a diploma in lieu of a M.Tech. or a M.Phil.

M.Sc. (Engg) in which research content is more than that in a M.Tech. programme. The duration of the project work under this programme is one and half year, while the duration of the course work is up to one year. This programme is offered at BARC, IGCAR, VECC and RRCAT and has been tailored for the employees of the DAE.

Integrated M.Sc. of five-year duration at IoP(NISER).

Super Specialty Courses at TMC

- **D.M.** (Medical Oncology)
- **D.**M. (Pediatric Oncology)
- **D.M.** (Gastroenterology)
- **D.M.** (Critical Care)
- **M. Ch.** (Surgical Oncology)
- **M. Ch.** (Gynecological Oncology)
- **M.Ch.** (Plastic Surgery)
- **M.Ch.** (Head & Neck Oncology)

Post Graduate Courses at TMC

- **M.D.** (Pathology)
- **M.D.** (Anesthesia)
- **M.D.** (Radio-diagnosis),
- **M.D.** (Radiotherapy),
- **M.D.** (Microbiology),
- **M.D.** (Nuclear Medicine),
- **M.D.** Palliative Medicine), and
- **M.D.** (Immuno-Hematology & Transfusion Medicine)

DRM: Diploma in Radiation Medicine at BARC.
M.Sc. (Nursing) at TMC

Dip.R.P.: Diploma in Radiological Physics at BARC.
DMRIT: Diploma in Medical Radio Isotope Techniques at BARC.

In addition, the TMC also offers a two-year Certified Fellowship programme in 23 different disciplines related to Oncology.

The Institute offers a unique Ph.D. programme where students are manadated to work at the interface of basic research and technology development. Under this programme, they work under the guidance of two supervisors, one having strength in basic research and the other in technology development.

All the CIs do not cover all disciplines. By way of example, BARC being the largest CI covers all disciplines and a broad range of programmes, while HRI and IMSc cater primarily to mathematics and theoretical physics. IMSc has recently started a doctoral programme in computational Biology under the Boeard of Studies in Life Sciences. It may be worth mentioning here that the DAE runs a contributory health service scheme for the benefit of employees and has a 390 bedded hospital located in Mumbai. This hospital is under the administrative control of BARC and has been accredited by the National Board of examinations, New Delhi for conducting post-graduate Diplomate of National Board (DNB) courses since 1983. It is proposed to convert this programme to MD/MS after obtaining all regulatory approvals and process for this purpose has already been initiated.

1.1.2 The process followed in the design and development of curriculum

The university follows a systematic process for the design and the development of curriculum for various programmes as explained below.

(i) M.Tech./ M.Sc.(Engg)/ M.Phil.

The curriculum development for the various programmes is carried out by a subcommittee of experts constituted for this purpose by the subject-specific Training School Committees (TSC). The TSCs base their recommendations on evolution of DAE programmes during the period since the last review and feedback from students. The report of the subcommittee is reviewed by the respective TSC. The revised syllabus incorporating the recommendations of the TSC is then forwarded to the Board of Studies (BoS) of respective discipline for final ratification. This process is carried out once in three years on a holistic basis. However, minor modifications if required are carried out on a case by case basis in an ongoing manner and duly ratified in the meetings immediately following the revision by the two committees as stated above.

(ii) DipRP

This programme comes under Board of Studies in Health Sciences and to conduct

this programme a Standing Academic Committee has been constituted in BARC. Any revision to its syllabus is approved first by the standing committee and then by the BoS. Its syllabus went through a major revision in 2013 as a result of a report of a committee specifically appointed for this purpose.

(iii) DRM/DMRIT:

This programme comes under Board of Studies in Health Sciences and to conduct this programme a Standing Academic Committee has been constituted in BARC. Any revision to its syllabus is approved first by the standing committee and then by the BoS. DRM programme has also to follow all guidelines of the Medical Council of India.

(iv) MD/ MS/ MCh/ DM:

Conduct of these programme including any revision of syllabus is governed by Board of Studies in Health Sciences and the guidelines of the Medical Council of India.

(v) M.Sc.(Nursing):

Conduct of these programme including any revision of syllabus is governed by Board of Studies in Health Sciences and the guidelines of the Nursing Council of India.

(vi) Ph.D. and Integrated Ph.D.:

Course work part of the programme is designed and approved by CI level academic committees and approved by BoS. Additionally student specific doctoral committees look into the requirements of individual students and prescribe additional courses which have to be taken as self-study courses. Syllabi for such courses are tailor made.

With regard to the M.Sc. part of the programme, the curriculum is designed by the faculty based on current national and international trends in Masters level education in Physics and Mathematics. It is then run through Board of Studies and their feedback is incorporated before finalizing the curriculum. Student feedback is taken both during the course as well as at the end of the course and based on that and feedback from instructors, course structure as well as content is incrementally updated. The feedback process is monitored and implemented by the Graduate Committee of the Institute.

(vii) M.Sc (5-Year Integrated): This programme is conducted only at IoP(NISER). The course structure of the programmes is designed by the experts

consisting of eminent scientists in the field and frozen for a minimum of 3 years. The syllabus for individual courses in any program is proposed by the faculty and submitted to the Under-Graduate Committee of the School (UGCS) of the respective school. It is discussed and sent to Undergraduate Committee of the Institute (UGCI) and then sent to the Academic Council. The Academic Council of IoP(NISER) meets once in every 3 months. Finally it is discussed and approved by the Under-Graduate Board of Studies of HBNI. Once approved it is included into the course curriculum as a core course or elective for the students to choose following Choice Based Credit system.

1.1.3 Aspects considered during curriculum design and development

Employability

Employability for different programmes is ensured in a way appropriate to them. As explained at Para 1.1.1, all those who do M.Tech. or PG Diploma are assured employment in institutions of the DAE. M.Sc (Engg) programme has been designed to enable employees of the DAE to upgrade their knowledge and academic qualification.

Students, who graduate from the DipRP programme, are in great demand in India and abroad and work as radiation safety officers in facilities handling radioisotopes. There is a need to increase seats in this programme, and it is plan to do so in 2014. With regard to the programme DMRIT situation is similar.

Integrated M.Sc. at IoP(NISER) is a new programme and because of very high standards in admission and teaching, students are either get absorbed in prestigious universities in India and abroad for Ph.D. programme or take up employment in national and international R&D laboratories including in the DAE. Some students also join industries.

All medical programmes at PG and super-specialty level being run at TMC are in great demand and with the approval of MCI, seats are being continuously increased. The programme M.Sc.(Nursing) is in demand amongst students for admission because of excellent employment prospects.

Ph.D. programmes at all CIs are well known for their quality of research and all students who complete doctoral programmes get offers of employment as faculty or post-doctoral fellowship in universities or in laboratories in India and abroad immediately after the viva voce. Some students have found employment in the industry as well.

Innovation

HBNI runs an innovative Ph.D. programme (DGFS) where a student works under the guidance of two supervisors: one having strength in basic research and the other having strength in applied research. Students who have completed doctoral programme under this scheme have found very good employment.

Syllabi of M.Tech. programmes are continuously updated and innovated to meet the needs of the units of DAE. Specialization in several new areas has been started to meet the requirements and include accelerators and lasers, material science, environmental chemistry and so on.

Students are encouraged to take up doctoral research in emerging areas, in particular those that transcend boundaries of individual disciplines.

Research

Hallmark of research being pursued by students of HBNI is the fact that research problems are selected based on the mandate and needs of DAE and have direct link with the ongoing plan projects approved by the Planning Commission as part of five year plans. In short, research problem chosen are India-centric. The result of such a selection process is a win-win situation as the students get opportunities to work on sophisticated experimental facilities and DAE gets valuable research inputs for projects which are a part of its mission. This is not only true for Ph.D., but also for M.Tech. projects.

1.1.4 Use of the guidelines of the regulatory bodies for developing and/or restructuring the curricula and national impact of the research programme of the Institute.

HBNI has set a benchmark higher than what is demanded by regulatory bodies. For example, UGC demands one semester of course work for doctoral students, but HBNI insists on one year of course work. Number of publications arising from a Ph.D. thesis is discipline specific, but in most cases it is more than the minimum specified by the UGC.

Scope of every M.Tech. project is invariably wider than what is the practice in institutes and universities in India. Same applies to medical programmes at TMC as the facilities available are excellent.

HBNI is a young and specialized university and most of the subject areas pursued are unique to HBNI. However, HBNI faculty has helped in starting and running M.Tech. in nuclear science and engineering at IIT, Madras, and Jadavpur university. This has been done by signing formal agreements with them.

HBNI faculty is also guiding others in conducting programmes in radiation protection and medical physics. Initial support for starting M.Sc. in medical physics was provided to Anna University, Chennai (started in 1982), Bharthiar University, Coimbatore (started in 2003), Manipal University, Manipal (started in 2003), Panjab University, Chandigarh (started in 2005), and MGR Medical University, Chennai (started in 2011). The field of nuclear medicine has taken root in the country because of research done in BARC.

1.1.5 Interaction with stakeholders and the benefits of such interactions

Interaction with stakeholders is a continuous process and our main stakeholders are institutions of the DAE. For the Training School programmes, there is an Apex Committee to look at all affairs and consists of faculty as well as senior scientific officers. Apex committee provides valuable guidance in framing and revising syllabi. Electives are introduced in the Training School to meet the emerging requirements of the DAE. For examples emphasis on reprocessing technologies and accelerator technologies have been increased in recent years. Courses on these areas of have been introduced in the M.Tech. program of BARC Training School-Mumbai last year as core courses.

Funds for research come directly from the Government of India through the DAE. The process of approval is an involved process and includes discussions in Internal Working Group set up the DAE, Working Group set up by the Planning Commission and the Planning Commission itself. This in fact constitutes our interaction with the stakeholders and ensures that research projects taken up by faculty are 'India centric.'

1.2 Academic Flexibility

1.2.1 Programme details

- All programmes are conducted on the campus. Details are given in response to question 17 in the 'Profile.'
- HBNI has no overseas campus.

1.2.2 Details with reference to academic flexibility

- M.Tech. programme offered at BARC Training Schools has one year of course work and one year of project work. The course work has three modules: foundation courses, core courses and electives.
- A Ph.D. student has to choose courses related to research to be pursued by the students. The student does get the option of self-study courses in many cases. Doctoral students are encouraged to enrich themselves by taking up courses beyond mandatory one year of course work to broad base their knowledge. Such courses could be in the form of self study courses, open seminars or minor R&D project.
- Credit accumulation and transfer facility is available to doctoral students in some of the CIs. In particular employees do earn credits towards course work prior to formally enrolling for a doctoral programme. Some of the CIs run courses after office hours for employees. To give an example, two course viz., Principles of alloy design and Advanced Chemical Thermodynamics were recently offered at IGCAR for employees.
- Lateral and vertical mobility within and across programmes, courses and disciplines: A student joining Training School was given the option of first enrolling for a PG Diploma and then upgrading it to M.Tech. if desired by him/her. Finding that all engineering students are upgrading to M.Tech., beginning from academic year 2013, engineering students were advised to enroll for M.Tech. and science students were advised to continue to enroll for a PG Diploma. Options for change over are still available. Ph.D. students are allowed to change the topic of research. It is possible for a student having M.Sc. in a science subject to enroll for Ph.D. in engineering provided he/she is working in an applied area. The reverse, where a student having a B.Tech. joins doctoral programme in Physics or mathematics is also possible.

1.2.3 Attracting international students

BARC Training Schools have the potential to attract international students. Under and inter-governmental agreement two batches of students from Vietnam studied at BARC Training School. In view of the sensitivity of technologies involved, any initiative in this area has to be taken up at the highest level of decision making in the country.

1.2.4 International collaborations.

There are no international collaborations in the form of twinning or dual degree. However, the Institute has provision to allow doctoral researchers to conduct a part of their research in an advanced laboratory outside India.

1.2.5 Self-financing programmes

The Institute has no self-financing programme.

1.2.6 Adoption of the Choice Based Credit System (CBCS)

Electives are offered in all the CIs to doctoral students as well as in BARC Training School. Employees are encouraged to accumulate credits by attending advanced courses at BARC.

IoP(NISER) follows choice based credit system (CBCS). To continue in any program, it is mandatory for the students to register for the courses at the beginning of each semester. The minimum and the maximum of the courses that can be registered by the students are fixed by the guidelines of the Institute. A list of courses to be offered during the semester is floated in the website. On the date of registration the students select the courses of their choice which they want to credit on the advices of their mentors.

1.2.7 Semester system

Semester system is followed in all CIs, but with some variations. BARC Training Schools have two semesters and a summer semester. IoP has three equal semesters. Other CIs have two semesters.

Medical programmes are conducted in accordance with the guidelines of the Medical Council of India and nursing programmes in accordance with the guidelines of Nursing Council.

IoP(NISER) also has a summer semester. Summer courses are floated by the faculty during summer to help slow learners and to take care of those who have not been able to cope with the work load during the regular semesters due to any reason. Students register for these courses at the beginning of the Summer term on the advice of their mentors.

1.2.8 How does the university promote inter- disciplinary programmes? Name a few programmes and comment on their outcome.

The Institute offers a unique Ph.D. programme where students are encouraged to work at the interface of basic research and technology development. Under this programme, they work under the guidance of two supervisors, one having strength in basic research and the other in technology development. Research output of such students is of direct interest to the mission of the DAE. Examples are listed hereafter.

i. “Material Characterization of Irradiated Material using small specimen testing with microstructure evaluation,” an inter-disciplinary work of mechanical, metallurgy and physics disciplines.

ii. "Structural and Magnetic Properties of Magneto-caloric Materials," an inter-disciplinary work of physics and metallurgy disciplines.
iii. "Diversity Oriented Synthetic Strategies for Functionalized Organo-Silicon Compounds and Their Applications," an inter-disciplinary work of chemistry and biology disciplines.
iv. "Structural Evaluation in Surfactant Assemblies and Their Application in Nanomaterials Synthesis for Biomedical Application," an inter-disciplinary work of chemistry and biomedical disciplines.
v. "Computational Investigations on the Structure and Reactivity of Nanomaterials," an inter-disciplinary work of chemistry and metallurgy disciplines.
vi. "Investigations on Subcritical and Supercritical Natural Circulation Phenomena Relevant to Advanced Reactors," an inter-disciplinary work of chemical engg and mechanical engg disciplines.
vii. "Behaviour of solids Under High Strain-Rate Deformation," an inter-disciplinary work of physics and metallurgy engg disciplines.
viii. "Experimental and numerical investigation of mechanical properties of irradiated ferritic/martensitic steel-T91 with microstructure evaluation," an inter-disciplinary work of mechanical and metallurgy engg disciplines.
ix. "Synthesis and fabrication of molecules for molecular electronic devices and sensors," an inter-disciplinary work of chemistry and electronics disciplines.
x. "Interaction of hydrogen with tabtalum metal and its alloys," an inter-disciplinary work of chemistry and metallurgy disciplines.
xi. Protein crystallography", an interdisciplinary work of biology, chemistry and physics

1.3 Curriculum Enrichment

1.3.1 The curriculum review and upgrade to meet the emerging needs of students and other stakeholders

The Nuclear Science and Engineering is knowledge intensive and inter-disciplinary. Individuals working in nuclear industry need training prior to induction and continuous up-gradation during service in the nuclear industry. This aspect has been fully internalized in the working of the DAE and the setting up of the BARC Training Schools is an essential element of the process of internalization. The faculty in the Training School consists of practicing professionals and they are fully aware of the latest developments in the nuclear industry as well as nuclear research. Governance mechanism for BARC Training Schools has evolved over the years and has an Apex Committee as the top academic body. Faculty as well as senior scientists are its members. Next level is

discipline specific Training School Committees (TSC). Knowledge generated during the process of research and development in the CIs is quickly incorporated into the syllabi of the academic programmes at the Training Schools. The revised syllabus incorporating the recommendations of the TSC is then forwarded to the Board of Studies (BoS) of respective discipline for final ratification. This process is carried out once in three years on a holistic basis. However, minor modifications if required are carried out on a case by case basis in an ongoing manner and duly ratified in the meetings immediately following the revision by the two committees as stated above.

In HRI, to review and up-gradate/restructure the curriculum, Graduate Committee meets with faculty members wherein the curriculum is reviewed at length, and after much brainstorming, suggestions are noted and recorded to improve the curriculum which are reported to BOS, who approves/review it with experts of the subjects and communicates the information to the Institute to inculcate the changes in the programme.

In IoP the syllabus is regularly discussed and revised depending on interaction with peers and feedbacks received from faculty and students. The Academic affairs committee takes feedback from students, discusses these, and with inputs from faculty suggests revisions of syllabus which are discussed and approved in faculty meetings. In VECC the syllabus is under revision to include some new topics and to align it with the research areas of the centre.

In IPR, looking at the current requirements in nuclear fusion, the course of advanced plasma physics is added to the courses on magneto-hydrodynamics and fusion physics. Special courses on non-linear dynamics and laser-matter interaction are taught so that scholars get an idea of emerging areas of plasma sciences.

At IoP(NISER), the curriculum of the each school is designed by eminent scientists and IoP(NISER) faculty. While doing so the feedback from students and teachers is given due consideration and once decided, the syllabus is frozen for three years.

1.3.2 Recent new programmes and future plans

New programmes have been introduced at BARC Training Schools as well as in other CIs in the recent past. Details are as follows.

i. BARC Training School: Considering the increased emphasis on uranium exploration in the five year plans, the need to train human resources in this

vital area arose and therefore, a programme in Exploration Geo-sciences was started in 2010 at the BARC Training School, Hyderabad. Intake qualification is M.Sc. in geophysics or geology and as is the practice in BARC Training Schools, the programme consist of one year of course work (compulsory) and one year of project work (optional). Those who do only course work get a diploma and those who go on to do project work get a M.Tech.

ii. Ph.D. in computational biology: Given the explosion of biological data (in genome trancriptome etc), there is a growing need to train high quality Indian researchers in modern methods of analysis of such data. IMSc is especially well situated in this regard, with existing groups well-versed in statistical and biophysical analysis, theoretical computer science and mathematics. Accordingly, the Ph.D programme in Computational Biology at IMSc, started in 2013, trains students to work at the cutting edge of this field, equipping them with skills in algorithms, statistical analysis and methodologies for the study of large data sets. The intake qualification is a masters-leval degree in any science or mathematics, followed by an interview in which interest in and aptitude for biology is tested. Students taken are put through rigorous year long course work programme in which many biologists from well known institutions all over India lecture in specific modules. Typically most projects will involve collaborations with existing biology groups elsewhere.

It is proposed to start the following academic programmes in near future.

i. Diploma in Fusion Imaging Technology at TMC,
ii. M.Sc. in clinical research at TMC,
iii. M.Tech. in fusion science and engineering at IPR,
iv. Converting Diplomate of National Board (DNB) programme (accredited by National Board of Examinations) being run in BARC hospital to a MD/MS programme after getting all statutory clearances, and

A new campus for IoP(NISER) is under construction and once it moves to its new campus, it will be converted into an independent CI. It is also proposed to start schools in Computer Science and Earth Sciences. It is also proposed to increase intake of students to Diploma in Radiation Protection (DipRP) programme at BARC.

Taking a longer term view, a new campus of BARC is being planned at Vizag and land for the campus has already been acquired. Centre of Plasma Physics, Sonapur, near Guwahati has merged with IPR and academic programmes leading to a Ph.D. could be started there as well in future. TMC is setting up new campuses at Vizag, and Mullanpur, SAS District, Punjab, near Chandigarh.

1.3.3 The strategies for the revision of the existing programmes and details thereof.

Revision of syllabus is done with the involvement of stakeholders. As indicated at 1.1.5, interaction with stakeholders is a continuous process.

For BARC Training School programmes, there is an Apex Committee to look at all affairs and consists of faculty as well as senior scientific officers. Apex committee provides valuable guidance in framing and revising syllabi. The Apex committee is assisted by discipline specific committees. Electives are introduced in Training School to meet emerging requirements. The details of recent changes follow.

The following courses or modules were introduced in the recent past.

BARC, Mumbai

- A course on "Accelerator Physics and Technology" was introduced first as an elective for mechanical engineers of 55th batch (2011-12) and for all engineers from 56th batch (2012-13).
- A course on "Nuclear Fuel Cycle Technology" was introduced first as an elective for mechanical engineers of 55th batch and for all engineers from 56th batch.
- "Advanced Reactor Concepts", a module was added to an existing course from 56th batch onwards for all engineers.
- A course on "Laser Spectroscopy" was added as an elective for chemistry students from 57th batch (2013-14) onwards
- A course on "Molecular Bioorganic Chemistry" was added as an elective for chemistry students from 57th batch onwards
- A course on "Astrophysics" as an elective for physics students was added from 56th batch onwards.
- A large number of new elective courses in physics have been announced for the students of 56th batch (2012-13) and are being offered as per demand. These include 'Introduction to neutrino physics', 'High energy Astrophysics', 'Synchrotron radiation and its applications', 'Computational plasma physics', 'Nonlinear plasma theory', 'Structure and crystallography of biomolecules', 'High energy density physics', 'Nuclear data physics for advanced nuclear applications', 'Accelerator driven systems'.

IGCAR, Kalpakkam

- Computational material science,
- Modelling and simulation in Physics,

- Advance Reactor Physics,
- Laser matter interaction and applications to advanced material processing
- Principles of alloy design,
- Advanced chemical thermodynamics

RRCAT, Indore

- Modern Optics,
- Physics of Semiconductor Quantum Structures, and
- Concepts in X-ray Physics.

The following courses received major revisions in the recent past

- Nuclear Reactor Physics,
- Nuclear Power Plant Engineering,
- Reactor Engineering and Radiation Shielding.

In addition to these courses listed above, almost the entire course material involving more than 150 courses has been thoroughly reviewed and modified wherever necessary, and ratified during the last academic year as part of the routine exercise of the Institute.

At IMSc, a review of the existing courses in physical sciences is currently underway and is expected to be implemented from the next academic year. At **IoP**, syllabus was discussed and revised in 2004 and in 2014. In 2014, subject details were revised by about 20%.

As plasma science is a new and evolving subject, the syllabus at **IPR** is under constant improvement. Also for most of the students, who join the institute, the subject of plasma science is a new area and so the course covers basics of plasma physics and advanced courses. Some courses improved and taught recently are

- Magneto-hydrodynamics
- Fusion Physics
- Non-linear dynamics
- Laser – Matter interaction

TMC-ACTREC

Syllabus of courses taught to doctoral students during one year of course work is reviewed by senior faculty. Feedback from students is also considered. Based on the ongoing research interests and the projects undertaken by the students, topics like Cancer Genomics, In vivo Animal Imaging, Biophysics and structural biology, stem cell biology, Raman spectroscopy and bioinformatics have been added to the course work during the last few years.

1.3.4 Value-added courses offered by the Institute

BARC Training Schools

Value added courses to enhance the professional skills of the students and improve their employability and research acumen are being conducted for the students of all branches of Sciences and Engineering. These include a five lecture audit course in 'Research Methodologies', a three day 'Soft-skills Workshop' aimed at enhancement of soft-skills, a two day workshop on enhancing knowledge of the administrative procedures, courses on Intellectual Property Rights (IPR), Project Management, Accounting and Purchase Procedures etc. These courses/workshops are held every year for all the M.Tech. students. These are mandatory and serve towards a purposeful beginning to the professional careers of the students**.** IGCAR has introduced a course on 'nuclear emergency and radiation preparedness' as an elective for students.

All CIs

All the doctoral students go through the first year course work. These courses give training in scientific and research methodology, and in particular train students In computer programming. There is a special course on numerical methods and Computer programming. This, along with general Ph.D. training, prepares students for taking any computer oriented job later on. In fact, several students, after finishing Ph.D. have taken computer oriented jobs, e.g. at CDAC.

IoP(NISER) periodically organizes workshops on topics such as Robotics, software skills and language skills.

1.3.5 Skill development programmes

The following academic programmes, in addition to having an academic content, also provide skills necessary for employment.

- Dip RP
- DMRIT
- DFIT: to be started in 2014
- M.Sc. Clinical Research to be started in 2014

1.4 Feedback System

1.4.1 Mechanisms to obtain feedback from students regarding the curriculum and how is it made use of?

All CIs have a formal mechanism to obtain feedbacks from the students regarding the course they have attended. Students play an important role in providing the detailed feedback about the course, course content, and delivery methodology adopted by the instructor. Students provide anonymous feedbacks at the end of

the semester or end of the year. The feedbacks are collected, evaluated and discussed during the apex committee/ graduate committee meetings. The results are then communicated to the concerned faculties and incorporated after approval from the BOS. Informal feedbacks are also obtained from the participants during the workshops/seminars/conferences. Feedback mechanism tends to be informal wherever batch size is small.

In case of BARC Training School the formal mechanism to obtain feedback. has been incorporated into an exclusive students' portal known as 'Training Management System (TMS). TMS generates automated forms for the students for providing grading to the lectures, courses, course content, examination patterns etc. Students are asked to give their feedback with respect to course grading, reading material provided, reference books, examination pattern, teaching capability, drawbacks, overall grading doubt clearing and problem solving. A summary report is then generated and forwarded to the respective Course Coordinators and Training School Committees. Suitable corrective action if necessary is initiated by the Course Coordinator/Training School Committee.

At VECC feedbacks from students are taken at the end of one year course works for Ph D. Based on the students feedbacks actions are taken (change of course instructors, etc.) to improve the course quality. Feedbacks from faculty members and students are also taken to improve the course content.

1.4.2 Does the university elicit feedback on the curriculum from national and international faculty? If yes, specify a few methods such as conducting webinars, workshops, online discussions, etc. and its impact.

HBNI is essentially a research university and peer review is conducted periodically to elicit views of others for the research being done. Details of reviews conducted are given at s. no 23 of the profile. The courses for the Ph.D. students are accordingly revised. Periodical review of the curriculum is done in IoP(NISER) by a review committee consisting of eminent scientists who review the curriculum and recommend changes in the syllabus as and when required.

1.4.3 What are the quality sustenance and quality enhancement measures undertaken by the university in ensuring the effective development of the curricula?

Feedback from students provides inputs for quality enhancement of the teaching process.

CRITERION II: TEACHING-LEARNING AND EVALUATION

2.1 Student Enrolment and Profile

The Admission process

The admission process depends on the programme, but has common features like adhering to the guidelines of the Central Government as applicable to the HBNI, transparency and nationwide publicity.

Admission to BARC Training School programme is by screening based on a common entrance test conducted by BARC as well as GATE followed by a selection interview. The programme is advertised in media every year and number of applications received is very large. In 2014, about 1,20,000 applications have been received and after screening about 5000 are being called for interview spread over six weeks.

For admission to the Ph.D. programme in the BARC, the same process is used. Admission to the Ph.D. programme for employees, who have been selected through the Training School process, is based on an interview and those who have been selected through other processes is based on a written test for screening followed by a selection interview.

The same procedure viz., a common entrance test for screening and a selection interview is followed for DipRP and DMRIT except for sponsored candidates. Candidates specifically sponsored by their employers go through a separate written test.

Students seeking admission in IoP(NISER) in the five-year integrated M.Sc programme appear for a National Entrance Screening Test (NEST) conducted every year at about 45 centers in India. NEST is now considered an important and prestigious examination for those who desire to pursue a career in basic sciences. The students who have passed the class XII qualifying exam in the last two years are eligible to apply for NEST. The minimum aggregate marks (or equivalent grade) in class XII (or equivalent) examination from any board in India to appear in NEST is 60% marks for general category and 55% for SC/ST/PD category.

Admission to medical programmes is through the approved national procedure. It consists of counseling which happens (i) at all India level through the national level entrance examination (For 50% seats), and (ii) at the state level through the state level entrance examination (For 50% seats). The admission to super-

specialty programmes (MCh and DM) at TMC is through all India level entrance examination conducted by TMC. Admission to M.Sc. (nursing) is also through all India level entrance test conducted by TMC.

Admission to the Ph.D. programmes in Physics is based on a screening test including National Eligibility Test (NET) conducted by CSIR-UGC, Joint Entrance Screening Test (JEST) conducted by a central nodal agency (www.jest.org.in), and/ or a specific test conducted by CIs followed by a selection interview. All these examinations are conducted throughout the country.

Admission to the Ph.D. programmes in Chemistry and Life sciences is based on a screening test including National Eligibility Test (NET) conducted by CSIR-UGC, or a specific test conducted by CIs followed by a selection interview. All these examinations are conducted throughout the country.

Similarly, admission to the Ph.D. and Integrated Ph.D. Programmes in Mathematics are conducted on the basis of NBHM (www.nbhm.dae.gov.in) examination held throughout the country.

After screening based on national level tests, further written tests are conducted by some CIs. All CIs conduct interviews for final selection for admission to Ph.D. programme. The process is monitored by CI level Graduate Committees/ Standing Academic Committees. It has been decided that students who have qualified for DST-INSPIRE fellowship can appear directly for interview.

Review of the admission process

The process of admission to BARC training Schools and IoP(NISER) is reviewed in detail to find out region and universities from which students are getting selected. This information for the past several years is available and is used to plan centres for screening examinations, arranging awareness programmes about nuclear programmes of the country in target regions and universities.

Strategies adopted to increase/ improve access for students belonging to SC/ST, OBC, Women, Persons with varied disabilities, Economically weaker sections and outstanding achievers in sports and other extracurricular activities.

All applicable guidelines of the Government of India are followed in the process of admissions. Screening tests are held in several places in the country to enable all to have an easy access. In general, interview committees have fair representation of women, SC/ST and OBCs. A good access is provided to persons with disabilities in various buildings. Fellowship or stipend is given to all

students and this is encouraging to students from weaker sections. Most of the programmes have no tuition fee.

Since a majority of programmes are at PG level, there is no provision for outstanding achievers in sports and other extracurricular activities.

Category wise distribution of students admitted to the Institute.

Categories	Year 2009		Year 2010		Year 2011		Year 2012	
	Male	Female	Male	Female	Male	Female	Male	Female
SC	09	02	18	02	14	01	11	02
ST	00	00	02	01	01	00	02	00
OBC	109	12	140	15	96	18	100	14
General	442	102	583	126	493	124	380	100
Others	03	01	05	01	04	00	04	01

Analysis of demand ratio of various programmes

Data pertaining to 2013 is as follows.

1. **BARC Training Schools**: Admission to BARC Training School is through a written test for screening followed by a selection interview. Two written tests are used for screening viz., a test conducted by BARC and GATE. Only those who score marks above a specified cut-off in the GATE are called for interview. Sum total of all those who applied for a written test and those who applied after having scored marks above specified cut-off in GATE was 92,971 in the year 2013 and 372 were selected giving a demand ratio of about 250. Since a cut-off was applicable to applicants who applied based on GATE score, true demand ratio was significantly higher. No analysis has been done to arrive at that number.
2. **Integrated Masters at IoP(NISER)**: Out of 24538, 60 were selected and demand ratio was thus 409.
3. Admission to medical programmes is based on the norms of the Central Government and it is difficult to arrive at a true demand ratio.
4. **DipRP**: For the programme DipRP demand ratio is about ten.
5. **M.Sc. (Nursing):** For M.Sc. (Nursing), the demand ratio is about ten.
6. **Ph.D**.: For Ph.D. programmes, the demand ratio is difficult to ascertain as about 50 % of research scholars are employees.

2.2 Catering to Student Diversity

2.2.1 Orientation/ induction programme for freshers

For every programme, the first day is oriented towards orientation. For

programmes conducted by BARC Training Schools, DipRP, DMRIT and DRM, the programme for the first day starts with an introductory lecture by Director of the CI or a senior officer of the CI. This day is also used for filling in a variety of forms. DipRP and DMRIT students are specifically told about career opportunities available to them after course completion and they also go round various laboratories.

For programmes at all Training Schools, situation is unique as admission to a Training School is also a passport to a Government job one year later. The first day starts with an inaugural lecture by some eminent person and is followed by filling of several forms, explanation about course structure, a meeting with course coordinators etc.

In case of Ph.D. students, the first day is used for introductions, filling in of forms and in many cases a fresher's party. At TMC the first day stars with familiarization with different departments of the hospital and a general introduction

Documents outlining guidelines for various programmes have been prepared and are made available to students on the very first day. These documents are available on the Institute web page as well.

In IoP(NISER), on the day of counseling, the students are sensitized on the rules and regulations of the institute and the academic program and they are required to fill up undertakings stipulated by UGC and the Government besides forms pertaining to IoP(NISER). Then they move around to visit various laboratories of different schools and meet different faculties to acquaint themselves with institute and its functioning.

2.2.2 Mechanism for identifying and addressing "differential requirements of the student population"

The capability of every student enrolling for the Ph.D. programme is analyzed and a set of courses keeping in view the knowledge base of the student is prescribed. Objective is to ensure that the student gets a broad based knowledge and acquires skills necessary to pursue doctoral research.

In case of other programmes, the selection process is so stringent that need for such a treatment has not been felt.

IoP(NISER) has a programme to address needs of slow learners during summer vacation through remedial courses.

2.2.3 Bridge/ remedial / add-on courses

The M.Tech. (Engineering Physics) Programme at RRCAT is open to both engineers and physicists and bridge courses have been designed to accommodate the differential prior qualification of the two categories. Structure of the time table accommodates conduct of such courses. The bridge courses are followed by one semester of compulsory core courses, and then in the final semester the students take several specialized courses with emphasis on the science and technology of lasers and accelerators.

In HRI, IoP(NISER) remedial / bridge courses are taken during summer to bring parity amongst student population.

Ph.D. in life science at IMSc.
The syllabus for the Computational Biology course includes two courses in basic biology, spread over two semester, in which students without a biology background are taught the essentials of what they will required for a Ph. D in Computational Biology. Students with a prior biology background can receive exemption from these. These courses, divided into separate modules, are taught by biologists from all over the country, in addition to resident faculty at IMSc. In addition, visits to laboratories, which is centered around specific projects provides these students with real life laboratory experiments.

BARC Training School
Considering the fact that the students joining from universities have very little experience in laboratory practices, two bridge courses are included in the physics discipline to give students hands on experience in advanced experimental techniques. These bridge courses are 'Engineering drawing and workshop practices' and 'Methods in Experimental Physics'.

2.2.4 Identifying and responding to the learning needs of advanced learners

In some CIs for the advanced learners, who are confident in a particular course can ask the course instructor to give them a test at the start of the course. If they clear this test, they can be exempted from attending the course and further examinations, etc. The request for an exemption test is not automatically granted, it depends on the graduate/monitoring committee to decide the course path for

such a student. Even if an instructor does not allow test-based exemptions in a particular case, he/she may allow the student to be absent from the regular lectures, but submit all assignments/projects, and take all the tests. He/she can utilize this period to study advanced course as guided by the graduate committee.

Advanced learners can finish Ph.D. programme faster than others and this variability can be seen in the time taken for the completion of a Ph.D. For Training School programmes, DMRIT, DipRP and medical programmes, such possibility is not provided.

IoP(NISER) follows a choice based credit system and permits good students to complete the five-year integrated M.Sc. programme in four and a half years.

2.3 Teaching-Learning Process

2.3.1 Planning and organising the teaching, learning and evaluation schedules

Detailed guidelines giving all details of major academic programmes have been prepared and are available to students as well as faculty. For example, for programmes at BARC Training Schools, the following information is included.

- Preface
- Academic vision and programme
- Guidelines
    - Enrolement
    - Programme management which includes calendar, stipend, residence and attendance, contact hours, credits for course work, performance assessment, detailed syllabus, continuation for project work, code of conduct, notification of results, and award of degree and diplomas.

Guidelines also include course schedule.

2.3.2 Challenges in completing the curriculum within the stipulated time frame and calendar

It has been ensured that the course load does not exceed the stipulated guidelines defined by UGC. The method of selection as detailed in the earlier paragraphs coupled with the philosophy of hire, train and absorb which is adopted by the DAE has been instrumental in ensuring that the commitment levels and dedication of the students is exemplary. Almost all the students are housed in campus and the ready availability of an extremely knowledgeable and skilled faculty within the

campus serves towards the enhancement of knowledge and feeding the intellect of these young and bright students. In view of these factors, the curriculum completion does not pose a challenge. The defined academic goals are not merely completed but often exceeded well within the stipulated time frame owing to the enthusiasm of the student community.

2.3.3 Making learning student-centric

Doctoral students constitute 50% of total enrolment and learning for them is totally student-centric. There are student specific doctoral committees which decide on the course work beyond the one year compulsory course work. The course work can take the form of class room courses, self study courses, independent study and minor R&D projects and are designed or chosen considering the topic of research and needs of a student. In many cases, students are mandated to go through courses in reputed instituted outside of HBNI with whom HBNI has an agreement for academic collaboration.

2.3.4 Lectures by experts/ people of eminence

This is encouraged and lectures are regularly arranged. Annual report gives details of such lectures. Seminars by students and for students are regularly organized. ACTREC, TMC regularly organizes a scholar's meet for research students pursuing life sciences.

2.3.5 Does the university formally encourage blended learning by using e-learning resources?

For self study courses meant for doctoral students options such as learning from text books, open online course-ware, periodic discussion with an expert on the subject are available. To enable students and faculty to have an easy access to e-learning sources, liberal internet facilities are available at all campuses.

2.3.6 The technologies and facilities used by the faculty for effective teaching

At all CIs, e-learning is an integral part of the education in terms of on-line lectures and discussions with experts. Students are also asked to make presentations on project work using visual aids and facilities necessary to do so are provided.

2.3.7 Class rooms as 24x7 learning places

The teaching learning process goes well beyond the boundaries of the classrooms. The ready availability of the faculty on the campus, the interactive method of imparting knowledge and the practical problems and case studies incorporated into the curriculum keeps the students stimulated and engaged with intellectually challenging problems. The students are in fact 24x7 learners due to this culture

ingrained into them by a dedicated and involved faculty.

2.3.8 Counseling and mentoring

The faculty of the CIs interacts regularly with the students in a variety of roles including that of mentors, advisers and counselors. In addition, course coordinators are also interactive and compassionate to all student concerns, both academic and non- academic. The availability of a students' warden and the formation of various student committees also provides support structure towards these objectives.

In BARC Training Schools, a detailed Psychological Aptitude Test (PAT) is also conducted for the students and any student requiring counseling or mentoring is provided professional guidance. The number of such students requiring professional counseling has been negligible over the years which speak eloquently of the strength of the support system and a humane management.

Doctoral committees keep a close watch on the progress of the students.

In IoP(NISER) every student is assigned a "faculty advisor" right from the first semester. Any action, academic or non-academic, on the student, is taken only after consulting the Faculty advisor. In fact the tree of governance of activities of students begins with the Faculty Advisor. Besides, IoP(NISER) is planning to appoint a part-time psychiatrist to take care of any social and emotional problems of the students.

2.3.9 Innovative teaching approaches/methods/practices adopted/put to use by the faculty during the last four years

The Institute has always been open to innovative teaching methods. Towards this objective, the faculty has adopted the use of simulators, dynamic reactor models and interactive boards to enhance the learning experience. The use of such practices has been well received by the students as elicited from them in the feedbacks received. The teaching community of the Institute is a self motivated and dedicated lot and the nomination of a specialist to the teaching process is by itself considered as a recognition of merit. However, in acknowledgment of the fact that appreciation and formal recognition are necessary towards the sustenance of any system, a mechanism to award meritorious and innovative teachers is in the process of being formulated and implemented.

2.3.10 Creating a culture of instilling and nurturing creativity and scientific temper among the learners

Instilling and nurturing creativity and scientific temper amongst the learners is a process which needs to be carried out in a gentle and unobtrusive manner. This role is often carried out by the faculty by incorporating challenging situations and case studies into the teaching process to stimulate the intellect, leading to a mindset of generating creative solutions to complex multidisciplinary challenges. Inspiration is provided by the presence of excellent role models amongst the faculty and the entire scientific and technical fraternity of the University.

2.3.11 Student projects

A student has to complete a minor project during the first year of M.Tech. and a major project during the second year. All such projects are undertaken within the CIs under the guidance of faculty and in guidance of Technology Advisers is taken as needed. It may be indicated that a technology adviser is a person having long experience in his area of expertise and guidance of such individuals proves valuable for the students.

While all M.Tech. and M.Phil projects are done within the CIs, occasionally use is made of advanced analytical facilities in other elite institutions in the country particularly for Ph.D. work.

In some of the CIs such as IoP, a mini project is mandatory during the first year of doctoral programme.

Students in IoP(NISER) take up projects from 3rd year onwards. The number of credits assigned to the dissertation varies with the school. In the 5th year, they submit a thesis which sometimes results in writing a paper along with the PI. IoP(NISER) picks up the best thesis in each school and encourages the concerned student with a befitting award.

2.3.12 Adequacy of faculty resources for teaching

University has well qualified pool of faculty for guiding research. For teaching courses for M.Tech. very often younger colleagues who are yet to complete a Ph.D. or senior colleagues who have long exposure to a subject area are also selected for teaching.

2.3.13 Use of computer-aided teaching/ learning materials

Extensive internet and computer facilities are available at all CIs.

The BARC Training Schools have an excellent IT infrastructure in place, which includes a large number of internet enabled computers. Many faculty members use these facilities for preparation of on line assignments and computational

problems etc. The process of acquisition of software packages towards research and education has also been put into the pipeline and would materialize in the near future. A dedicated portal for uploading information, assignments and other academic content, known as 'Pathshala', is also available at the BARC Training School. This portal has currently uploaded course material on more than 500 technical courses obtained from national and international sources. The university has also been wi-fi enabled due to which the processes for dissemination of information and incorporation of computer aided methods into the teaching learning process would receive a boost.

At IMSc, many of the lectures under course work, public talks, special lectures and conference proceedings are video-graphed and made available to the public.

IoP(NISER) has a computer centre with internet enabled computers. The computer center functions on all days from 8.00 AM to 11.00 PM. The whole campus is wi-fi enabled. The faculties use the computer assisted technologies while teaching.

In other CIs, need for computerization has not been felt due to small number of students.

2.3.14 The mechanism for the evaluation of teachers by the students / alumni

Please see response at 1.4.1

2.4 Teacher Quality

2.4.1 Managing the changing requirements of the curriculum

Faculty in HBNI consists of individuals who are engaged in research, and/or in engineering and/or in technology development. They update syllabus as needed based on latest advances in the subject or experience gained from latest projects handled by them. Since change in requirements arises from their own work, they are invariable equipped to handle the change. For example, pursuit of closed fuel cycle approach demands training of engineers in reprocessing technology and at the same time several reprocessing projects are currently under implementation. Engineers involved in projects are also involved in teaching and they can handle the subject. In this kind of new areas, no one from outside HBNI can be of help and faculty has to do the job. In the first year or two of any new programme, there are always hiccups as faculty tries to find best way to convey a new technology, but it gets established within a year or so.

2.4.2 Furnish details of the faculty

Faculty Data as on 31 March 2014

CI Name	Sr. Prof./ Prof.			Associate Prof.			Assistant Prof.			Grand Total
	Male	Female	Total	Male	Female	Total	Male	Female	Total	
BARC	124	11	135	74	15	89	90	25	115	339*
IGCAR	40	5	45	19	3	22	15	2	17	84
RRCAT	13	1	14	17	2	19	16	2	18	51
SINP	26	1	27	32	5	37	21	8	29	93
IPR	5	0	5	7	1	8	27	0	27	40
IoP	4	1	5	7	0	7	5	0	5	17
IoP(NISER)	4	0	4	2	0	2	49	3	52	58
HRI	13	1	14	13	1	14	6	2	8	36
TMC	42	19	61	35	20	55	51	22	73	189*
IMSc	24	2	26	11	2	13	13	3	16	55
VECC	14	1	15	3	1	4	11	7	18	37
Total	309	42	351	220	50	270	304	74	378	999

*Medical doctors designated as faculty in accordance with MCI guidelines for teaching and guiding PG and super-specialty courses are included in the data.

2.4.3 Diversity in its faculty recruitment. CI – wise details.

Sr. No.	CI Name	Discipline (Board of studies)	No. of Faculties Discipline-wise	Total
1	BARC	Chemical Sciences	130	339*
		Engineering Sciences	63	
		Life Sciences	43	
		Physical Sciences	96	
		Health Sciences	4*	
		Strategic studies	3**	
2	IGCAR	Chemical Sciences	22	84
		Engineering Sciences	21	
		Physical Sciences	41	
3	RRCAT	Chemical Sciences	2	51
		Engineering Sciences	3	
		Life Sciences	2	
		Physical Sciences	44	
4	VECC	Chemical Sciences	1	37
		Engineering Sciences	3	
		Physical Sciences	33	
5	SINP	Chemical Sciences	5	93
		Life Sciences	15	
		Physical Sciences	73	
6	IPR	Engineering Sciences	5**	40
		Physical Sciences	35	
7	HRI	Mathematical sciences	13	36
		Physical Sciences	23	
8	TMC	Life Sciences	40	189*
		Physical Sciences	1**	
		Health sciences	148*	
9	IMSc	Life Sciences	4**	55
		Mathematical sciences	25	
		Physical Sciences	26	
10	IOP and IoP (NISER)	Chemical Sciences	19	75
		Life Sciences	14	
		Mathematical sciences	8	
		Physical Sciences	17 + 17	
Grand Total = 999				

*Medical doctors in TMC and BARC have been designated as faculty for teaching and guiding PG and super-specialty medical courses. Their academic designations and academic promotions are based on MCI norms.

**These are included in other disciplines as well and so are not accounted while totaling.

Data this table requires an explanation. Method of recruitment of faculty is elaborated in paragraph 2.4.4. In case of R&D centres, method provides for induction (i) after B.Tech./M.Sc. through Training School, (ii) after M.Tech. at select institutes, and (iii) after Ph.D. through KS Krishnan Associate-ship scheme. Major fraction of the recruitment is through Training School and individuals so recruited acquire capabilities and higher qualifications while on the job. Ample opportunities are provided for interaction with outside world through sabbatical leave, participation in national and international conferences, deputations abroad for working on collaborative projects and experimental facilities. While higher qualification is acquired based on in-house research, name of the university is not HBNI as HBNI has been set up only recently.

In aided institutions except IPR, method of recruitment is as faculty and almost all members of the faculty are from outside.

2.4.4 Faculty for new programmes/ emerging areas of study

Different CIs have different mechanism for this purpose. R&D centres viz., BARC, IGCAR, RRCAT and VECC have similar structures and follow one model for recruitment. Most of fresh scientific officers (about 250 every year) recruited have a B.Tech. or a M.Sc. and they are academically trained first in the BARC Training Schools and then throughout their career. About 8% of scientific officers, after they have obtained a Ph.D. and have adequate number of publications, are recognized as faculty by HBNI. In these CIs, in most of the cases, new programmes are started based on in-house research.

In order to cater to widening spectrum of the research connected to the nuclear sector, with respect to development of advanced reactor systems and back end technology, fast breeder reactor technology, heavy water production, fuel fabrication, applications of lasers and accelerators to the development of advanced reactor technologies and uranium exploration, several new programmes to generate and disseminate specialized knowledge in these domains have been

initiated during the recent years. The thrust of research at BARC has shifted towards the development of advanced reactor technologies, reprocessing and waste management. Programmes connected to development of fuels, materials and technology for the Fast Breeder Reactor are the mainstay at IGCAR. Advances in fuel fabrication for existing as well as emerging reactor systems are carried out at NFC. Development of lasers and accelerator technologies are the flagship programmes at RRCAT while the incorporation of advanced mining and exploration methodologies receive attention at AMDER. These specialties need a continuous input of faculty with the necessary knowledge base. The faculty is selected mostly from amongst in-house scientists and the selection process is an ongoing process at all centres of the Institute. The process includes grooming younger faculty members as well as introducing new areas arising from research done in-house or elsewhere. An average of 20-30 % of new faculty are inducted to cater to the emerging needs every year.

A small number of scientific officers (about 20 per year) with Ph.D. are recruited as KS Krishnan Associates and are confirmed after a year or two. These come from universities in the country or abroad and are selected because of their expertise in emerging areas as well as areas already being practiced and needing additional human resources.

In other institutions except IPR, which are grant-in-aid institutions of the DAE, faculty is recruited by open advertisement and care is taken to choose only those who have qualification in emerging areas. IPR follows a practice similar to R&D centres.

2.4.5 Emeritus/ Adjunct Faculty/ Visiting Professors on the rolls of the Institute

The Department of Atomic Energy has instituted schemes to get advantage of expertise of senior retired experts and under these schemes individuals are appointed as Homi Bhabha Chair professors or Raja Ramanna Fellows. The following are at present working as Homi Bhabha Chair Professors.

Prof V C Sahni
Prof S Banerjee
Prof J B Joshi
Prof R B Grover

About 9 senior scientists are working as Raja Ramanna Fellows in BARC, two at IGCAR, two at VECC, one at IoP, and one at TMC-ACTREC. RRCAT has one

Ramanujam Fellow and three visiting scientists.

Institute for Plasma Research has also instituted schemes for employing senior retired faculty and Prof Abhijit Sen is working as S. Chandrasekhar Chair at IPR.

In addition, some senior scientists are occupying chairs funded by outside agencies. Prof PK Kaw is at IPR as DST Professor, Dr SS Kapoor as INSA Honorary Scientist at BARC, Dr J P Mittal as M N Saha distinguished fellow at BARC, Prof. Indraneel Mitra is a Dr. Ernest Borges Chair in Translational Research at TMC-ACTREC, and Dr. Anurag Srivastava is a visiting clinical scientist at TMC-ACTREC.

HRI has 6 adjunct professors and 2 visiting scientists on its rolls. IMSc has 2 adjunct professors. IoP(NISER) has 6 visiting faculties and 2 adjunct professors.

2.4.6 Academic recharging and rejuvenating of faculty

To academically recharge and rejuvenate the faculty members, CIs provide the following facilities for research purposes:

- Opportunities to work at organizations like Fermi lab, CERN, CEA laboratories and similar other laboratories through formal arrangement of co-operatipon.
- Liberal opportunities for foreign travel to attend training courses organized under the aegis of International Atomic Energy Agency (IAEA), and conferences and workshops.
- Both R&D Centres and grant-in-aid institutions provide sabbatical or study leave to work as visiting faculty / researcher in other universities and laboratories in India and abroad.
- Opportunities for employment on deputation to work in international organizations like the International Atomic Energy Agency and ITER organization.
- DAE Science Research Council Outstanding Investigator Award, open to all CIs. The award carries a grant of up to Rs 1 crore spread over a period of five years to pursue research on a project. The awardees get an incentive of Rs 25,000 per year in addition to salary during the period of award.
- Prospective Research Fund to provide funding for projects undertaken by any of the faculty in any of the CIs to undertake research complimentary to major plan projects, to work on critical gap areas and for any futuristic research.

Faculty also gets an update allowance. Faculty members also organize National as well as International Conferences in their respective areas in India.

2.4.7 Awards / recognitions for excellence received by faculty during the last four years

Please see Appendix 1

2.4.8 Participation in faculty development programmes, conferences, seminars and consultancy

Almost all faculty members participate in conferences and seminars at the national and international level and present papers. Teaching experience at universities within India or outside is, however, sporadic.

With regard to consultancy, situation is different from other universities. Every member of the faculty in R&D centres is recruited as a scientific officer and works on projects assigned to him and that includes projects that have application in industrial units of the DAE or foe possible deployment outside of the DAE. This is true for IPR as well. Faculty also works in various committees related to regulatory review of nuclear facilities. In case of other institutions also, faculty works on large research projects and their involvement is comparable to industrial consultancy.

2.4.9 Academic development programmes

This aspect has to be examined considering that HBNI is a research university and academic development is, therefore, primarily related to identification of topics for research. Research areas to be pursued are identified at the beginning of every five year plan through an elaborate exercise explained in detail under criterion 3. Topics for research to be taken up by doctoral students are identified based on topics of projects funded under five year plans.

HBNI recognizes that knowledge enhancement is a continuous and unending process and the faculty is encouraged to update knowledge and skills by a variety of channels including attending specialized courses, participating in national and international symposia and also carrying out post doctoral research within HBNI and in universities and research centres around the globe. Teaching by practicing scientists and active researchers leads to knowledge transfer in an organic fashion.

In addition to publishing papers in journals and conferences, faculty and scientists in some of the CIs publish reports to archive details of experimental facilities, data obtained from facilities, design of products, and development of processes.

2.4.10 Academic collaborations

The DAE has always encouraged collaborations at the national and international

level. Some international collaborations are very active and include CERN, Geneva; Fermi laboratories, USA; Brookhaven National Laboratory, USA; GSI, Germany; TRIUMF, Canada, CEA laboratories, France; FAIR, Germany etc.

DAE provides funds for extra-mural research in the country and one agency for this purpose is Board of Research in Nuclear Sciences (BRNS). A significant part of the funding is for collaborative projects wherein faculty/scientists from CIs work as collaborators with principal investigators from universities. Through BRNS funds and expertise have been provided to set up several major facilities for research in universities and institutes in the country. Two important facilities for which expertise was provided are National Centre for Free Radical Research (NCFRR), University of Pune and Microtron at University of Mangalore. Faculty and Scientists from CIs of HBNI are contributing towards running and use of these facilities.

With the setting up of the HBNI, collaborations with academic institutes have been further strengthened by signing formal agreements of cooperation between the HBNI and institutes and universities. These MoUs provide for academic collaborations including joint supervision of doctoral research. The list of Institute/ Universities with whom MoUs have been signed follows.

1. Institute of Chemical Technology, Mumbai
2. Indian Institute of Science, Bangalore
3. Indian Institute of Technology, Bombay
4. Indian Institute of Technology, Madras
5. Indian Statistical Institute, Kolkata
6. Jadavpur University, Kolkata
7. Indian Institute of Technology, Kanpur
8. Tata Institute of Fundamental Research, Mumbai
9. The Rector and Visitors of the University of Virginia
10. The Commissariat á l'énergie atomique et aux énergies alternatives, France
11. University of North Texas, USA

CIs have the freedom to collaborate on an independent basis. For example, IoP(NISER) has collaboration with the following two Institutes.

1 Max Planck Institute for Plant Breeding Research (MPIPZ), Germany,

2 University of Freiburg, Germany.

The Institute also has provision for 'study away from university' to enable any doctoral student to do a part of the research in any collaborating institution. The faculty regularly examines doctoral theses from other universities and work as moderator for medical programmes such as MD, DM, MCh. Senior faculty is also involved in peer review of programmes at other universities and laboratories.

In the area of Health Sciences, the Institute encourages faculty to participate in continuing education programmes.

Faculty from CIs of HBNI has been recognized by other universities in the country for guiding doctoral students and work as co-guides. Faculty also provides expertise to students through DAE-UGC-Consortium for Scientific research.

2.5 Evaluation Process and Reforms

2.5.1 Awareness about evaluation processes amongst all the stakeholders

For most of the programmes, detailed guidelines have been formulated and are made available to students, who are the major stakeholders. Guidelines include all that they need to know. In addition to HBNI level guidelines, CIs also inform students about more details on aspects like syllabus, and evaluation pattern before the beginning of the semester. The dates for conducting mid-term assessment tests and final exams are printed in the Academic Calendar before the start of every semester. The examination schedules, notices, timetable etc. are put up on all the notice boards of the institute also.

These details are uploaded on web pages of the CIs

2.5.2 Examination reforms

HBNI has a policy of providing flexibility to CIs with regard to conducting examinations. Accordingly a very liberal examination pattern is followed at CIs. General structure consists of course evaluation based on home assignments, mid-term examination and final examination. Pattern of mid-term and final examination is left to instructors. These exams range from close book, closed notes exams to open book, indefinite time exams. Clearly this has helped in tapping creative potentials among students.

Results are generally announced within a couple of weeks of examinations. The results/grades are published and communicated to the students by the CIs. In case of doctoral students, while every care is taken to complete the evaluation process

in a short time, there have been instances wherein external examiners have delayed sending reports. External examiners are expected to complete evaluation process within 60 days, but there have been instances where external examiners have taken four to six months to evaluate the theses.

2.5.3 Transparency in the evaluation process

Evaluation process is completely transparent. Students have access to evaluation of answer sheets and can discuss pattern of evaluation with instructor.

In IoP(NISER) evaluation process is completely transparent. At the beginning of the course the teacher provides the assessment plan to the students. The evaluation is a continuous process. There are midterm examinations and quizzes. At the end of the course, students have access to evaluated answer sheets. There is a grievance cell operating in the academic section to take care of the grievances of students if any.

2.5.4 Use of an examination platform

Large student population is at BARC Training Schools, where the examination process has been streamlined with the introduction of several measures such as the receipt of online password protected question papers, direct printing through a dedicated printing machine connected to the online system, a monitoring system for tracking the receipt of results and instant online communication to students of the updated results. Mark sheets and certificates are generated by Trainee management System (TMS) portal, ensuring data integrity and instant computations and communications to the faculty as well as students. A biometric attendance capture system monitors attendance and ensures compliance during the course work.

In other CIs, student population is small and no need has been felt of having such a system.

IoP(NISER)

Grades are given by the faculties within 72 hrs of the exam. It is mandatory for the faculty to show the answer scripts to the students and convince the students in case of any dispute. There is a grievance committee to take care of any dispute in the assessment system. IoP(NISER) is soon going to migrate to an online system.

2.5.6 Ph.D. evaluation process

HBNI expects a doctoral thesis to be a significant original and independent contribution to knowledge in a chosen field of study and be of such lasting value as to merit publication. It should demonstrate an ability to select an important problem and deal with it completely including an ability to effectively communicate what has been achieved through the research activity. It should be short, not longer than 300 pages.

Ph.D. evaluation process flowed by HBNI has the following main steps.

- A general comprehensive examination in the beginning of the Ph.D. programme to evaluate the broad based knowledge of the student.
- Periodic progress reviews by students specific doctoral committees
- Pre-synopsis open seminar
- Permission to submit the thesis only after student has published in peer reviewed journals and number of publications required depend on the discipline and topic.
- Thesis evaluation by two external examiners
- Final public viva voce by doctoral committee along with one external examiner.

2.5.7 Including the name of the CI in the degree certificate

The Institute includes the name of the CI in the certificates.

2.5.8 The mechanism for redressal of grievances with reference to examinations

As a first step, any complaint received is referred to the CI where the student is studying. If not resolved, Dean is authorized to constitute a complaint specific committee to resolve the complaint.

2.5.9 Conduct of examinations

HBNI has a distributed structure and each institute has Deans-Academic and/ or Standing Academic Committees to carry out university level functions. This distributed structure ensures that work load on one person is not excessive and no particular difficulty has been encountered.

With regard to examination of doctoral theses, subject expertise lies with Boards of Studies and they play a role in evaluating the synopsis and deciding list of examiners.

2.6. Student Performance and Learning Outcomes

When looked at from the point of outcomes, the programmes offered by the university can be divided into three categories: professional programmes (M.Tech., PGDiploma, DipRP, MD, DM, M.Ch., M.Sc.(Nursing), DMRIT, DRM,) research based programmes (M.Sc.(Engg), M.Phil., and Ph.D.), and integrated M.Sc. programme at IoP(NISER).

Professional programmes conducted at BARC Training Schools prepare students for a lifelong career in DAE. Their successful outcome is demonstrated by the success of indigenization of nuclear power programme, development of new reactor concepts etc. These programmes have seen continuous evolution over the

years in terms of updating of syllabus, addition of new streams and addition of new campuses. Assessment of students includes end-semester viva voce which tend to look at what a student has learned in a holistic manner rather than subject wise. A mini project and viva voce following it evaluates problem solving abilities of students. It may be added that though not articulated formally so far, the expected outcome of programmes at BARC Training School is to equip its graduates to apply fundamental knowledge of nuclear science and engineering in day to day working in units of the DAE.

Outcome of DipRP programme is again demonstrated by the fact that all DipRP graduates are in great demand and BARC has being asked by the "Department related Parliamentary committee" to increase the student intake to this programme. All medical courses are structured in accordance with the guidelines of MCI or Nursing Council as applicable.

Quality of theses produced by doctoral students is demonstrated by comprehensive research abilities acquired by students. Invariably number of publications in peer reviewed journals coming out of a thesis varies from one to several as can be seen from previous annual reports. Students after their completion of PhDs are generally selected for employment (including as INSPIRE faculty) in national laboratories, universities or industry in India or abroad.

Overall, apart from IoP(NISER), while formal statements on learning outcomes of various programmes has not been made, performance of HBNI graduates in their careers as evident by technologies developed and deployed by the DAE is a testimony to the quality of outcome.

IoP(NISER) aims to attract bright, motivated students and nurtures them to become world class scientists who will take up challenging research and teaching assignments in universities, DAE institutes, research and development laboratories and various industries. IoP(NISER), envisions research as a catalyst for expanding and diversifying the country's economy; enhancing the education of its citizens and the training of its work force. In striving towards this vision, IoP(NISER) will distinguish itself as a premier institute that embraces scholarly excellence, innovation, creativity inclusiveness, and merit.

CRITERION III: RESEARCH, CONSULTANCY AND EXTENSION

3.1 Promotion of Research and Resource Mobilization

As already explained HBNI is an umbrella for the academic programmes of the DAE which has a strong R&D culture. Development of an indigenous nuclear power programme as well as non-power application of nuclear science is a testimony to support provided to research by the DAE. Since HBNI and R&D unites of DAE are fully intertwined, the best way to look at how HBNI promotes research and mobilizes resources is to look at the XII plan, R&D sector, report of the DAE. The following is an extract from the executive summary of the document. Since a lot of research is done in Tata Institute of Fundamental Research (TIFR), which is a part of the DAE but not of HBNI, appropriate editing has been done.

The DAE has been pursuing R&D in nuclear science and engineering and also in advanced mathematics including theoretical computer science. Research and development by the R&D units of DAE provide valuable support to sustain and expand the indigenous nuclear power programme and also to develop non-power applications of nuclear technology for use in industry, food and agriculture, healthcare and advanced research. The research centres and aided institutions also lay strong emphasis on frontline basic and applied research, supporting special technologies, and human resource development for sustained growth and establishing the strong linkages with the academic and research community as well as industries in the country. The initiative of the DAE to set up Homi Bhabha National Institute (HBNI) as a deemed to be university is a step towards strengthening the linkage between the institutions of the DAE and also with the academic and research community in the country. HBNI is also serving as a facilitator for enhancing the accessibility of DAE's R&D infrastructure and facility to research students from all over the country.

The DAE's R&D activities are categorized into seven major programmes MP-1 to MP-7 as follows.

MP-1	Nuclear Power Programme – Stage -1
1.01	PHWR (Pressurised Heavy Water Reactor)
1.02	LWR (Light Water Reactor)
1.03	Front End Fuel Cycle – Exploration, Mining & Ore Processing, Fuel Fabrication, Heavy Water Production
1.04	Back End Fuel Cycle- Reprocessing

1.05 Health, Safety & Environment
1.06 Waste Management
MP-2 Nuclear Power Programme – Stage -2
2.01 Fast Reactors
2.02 Materials
2.03 FBR-Front End Fuel Cycle (including Fuel Selection, Chemistry, Fabrication, Sodium and its related activities, Boron etc)
2.04 FBR-Back End Fuel Cycle
2.05 Repair and Inspection Technologies
2.06 FBR-Health, Safety & Environment
MP-3 Nuclear Power Programme – Stage -3 and beyond
3.01 AHWR (Advanced Heavy Water Reactor)
3.02 Thorium Fuel Cycle
3.03 Other Thorium Reactor Systems
3.04 Accelerator Driven Sub-critical System
3.05 Materials
3.06 Hydrogen Energy
3.07 Fusion Reactor
MP-4 Advanced Technologies and Radiation Technologies and their Applications
4A Advanced Technologies and their Applications
4.01 Research Reactors
4.08 Accelerators
4.09 Lasers
4.10 Special Materials
4.11 Advanced Technologies
4.12 Special Programmes
4B Radiation Technologies and their Applications
4.02 Isotope Processing
4.03 Agriculture
4.04 Food Processing
4.05 Health
4.06 Water
4.07 Industrial Applications
MP-5 Basic Research
5.01 Mathematics and Computational Sciences
5.02 Physics
5.03 Chemistry
5.04 Biology
5.05 Cancer

5.06 Synchrotrons & their Utilisation
5.07 Cyclotrons & their Utilisation
5.08 Fusion & Other Plasma Technologies
5.09 Materials Science
5.10 Interdisciplinary Areas
5.11 International Research Collaboration
MP-6 Research Education Linkages
6.0 Human Resource Development
6.02 Sponsored Research
6.03 Prospective Research Fund
6.04 HBCSE
6.05 Information Technology Applications Development
MP-7 Infrastructure & Housing
7.01 Infrastructure
7.02 Housing

Specialists Groups (SG) are constituted for the review and monitoring of R&D project proposals by the various Units of DAE and have proved to be an excellent peer review mechanism. For the continuing projects of XI Plan, status of the progress was reviewed. Reasons for delay and factors favouring continuation/ foreclosure were also examined, as a result of which it has been decided to continue with 138 projects in the XII Plan. Some of the major projects have also been reviewed by the Atomic Energy Commission (AEC).

Highlights of achievements, accomplished during the XI Plan are briefly given in the Chapter on 'Achievements of XI Five Year Plan' in the document. Indicators for the performance in basic research namely the publications in peer reviewed journals and citation indices are given towards the end of chapter 3 of the plan document.

The future direction of R&D and priorities are periodically reviewed taking into account the capabilities acquired, based on which new goals are set. The process of formulation of XII Plan was initiated by discussions during the 12th Meeting of DAE-Science Research Council chaired by Prof CNR Rao held on 8th July 2010. A detailed exercise to evaluate the capabilities and identification of the gap areas was carried out during the brainstorming session organized by the R&D sector of DAE on May 17, 2011. Following deliberations, priority areas were identified and guidelines to formulate XII Plan proposals were given by the Internal Working Group. DAE has mastered the Pressurised Heavy Water Reactor technology as a part of first stage of nuclear power programme. Need to accelerate the growth of nuclear power led to a policy initiative of the Government to open up civil nuclear

international trade and now it is planned to set up light water reactors. The DAE was already pursuing development of fast breeder reactors and reactors for utilization of thorium.

The natural calamity that Japan (Fukushima – Daiichi) on 11 March 2011 has warranted the need to identify and address safety upgrades required as well as support safety research in relevant areas including in addressing challenges due to Beyond Design Basis Accidents. To accelerate growth of nuclear power installed capacity, the DAE also has to expand outreach programmes, strengthen linkages with universities and lay increased emphasis on non-power applications of nuclear technologies. The projects and programmes planned to be pursued accordingly during XII Plan are given in the Chapter on DAE XII Five Year Plan Proposals. Only brief details with regard to proposals from CIs of HBNI are given here.

Efforts towards ageing management and safety upgrades of all nuclear plants in operation, and incorporating enhanced safety features in the plant to be set up are planned to be continued. Some of the topics taken up in the XII Plan are analysis of safety related issues, endurance studies, degradation studies, development of rehabilitation and remote tooling devices, development of construction technologies, joining technologies, nondestructive examination and investigation of new safety concepts to address extreme external events. As India is embarking on Light Water Reactor programme, it is necessary to develop, design and verify indigenous LWR concepts and broaden vendor base.

The second stage of the Indian nuclear power programme involving setting up of fast breeder reactors along with the associated fuel cycle facilities is essential to utilize the full energy potential of uranium resources in the country as well as commencement of the third stage through establishing the use of thorium. The construction of the PFBR is in an advanced stage and the reactor is expected to be commissioned by the end of 2012. Two 500 MWe MOX fuelled fast reactors are planned to be set up. Metallic fuel deployment with its associated fuel cycle in the fast reactor is the key to reducing doubling time thus accelerating the pace of nuclear power deployment. To ensure expeditious development of metal fueled FBRs, R&D programmes are under implementation during XII Plan. For validating the design of the fuel subassembly and to gain large scale experience in the fabrication and irradiation testing of metallic fuels, a 120 MWe metal fuelled fast reactor is being designed by IGCAR during the XII Plan with construction proposed in the XIII Plan.

The development and demonstration of thorium fuelled Advanced Heavy Water Reactor is an important initiative for thorium utilization and for the third stage of nuclear power programme. This reactor also already embodies several innovative passive safety features that have now assumed added significance internationally following the Fukushima- Daiichi events. A major programme to experimentally demonstrate the available margins to extreme internal and external events will be carried forward in the next Plan period to further add to validation of these advanced safety features, many of which are generic in nature.

In addition to AHWR, planning for a Compact High Temperature Reactor (CHTR) is an important step towards the development of advanced reactor technologies required for hydrogen generation. For designing CHTR, consideration of material behavior as well as technologies for utilization of high temperature heat warrant investigations for assessing the performance of structural material in corrosive environment of liquid metal and molten salt coolants. Molten salt is a promising coolant for high temperature application as it also offers the possibility of a thorium based thermal breeder reactor design suitable in the Indian context with a high level of passive safety. The advanced reactor systems including fusion reactor systems require appropriate materials to be specially developed, characterized and compatibility issues resolved. Furthermore, special instruments and sensors also need to be developed for measurement of process parameters in such harsh environment. All necessary studies are being taken up in XII Plan.

India, as a member country of the ITER venture, has initiated focused development on all areas relevant to in-kind contribution to be made by India to ITER and has successfully bid for a half port at ITER to test its Test Blanket Module concept. The test blanket module development for testing in ITER will be a major activity. The Indian concept for TBM is based on building a Lead Lithium Cooled Ceramic Breeder (LLCB).

Research reactors serve the purposes of not only supporting R&D, production of radioisotopes and training, but also provide the test bed for R&D on reactor fuels and materials and validation of computational codes, as for example in shielding design. At present Dhruva is the only research reactor to support such activities in Trombay. It is necessary to plan for a new high flux reactor facility in Vizag to meet the demands of research and isotope production. This is an important area of focus in XII Plan though the new reactor itself will be built only around the end of XIII Plan.

Accelerators and lasers are very powerful tools for basic as well as applied research. Better beam properties and enhanced reliability would help carry out frontline research on probing deeper into the matter as well as carry out the applications with better precision and control. Several new beam lines are being installed at INDUS 2 and the existing ones are being upgraded with modern equipment for supporting high quality research. BARC and RRCAT have formulated project proposals to develop enabling technologies like RF cavity for superconducting high power proton LINACs.

Projects on diversifying the sources of production of radioisotopes based on exploring the application of accelerators and including electron accelerators (involving collaboration of VECC with TRIUMF, Canada) as well as production of some specific isotopes like Strontium-89 in FBTR-IGCAR is proposed. India with over 1.2 billion population has several challenges in ensuring food security and industrial economy. All the possible nuclear contributions to food and agriculture (radiation mutants, food preservation by radiation treatment, better use of water resources etc) as well as in enhancing industrial productivity using radiation aided industrial process management and troubleshooting are being supported in XII Plan.

Radioisotopes and their formulations (labeled compounds, radiopharmaceuticals) and radiation sources (isotope sources, gamma plants and electron accelerators) are required for nuclear applications in health care, industry, food security, agriculture, water resources management and research. The XII Plan projects in these topics aim to strengthen DAE support for sustainable adoption and/or expanded deployment of these applications for societal benefits. Continued interactions with stakeholders beyond the DAE including several State and Central Ministries and Organisations is being followed to further promote awareness and outreach. A national hadron therapy facility for cancer treatment and other augmentation plans at ACTREC-TMC will help expand the range and capabilities in radiation medicine.

In the area of basic research, thrust areas include inter alia nuclear and high energy physics, laser science technologies and applications, condensed matter physics and materials science, separation sciences, hydrogen energy systems, analytical chemistry, radiation chemistry, radiation biology and cancer research, etc. In the area of plasma and fusion physics, the participation in the ITER programme has given an impetus to the R & D efforts in the domestic fusion programme based on ADITYA in IPR, Gandhinagar.

Considering the importance of the solar energy, the utilisation and storage of hydrogen energy and the clean coal technologies in the optimum energy mix, components of basic science and technology development relevant to the generic area of advanced engineering technologies have been included in several proposals. There are several features common to these diverse energy systems such as materials, thermal engineering, manufacturing technologies, which are of relevance to relevance to nuclear technologies as well. Similarly basic research in disciplines like physics, chemistry and biology can also be directed towards process development related to energy production, storage and efficient utilisation. Special effort has been made in formulating projects to build enabling technologies and relevant basic research which can cover the entire gamut of advanced energy systems.

DAE continues to increasingly participate in international collaborative ventures. Participation in activities at LHC, CERN, Geneva, has led India to obtain the status of an 'observer state.' Indian participation in the seven Member ITER project will continue during XII Plan. India's participation in ITER has demonstrated our scientific and economic strength to be a partner in mega-science projects and has led to several global groups seeking Indian contributions in their projects, as for example Project X proposed by Fermi Lab in the US. India has joined the multi-national, multi-organisational project, Facility for Anti-proton and Ion Research (FAIR), being set up at Germany.

An extremely high degree of technical excellence and competency of human resources is crucial for the success and sustainability of nuclear programmes. The DAE SRC award scheme has led to some very significant research outputs and is being continued to provide further incentive to competent professionals within and outside DAE. Increasing linkages with the national higher education institutions (Universities, IITs, NITs etc) will be continued so as to ensure availability of quality manpower for inputs to DAE programmes and projects.

The DAE initiative to set up HBNI as a Deemed University is being used to further strengthen linkages with IITs and some Universities. The present methods of collaboration through BRNS and MOUs with select academic institutes will continue to be supported and further strengthened. The scope of BRNS functions will be supplemented by extending additional support from the DAE R&D Units to select R&D organizations and Universities, which would enhance the linkages with academic institutions and also help, achieve greater awareness on the benefits of nuclear applications.

In order to meet the growing number of programmes and projects, it is necessary to strengthen and expand the investments in infrastructure. New campuses coming up, for example of BARC in Vizag. The ongoing projects towards strengthening and upgrading existing security systems need to be continued. The Global Centre for Nuclear Energy Partnership (GCNEP) will be set up in Haryana near Delhi, while a good part of these activities will continue also in XIII Plan.

Overall outlay for R&D sector for the CIs of HBNI for the XII five year plan is as follows.

CI	Outlay in crores of Rs
BARC	5885
IGCAR	1492
RRCAT	1015
VECC	652
TMC	1393
IPR	635
SINP	288
IMSc	91
HRI	74
IoP	50

3.2 Research Facilities

All CIs have state-of-the-art research facilities. These facilities are used by faculty and students of the CIs and also made available to researchers of other universities through DAE-UGC-CSR. Adequate hostel and guest house facilities are available at all CIs to cater to the requirements of researchers. Setting up of new facilities and up-gradation of existing facilities is a continuous process and grants for this purpose are provided by the Central Government through five year plans. Some of the major facilities in various CIs are given here.

BARC

Nuclear science and engineering is a multi-disciplinary subject, and research and development done at BARC covers all disciplines. BARC has excellent research facilities to cater to its requirements. It is difficult to have a detailed compilation of research facilities, but an attempt is made here to provide a broad compilation. Apart from state of the art High Performance Computing Facilities, BARC has following Laboratories to cater major experimental research activities in various disciplines.

- In the area of physical sciences, major research facilities are the following.

- **Accelerator facilities**: the Pelletron plus superconducting linac at TIFR, FOlded Tandem Ion Accelerator (FOTIA), Low energy accelerator facility (LEAF), Superconducting ECR source, all at Trombay, The 3 MV Tendetron accelerator at the National Centre for Compositional Characterization of Materials, Hyderabad
- **Electron accelerators**: 500 keV DC and 3 MeV DcC, the 10 ~~meV~~ MeV RF electron accelerator at the Electron Beam Centre, Navi Mumbai,
- Neutron facilities: the National Neutron Beam facility at Dhruva, Purnima fast neutron facility at Trombay
- Telescopes: the TACTIC (TeV Atmospheric Cherenkov Telescope with Imaging Camera) telescope set up at Mt. Abu,
- Pulsed power systems: KALI 1000, KALI 30 GW, KALI 1kJ Rep rated, LIA 200, LIA 400
- High pressure physics facilities: High power lasers, Gas gun, Electric gun, Rail gun, Z-pinch, Theta-pinch,
- Low temperature physics facilities including SQUID
- Crystal growth systems: Czochraski and Bridgman and Molecular Beam Epitaxy
- Wide range of characterization facilities: SEM, TEM, XRD, XPS, SIMS, AFM, Kelvin probe, I-V measurements, impedance spectroscopy etc.
- a wide range of spectroscopic facilities: High resolution FTS, FTIR, UV-Vis, Raman, photoluminescence etc.
- Wide range of thin film deposition facilities
- A number of state-of-the-art beam lines at INDUS, Indore, e.g., Photophysics, High Resolution Ultraviolet, ARPES, AIPES, EXAFS (dispersive and scanning), Protein Crystallography, EDXRD etc.
- Laser cooling and ultra-precision spectroscopy facility
- State of the art laser and laser spectroscopy facility
- EBPVD, ECR-PECVD, RF Plasma processing system
- High end computational facility for design of materials

- In the area of chemical sciences major research facilities are the following.
  - Dhruva reactor, 14UD Pelletron accelerator, Ion beam facility at 6MeV Folded tandem Ion Accelerator (FOTIA)
  - Pulse radiolysis Facility with 7MeV LINAC
  - Femtosecond Transient Absorption, Fluorescence Up-conversion & Laser-Induced Breakdown Spectroscopy Set up
  - Coherent control facility
  - GC, GC-MS and Raman Spectroscopy set-up

- Gas Phase & Surface Dynamics Labaratory
- BET surface area analyser
- Stopped flow spectrometer with absorption, fluorescence and circular dichroism detector
- Laboratory for the preparation of Ultrapure Material
- SEM (scanning Electron Microscope) with EDX (Energy Dispersive X-ray Spectra) & Atomic Force Microscopy
- Various XRD facilities
- Various spectrophotometer: ICP-MS, ICP-AES, AAS, ESR, TOF MS, TI MS, GD-MS & Photo-acoustic, FT NMR
- Positron Annihilation Spectrometer
- Ultra-trace analytical laboratory
- Electrochemical & elemental analyzer
- Solid oxide fuel cell laboratory
- Laboratory for hydrogen energy research
- Laboratory for solar energy: photovoltaic and photocatalysis
- High end computation facility for theoretic chemistry
- Laser laboratory for atmospheric chemistry

- In the area of life sciences, the major facilities are the following.
  - Radiation sources for research in radiation biology, mutation breeding, food irradiation : Co-60 and Cs-137 based gamma sources (including BHABHATRON), proton beamline at FOTIA, alpha irradiator, X-ray and electron beam facilities,
  - Next-generation DNA sequencer , DNA fragment analyzers, DNA/RNA microarray and protein chips, Real-time PCR equipments
  - Fluorescence activated cell sorters and flow cytometers.
  - SEM, SEM-EDX and TEM facilities, EDXRF and XRD facilities
  - Crystalisation robot and X-ray and NMR-based structural biology facility
  - Confocal and Fluorescence Microscopes, Atomic Force Microscope
  - MALDI-ToF-MS, ESI-LC-MS, GC-MS facilities for proteomics and metabolomics
  - ICP-MS and AAS and Ion electrodes for metal determinations
  - Surface Plasmon Resonance and CD spectrometers, UV-Visible absorption and fluorescence spectrometers, FT-IR and FT-NMR facilities
  - Ultracentrifuges and high-speed centrifuges for sub-cellular fractionation and molecular separations
  - Fermentors, growth monitoring stations and incubator-shakers for microbial and cell cultures

- Bio-informatics facilities
- Animal and Plant Tissue culture facilities, including animal house and green house
- Agricultural fields at Trombay, Tarapur, Vizag campus, Gauribidnur for crop improvement programs

- Health sciences
  - Radiotracers for diagnosis and therapy of a variety of diseases including advanced imaging equipments like state of the art PET-CT facility, gamma camera with SPECT system and an advanced radionuclide therapy ward
  - In house Medical cyclotron facility for Research and development of PET and Radio-pharmacy laboratory for SPECT radiopharmaceuticals for diagnostic and therapeutic Nuclear Medicine.
  - Research facilities to understand the pathophysiology of thyroid diseases including thyroid cancer, tuberculosis, the use of antioxidants to mitigate radiation induced damage following radionuclide therapy, development of immunoassays for thyroid disorders and diabetes.
  - Equipment for research in radiation dosimetry, quality assurance, patient dosimetry, development of radiological standards and related aspects of medical physics.
- Engineering sciences
  - A wide range of well equipped workshops for fabricating and instrumenting experimental set ups,
  - Laboratories for stress analysis, heat transfer, vibration and balancing, robotics and remote handling,
  - Laboratories for material testing and characterizing including equipment like SEM and TEM
  - Electronics, instrumentation, signal processing and control laboratories
  - Many large scale experimental set ups such as loops for heat transfer studies, desalination studies, type testing etc. are made and commissioned as and when required,
  - Electromagnetic Forming/Welding Equipments,
  - Radiological laboratories for testing irradiated samples and for hot fabrication,
  - Solar plants
  - Extensive facilities in the area of computer science that has enabled BARC to develop parallel computers

IGCAR

Indira Gandhi Centre for Atomic Research has the mandate to conduct broad based multidisciplinary programme of scientific research and advanced

engineering development, directed towards the establishment of technology of Sodium Cooled Fast Breeder Reactors (FBR) in the country. The mission includes the development and applications of new and improved materials, techniques, equipment and systems for FBRs and associated fuel cycle. Apart from pursuing a mission-oriented technological development, at IGCAR, a strong emphasis on basic research has been placed, since its inception. Research on topical problems in materials science, Metallurgy, chemical and engineering sciences are being carried out at IGCAR, that contribute towards sustaining the dynamism and robustness of a research centre involved in the indigenous development of advanced technologies.

- Ion accelerators, Rutherford Backscattering, Channeling, Positron lifetime measurements and Mossbauer Spectroscopy, Laser Raman Spectroscopy, Advanced sensor technology like SQUIDS, Pulsed Laser ablation, Magnetron Sputtering and Plasma methods
- High Resolution Electron Microscopy, Secondary Ion Mass Spectroscopy and Atomic Force Microscopy, Electron Probe Microanalysis and Computational facilities for theoretical modeling studies
- Laser induced vaporization mass spectrometry, High temperature mass spectrometry, MALDI-TOFMS, Different types of Calorimetry and Differential Scanning Calorimetry, Supercritical Fluid Extraction Chromatography, IR spectroscopy, Neutron Activation Analysis, X-ray diffractometry, Thermal Expansion and Phase transition studies
- High temperature component testing facilities, In-sodium testing facility, Steam Generator Test Facility, Large components testing facility and Boron enrichment plant
- Shake Table for seismic simulations, Core Disruptive accident analysis, Design of major equipments and components for PFBR, Gas entrainment studies, Thermal Hydraulics and Structural Integrity assessment(experimental and theoretical)
- Development of Full Scope, Replica type PFBR Operator Training Simulator, providing & management of Computing & Data Communication Facilities, Design & Development of Electronic Instrumentation & Control systems for Nuclear Reactors
- Nuclear counting facility, Thermo Luminescent Dosimetry (TLD) facility, Radon laboratory, Aerosol Transport Facility, ECR X-ray source and ESR spectrometer, Gamma scanning facility, Bubble detectors, Automated Metaphase finder, fluorescent light microscope, inverted phase contrast microscope, PCR machine and electrophoresis apparatus for bio-dosimetry, Core Catcher and Sodium fire experimental facility.

RRCAT

- Synchrotron radiation source Indus-1, a 450 MeV, 100 mA electron storage ring emitting radiation from mid-IR to soft x-ray, with 4 beam-lines for carrying out research activity on various kinds of materials.
- Synchrotron radiation source Indus-2, a 2.5 GeV, 150 mA, electron storage ring emitting radiation from its bending magnets covering soft and hard x-ray regions. Twelve beam-lines have been commissioned in Indus-2 and several others are in advanced stages of development and commissioning.
- Facilities for the study of structure and morphology of materials using state-of -the-art X-ray diffractometer, electron-microscopes and atomic force microscopes.
- Various lasers and laser based state-of-the-art experimental facilities for research in front line areas of laser plasma interaction, laser-based charge particle acceleration, laser cooling and trapping of the atoms, non-linear optics, ultrafast dynamics, laser materials processing, laser fluorescence spectroscopy of tissues, effects of narrow band width of light on cells and animal models, imaging through turbid media, laser micromanipulation of microscopic objects etc.
- Facilities for the growth of single crystals of materials using solution, flux, melt and optical floating zone techniques, and characterization of single crystals using X-ray diffraction, FTIR, DSC, TG-DTA, polarizing light microscope, optical interferometers, thermo-luminescence, impedance analyzer etc.
- Facilities for the growth of low dimensional structures (thin film, multi-layers, quantum wells, quantum dots etc.) using MOVPE, Laser ablation, Atomic layer deposition, e-beam evaporation, ion-beam sputtering and magnetron sputtering techniques, and their characterization with electrical, optical and structural studies.
- Facilities for synthesis and characterization of magnetic materials for high frequency and microwave applications.
- Facilities for measuring electrical, thermal, magnetic and mechanical properties of materials in the environment of low temperature and high magnetic field.

VECC

Variable Energy Cyclotron, Charged particle detector array (Si -Strip,CsI(Tl) detectors), High energy gamma detector array of BaF2 detectors(LAMDA),

MWPC type fission detectors, Ionisation chambers, Time of flight type of neutron detectors (organic scintillators), segmented HPGe detectors, Gaseous detector development facility: gas mixing units, X-ray generator to test the detector, semi-clean room and laminar flow tables for local clean regions, facility for development of GEM chambers, single gap and multi-gap resistive plate chambers, General detector development facility and readout systems for scintillator and other type of detectors., Grid computing facility, INO prototype laboratory for cosmic muon detection using RPCs, Nuclear electronics laboratory, ECR ion-source based ion implantation facility for materials science, RFQ linac for high energy ion implantation, Positron annihilation lifetime spectroscopy, Coincidence Doppler broadening of electron positron annihilation spectroscopy, Vibration free temperature dependent Mossbauer spectroscopy, Temperature dependent (300 K to 6 K) four probe resistivity measurement facility, Atomic Force Microscope and Secondary Electron Microscope for structural studies in materials, Isotope Separator On Line (ISOL) and Laser optics set-up for beta-stable and radioactive ion beams, Wide angle X-ray diffractometer (with high temperature stage up to 1600^{O}C), Grazing Incidence X-Ray Diffractometer (with High temperature up to 1500^{o}C and low temp upto LN2 temperature, Field Emission Scanning Electron Microscope (with EDX,WDX and EBSD facilities), Vibrating Sample Magnetometer (9 tesla) (for measuring resistivity, Ac susceptibility, sp. heat etc.), High temperature thermal diffusivity (laser flash technique) setup (upto 900^{O}C), Simultaneous thermal analyzer (TG/DSC up to 1200^{O}C) and DSC up to 725^{O}C), Electrochemical set up with cyclic voltammetry and electrodeposition, P-E loop analyser with piezoelectric measurement, Dielectric measurement set up, Universal testing Machine for stress-strain studies, Spin Coater and dip coater for thin film deposition, Ball-mill apparatus for fine particle preparation, Metallurgical microscopes, Programmable temperature controlled furnaces- a) Box type up to 1700 deg. C and b) tubular type up to 1200 deg. C, Sample preparation units such as Diamond wheel cutter, Automatic fine polishing machine and Electro polishing machine, Facility of low energy ion irradiation providing various ions of keV energy, High current ion source beam transport system, The gamma detector facility with several Clovers, single crystal HPGe, LEPS and scintillator detectors, Target Laboratory, Liquid helium facility, Cryogenic Penning trap facility, High efficiency (80%) HPGe detector, Electronics circuit test setup under cryogenic condition, A room temperature magnet operating at 0.24 Tesla.

IPR

- ADITYA tokamak with plasma duration of more than 100 ms, and advanced plasma diagnostics, large volume UHV system and large electromagnets producing more than 1 T field;
- SST-1 tokamak, with superconducting magnets having 3 Tesla field, plasma duration of few 100 ms at discharge currents of more than 70 kA, large super conducting magnets producing 2T field for more than 15,000 sec, two phase helium cooling for the first time globally;
- High heat flux testing facilities, electron beam irradiation facilities, gleeble facilities;
- Optical, far infrared and microwave characterization facilities, bolometer, magnetic and Langmuir probes, etc. ;
- Facilities for the study of structure and morphology of materials using state-of -the-art X-ray diffractometer, electron-microscopes, FTIR and atomic force microscopes;
- Laser based experimental facilities for research in front line areas of laser plasma interaction, expansion of plasma plume in vacuum and at high pressures, fast imaging;
- High power radiofrequency sources to the tune of 1.5 MW at frequencies ranging from MHz to GHz. High power waveguides, transmission lines, VNA, high voltage power supplies, etc.
- Plasma pyrolysis, Nitriding, torches, ion-beam sputtering and magnetron sputtering techniques, multilayered coatings, and their characterization with electrical, optical and structural studies;
- Facilities for synthesis and characterization of superconducting magnetic materials for high current applications, prototype production of large volume magnets, superconducting conductors carrying more than 30,000 A indigenously developed;
- Development of special steel IN-RAFM for use in Test Blanket Modules for ITER in collaboration with IGCAR, BARC and MIDHANI;
- Facilities for measuring electrical, thermal, magnetic and mechanical properties of materials in the environment of low temperature and high magnetic field;
- Liquid metal MHD facilities, erosion studies of material at high temperature in contact with flowing liquid;
- Large Volume Plasma Device, Basic Experiments in Toroidal Geometry, Free electron laser, non-neutral plasma, and dusty plasma facilities.

SINP

Apart from CRAY supercomputer for high end computations, SINP has several modern experimental facilities:

- Transmission electron microscope, Scanning electron microscope, HRSEM
- Molecular beam epitaxy, Metal organic vapour phase epitaxy & Nanocluster deposition system
- Langmuir Blodgett trough
- Magnetron sputtering unit
- Surface magneto-optic Kerr effect setup
- Cross sectional TEM sample preparation unit
- SQUID magnetometer
- Pulsed laser deposition system
- Pulsed NMR spectrometer
- MALDI ToF/ToF mass spectrometry
- Confocal imaging
- Single molecule FRET imaging
- NSOM-AFM-Confocal
- TSFZ image furnace
- Laser flash photolysis, Time correlated single photon counting
- XPS
- Flow cytometry
- SPM-cum-Triboscope
- Precision etching and coating system

IoP

Ion Beam Facilities: 3.0 MV Pelletron Accelerator, with beam lines for RBS/Channeling, ERDA, PIXE, Implantation, AMS, as well as Surface science beamline, micro PIXE, 50 keV Low Energy Ion implanter – SNICS ion source, Focused Ion Beam (FIB).

Microscopy Facilities: Transmission Electron Microscope, Scanning Probe Microscopes, Atomic Force Microscope

Spectroscopy Facilities: X-Ray photoelectron Spectroscopy, Angle Resolved UPS, Photoluminescence, Spectrophotometer, Micro-Raman System.

Magnetic Characterization: SQUID–VSM based MPMS System

Thin Film Growth Facilities: CVD set-up, HV thin film deposition unit, UHV e-beam evaporation, DC/RF magnetron sputtering, Molecular Beam Epitaxy (MBE),Pulsed laser deposition unit, Langmuir Boldgett, Cluster Deposition Facility

X-ray Based Analyzing Methods: Grazing Angle X-ray Diffractometer (GAXRD), Powder Diffractometer (Bruker-make), High-resolution XRD system, X-ray Reflectometry and X-ray Standing wave facility, X-ray Fluorescence set-up
Other Facilities: Chemical Labs, Furnaces, Surface Profilometer, Cyclic Voltameter set-up, Low energy Ion Milling Station, Probe-station, Transport Facilities , Spectral Response Set-up, Physical Property Measurement System (PPMS).

IoP(NISER)

IoP(NISER) has extensive experimental facilities for routine experiments by students and also for research. Its School of Physical Sciences has a laboratory for magnetism and magnetic materials, a thin film laboratory, a non-linear optics laboratory, an ultra-cold atom laboratory, and experimental facilities for open-ended higher semester teaching. School of biological sciences has facilities like animal cell culture facility, fly facility, plant facility, animal facility, confocal facility, microarray and genomics and proteomics facility. School of chemical sciences has 400 MHz FT NMR with 5 mm multi-nuclear observe probe head, low and high temperature facility. It has also FTIR, UV-Vis, UV-Vis-NIR, Fluorescence spectrometer and a single crystal X-ray diffractometer.

HRI & IMSc

At HRI & IMSc, the research facility is essentially the Library and Computers. The library details are given in section 4.2 while the computer system details are given in section 4.3. High performance computers comprise a diverse mix of computing and data resources and allow research scholars and faculty members to maximize their individual research resources. Both the library and the computational facilities are continuously upgraded. All research scholars, research associates and most but not all (subject to availability) post-doctoral fellows and summer students are provided residential facilities with internet access.

TMC

TMC has a hospital located at Parel called Tata Memorial Hospital (TMH) and a research centre (ACTREC) located at Kharghar.

TMH, Parel

At TMH has well equipped Biochemistry, Pathology, Micro-biology, Molecular Pathology, Haemotology, Cytology, Immunology laboratories and in addition it has a cancer Research Secretariat having (1) Institutional Review Board (IRB), (2) Ethical Committee, and (3) a Hospital Scientific Advisory Committee for carrying out clinical trials under Indian Council of Medical Research (ICMR) and Drug Controller General of India (DCGI) guidelines.

ACTREC, Kharghar

Each of the Principal Investigators at ACTREC have their own full-fledged research labs equipped with most of the molecular biology, protein chemistry related equipments (For example, centrifuges, incubators, gel electrophoresis apparatus, freezers etc) and tissue culture facility. The manpower of each lab includes, besides the Principal Investigator, scientific and technical staff, graduate students registered for the Ph.D. degree in Life Sciences, short term trainees and staff employed on projects funded by external funding agencies like DBT, ICMR.

The centre also maintains vital research support facilities like Common Instrument rooms containing high end equipment such as ultracentrifuges, gel documentation equipment, ELISA readers. Common Facilities like Glassware washing facility, Radioisotope room, Bacteriology room, Dark room for autoradiography, Milli Q water plants, Ice Making machines, are also available. Besides, Laboratory Animal Facility for work involving experimental animals, Biorepository of tumor tissues required for research, Anti Cancer Drug Screening facility for in vitro and in vivo testing of plant extracts, drug formulations. Other common facilities include Digital Imaging facility containing high end optical, phase contrast, confocal microscopes, Electron Microscopy facility, Bioinformatics (BTIS) facility for advanced data analysis, Library with journals on cancer, oncology and life sciences, DNA sequencing facility, Flow cytometry facility for DNA ploidy, cell cycle analysis, Histology facility, Mass spectrometry, X-ray Crystallography, PET-CT and luminescence based Small animal imaging

3.3 Research Publications and Awards

3.3.1 Publications by the Institute

While the university doesn't publish any journal, CIs do publish newsletters and external and internal reports. External and internal reports are intended to record details of development jobs taken up by faculty and scientists and are a valuable tool for knowledge management. Frequency of publications of newsletter varies from CI to CI and lies between two to six.

3.3.2 Details of publications by the faculty

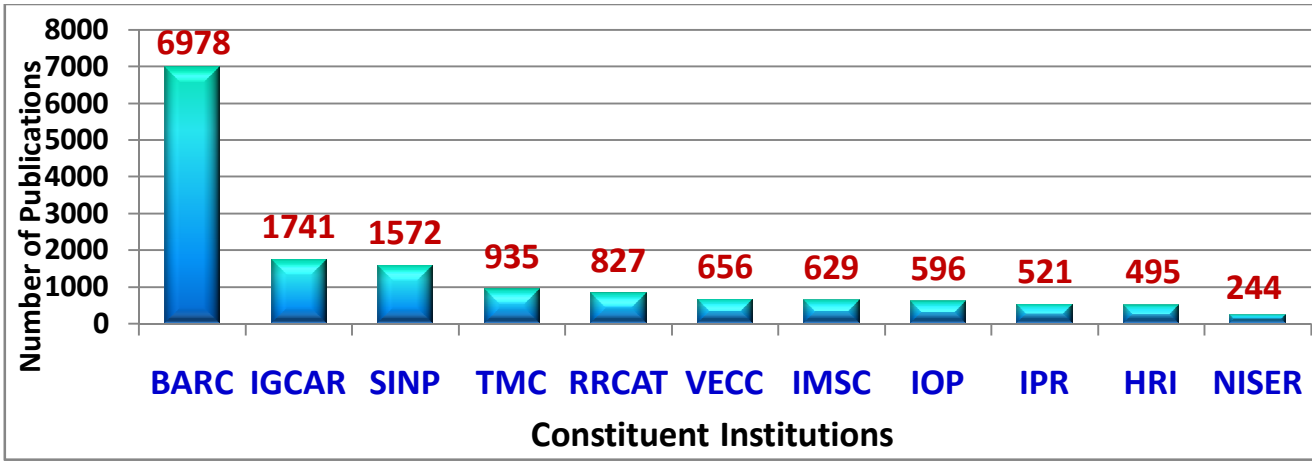
Papers in journals

CIs of HBNI are engaged in research and technology development. Indigenous nuclear technology capability is a testimony to the technological output of CIs. It is to be noted that while technologies related to generation of nuclear power and associated nuclear fuel cycle facilities have been deployed by the public sector companies and industrial units within the DAE, non-power related technologies have been transferred to entities outside of the DAE. Institutions of the DAE have

a well structured mechanism for transfer of technologies. It may be added that as per the section 20 of the Atomic Energy Act, 1962, inventions related to atomic energy are not patentable in India and accordingly CIs have not filed many patents.

Research output of CIs is impressive both in terms of total number of publications and citations thereof. Publications data was downloaded from the *Web of Science* (WoS) for the period of 2009-2013 during the last week of March, 2014[1]. A total of 15194 publications from CIs of HBNI and 71686 citations thereof during the period were downloaded. All the records were classified into 10 broad subject categories based on *WoS* Subject Categories. The following tables and bar chart give a summary of publication record of HBNI.

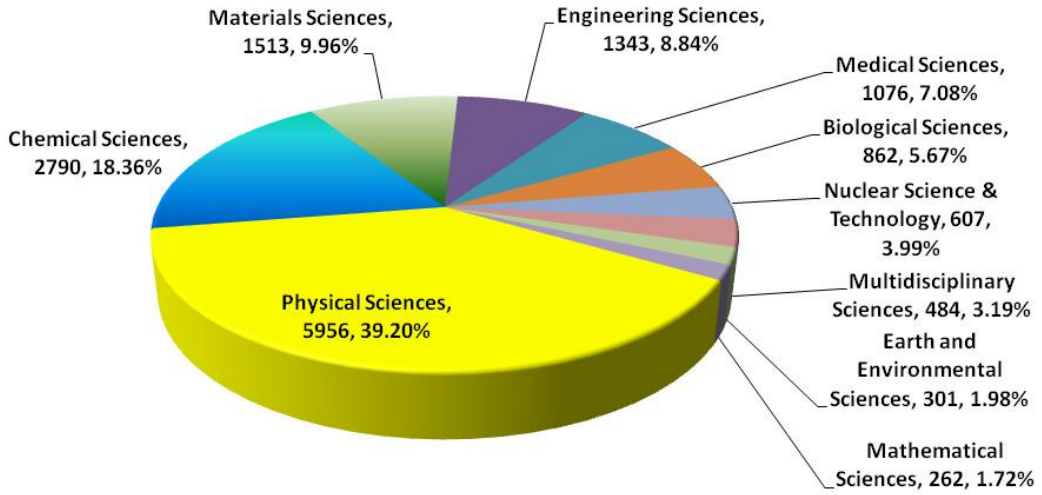
[1] Data compilation was done by Scientific Information Resource Division, BARC.



Sr. No.	Constituent Institution	TP	APY	TC	ACP	*h*-Index	AIF	IF Range (JCR 2012)
1.	BARC	6978	1395.60	30684	4.40	45	2.11	0.00 - 41.30
2.	IGCAR	1741	348.20	4964	2.85	22	1.51	0.00 - 09.74
3.	SINP	1572	314.40	10405	6.62	38	3.11	0.00 - 44.98
4.	TMC	935	187.00	5002	5.35	27	2.85	0.00 - 51.66
5.	RRCAT	827	165.40	2312	2.80	16	1.76	0.00 - 38.60
6.	VECC	656	131.20	5576	8.50	36	3.11	0.00 - 38.60
7.	IMSc	629	125.80	2403	3.82	23	2.39	0.00 - 44.98
8.	IoP	596	119.20	4826	8.10	33	3.33	0.00 - 38.60
9.	IPR	521	104.20	1193	2.29	11	1.54	0.00 - 09.74
10.	HRI	495	99.00	3480	7.03	26	3.77	0.00 - 22.93
11.	IoP(NISER)	244	48.80	841	3.45	13	3.72	0.00 - 35.75
Total		15194	3038.80	71686	4.72	-	2.34	-

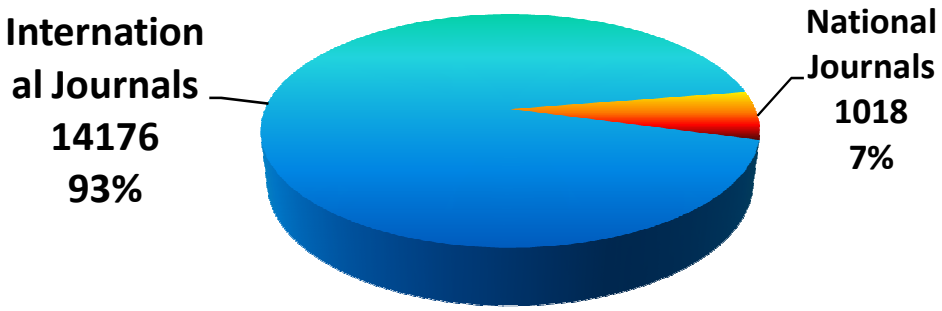
TP=Total Publications; APY=Average Publications per Year; TC=Total Citations; ACP=Average Citations per Publication; AIF=Average Impact Factor per Publication; JCR=Journal Citations Report

Subject-wise Distribution of Publications of for the period 2009-2013



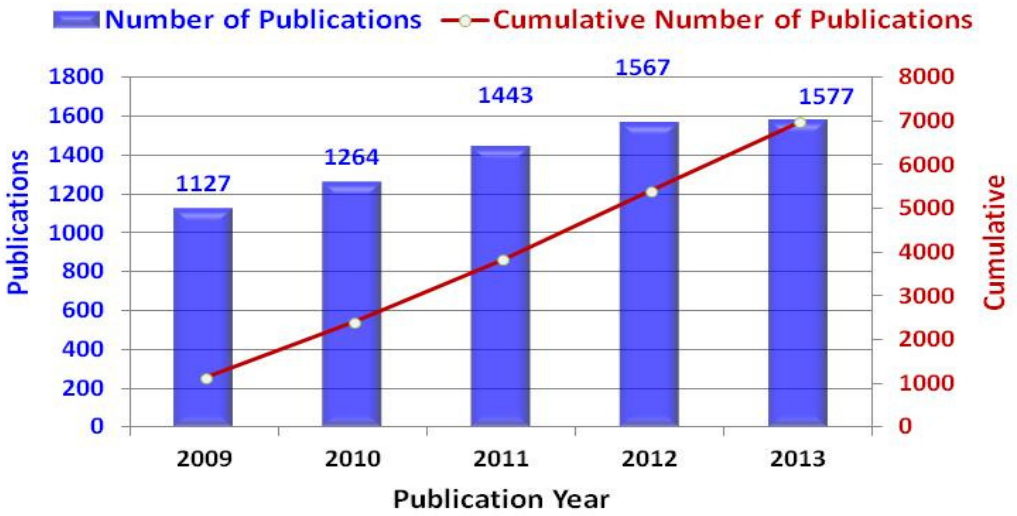
Subjects	TP	% of TP	TC	ACP	AIF	IF Range (JCR-2012)
Physical Sciences	5956	39.20	36340	6.10	2.88	00.00 - 44.98
Chemical Sciences	2790	18.36	12302	4.41	2.43	00.00 - 41.30
Materials Sciences	1513	9.96	4268	2.82	1.39	00.00 - 23.19
Engineering Sciences	1343	8.84	4998	3.72	1.48	00.00 - 07.71
Medical Sciences	1076	7.08	5023	4.67	2.61	00.00 - 51.66
Biological Sciences	862	5.67	4123	4.78	2.68	00.00 - 31.96
Nuclear Science & Technology	607	3.99	921	1.52	0.68	00.00 - 01.03
Multidisciplinary Sciences	484	3.19	2694	5.57	2.68	00.00 - 38.60
Earth and Environmental Sciences	301	1.98	742	2.47	1.47	00.00 - 04.74
Mathematical Sciences	262	1.72	275	1.05	0.64	00.00 - 02.98
Total	15194	100%	71686.00	4.72	2.34	00.00 - 51.66

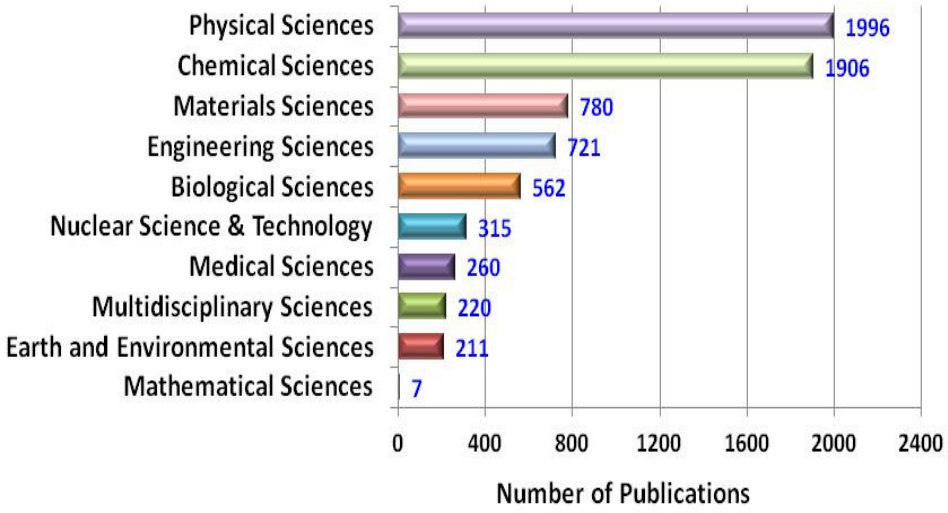
Publications in national and international journals for the period 2009-2013



CI	Publications in				Total
	National Journals	%age	International Journals	%	
BARC	384	5.50	6594	94.50	6978
HRI	28	5.66	467	94.34	495
IGCAR	115	6.61	1626	93.39	1741
IMSC	50	7.95	579	92.05	629
IOP	29	4.87	567	95.13	596
IPR	21	4.03	500	95.97	521
IoP(NISER)	7	2.87	237	97.13	244
RRCAT	63	7.62	764	92.38	827
SINP	58	3.69	1514	96.31	1572
TMC	230	24.60	705	75.40	935
VECC	33	5.03	623	94.97	656
Total	1018	6.70	14176	93.30	15194

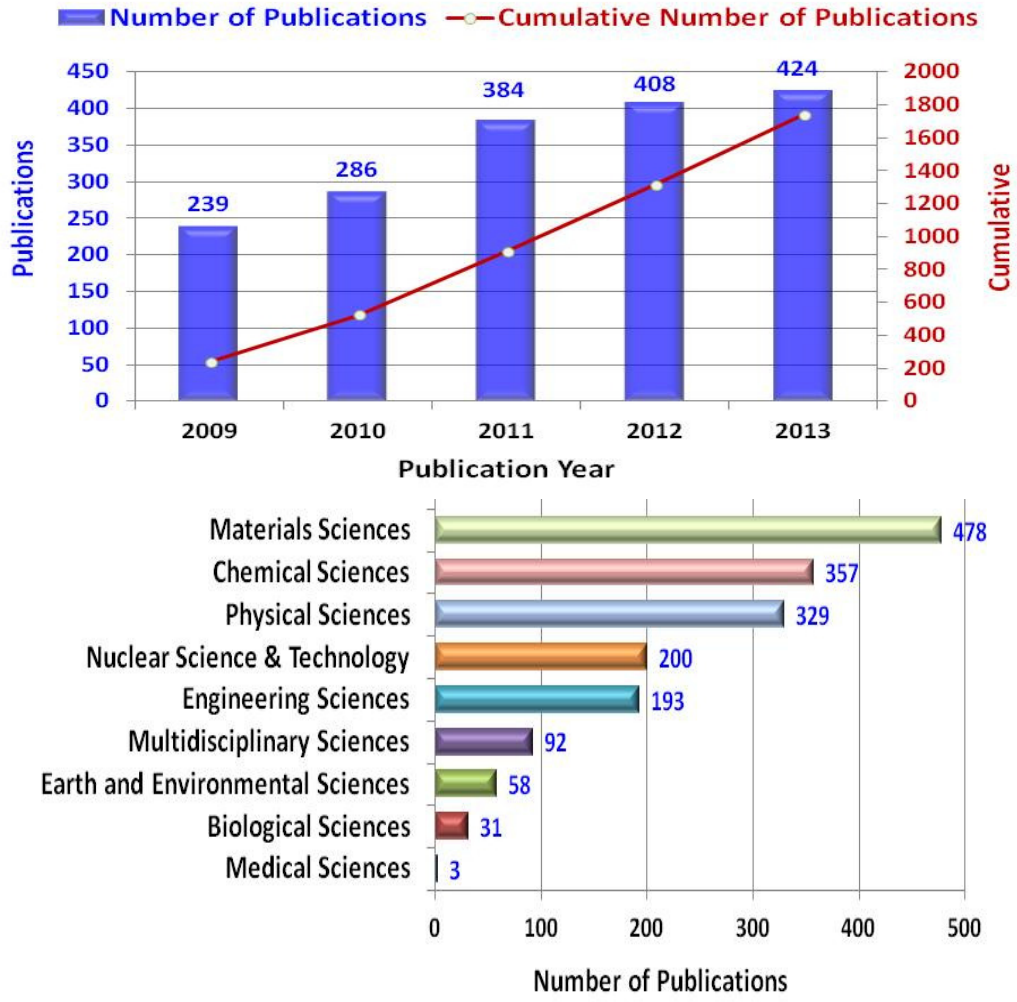
Bhabha Atomic Research Centre





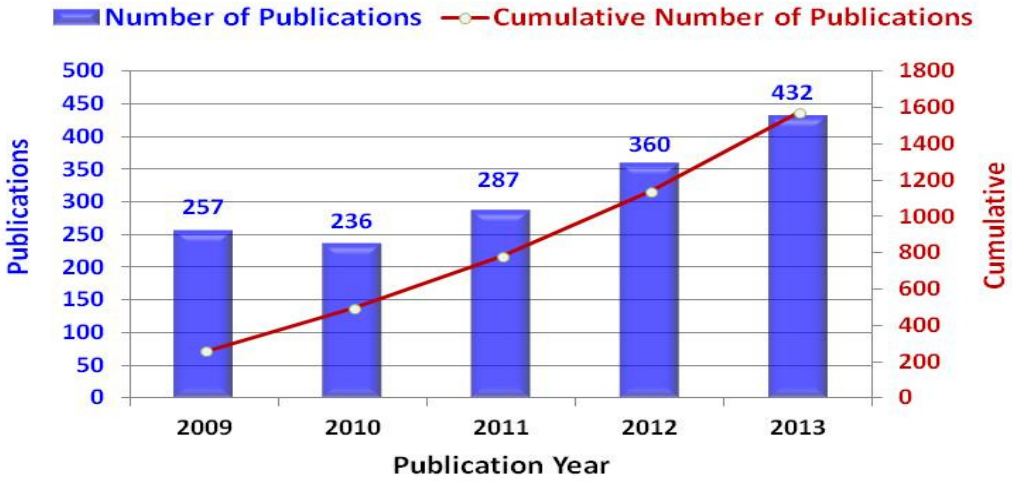
Subjects	IF Range (JCR 2012)	ACP
Biological Sciences	00.00 - 22.49	4.64
Chemical Sciences	00.00 - 41.30	4.76
Earth and Environmental Sciences	00.00 - 04.35	2.38
Engineering Sciences	00.00 - 07.71	4.40
Materials Sciences	00.00 - 07.48	2.92
Mathematical Sciences	00.36 - 02.77	1.43
Medical Sciences	00.00 - 15.03	4.55
Multidisciplinary Sciences	00.00 - 31.03	4.13
Nuclear Science & Technology	00.00 - 01.03	1.49
Physical Sciences	00.00 - 07.94	5.25

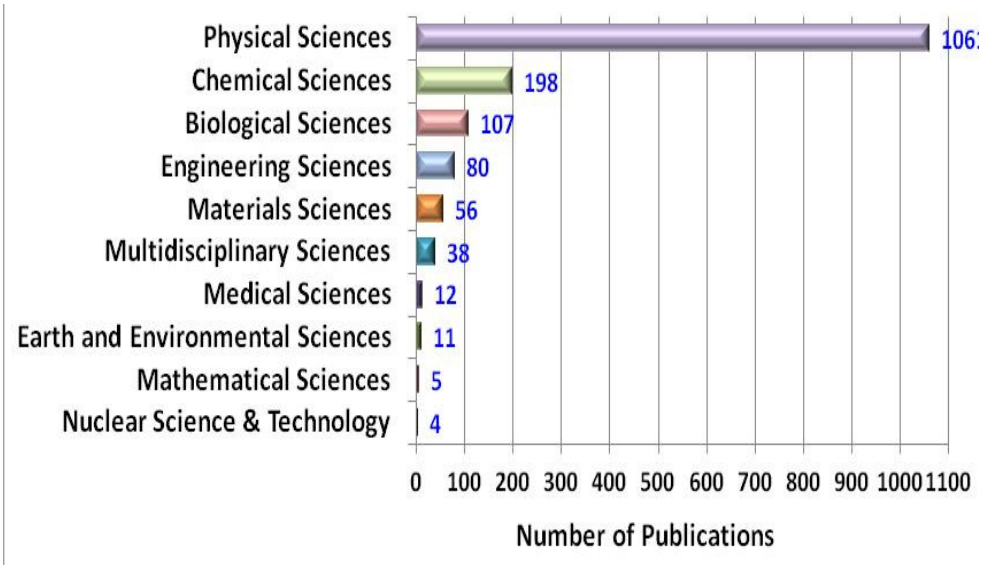
Indira Gandhi Centre for Atomic Research



Subjects	IF Range (JCR 2012)	ACP
Biological Sciences	00.00 - 05.44	1.84
Chemical Sciences	00.00 - 06.17	3.27
Earth and Environmental Sciences	00.00 - 03.33	2.74
Engineering Sciences	00.00 - 05.17	2.75
Materials Sciences	00.00 - 03.94	2.62
Medical Sciences	00.40 - 02.25	2.67
Multidisciplinary Sciences	00.00 - 09.74	4.98
Nuclear Science & Technology	00.00 - 01.03	1.37
Physical Sciences	00.00 - 03.79	3.22

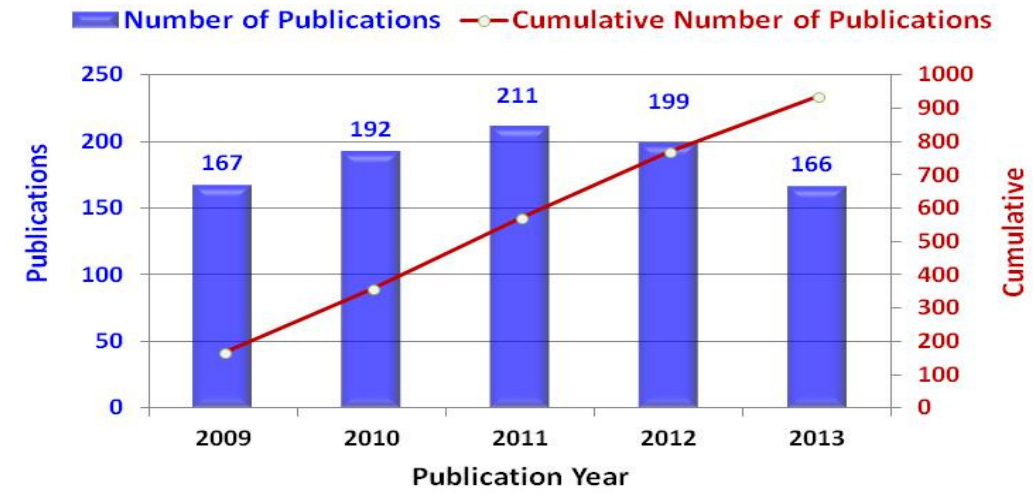
Saha Institute of Nuclear Physics

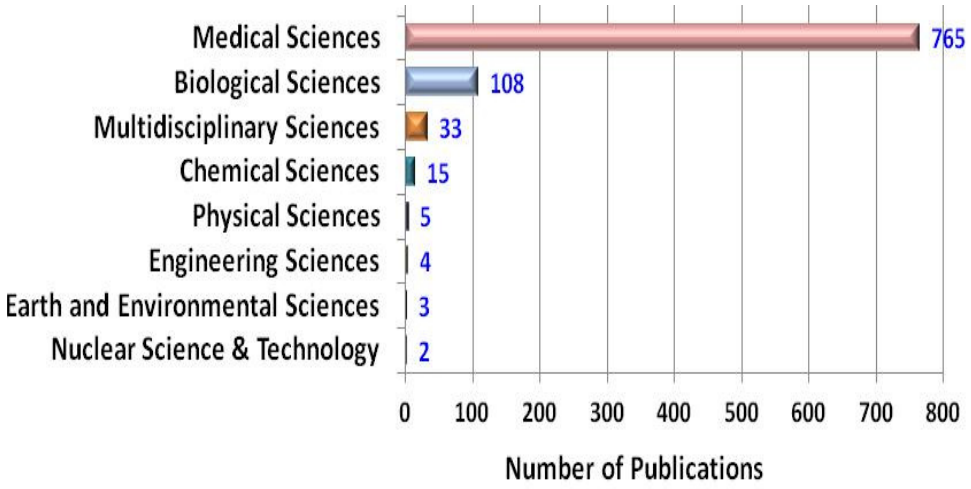




Subjects	IF Range (JCR 2012)	ACP
Biological Sciences	00.00 - 14.10	4.33
Chemical Sciences	00.00 - 12.06	3.36
Earth and Environmental Sciences	00.00 - 02.38	2.36
Engineering Sciences	00.00 - 03.93	3.19
Materials Sciences	00.00 - 03.84	2.79
Mathematical Sciences	01.17 - 02.98	5.00
Medical Sciences	01.22 - 05.61	6.25
Multidisciplinary Sciences	00.00 - 05.01	2.74
Nuclear Science & Technology	00.86 - 00.86	3.25
Physical Sciences	00.00 - 44.98	8.13

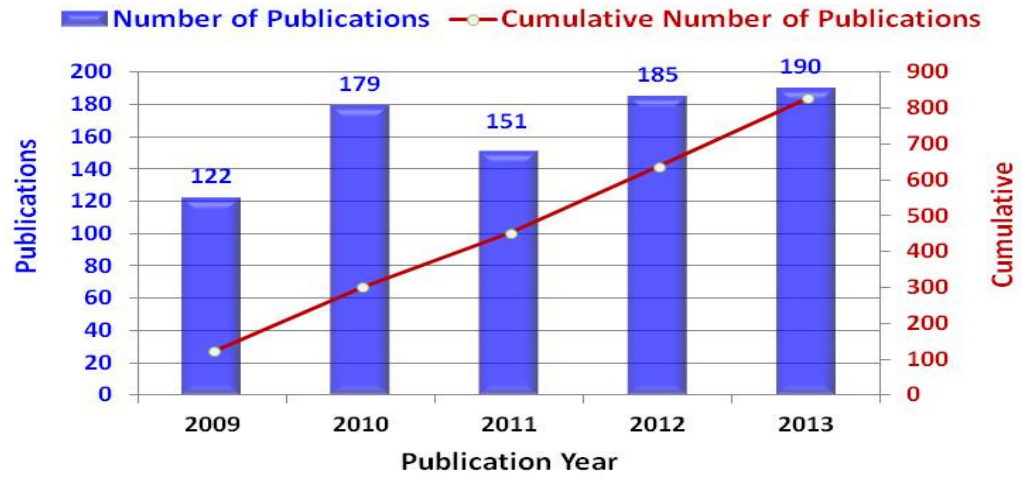
Tata Memorial Centre

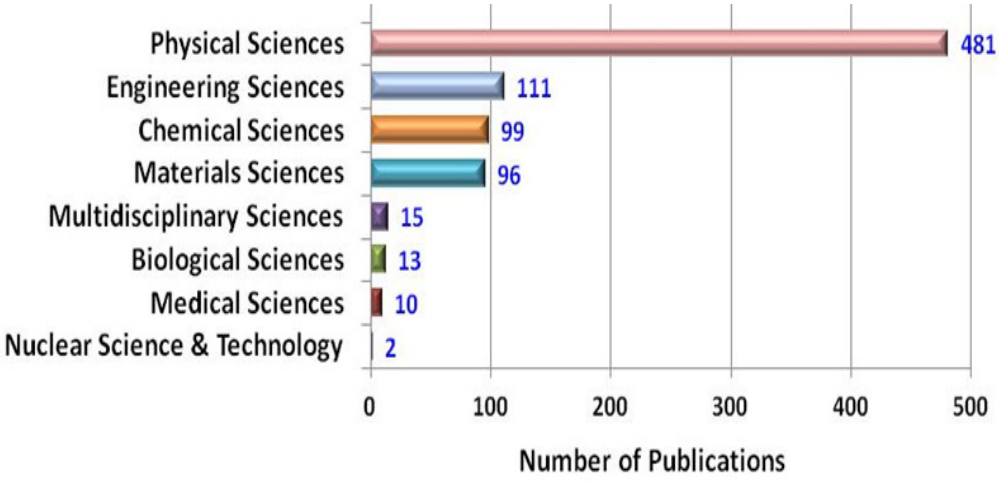




Subjects	IF Range (JCR 2012)	ACP
Biological Sciences	00.00 - 31.96	6.70
Chemical Sciences	00.79 - 04.74	3.47
Earth and Environmental Sciences	01.31 - 03.50	3.67
Engineering Sciences	01.66 - 07.60	7.75
Medical Sciences	00.00 - 51.66	4.67
Multidisciplinary Sciences	00.87 - 38.60	17.85
Nuclear Science & Technology	00.86 - 00.86	2.00
Physical Sciences	00.63 - 02.56	3.20

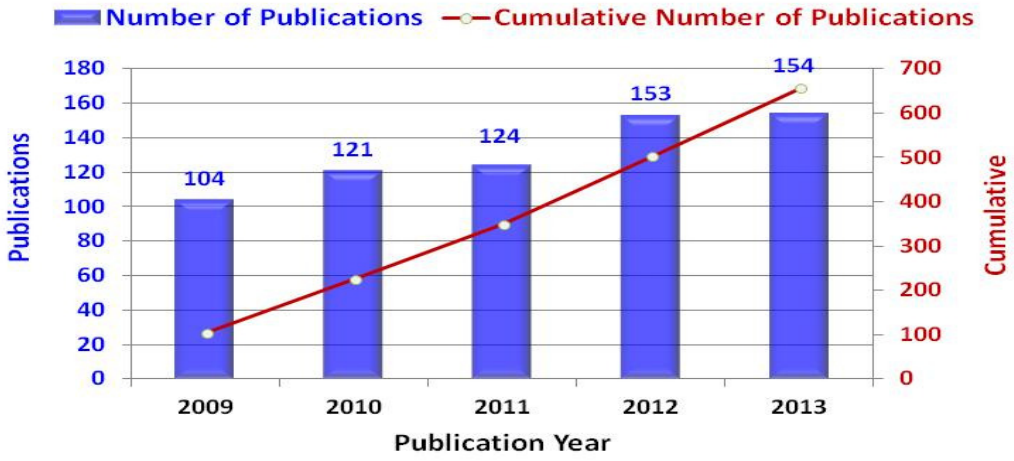
Raja Ramanna Centre for Advanced Technology

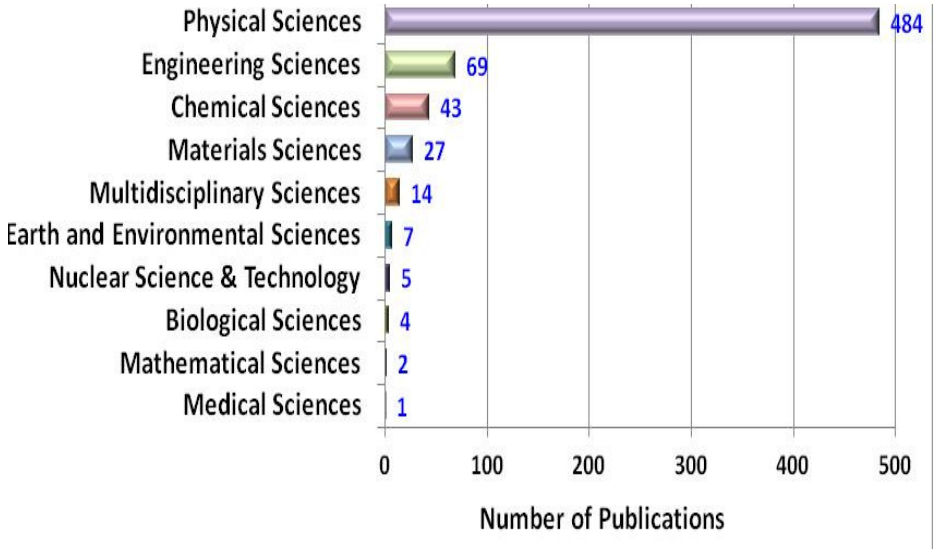




Subjects	IF Range (JCR 2012)	ACP
Biological Sciences	01.12 - 03.11	7.00
Chemical Sciences	00.25 - 04.81	3.81
Engineering Sciences	00.00 - 05.17	2.12
Materials Sciences	00.00 - 03.84	2.84
Medical Sciences	00.76 - 03.88	4.40
Multidisciplinary Sciences	00.00 - 02.11	2.40
Nuclear Science & Technology	00.00 - 00.50	1.50
Physical Sciences	00.00 - 27.25	2.60

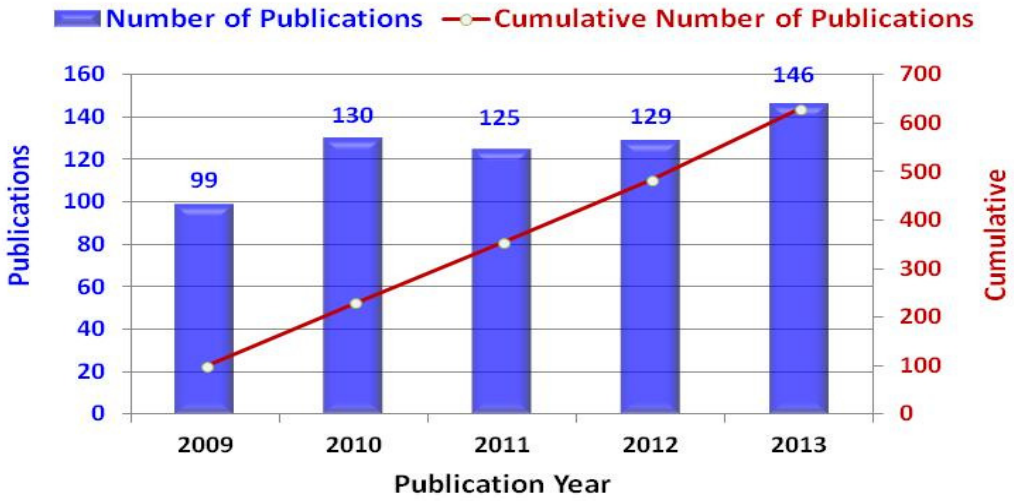
Variable Energy Cyclotron Centre

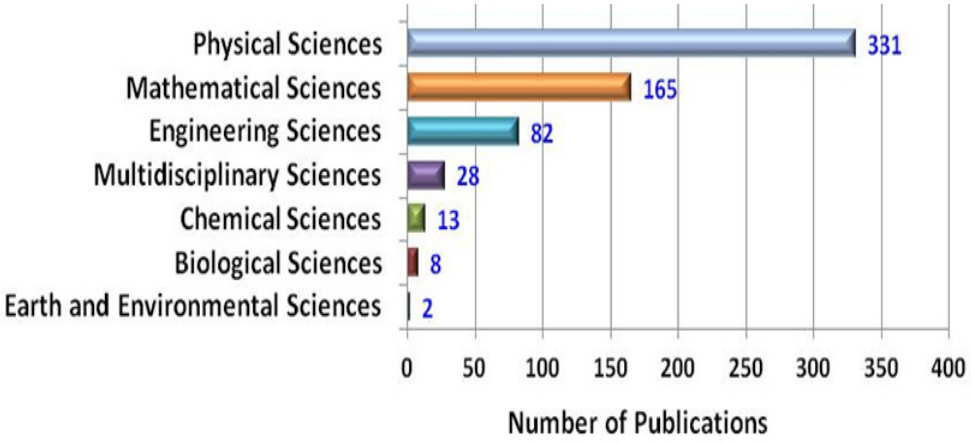




Subjects	IF Range (JCR 2012)	ACP
Biological Sciences	01.24 - 04.10	0.25
Chemical Sciences	00.25 - 04.19	4.86
Earth and Environmental Sciences	00.35 - 02.38	2.57
Engineering Sciences	00.00 - 04.66	3.13
Materials Sciences	00.00 - 23.19	5.48
Mathematical Sciences	00.36 - 01.25	1.50
Medical Sciences	01.78 - 01.78	3.00
Multidisciplinary Sciences	00.91 - 38.60	11.29
Nuclear Science & Technology	00.00 - 00.86	2.80
Physical Sciences	00.00 - 07.94	9.93

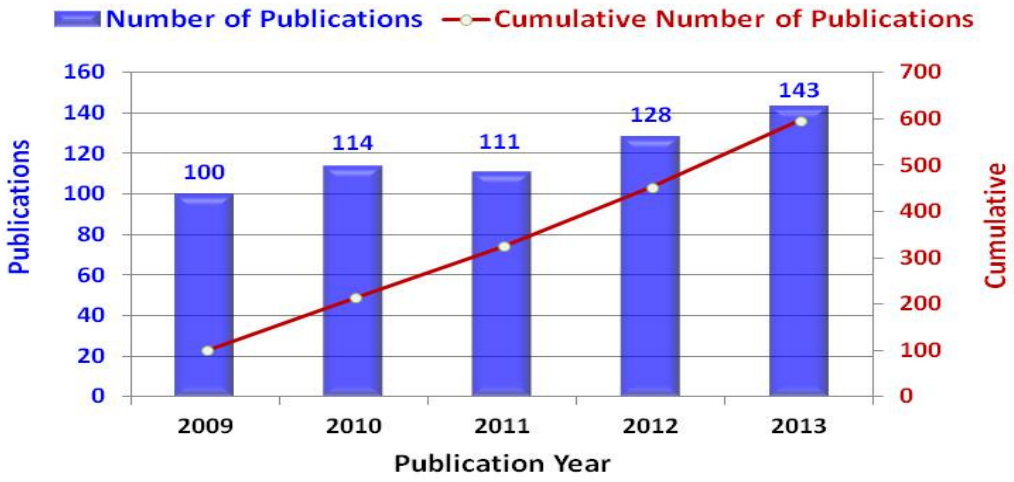
The Institute of Mathematical Sciences

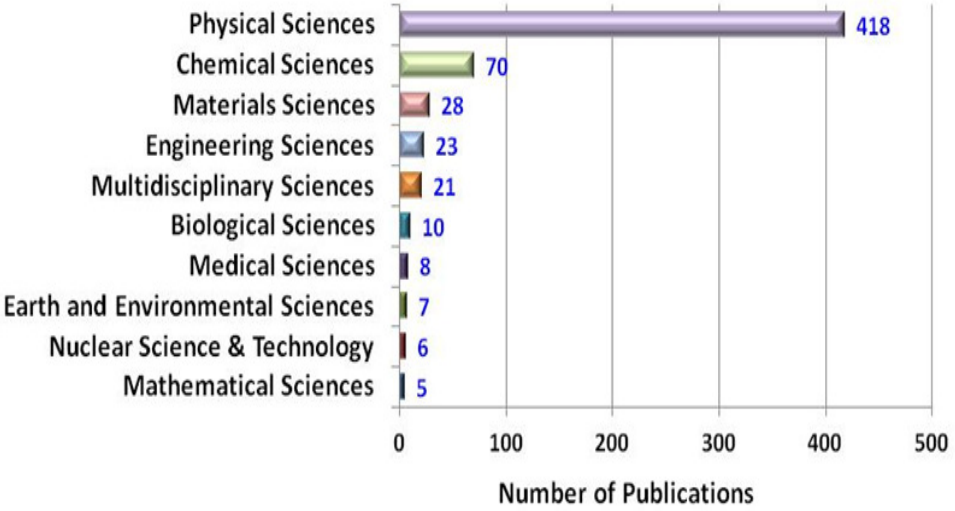




Subjects	IF Range (JCR 2012)	ACP
Biological Sciences	02.02 - 05.37	2.75
Chemical Sciences	01.82 - 20.83	7.77
Earth and Environmental Sciences	01.64 - 02.88	2.50
Engineering Sciences	00.00 - 0.214	2.38
Mathematical Sciences	00.00 - 02.77	1.01
Multidisciplinary Sciences	00.00 - 31.03	7.00
Physical Sciences	00.00 - 44.98	5.19

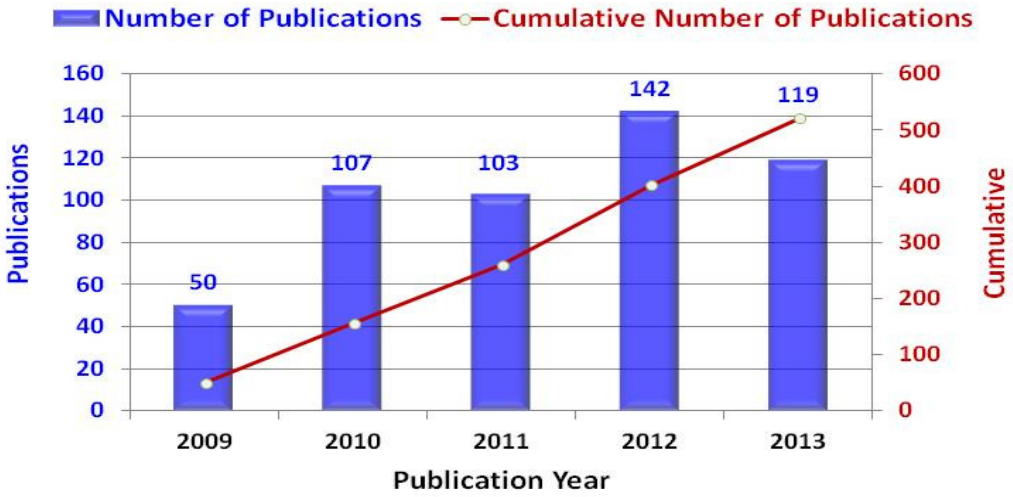
Institute of Physics

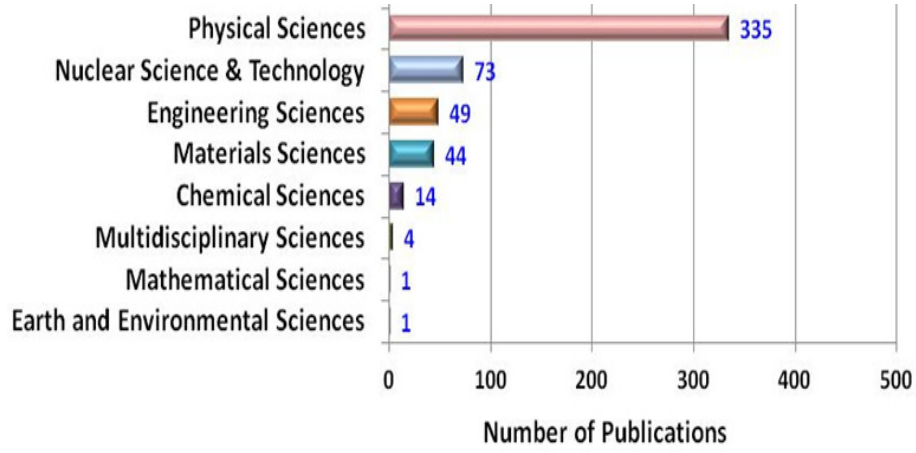




Subjects	IF Range (JCR 2012)	ACP
Biological Sciences	01.36 - 05.44	5.30
Chemical Sciences	00.00 - 20.83	3.57
Earth and Environmental Sciences	00.70 - 03.15	2.43
Engineering Sciences	00.00 - 02.07	6.17
Materials Sciences	00.00 - 02.07	2.36
Mathematical Sciences	00.43 - 01.35	0.60
Medical Sciences	02.56 - 05.22	6.63
Multidisciplinary Sciences	00.00 - 38.60	6.24
Nuclear Science & Technology	00.50 - 00.50	1.00
Physical Sciences	00.00 - 07.94	9.82

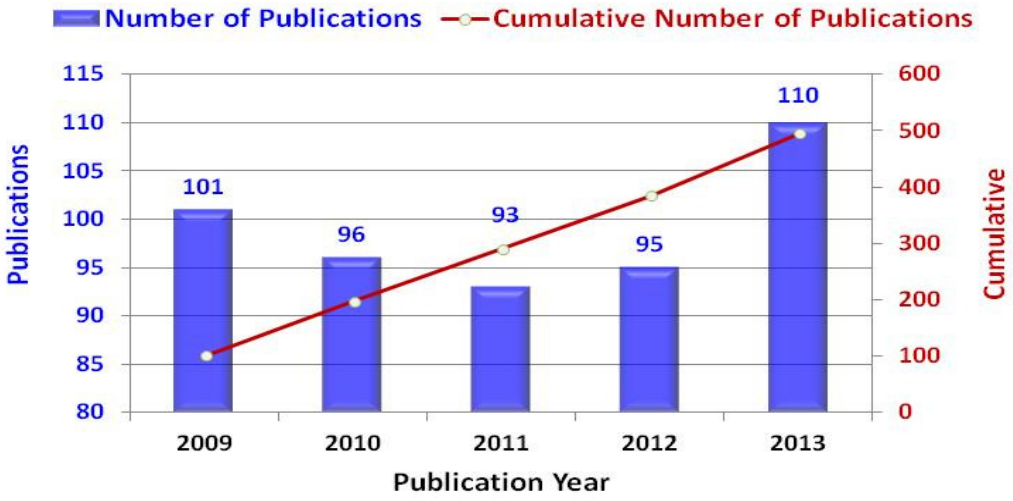
Institute for Plasma Research

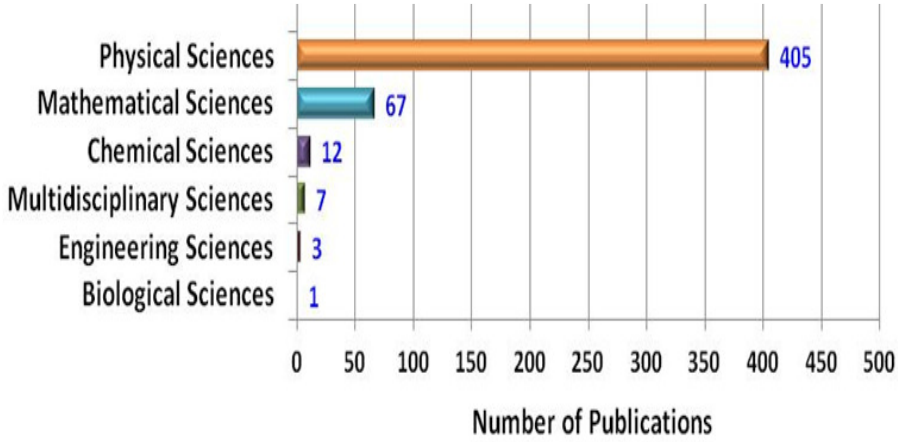




Subjects	IF Range (JCR 2012)	ACP
Chemical Sciences	01.15 - 03.34	2.64
Earth and Environmental Sciences	02.55 - 02.55	2.00
Engineering Sciences	00.00 - 02.33	1.73
Materials Sciences	00.00 - 03.94	1.57
Mathematical Sciences	02.77 - 02.77	1.00
Multidisciplinary Sciences	01.35 - 09.74	3.25
Nuclear Science & Technology	00.52 - 01.00	1.90
Physical Sciences	00.00 - 07.94	2.53

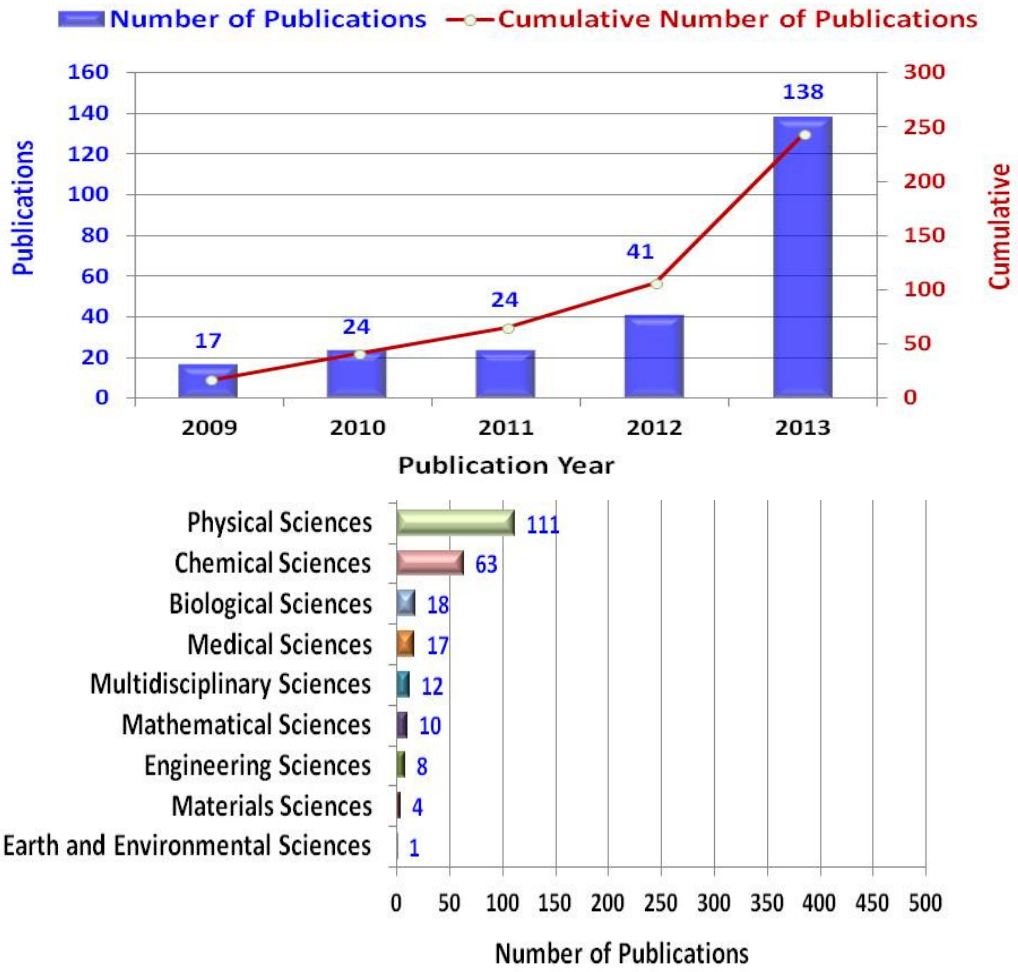
Harish-Chandra Research Institute





Subjects	IF Range (JCR 2012)	ACP
Biological Sciences	00.00 - 00.00	0.00
Chemical Sciences	01.96 - 21.76	9.33
Engineering Sciences	01.65 - 03.08	38.67
Mathematical Sciences	00.00 - 01.39	0.87
Multidisciplinary Sciences	00.00 - 09.74	5.00
Physical Sciences	00.00 - 22.93	7.80

Institute of Physics (National Institute of Science Education and Research)



Subjects	IF Range (JCR 2012)	ACP
Biological Sciences	01.51 - 05.88	5.78
Chemical Sciences	00.00 - 35.75	4.16
Earth and Environmental Sciences	04.74 - 04.74	2.00
Engineering Sciences	00.00 - 02.56	2.25
Materials Sciences	00.00 - 01.83	7.25
Mathematical Sciences	00.70 - 01.35	0.80
Medical Sciences	00.36 - 05.61	4.88
Multidisciplinary Sciences	00.00 - 31.03	5.50
Physical Sciences	00.00 - 07.94	2.42

Monographs, Books and chapters in books
Please see Appendix 2

3.3.3 Details of Involvement of faculty in editorial boards of journals; professional societies, important academic, scientific and policy making forums; and organization of conferences

Please see Appendix 3

3.3.4 Details of research awards

Details of national and international recognition received by the faculty are given in Appendix 1 and awards received by students in Appendix 4.

3.3.5 Research degrees guided by the faculty at the Institute

Research based degree programmes or degree programmes involving writing a thesis consist of Ph.D., M.Tech., M.Phil., M.Sc.(Engg), MD, DM, and MCh. A total of 321 students have completed doctoral research up to March 2014. University has sent all open category theses to INFLIBNET. Above 1600 students are enrolled for doctoral research.

In addition 8 students have completed M.Phil., 586 students have completed M.Tech., 23 students have completed M.Sc.(Engg) and more than 106 have completed post-graduate medical degrees.

3.3.6 Policy to check malpractices and plagiarism in research

Adhering to highest ethical standards is one of the guiding values of the Institute. Every complaint of malpractice or plagiarism received is investigated and appropriate action is taken. So far two complaints have been received and details follow.

One complaint was received from a faculty member and on checking it was found to be a case of not acknowledging the concerned faculty in the thesis. It was not a case of plagiarism, but of not showing courtesy to an ex-guide.

In another complaint, on investigation, it was found that permission of a colleague was not taken for including the content of a paper in the thesis. The student took post-facto permission and the case was resolved

3.3.7 Promotion of interdisciplinary research

Nuclear science and engineering is an inter-disciplinary subject and several research topics span more than one discipline. This is particularly so in engineering science and therefore, right in the beginning it was decided to club all branches of engineering under one umbrella viz., engineering science.

The Institute offers a unique Ph.D. programme where students are encouraged to work at the interface of basic research and technology development. Under this programme, they work under the guidance of two supervisors, one having strength in basic research and the other in technology development. An illustrative list of doctoral research completed or about to be completed is given at section 1.2.8.

There are often collaborative works involving different areas of physics, such as experimental and theoretical condensed matter physics, experimental condensed matter and biological systems, high energy theory and condensed matter theory (as well as experiments), high energy physics and nuclear physics, Bio-physics, physical chemistry, etc. Such cross-disciplinary works have led to novel insights and unexpected results. One such program at IoP is the program of "Laboratory Cosmology" wherein condensed matter experiments are used to probe and verify theories of early universe. Similarly, concepts from high energy theory, nuclear physics, and cosmology are used for astro-nuclear physics as well as heavy-ion experimental programs. There is a new inter-disciplinary area emerging where ideas from string theory are being used to investigate physics of condensed matter systems. The area of computer information is highly inter-disciplinary, bringing together researchers from mathematics, computer science, experimental condensed matter physics, as well as those working on foundations of quantum physics. The area of complex systems brings together many disciplines of physics together. The new era of biological physics involves applications of ideas of statistical physics to develop theoretical approaches to biological phenomena. A major thrust is in the area of surface and interface physics, nanoscience and nanotechnology. In this program, the nanostructures that are developed at IOP has been utilized as sensors, target substrates for detection of biological molecules and in energy materials, such as solar energy.

3.3.8 Research awards instituted by the Institute.

Awards have been instituted at DAE level. A very extensive awards scheme has been instituted by the DAE and includes the following awards.

- DAE Science Research Council Outstanding Investigator Award, open to all CIs. The award carries a grant of up to Rs 1 crore spread over a period of five years to pursue research on a project. The awardee gets an incentive of Rs 25,000 per year in addition to salary during the period of award.
- Prospective Research Fund to provide funding for projects undertaken by any of the faculty in any of the CIs to undertake research complimentary to major plan projects, to work on critical gap areas and for any futuristic

research.

- Lifetime achievement awards, Rs 10 lakhs, up to five wards every year, open to all CIs.
- Homi Bhabha Science and Technology awards, Rs 5 lakhs, up to nine awards every year, age limit 50 years, only for R&D centres.
- Scientific and Technical Excellence Awards, Rs one lakh each, up to 50 awards every year, no age limit, only for R&D centres.
- Young scientist awards, Rs 50,000 each, up to 46 awards every year, age limit 35 years, only for R&D centres.
- Young engineer awards, Rs 50,000 each, up to 46 awards every year, age limit 35 years, only for R&D centres.
- Young applied scientist/technologist awards, Rs 50,000 each, up to 46 awards every year, age limit 35 years, only for R&D centres.

3.3.9 The incentives given to the faculty for receiving state, national and international recognition for research contributions

All units of the DAE follow a merit based promotion scheme and during promotion of an individual, national and international recognitions received are given due consideration. In addition, as explained at section 23 of the profile, a Performance Related Incentive Scheme (PRIS) is being operated in the DAE for providing incentive to employees. This scheme has three components: at the level of organization as a whole called PRIS-O, at the level of groups called PRIS-G and at individual level called PRIS-I. PRIS-O is decided based on a review of the performance of the DAE as a whole and the review is carried out by the Atomic Energy Commission. It is carried out twice during five years and is based on accomplishment of overall targets set for the five year plan. Employees are at presently getting maximum permissible PRIS-O. PRIS-G is available to R&D centres and for this purpose performance of groups is assessed by an external peer group against set targets. Various groups are getting near maximum admissible PRIS-O. PRIS(I) is given to employees of R&D centres and is based on individual merit judged on annual basis.

3.4 Consultancy

With regard to consultancy, situation is different from other universities. Every member of the faculty in R&D centres is recruited as a scientific officer and works on projects assigned to him and that includes projects that have application in industrial units of the DAE or foe possible deployment outside of the DAE. This is true for IPR as well. Faculty also works in various committees related to regulatory review of nuclear facilities. In case of other institutions also, faculty works on large research projects and their involvement is comparable to industrial consultancy.

3.5 Extension Activities and Institutional Social Responsibility (ISR)

All students at HBNI, except those at IoP(NISER), are at post-graduate level and extension activities for them mean something different from participation in NCC etc. The main mandate of DAE is to promote nuclear power and non-power applications and extension activities are directed towards this mandate. A well-structured programme is being pursued by the DAE towards this end and includes appropriate set-ups at the level of institutions and also at the level of DAE. Programmes being conducted involve delivering lectures, organizing exhibitions, writing popular articles in print media and bringing out journals. Indian Association of Nuclear Chemists and Allied Scientists (IANCAS) regularly brings out IANCAS Bulletin on subjects of topical interest. IANCAS also conducts programmes in universities and colleges to explain basics of nuclear radiation to students. Indian Nuclear Society, a professional body of nuclear scientists and engineers brings out a quarterly bulletin for the purpose of public outreach.

Several short-term courses are conducted by faculty regularly to train technicians in industrial radiography and to train scientists as radiation safety officers. These courses do not involve any certification by HBNI, but are very useful for the trained individuals for getting employment.

CIs attract a large number of students for projects and training. These include under-graduate engineering students for training during summer vacation and regular projects during the final year of the under-graduate programme, graduate engineering students for one year projects, science students sponsored through science academies and several other categories of students. Number of summer trainees is very large: about 1200 in BARC, 1000 in IGCAR and 300 in VECC. IoP conducts summer students visitors program where M.Sc. students from the whole country come and do projects with IoP faculty for about 6 weeks. Students selected by Indian National Science Academy, Bangalore also do projects at IoP and BARC.

National Science Day and National Technology day programmes are celebrated at all CIs in a suitable way and eminent persons are invited to deliver lectures, students from schools and colleges are invited to visit facilities or specifically organized exhibitions. Many from the faculty participate in various ways in programmes to train students for Olympiads etc. Objective of interaction with students is to enable students discover the true spirit of “creative thinking” develop a culture of free discussions. A Science Education program of the Samanta Chandra Sekhar Amateur Astronomers' Association (SCAAA),

Bhubaneswar, in collaboration with several scientists from IoP. Educational programmes such as CHEMFEST organized at HBNI-BARC during Feb.28-March 03, 2014 are conducted to sensitize the college and university students on the latest developments in science and technology.

Additionally programmes to encourage use of Hindi, various kinds of talent search programmes etc. are also regularly carried out.

It is worth mentioning that VECC (in collaboration with Webel Mediatronics Limited, Kolkata) has developed software, named Mounisara, which acts as translator from text to sign language. E-books based on sign language have also been developed. Developed software items are very useful educational aids for hearing-impaired persons/children.

CRITERION IV: INFRASTRUCTURE AND LEARNING RESOURCES

4.1 Physical Facilities

The DAE has well maintained townships at its major sites and these townships offer residential facilities for employees, hostels for students, guest houses for visitors, sports and medical facilities for all residents including students, schools for children of employees and shopping centres. All townships are well maintained and present green ambience conducive to a pleasant stay and can be said to be amongst the best places to live and work in the country. Construction and maintenance of these townships follow the policies of the Central Government including for being disabled friendly. A centralized agency, Directorate of Construction, Services and Estate Management (DCSEM) is responsible for constructing new infrastructure and maintaining existing infrastructure. At the local level there are additional agencies or divisions such as General Services Organisation at Kalpakkam, Construction and Services Division within RRCAT etc.

For office and laboratory space as well, centres of DAE are well known for meticulous planning, safety and security.

4.2 Library as a Learning Resource

Well funded libraries exist at all CIs. The DAE has set up a consortium to ensure that a large number of Journals are available to researchers. DAE consortium subscribes to 2405 journals through Science Direct and these are available to all DAE institutions (CIs of HBNI and Tata Institute of Fundamental Research). Each library has an advisory committee, while coordination of purchase of journals is handled at the DAE level. Summary of library holdings follows.

S. No.	CI	Area in m^2	Seating capacity	Books (Print)
1	BARC	4911	250	108811
2	IGCAR	5000	200	70000
3	RRCAT	1700	100	14226
4	VECC	500	50	7349
5	SINP	1200	80	34972
6	IPR	745	90	24369
7	IMSc	1115	50	70400
8	HRI	558	38	56625
9	IoP	2044	100	15284
	IoP(NISER)	500	50	15000
10	TMC	493	50	7775
	TMC- ACTREC	590	60	5854

Large units like BARC have additional libraries to cater to the fact that they have many small campuses. Additional libraries also have a collection of books.

In place of giving details of all libraries, details are given only about the Central library of BARC as an example.

BARC Central Library

Advisory Committee

Yes, the Library has an Advisory Committee. The Library Committee comprises of senior scientists and engineers. This committee meets regularly to discuss the budgetary issues, review the renewals and purchase of library resources; discuss changes in policies to be adopted by the Library to satisfy various information requirements of users.

Library details

Total area of the library	:	4911 Sq.Mts.
Total seating capacity	:	250
Working hours	:	8.00 am to 8.30 pm (on working days) 10.00 am to 6.00 pm (on Saturdays/Sundays) Closed on Public Holidays

While floor plan is shown separately, adequate and comfortable reading and browsing facility has been provided. Separate Electronic Library facility has been created to access e-resources. Adequate sign boards, fire alarm system, access plan to enable differently able persons to use library and mode of access to collection and return have been provided.

Library holdings

a) Print: Books (108811), Back volumes (111650), Theses (360)
b) Average number of books added: 1313during the last three years
c) Non Print (Microfiche, AV): 3.5 lakh
d) Electronic: e-books (126), e-journals (3152)
e) Special collections: Standards in hardcopy (approximately 20,000). Ten Standard sets are available online onLakshya. (ASMEBPVC, ASTM-DL-Stds, British standards, IAEA Safety Standards, IEC Stds, and ISO Stds.)

Means to access collection:

- OPAC: BARC Library uses commercial software package LibSys (Integrated Library Management Software) with user-friendly OPAC accessible from standard browsers as well as Window based GUI interface.
- Electronic Resource Management package for e-journals:
    - Acquisition of E-Resources: LibSys is being used for

subscription and issue/volume management of Journals (Online/Print). Other E-Resources and databases are also ordered through LibSys Acquisition System.

- Access to E-Resources: E-resources are accessible through in-house developed portal LAKSHYA, available on Campus wide Internet Network. Bibliographic and Access details of these resources are updated through in-house developed Content Management System (CMS) using PHP and MySQL.

- Federated searching tools to search articles in multiple databases: Due to several security restrictions in BARC, Intranet and Internet systems have not been recommended Federated search tools.

- Library Website: Scientific Information Resource Division, a division under Knowledge Management Group of BARC has three campus wide portals of BARC Library. These portals are updated and maintained using in-house expertise. Information on SIRD is also available at BARC website http://www.barc.gov.in/kmg/sird/index.html

- In-house/remote access to e-publications: Remote access facility is extended to users for Science Direct journals by Elsevier publisher.

Deployment of ICT in the library

Library automation: LibSys(Integrated Library Management Software) is being used for all in-house activities viz., Acquisition, Cataloguing, Circulation, Serials etc. RFID is used for tracking and other library transactions such as issue, return, renewal etc., of books. With the help of RFID fully automated kiosk system has been implemented by which the library users themselves do the transactions.

Total No. of computers for general access:

For general access around 60 Desktop computers have been provided for Internet and Intranet based resources at central library.

Total No. of Printers for general access:

Two high speed network printers have been provided for general access. About 20 printers are in use by various sections/facilities.

Internet band width Speed: 300mbps shared pool

Institutional Repository

SIRD has created an institutional repository for using open source software D-space. The journal publications, Theses/Dissertations of BARC scientists and engineers are uploaded on the SIRD website on Saraswati, the library intranet under **E-Sangrahay.**

Participation in Resource sharing network/consortia: SIRD, BARC is part of Science Direct Consortia of DAE Libraries.

Specialized services provided by the library

Reference: Dedicated staff members are available to provide reference service to the Library users.

Reprography/Scanning: SIRD has a very good set-up of reprography unit with sophisticated and high speed copiers to cater to various reprographic needs of BARC. It has also 10 self-operating photocopiers in the Central Library premises to meet the photocopy needs of Scientists and Engineers. In addition, we have high quality scanners for digitizing the documents.

Inter-Library Loan Service: SIRD interacts with other national and international institutes including DAE institutes, in order to cater to the information needs of BARC scientists and engineers . SIRD maintains close liaison with local libraries like Indian Institute of Technology Bombay, Mumbai, Tata Institute of Fundamental Research, Mumbai and national institutes like National Institute of Science Communication and Information Resources (NISCAIR), Indian Institute of Science and others. The division also maintains a close liaison with INIS Centres abroad, for meeting the information needs of Scientists and Engineers.

Information Deployment and Notification about new arrivals: Every week a list of new books and reports received in the library is displayed in the New Arrivals Corner of the library. This list is also made available on Saraswati and BTS.

Scientific Information Resource Bulletin (SIRB): SIRD publishes SIRB every month. This bulletin carries information of interest to BARC scientists and engineers regarding addition of new resources to the library as well as other related news and events.

Newspaper Clippings Service: News related to Nuclear Science & Technology is made available to Scientists and Engineers of BARC. A number of leading newspapers in English, Hindi and Marathi are scanned on a daily basis and the full text images of articles are made available on Saraswati. Clippings from January 2000 onwards are available.

Selective Dissemination of Information (SDI) service is being provided by SIRD.

OPACS: Five (5) dedicated computer terminals have been provided for searching the books and other resources in the Central Library in addition to the facility of intranet (Saraswati) provided across the campus through which users can access the Library OPAC

Internet Access: Nine (9) dedicated computer terminals have been provided in the Central Library for accessing internet resources in addition to the facility provided across the institute.

In-house/remote access to e-resources: About 30 computer cubicles have been installed at SIRD in the New Extension wing, Mezzanine Floor of the Central Library for accessing Internet and Intranet facilities. The Digital node provides seamless access to Information available on *Lakshya* and *Saraswati*. Remote access facility has been extended to users for Science Direct journals.

User Orientation: User orientation service is provided on a regular basis.
Assistance in searching Databases Expert assistance is available to users in searching databases

Budget details

Annual library Budget for 2013-2014: Rs. 1100 lakh
Amount spent for purchasing new books: 20 %
Amount spent for purchasing journals: 80 %

Library as a happening place

SIRD arranges periodic exhibition on topics of interest to BARC Scientists and Engineers. SIRD has also created a 'Stop Corner' where the highly used books on various topics have been housed to attract the users.

Publications of BARC Scientists and Engineers: Publications of BARC Scientists and Engineers are displayed every month at the Display Unit of the Central Library. These publications are also listed in the monthly publication 'Scientific Information Resource Bulletin'. The full text of these publications are simultaneously made available on *Saraswati*. (http://saraswati.barc.gov.in)

Efforts made towards the infrastructural development of the library during the last four years.

- Augmentation of Integrated Library Management System
- Enhancement of OPAC systems from Window to web browser
- Implementation of RFID system with self-operation through kiosk

- Internet and Intranet accessibly to all Library staff with structured CAT6 cabling
- Up-gradation of Library Servers and user and staff Desktops
- Consolidation of Lakshya and Saraswati servers and its resources.
- Introduction of remote access facility for Science Direct journals (24X7)
- Implementation of In-house developed RSS Feed for Lakshya and BARC website
- Re-launch of enhanced BARC website
- Enhancement of Staff furniture and acquisition of steel furniture for back volumes of journals
- Digital collection development of journal articles published by BARC fraternity
- Digital collection development of Ph.D theses published by BARC fraternity
- Implementation of mirror site of Lakshya at Training School Complex, Anushakti Nagar
- In-house software development for achieving total web based automation of major activities.
- Hardware and software implementation for Email based NUCNET circulation to registered users.

4.3 IT Infrastructure

General

HBNI has a large community of researchers working in advanced fields of science and engineering, who need access to state-of-the-art IT facilities to carry out their research. The IT facilities made available include access to high performance computers, storage, graphics displays, high speed networks within CIs and access to the outside world through multiple Internet links. IT services also include routine services such as E-Mail, Video conference, Internet and Intranet services, Information Services and Online Library services.

The entire gamut of IT services are managed in-house by personnel belonging to CIs or in some cases, outsourced to Electronic Corporation of India Limited (ECIL), a Public Sector Undertaking within the DAE. Most of the hardware needed for the IT setup comprises commodity off-the-shelf servers, running open source operating systems and other software. The use of open source software and commodity hardware is encouraged.

Since data security is a prime concern in the organization, the access to these facilities is governed by a comprehensive Internet and Network Security Policy.

Details of only BARC and IMSc is given here by way of examples.

BARC

The computing facilities in BARC span a wide range of computing powers, starting with high speed supercomputers down to individual desktop PCs. Following is a list of various facilities in BARC:

1. High Speed Supercomputers: Currently, five in-house developed supercomputers with different configurations and speeds are operational. These systems are 'Aggra' (8160 cores, 80 GPUs, 109 Teraflops), 'Adhya' (4600 cores, 47 Teraflops), 'Ajeya' (1152 cores, 9 teraflops), Sankalp (640 cores, 5 Teraflops) and Utkarsh (640 cores, 6 Teraflops).
2. Graphics Clusters: Two high resolution displays with 47 Megapixel (6x6 LCD panel) and 9 Megapixel (3x3 back projection with stereo capability) are available to visualize large data sets and outputs from scientific applications. Both the displays have been designed and developed in-house.
3. Centralized storage of about 1 Petabyte with remote backup.
4. More than 100 servers managing various Internet and Intranet services.

Apart from these centralized systems, there are more than 5000 desktop PCs and laptops all over the campus. These PCs are mostly used by individual users and the above mentioned centralized systems are available to all users who need access to large computing power. All PCs are connected to BARC's internal LAN, using which, users can access centralized computing services as well as a large number of Information services such as HR, Payroll, Library and so on.

Many of these desktop PCs are also connected to Internet segment of the LAN from where users can access Internet services. BARC also has a 6500 lines voice and data network.

IMSc

The history and growth of the Institute of Mathematical Sciences' Computer Facility begins from 1991 and has grown rapidly keeping pace with increased numbers of users, new research areas, and new requirements. The Institute has a highly sophisticated user community working in computationally challenging frontline research areas of physics, computer science, mathematics and computational biology. In addition to desktop workstations, services provided include cluster (MPI) computers, shared-memory multiprocessor (SMP) compute servers, symbolic manipulation and visualisation, database archives, network services including web and e-mail. We have over 300 users in the computer network (including external users) with wide variation in the type of usage.

For scientific computing, currently IMSc has a 12 teraflop supercomputer (SGI Altix), as well as a network of Sun Fire X4600 SMP cluster, Supermicro SMP server, Cray XD-1 machines for high-performance computing. A tender has been awarded for upgradation of these facilities with an additional HPC cluster, SMP computer servers, and GPU computing, as well as high-performance storage systems.

Recorded lectures of the conferences and other activity are being made available to the research community to some extent currently by way of hosting the video contents through the web interface. This content retrieval will enable advance level of e-learning and better understanding in the research fields. This multimedia effort is under active expansion.

IMSc hosts the Indian mirror site for the arXiv e-print archive server. IMSc also has its own pre-print server where IMSc members routinely upload their research papers. IMSc also hosts a debian mirror for in-house purposes. There are plans to host other databases and servers, including bioinformatics databases.

Most of the access stations in the Institute use a 100BaseT switched network (100 Mbps throughput). The backbone connectivity at present is 1Gbps which will be enhanced to 10Giga backbone with end use desktops connected with 1Giga. IMSc' external connectivity is provided by Bharti Airtel (24 Mbps) and National Knowledge Network (100 Mbps).

	Description	**Make/Model/Purpose**	**Remark**
Hardwares			
Servers	LDAP/NIS/Mail/IMAP/Web/ DNS/CUPS/ WiFi/DHCP/VPN servers etc.	Acer Altos G710, IBM x3655, Dell PowerEdge R510, Tyrone servers	Network services
Desktops	Access stations per user	Assembled, Dell	In Campus facility
Laptops	Loan to faculty and off-campus usage	Dell,AcerLenovo,Apple,IBM ,Sony,HP	Facility for mobility
Netbook	Loan to off-campus students	Acer Aspire ONE	Access to IMSc LAN
LAN Switches	Layer 3/2 Giga switches	3Com,Dlink, CISCO	LAN & WAN
WiFi APs	Access Points with high gain & uni-directional multiple antennas	DLink	OpenSource WiFiDog is used for ACL

Backbone	1) Multimode fibre cable between buildings 2) CAT-6 cables for LAN distributions	Digilink/Dlink	Campus backbone
WAN	1) Internet 26Mbps 1:1 2) Internet 1Giga NKN 3) VSAT 4) Grid 5) BroadBand	1) Airtel ISP through fiber link 2) NKN – NIC link 3) ANUNET 4) GARUDA(NKN) 5) Off-campus link through BSNL BB	Network connectivity
Peripherals	MFP A3 color laser printer, A4 duplex laser printers,	HP LJ, Canon LJ, Ricoh, Xerox, Toshiba	Network printing facility
HPC	Cray XD1(vindhya)	6xAMD Opteron Quad core nodes	24Core Cluster
	Sun Fire 4200(aravali)	4 nodes of 8 socket 4 Core AMD Opteron SMP cluster	128Core SMP cluster
	Tyrone(satpura)	7 nodes of 4 socket 12 Core AMD Opteron	336 core SMP cluster
	SGI ICE 8200EX	ANNAPURNA CPU Cluster 1024Core 128 Node with Intel Xeon Nehalam processor and 30TB Lustre storage	12TF peak HPC cluster 7th rank in Indian Supercomputer list 2010
Softwares			
Operating Systems	Debian GNU/Linux 64bit	Mail/Web/DNS/CUPS/ WiFi/DHCP servers etc.,	Updated/ Upgraded regularly
	Ubuntu	Acer Aspire netbooks, Desktops(Assembled)	Updated/ Ugraded regularly
	SuSE	HPC Cluster - ANNAPURA	Updated/ Upgraded regularly
	RedHat	Library server	
	Cray Linux	Cray XD1 Supercomputer	Updated/ Upgraded regularly
	MS Windows XP,7,8	Dell, HP, Lenovo, Sony	Updated/Upgraded regularly
	Mac O/S	Apple MacBooks, iMac,MacMini	Updated/Upgraded regularly

Application S/Ws	Mathematica version 8,9	20+10 network licenses	Network S/W facility
	Matlab 2010b	15 network licenses	
	Matlab ToolBox	1 network license	
	Compiler,Optimization, Image Processing, Signal Processing, Statistics, SimBiology, Symbolic Math,	Each 1 network license	
	Maple	5 network licenses	
	COMSOL	1 network license	
Compilers	PGI Compilers Fortran, C, C++	SMP cluster	
	Intel Cluster Studio	HPC Cluster	

The institutional plans and strategies for deploying and upgrading the IT infrastructure and associated facilities

All central computing and IT infrastructure are regularly upgraded in order to cater to increasing demands from users. Supercomputing systems generally have an active service life of about 6-7 years, after which they are replaced with faster machines. Since there are about 3 different systems in operation at any time, this results in a new system being deployed once every 2-3 years. Similar approaches exist in other areas of IT services too. In the 12th plan, BARC has embarked on a plan of upgrading the computing infrastructure to an aggregate performance of 1 Petaflop and campus LAN backbone to multiple 10G links. IPR plans to upgrade the speed of the network, and also improve connectivity between various centres of IPR (CPP-Guwahati, FCIPT and ITER-India)..

Desktop PCs of individual users are also upgraded usually once in 6-7 years.

On-line teaching and learning resources

The institute subscribes to online access to many science and engineering journals which are available at the desktop of students and faculty members of the Institute through campus based network as well as internet.

Issues related to authenticity and copyright with regard to online resources

The institute subscribes for online access of journals published only by reputed publishers and Society.

Technologies deployed for enhancing student learning and evaluation

Class rooms are equipped with projectors connected to PCs and the PCs are connected to internet. Thus the teachers have on-line access to internet for any reference etc. and they also use the projector for slide based teaching in addition to conventional black board teaching. Students have been provided internet connections in the hostels and can access on-line journals.

IT facilities available to individual teachers for effective teaching and quality research

All the faculty members have access to IT facilities like, PC, internet etc., which is used by them to prepare their talks and provide effective teaching. The institute subscribes to online access to journals which are available at the desktop of faculty members of the Institute through campus based internet facility. Institute also subscribe for online access to SCOPUS and ISI citation data base.

ICT-enabled classrooms/learning spaces available within the university

Every classroom is equipped with LCD projector and a desktop computer to assist teaching and learning process.

Assistance provided to the faculty in preparing computer- aided teaching-learning materials

Teachers are IT savvy they are equipped to use various computer based teaching materials, ex. ppt slides and CIs provide them internet connected PCs in their office room.

Maintenance of the computers and their accessories

All computer hardware in all CIs is procured with a standard warranty of 3 years. During this time, support for the hardware is provided by the vendor who has supplied the equipment. After the warranty period, the hardware is either put under AMC or maintained in-house depending on the type of hardware and criticality of the particular system. Generally, the AMC period is for 2-3 years after which most hardware components are at the end of their working life.

Use of the National Knowledge Network connectivity

BARC, RRCAT has connectivity to the National Knowledge Network. Currently it is being used for connectivity to the Worldwide LHC Computing Grid and to run the ANUNET, which is a private network connecting all DAE sites.

Use of web resources such as Wikipedia, dictionary and other education enhancing resources

HBNI provides extensive access to internet and services to be used are decided by faculty.

Details on the provision made in the annual budget for the update, deployment and maintenance of computers in the university.

Apart from IT facility, a large number of faculty and students use high performance computer facility of the institute for research. The facility is accessible from their desktop computers.

To give an idea about budget, annual budget for total computer facility is 17 crore for BARC, 29 crores for RRCAT, 90 lakhs for IoP.

CRITERION V: STUDENT SUPPORT AND PROGRESSION

5.1 Student Mentoring and Support

Student mentoring

Support is extended to different categories of students in ways appropriate to the category they belong to. For doctoral students, there are student specific doctoral committees, which mentor students in addition to monitoring academic progress. Doctoral committees also help in fine tuning topic of research and change of guide if needed.

Programmes for BARC Training Schools include end-semester viva-voce. This covers all subjects taught during the semester and helps in understanding progress made by students in learning the subjects and the extent to which a student appreciates inter-relationships between subjects. This helps senior management in understanding how the student is coping with work load in the class and mentor him if needed.

Tata Memorial Hospital (TMH) is a standalone post graduate institute for conducting MD and super-specialty programmes in accordance with the guidelines of MCI. Every student admitted to TMH is assigned to a PG teacher and a co-teacher for carrying out research on a topic for three years leading to a thesis. A teacher, while delivering lectures on theory, carrying out practical work inside an operation theater, ward or laboratories continues to guide the student for three years academically, socially and psychologically, and also builds up his/her career.

On joining IoP(NISER), every student is assigned to a faculty advisor for the first year. Second year onwards, another faculty advisor from the stream of the student is assigned to him/her. The faculty advisor closely monitors the performance of his ward and may permit him/ her to take reduced or extra load on the basis of performance of the student. The faculty advisor is expected to be acquainted not only with the academics of a student, but with his/ her social life as well. In case the student is passing through a troubled phase or show signs of depression or of addiction to alcohol or drugs, he/she alerts appropriate authorities for necessary action and counseling.

Financial support

All doctoral students get financial support. The present rates of scholarship are as follows.

Programme	Fellowship/ Stipend
Ph.D.	Rs 16,000 pm for the first two years, Rs 18,000 pm in the subsequent 3 years after a review.
Ph.D. under DGFS	Rs 20,000 for the first two years, Rs 24,000 in the subsequent 3 years after a review.
Integrated Ph.D.	Rs 16,000 pm for the first two years, Rs 18,000 pm in the subsequent 3 years after a review.
BARC Training Schools	Rs 20,000 pm
Dip RP	Rs 9,300 pm
DMRIT	Rs. 9,300 pm
DRM	Rs. 17,000 pm
MD	Rs. 40,000 pm in the 1st year Rs. 42,000 pm in the 2nd year Rs. 44,000 pm in the 3rd year
M Ch/ DM	Rs 50,000 pm in the 1st year Rs 52,000 pm in the 2nd year Rs 54,000 pm in the 3rd year
M.Sc. (Nursing)	NIL
Integrated M.Sc.	INSPIRE scholarship of Rs 5000 pm and Rs 20,000 per year as mentorship cost for doing project work.

Contingency and HRA, as per the rules and in lieu of hostel, are provided in addition to the above fellowship.

Sports

Excellent sport facilities are available to students at all campuses.

Health care

Health care facilities are provided to all students admitted to all CIs. This includes access to dispensary for routine health care and hospitalization to a limited extent. TMC, being a hospital, provides all health care facilities.

Placement Cell

As explained in detail under criteria 1, employability of graduates of HBNI is

excellent and no need of has been felt for having a placement cell on a formal basis. Guides of doctoral students do assist them in getting post-doctoral positions as appropriate including by giving letters of recommendation. A placement cell at IoP(NISER) is being set up and will be operational from 2015.

Alumni Association

It is planned to launch an Alumni Association soon.

Guidelines

University and CIs have published guidelines for the following programmes.

- Ph.D./ M.Sc.(Engg) /Integrated Ph.D.
- M.Tech. / M.Phil. /PG Diploma
- Integrated M.Sc. at IoP(NISER)

Guidelines for the remaining programmes are under preparation

Grievance Redress

As per the Rules of the University, the Dean, HBNI is designated as the office for resolving the individual grievances and complaints and he does so through the authorities of the Constituent Institutions or the Institute as the case may be. As per the Rules of the University, the Dean, HBNI is designated as the office for resolving the individual grievances and complaints and he does so through the authorities of the Constituent Institutions or the Institute as the case may be.

Women' Cell

Women's cell exists in all institutions as per norms of the Central Government.

Anti Ragging Cell

But for IoP(NISER), students when they join academic programmes, are at a mature age and no incident of ragging have been reported. Therefore, there are no anti ragging committees in CIs except IoP(NISER). Affidavits as per legal requirements have been taken from all students who are not employees. IoP(NISER) since its inception is following the guideline of UGC and taking affidavit from the student as well as from their parents at the time of their admission in the UG and the PG programme of IoP(NISER). There is Disciplinary Action Committee for Students (DACS) which looks into the matter of all complaints including ragging and disturbances of the students.

5.2 Student Progression

Student progression for HBNI has to be seen in two parts, one for students pursuing integrated M.Sc. at IoP(NISER) and the other for the rest.

For students other than IoP(NISER), progression within the university is only for those who joining BARC Training Schools. Graduates of Training Schools become employees of DAE and at some stage come back to enroll for Ph.D. About 50% of those who have completed Ph.D. are past graduates from BARC Training School. Amongst those who complete a DipRP programme, the first one or two join DAE as employee, while other get employment elsewhere. Similarly medical doctors pursuing post-graduate programmes at TMC get immediate employment and no need has been felt for arranging campus selection.

In case of IoP(NISER), some of the students have joined Ph.D. programme after completing M.Sc.

All theses submitted so far have been accepted.

5.3 Student Participation and Activities

Students participate in activities of CIs in various ways. CIs where students is large, there are various committees such as mess committee, cultural committee, sports committee, library committee, nature club etc. Students actively organize sports and cultural events.

National Research Scholars Meet (NRSM) in Life Sciences is a unique event organized at ACTREC by Ph. D. students each year in the month of December. Previously known as Graduate Students Meet (GSM), was initiated by the ACTREC students with the intention to provide a platform – a conference for the students to be organized by the students. GSM became immensely popular right from the time of its inception in 2005 that gave opportunity to research scholars to meet other scholars from across the country, share their research experiences, their views, ideas.. Students are encouraged to put forward their suggestions, grievances to the Students Council. Senior students participate as members of Students Council.

IoP(NISER) has set up a large number of committees with representation from students. These include UGCI, PGCI, DACS, Drama and Music Club, and Gymkhana.

CRITERION VI: GOVERNANCE, LEADERSHIP AND MANAGEMENT

6.1 Institutional Vision and Leadership

Vision and Mission of the university

The DAE was established in 1954 and its mandate includes

i. Research, including fundamental research in matters connected with atomic energy and the development of its uses in agriculture, biology, industry and medicine; and
ii. Advancement of higher mathematics.

In pursuit of its mandate, the DAE has established research and development centres and grant-in-aid institutions, and has taken in its fold several existing institutions as its grant-in-aid institutions. Together all institutions under the umbrella of the DAE present a formidable group in terms of expertise and research infrastructure. All research institutions under the umbrella of the DAE had been pursuing academic programmes with affiliation from universities located nearby. These programmes were either research based degree programmes (Ph.D. and M.Sc. by research) or class room based course work programmes in certain specialized areas (DipRP, and DMRIT) or those having a combination of class room courses and research (M.D., M.Ch. and DM). Student intake for these programmes was less than the full potential of the institutions and intensity of academic exchanges between R&D centres and grant-in-aid institutions had scope for improvement.

Additionally, BARC has been running a Training School to teach nuclear science and engineering to young graduates prior to their induction in the DAE, this programme was not accredited by any university.

In this background, a decision was taken to set up a university level institution under the umbrella of DAE with the following as its constituent institutions for the purpose of academic programmes.

a. Bhabha Atomic Research Centre (BARC), Mumbai established in 1957 and having campuses at other places including Kalpakkam, Tarapur and Mysore, and field laboratories at all nuclear power stations, gauribidanur, New Delhi, high background radiation areas in Kerala, high altitude laboratories in Gulmarg, gamma ray telescope at Mount Abu etc. and BARC Training Schools at Mumbai, Indore, Kalpakkam and Hyderabad.

b. Indira Gandhi Centre for Atomic Research (IGCAR) , Kalpakkam set up in 1969.
c. Raja Ramanna Centre for Advanced Technology (RRCAT), Indore set up in 1984.
d. Variable Energy Cyclotron Centre (VECC), Kolkata. Cyclotron became operational in 1977 while VECC was still a part of BARC.
e. Saha Institute of Nuclear Physics (SINP), Kolkata set up in 1950.
f. Institute for Plasma Research (IPR), Gandhinagar set up in 1986
g. Institute of Physics (IoP), Bhubaneswar, set up in 1972
    - National Institute for Science Education and Research (NISER), Bhubaneswar set up as a project of IoP in 2006.
h. Harish-Chandra Research Institute (HRI) , Allahabad set up in 1966.
i. Tata Memorial Centre (TMC), Mumbai set up in 1941.
j. Institute of Mathematical Science (IMSc.), Chennai set up in 1962.

From the year of establishment, it may be seen that all CIs of HBNI have been carrying out advanced research and development for several decades in accordance with its mandate. CIs have also been training human resource in the areas of nuclear science and engineering and advanced mathematics. It is because of research conducted in the institutions of the DAE that India is now self-reliant in this advanced field. Mission, vision and guiding values of the Institute were formulated in this background and are as follows.

Mission

- To encourage pursuit of excellence in sciences (including engineering sciences) and mathematics in a manner that has major significance for the progress of indigenous nuclear technological capability.

Vision

- To provide an academic framework for integrating basic research with technology development.
- To encourage inter-disciplinary research.
- To nurture an environment for attracting high quality manpower in the sciences including engineering sciences to take up a career in nuclear science and technology and related areas.

Guiding values

- Always adhere to highest ethical standards.
- Put good of students first.
- Value excellence in research and foster innovation and creativity.
- Recognize importance of science for the development of society.

Distinctive Characteristics of the University

HBNI is a research university and educates students at the doctoral and masters level, and pursues research in accordance with its mandate. It is meritocratic in hiring and promotion of faculty, admission and progression of students and all other policy aspects. As a result, it has a high concentration of talent in its faculty members and students.

Distinctive characteristic of the Institute is to advance indigenous nuclear technological capability. In view of association of nuclear science with nuclear weapons, technology control regime is an established practice in the nuclear field and for India to exploit full potential of nuclear sciences, it is necessary to develop a complete range of nuclear technologies based on indigenous efforts. Nuclear technologies have applications in generation of nuclear power; in health care where it is useful in diagnosis, therapy as well as sterility assurance; in industry for radiography, nuclear gauging and gamma scanning of chemical towers; isotope hydrology; and research. Mathematics is basic to all branches of sciences and serious research in pure and applied mathematics including theoretical computer science is very important for indigenous development of information technologies and for cyber security.

Nuclear engineering is an inter-disciplinary subject and any institution involved in its development has to have expertise in several branches of engineering, physical sciences, chemical sciences, life science, health sciences and mathematics. Scope of nuclear engineering and thus that of the HBNI is very vast.

The DAE has pursued a science based approach for nuclear power development and this has resulted in indigenization of nuclear power programme including associated fuel cycle facilities. This approach has also given India confidence to construct reactors based on technology development in the country. This is demonstrated by the ongoing construction of Prototype Fast Breeder Reactor, which is now nearing completion. India's participation in the international venture ITER has been possible only because of robust basic research in plasma physics and development of related technologies at IPR and other institutions in the country over the past three decades. DAE institutions continue to pursue basic research in areas such as nuclear physics, accelerator physics, laser physics, astrophysics, biophysics, string theory, quantum information and computation, pure and applied mathematics, theoretical computer science, organo-metallic materials, nano and condensed matter physics, atomic/ molecular clusters, catalysis, generation and storage of hydrogen, molecular mechanisms of abiotic stress tolerance, molecular marker techniques for marker assisted selection,

development and characterization of transgenic plants, oncology and nuclear medicine, and many other similar areas including several areas which may be classified as blue sky research.

To pursue research, the Institute has a wide range of facilities ranging from table top set up to mega science facilities such as research reactors, accelerators and tokamaks. Computational resources available to faculty and students are quite extensive and faculty is well trained to build own instrumentation and facilities. The Institute seeks to serve the following categories of students.

- Doctoral students in all branches of science and engineering having a relation with nuclear technology and mathematics and underlying basic sciences. Doctoral students in HBNI work on problems related to the mandate of the DAE and deliver a lot in terms of research output. Increased intake of doctoral students can contribute a lot towards realizing the full potential of the research infrastructure and help the DAE in accelerating the pace of developing indigenous technologies. Employees of DAE also register for Ph.D. programme. Employees also have the possibility of enrolling for M.Sc.(Engg).
- Young graduates inducted in the DAE for a job have to study nuclear science and engineering for a period of one year at the BARC Training Schools. After setting up of the HBNI, for engineers, the programme has been converted to an M.Tech. programme by adding one year project work. Scientists are given three options, (i) getting an M.Phil by doing one year of project work, (ii) using the credits earned during the one year at the Training School towards course work for a Ph.D. from the HBNI and (iii) getting an M.Tech. by doing one year of project work. The third option is available only to those who work in applied areas such as lasers, accelerators, radiological safety engineering, material science and exploration geosciences. Those who do just one year of course work get a PG Diploma.
- Medical doctors continue to pursue post-graduate medical programmes at TMC and intake of students has been significantly increased both at the post-graduate level and at the super-specialty level.
- DipRP, DRM and DMRIT programmes conducted at BARC continue as earlier

It may be noted from the above that a significant percentage of students of the Institute are either employees or potential employees. All BARC training School students are potential employees and roughly half of the doctoral students are employees of the DAE institutions.

Leadership and management

Council of Management is the governing body of the university and is chaired by Secretary, DAE. The university was set up by the DAE as its own initiative and the DAE leadership is fully committed to the university.

The Academic council is the principal academic body of the Institute and has the control over and is responsible for the maintenance of standards of education, teaching and training, co-ordination between the Constituent Institutions, research, examinations and tests within the Institute. The Academic Council makes recommendations to the Council of Management on all academic matters. All constituent institutions have representation on the Academic Council.

There is a Dean for coordination with CIs and is directly responsible to the Director of the Institute. The Dean advises the Director on all matters related to academics including research, planning, quality control and maintaining discipline in the Institute. The Dean is assisted by an Associate Dean, who is appointed by the Director from amongst the faculty in CIs.

Directors of CIs appoint Dean-Academic at their respective CI. A Dean-Academic in a CI oversees academic programmes for a particular discipline. Number of Deans-Academic at a CI depends on the breadth of the research and academic programmes and is decided by the Director of a CI in consultation with the Director, HBNI.

All Deans and Associate Dean together form a standing committee which meets as frequently as desired. The standing committee is chaired by the Director. The Academic Council has delegated several of its functions to the Standing Committee of Deans so as to reduce the frequency of its meetings to once per year.

Main stakeholder of the university is the DAE itself and DAE is fully involved in the management of the university. Culture of excellence prevalent in DAE has fully percolated to HBNI. The university was set up only in 2005 and since then all important positions have never been vacant. Meetings of the Council of management are conducted two to three times a year. Academic council meets at least once a year. Standing Committee of Deans meets as often as necessary. In the year 2103-14, it met four times and at different campuses of the university. All decisions are taken after due consultations with Deans. Powers have been delegated to Deans so that they are not dependent on the Central Office for day to day working. In essence this also amounts to grooming them for higher

responsibilities.

Nuclear Knowledge Management

Nuclear Knowledge Management (KNM) has been at the centre stage at the global level for the past decade or so. First generation of experts in this area has retired and tacit knowledge available with them is likely to be lost if not recorded. Globally several concepts of nuclear power plants were developed, but only some of them have been deployed. It is likely that detailed knowledge about concepts that were not deployed will be lost if such knowledge is not documented. Notable example of one such concept is Molten Salt Breeder Reactor. There is a renewed interest in this concept as it is considered to be a good candidate for thorium utilization. IAEA has launched an initiative to preserve knowledge and is taking steps to document knowledge about concepts as necessary. The DAE in India has followed a system where every year scientists and engineers are recruited, trained in house in the BARC Training School, and then deployed in the units of DAE. Senior experts working in the units teach in the Training School and pass on explicit as well as tacit knowledge to the students. This ensures that even tacit knowledge is preserved and is eventually converted to explicit knowledge by appropriate documentation.

Value system

The DAE is committed to meet its social obligations: to offer the most responsible utilization of nuclear energy, ensure safety of all its installations, improve public welfare and protect the environment. To meet these obligations, in addition to excellence in Science and Engineering, a strict adherence to high ethical standards is a necessity. The core ethical policy of DAE is to establish a tradition with highest ethical standards, ensuring a harmonious future for the entire humankind, where every individual can live with dignity and self-respect.

Guiding values for the Institute have been accordingly formulated and are as follows.

- Always adhere to highest ethical standards.
- Put good of students first.
- Value excellence in research and foster innovation and creativity.
- Recognize importance of science for the development of society.

Students are expected to adhere to copyright law and plagiarism is not tolerated. Faculty is expected to provide pastoral support to students on a regular basis. Students should find faculty interested, available, critical, supportive, inspiring and encouraging. Faculty is also expected to select authorship/credit sharing of all technical reports/patents/research reports in a judicious manner upholding the integrity of the scientific community.

6.2 Strategy Development and Deployment

Vision for the future

The CIs of the university have excellent faculty and research infrastructure and potential for increase in enrolment of doctoral students exists in many CIs. This requires increase in facilities such as hostel for students and sitting space in laboratories. Action in this regard has been initiated in various CIs. In IGCAR, additional residential space for students has been created, while at BARC a hostel for 500 students is under construction and another for 500 students in being planned.

Considering increasing employment opportunities, there is a demand for increasing intake of students for DipRP progrmme and this will be done once hostel space is available.

Intake of students in TMC will also be expanded in accordance with the norms of MCI. Considering increased emphasis on clinical research in India, possibility of starting M.Sc. (clinical research) is being examined. Demand for technicians trained in handling equipment in nuclear medicine centre has increased and so a Diploma Programme in Fusion Imaging Technology is likely to be started at TMC.

A 390 bed hospital for the benefit of DAE employees is a part of BARC and DNB programme is conducted in the hospital. After obtaining all clearances, this will be converted to MD programme.

Under agreement of cooperation between BARC and its counterpart in Vietnam, two batches of scientists from Vietnam were admitted to BARC Training School in Mumbai. This can be repeated but has to be done strictly under inter-government agreement of cooperation.

Interaction with industry

Research output of CIs can be divided in three categories viz., (i) directly useful for nuclear power programme including fuel cycle activities, (ii) directly useful for applications of nuclear science to health care, industry, agriculture and research, and (iii) blue sky research. Industrial users for the first category of research are within the DAE and CIs have an organic linkage with them. Therefore, the process of interaction is a continuous process. With regard to the second category, there is a well established mechanism of technology transfer which is used to engage industry. Third category of research is necessary to provide inputs for the future and is nurtured through national and international

linkages. Notable international linkages include with CERN, FAIR, Fermi Lab etc.

Organisational structure

For the purpose of conducting academic programmes, the university structure has two layers; at the level of university and at the level of CIs. The university has an academic council and Boards of studies as follows,

- Board of studies in chemical sciences,
- Board of studies in engineering sciences,
- Board of studies in health sciences,
- Board of studies in life sciences,
- Board of studies in mathematics,
- Board of studies in physical sciences, and
- Board of strategic studies.

At the level of CIs, each CI has Deans and Standing Academic Committees. Number of deans and committees in a CI depend on the spread of subjects being pursued at the CI. CIs enjoy autonomy with regard to admission and conduct of academic programmes. CIs frame their own syllabus and implement after approval by the concerned Board of Studies.

Grievance redressal mechanism

As per the Rules of the University, the Dean, HBNI is designated as the office for resolving the individual grievances and complaints and he does so through the authorities of the Constituent Institutions or the Institute as the case may be. While there have been complaints, so far no complaint has reached the level of courts.

Mechanism for analyzing feedbacks

This is explained in detail in section 1.4.

Performance audit.

Please see paragraph 23 of the profile.

6.3 Faculty Empowerment Strategies

Recruitment and training

From the point of recruitment of faculty, two distinct systems co-exist within HBNI. The R&D centres viz., BARC, IGCAR, RRCAT and VECC follow one system, where the individuals are recruited as scientific officers and grow

professionally while on the job.

Provision exists for recruitment by four different methods. The first is thorough BARC Training School for those who have a B.Tech. or a M.Sc. in relevant disciplines. Individuals so selected have to successfully complete one year of class room work before being designated as scientific officers. The second is after students have completed a M.Tech. from one of the select institutions (IITs and IISc). Selection of such individuals is done prior to their joining M.Tech. programme. The third method is for those who have completed doctoral research. Such individuals are selected as KS Krishnan Associates and remain as associate for between one to two years before being absorbed as scientific officers. Competition for selection all three categories is very stiff.

The candidates considered under the fourth method of recruitment are called prospective candidates. Exceptionally bright individuals working in areas of interest to the programmes of the DAE, particularly emerging areas are considered under this category. The process of establishing contact can be initiated by the individual interested in working in the DAE or by a senior person in the DAE approaching the individual. If selected the individual is given an offer to join at a level appropriate to his/her expertise.

Depending on the requirements of the assignment and inclination of an individual, the professional growth of an individual can follow any of the several possible trajectories. Some develop expertise in plant operation and maintenance, some in project construction management, some in techno-commercial aspects, some in design and development, and some in research and development. Also one may not stay in the same field throughout one's career and develop a composite expertise. New requirements (such as nuclear law consisting of nuclear safeguards, safety regulation, export controls, civil nuclear liability etc.) are also emerging. Those recruited as scientific officers and meeting defined criteria to be eligible for being a member of a faculty have been designated as faculty of HBNI. They constitute about 8% of the scientific officers.

In IPR, which is a grant-in-aided institution, the practices are similar. In other grant-in-aid institutions, individuals are recruited as faculty. At other grant-in-aid institutions, the faculty appointments are made based on open advertisements, referrals by experts in the relevant fields, and by direct contact with promising candidates. A screening committee prepares a short list of candidates and a Selection committee consisting of external experts makes the final selection.

There are training programmes for scientific and technical staff as well as administrative staff. Promotions of scientific and technical staff are also based on a merit based promotions scheme. For training of administrative staff, an Administrative Training Institute (ATI) has been specifically set up.

Annual appraisal and promotions

Promotions are on the basis of a merit based promotion scheme. Individuals are appraised annually and interviewed for promotions in accordance with a set procedure. Merit based promotions scheme ensures that only the best are able to rise to the top. not based on seniority, but on merit.

Grant-in-aid institutions have a well formulated Promotion procedure where for every position, after a designated number of years, the faculty is considered for promotion. Promotions are decided by a promotion committee consisting of external experts as well as internal members. The committee bases its decision on the evaluation of the performance of the faculty and recommendation letters of experts.

Welfare schemes

Welfare schemes adopted in the DAE follow the norms of the Central Government and include a benevolent fund to render financial aid to low paid employees, a scheme for employees' health care, schools managed by the Atomic Energy Education Society, talent nurture programmes, and sports and cultural activities managed through DAE Sports and Cultural Council.

Gender audit and sensitization

All CIs have a women's cell constituted in accordance with the guidelines of the Department of Personnel and Training. Employees are sponsored to attend gender sensitization workshop from time to time.

6.4 Financial Management and Resource Mobilization

Four of the ten CIs are subordinate offices of the Government of India and get funding directly from the Government of India for both plan and non-plan expenditure. Staffs in these centres are employees of the Central Government.

Six of the CIs are grant-in-aid institutions of the DAE and get full funding from Government of India through the DAE.

6.5 Internal Quality Assurance System

As explained under section 6.1, HBNI was accredited as a university only in

2005, while all the CIs of HBNI have a long history of conducting academic programmes. Certain structures for quality control were existing prior to formation of HBNI and certain new structures have now been created. The following are involved in quality control from the beginning of HBNI.

- Board of studies,
- Standing academic committees at the level of CIs,
- Student specific doctoral committees,
- Student specific committees for M.Tech./ M.Phil
- Apex committee and discipline specific for BARC Training Schools

In addition, a thorough scrutiny is done by the team in the Central Office, particularly at the time of submission of synopsis of a thesis by a doctoral student, before short-listing examiners for thesis evaluation.

We are now in the process of creating an overarching cell for internal quality assurance to undertake periodic review and point out any shortcoming.

CRITERIA VII: INNOVATIONS AND BEST PRACTICES

7.1 Environment Consciousness

All institutions of DAE are extremely conscious about environment as can be seen from the greenery on the campuses. At the Trombay campus of BARC, a Nisurgaruna plant has been operating to generate to process waste generated in the kitchen. It generates cooking gas and also manure. A water harvesting scheme has also been implemented in the Trombay campus. For disposal of hazardous chemical waste, a plant is planned to be set up in BARC, Trombay. Chemistry laboratories encourage use of 'green chemistry' methodologies.

A Nisurgaruna plant to process kitchen waste is being installed at RRCAT.

Tree planting and growing of flowers is given special emphasis on all campuses and this has resulted in beautiful ambience in the campuses. Tree cover attracts birds. Greenery of IoP attracts hundreds of migratory birds every winter when they are on their way to the Chilka lake of Odisha.

As part of environmental monitoring programme, studies on physiochemical, biological and geo-chemical characteristics of coastal environment (water, biota and sediment) were conducted at IGCAR to meet MoEF (Ministry of Environment and Forests) regulation. Results of the studies on bio-fouling organism, phytoplankton, zooplankton and fish diversity in the coastal water indicated high diversity and high density indicating the healthiness of the Kalpakkam coastal environment. Among antifouling paints screened, one was found suitable for use at MAPS water intake gate. Results of studies on dissolved heavy metal in Kalpakkam seawater indicated that the coastal water is not polluted with heavy metals. A new fish species to the world of fishery science has been identified and named as Scolopsis igcarensis, in recognition of IGCAR's contribution to marine diversity study. Water quality studies on ground water samples from Kalpakkam region were carried out for fluoride and nitrate content, fluoride content were below permissible limit, however, nitrate contents were beyond the limit in some of the areas. Ambient air quality monitoring at different places of IGCAR was continued to meet MoEF and AERB requirements.

At ACTREC, a biogas plant is installed that processes kitchen waste. Biological and toxic waste is collected separately for disposal. Vermi-culture is practiced on the campus that generates manure. The animal facility at ACTREC has solar heating panels that provide hot water. The campus has several medicinal plants and trees.

7.2 Innovations

The concept of HBNI itself is an innovation in India. It is helping to use the research infrastructure and faculty for human resource development without any significant additional investment. In turn the DAE is getting the benefit of research output of doctoral students for its programmes.

It may be added that after the setting up of HBNI, we found that a similar university exists in Japan and is called Sokendei, which is a Japanese abbreviation for Graduate University for Advanced Studies.

7.3 Best Practices

Details of two best practices follow on the next two pages.

A Brief on Best Practice 1
Title: Conduct of doctoral programme

Objectives: It is desirable that doctoral students are given a broad based knowledge in addition to the research problem and are monitored periodically by a committee and not just the guide. This strengthens the guide and improves mentoring of the student.

The Context: HBNI is a research university and close to 1500 students are pursuing research towards a doctoral degree. It is not practicable for top functionaries of the university to keep track of such a large number of students and it was necessary to adopt a distributed approach. Additionally, while faculty in HBNI was well versed in conducting research, many of them had not guided doctoral students, where it is necessary to choose a research problem that can be completed in a limited time available to the student.

The Practice: For every doctoral student starting doctoral programme after M.Sc. or B.Tech., one year of course work is compulsory. During this one year, his/ her progress is monitored by a monitoring committee or a doctoral committee. Subsequent to completion of course work, a student specific doctoral committee is constituted by the CI and it can have members from amongst faculty across CIs and also from outside of HBNI. Experts working in CIs and having knowledge of a subject can be called in as Technology Advisers. Guide is the convener of the doctoral committee and takes the initiative of conducting all meetings. Doctoral committee is responsible for conducting Oral General Comprehensive Examination (OGCE) of the student, monitor progress by conducting periodic reviews, take decisions about change of topic of research if needed, decide about change of guide if needed, and decide based on a pre-synopsis seminar about submission of the thesis.

Evidence of success: Doctoral committees have been helpful in

- Mentoring research scholars
- ensuring the success of the doctoral programme,
- training young faculty,
- involving faculty from other CIs as necessary,
- involving outside institutions where found necessary,
- maintaining uniform standards across CIs, and
- changing guides where found necessary.

Problems: It is burdensome for senior faculty.

A Brief on Best Practice 2
Title: Delegation of power to Deans-Academic at CIs

Objectives: The process of evaluation of a thesis should be completed as fast as possible as a student has to move on with his/ her career.

The Context: HBNI is a research university and close to 1500 students are pursuing research towards a doctoral degree. It was felt that after examiners have been decided in accordance with the procedure for the conferment of research degrees, further follow up with the chosen examiners should be pursued in a decentralized manner so as to expedite the process of evaluation of the thesis. It was also felt desirable that this job is handled by individuals with academic background rather than administrators.

The Practice: Deans-Academic at CIs are responsible enough to handle this job and the job of corresponding with the external examiners and conducting final viva voce has been assigned to them. After having been told by the doctoral committee to do so, the guide of a student submits the synopsis and a list of examiners to Dean-academic at the CI. Dean-academic sends the synopsis to the convener, Board of studies. The convener, Bord of studies, examines the synopsis along with members of the board and if satisfied, forwards name of four examiners to Central office of HBNI. After a through scrutiny, Director, prioritise examiners and this list is sent to Dean-Academic for further action. All correspondence with examiners is handled by the Daen-Academic and they maintain strict confidentiality of the process. After receipt of reports from examiners, final viva voce is conducted by the doctoral committee and recommendation send to Central office through Dean-academic.

Evidence of success: The success of the practice is evident by the fact that the entire process within HBNI gets completed in a short time. Time taken by the examiners determines the total time for the evaluation process.

Problems: No problem has been encountered in this process.

Appendix 1: Awards/ recognitions for excellence received by faculty since 2009

During this period, several members of faculty were elected to fellowship of various academies and received national civilian awards. Since lists of fellows of academies and civilian awardees are provided in the executive summary, such recognitions are not listed here.

Year	Name	Awards/Recognitions received at State/National and International Level
2009	Ashoke Sen, HRI	Infosys Award for Mathematical Sciences for 2009; Doctor of Science (Honoris Causa) by IIT Kharagpur.
2009	A.M. Jayannavar, IoP	J.C. Bose Fellow (DST, India), 2009
2009	Rajesh Gopakumar, HRI	Shanti Swarup Bhatnagar Prize for Science and Technology
2009	Manoj K. Yadav, HRI	INSA Young Scientist Award in Mathematics (2009)
2009	A.K. Pati, HRI	Awarded Samanta Chandra Sekhar Award for the year 2009 from Orissa Bigyan Academy, Bhubaneswar, Orissa
2009	A Raychaudhuri, HRI	Elected for J.C. Bose Fellowship of DST
2009	H N Ghosh, BARC	Homi Bhabha Science & Technology Award
2009	Pradeepkumar K S, BARC	Homi Bhabha Science & Technology Award
2009	P K Vijayan	Homi Bhabha Science & Technology Award
2009	Jan-e Alam, VECC	Homi Bhabha Science & Technology Award
2009	Swapan K Ghosh, BARC	Awarded the TWAS Prize in Chemistry by The World Academy of Science (TWAS), Trieste, Italy

2009	Swapan K Ghosh, BARC	Jagdish Shankar Memorial Lecture Award, Indian National Science Academy, New Delhi
2010	S K Nema, IPR	National Academy of Sciences, India (NASI) – Reliance Industries Platinum Jubilee Award
2010	Suvrat Raju, HRI	Elected for Ramanujan Fellowship of DST
2010	R B Grover	Election as President, Indian Society of Heat and Mass Transfer for the period 2010-13
2010	Somendra M. Bhattacharjee, IoP	J.C. Bose Fellow (DST, India), 2010
2010	Swapan K Ghosh, BARC	Awarded the JC Bose National Fellowship, Department of Science & Technology, New Delhi
2011	Sudhakar Panda, IoP (earlier with HRI)	Erskine Fellowship, University of Canterbury, Christ Church, New Zealand, 2011
2011	Andreas Nyffeler (Visiting Prof.), HRI	Heinrich Greinarcher Award by University of Berne, Switzerland
2011	D C Kar, BARC	Homi Bhabha Science & Technology Award
2011	Amar Sinha, BARC	Homi Bhabha Science & Technology Award
2011	S Kannan, BARC	Homi Bhabha Science & Technology Award
2011	Archana Sharma, BARC	Homi Bhabha Science & Technology Award
2011	P V Ananthapadnabhan, BARC	Homi Bhabha Science & Technology Award
2011	R K Vatsa, BARC	Homi Bhabha Science & Technology Award
2011	R K Singh, BARC	Homi Bhabha Science & Technology Award
2011	D Ponuraju, IGCAR	Homi Bhabha Science & Technology Award
2011	T K Sharma, RRCAT	Homi Bhabha Science & Technology Award
2011	R B Grover	Lifetime achievement award by DAE
2011	R Balasubramanian, IMSc	Lifetime achievement award by DAE
2012	Sandeep Basu, BARC	Shanti Swarup Bhatnagar Prize for Science and Technology

2012	Ashoke Sen, HRI	Fundamental Physics Prize
2012	V K Aswal, BARC	Homi Bhabha Science & Technology Award
2012	P.D. Naik, BARC	Homi Bhabha Science & Technology Award
2012	NK Sahoo, BARC	Homi Bhabha Science & Technology Award
2012	Raghvendra Tewari, BARC	Homi Bhabha Science & Technology Award
2013	Ashoke Sen, HRI	D.Sc. (h.c.) Panjab University
2013	Dhiraj Bora	Kamal Kumari National Award for "Science & Technology"
2013	Anshuman Maharana, HRI	Ramanujan Fellowship of DST (2013)
2013	Rajesh Gopkumar, HRI	2013 TWAS (Third World Academy of Sciences) Prize
2013	Raj Gandhi	Intensity Frontier Fellowship of Fermilab, USA
2013	Ashoke Sen, HRI	M P Birla Memorial Golden Jubilee Award
2013	Aditi Sen De, HRI	BUTI Foundation Award of Indian Physics Association - 2013
2013	P K Kaw	Foreign Associate in the Royal Academy of Science, Arts & Literature, Belgium. DST Year of Science Professorship
2013	S Pradhan	BUTI Foundation Award - 2013
2014	Chandana Bhattacharya, VECC	India's Most Inspiring Women Engineers & Scientists" recognized by Engineering Watch for the year 2014.
2014	Sanjib Agarwalla	Young Scientist Award of the Indian National Science Academy (INSA), 2014.
2014	Swapan K Ghosh, BARC	Prof. R P Mitra Memorial Lecture Award, University of Delhi, New Delhi

Appendix 2: Monographs, books and chapters in books since 2009

Apart from books listed below, faculty has edited many conference proceedings. Edited conference proceedings are not listed here as that number is very large.

Authored books and monographs				
S. No.	Author/editors	Title	Publisher and year of publication	ISBN no
1.	Sitabhra Sinha, Arnab Chatterjee, Anirban Chakraborti, and Bikas K. Chakrabarti.	Econophysics: An Introduction.	Wiley-VCH, Berlin, 2010.	9783527-408153
2.	S.R. Shimjith, A.P. Tiwari and B. Bandyopadhyay	Modeling and Control of a Large Nuclear Reactor - A Three Time Scale Approach (A monograph)	Springer Germany, Lecture Notes in Control and Information Sciences Series, 2012	9783642-30588
3.	M. Ranjan, IPR	Applications of ion induced patterned substrates in plasmonics	Pan Stanford, Singapore, 2012	9789814-303750
Chapters in books				
1.	R.B. Grover	Nuclear Power for India's Energy Security: External and Internal Challenges	In "India's National Security: Annual Review" edited by Satish Kumar, Routledge India, 2014	9781138-796386
2.	R.B. Grover	National Framework for Governance of Nuclear Power	In India's Nuclear Energy Programme: Future Plans, Prospects and Concerns edited by R. Rajaraman, Academic Foundation, New Delhi, 2013	978933-2700307

3.	R.B. Grover	Nuclear Power Growth: An Option for Sustaining Indian Energy Requirements	India's Energy Security" edited by Ligia Noronha and Anant Sudarshan, Routledge. 2009	10:0415-468388
4.	R.B. Grover	Role of Nuclear Energy in India's Energy Mix	In "India in a Changing Global Nuclear Order" edited by Arvind Gupta, Academic Foundation, 2009,	9788171-887705
5.	P. V. Satyam et al. IoP	High resolution transmission electron microscopy studies of ion beam induced modifications in gold nanostructures on silicon: sputtering and enhanced diffusion	In "Synthesis and Engineering of nanostrcutures by energetic ions", edited by D. K. Avasthi and J. C. Pivin, Nova Publishers, 2011	9781616-682095
6.	P. Mukherjee, P. Barat, A. Sarkar, M. Bhattacharya, N. Gayathri, VECC	Microstructural Characterisation of Structural Materials of Pressurized Heavy Water Reactor,	In "Nuclear Materials", Michael P. Hemsworth (Ed.), Nova Science Publishers, 2011	978161-3240106.
7.	Abhijit Sen, IPR	Amplitude Death, Synchrony, and Chimera States in Delay Coupled Limit Cycle Oscillators,	In "Complex Time-Delay Systems, Understanding Complex Systems" edited by F.M. Atay, Springer-Verlag Berlin Heidelberg 2010.	103642-023282

8.	Ashwin J.et al, IPR	Atomistic Theory of Shear-Band Direction in Amorphous Solids	In "Fragility of Glass-forming Liquids" edited by A. Lindsay Greer, Kenneth F. Kelton&SrikanthSastry, Hindustan Book Agency, 2014.	9789380-250618
9.	M. Kakati and A.K. Das, IPR	Thermal plasma assisted techniques for synthesis of high temperature nanoparticles,	in New Nanotechniques, edited by A. Malik, Nova Science Publishers; New York; 2009	9781606-925164
10.	Prasenjit Sen, HRI	"Electronic shells and magnetism in small metal clusters" in the book titled "Aromaticity and Metal Clusters"	CRC Press – Taylor and Francis, LLC 2010	13:9781439-813348
11.	Ray P., ACTREC, TMC	Illustrating molecular events with light: a perspective on optical reporter gene.	In "Optical Imaging of Cancer", edited by Rosenthal & Zinn. Springer, New York, 2009.	9780387-938745
12.	Maru GB, et.al. ACTREC, TMC	Curcumin-mediated cellular responses in chemical carcinogenesis: in vivo studies.	In "Bioactive Foods and Extracts: Cancer Treatment and Prevention", edited by Watson RR and Preedy VR. USA: CRC Press, 2010.	9781439-816196
13.	Kode J and V Tanavade. ACTREC, TMC	Mesenchymal Stromal Cells and Their clinical applications.	In "Applications of Laser Flow Cytometry in Stem Cell Research and Tissue Regeneration", edited by Krishan A, H Krishnmurthy , Satish Totey. USA: Wiley, 2010.	9781453-748602

14.	Warawdekar U & Rita Mulherkar. ACTREC, TMC	Suicide gene therapy : a promising strategy for cancer gene therapy.	In "Cancer Gene Therapy", 2010.	9788130-804101
15.	Tanavde V and Jyoti Kode. ACTREC, TMC	Mesenchymal Stromal Cell Analysis	In "Flow Cytometry Lab Protocols: Protocols from the International Cytometry Workshops" edited by Awtar Krishan. USA: SC Publishers, 2011.	9780470-543986
16.	Chikne V and Shubhada V Chiplunkar . ACTREC, TMC	Role of probiotics in immune modulation and anti-tumor immunity.	IN "Health and Impact of Probiotics : Vision and Opportunities ", edited by G Balkrishan Nair & Yoshifumi Takeda. New Delhi: Elsevier , 2012.	9788131-232842
17.	Chiplunkar SV and S Shah. ACTREC, TMC	Infection, inflammation and cancer.	In "Infections and Cancers. Mumbai : Tata Memorial Centre", edited by Dhir Aruna Alahari & Sawant Sheela P. 2012.	9789380-251135
18.	Gupta N, et al. ACTREC, TMC	Nanoparticles for cancer vaccines.	Nanotechnology: Diagnosis and treatment of cancers. edited by Banerjee R. New Delhi: Society for Cancer Research and Communication. 2012.	9788184-871593
19.	Sarin R. ACTREC, TMC	Cancer Genetics	In "API Textbook of Medicine, Mumbai", edited by Y P Munjal. The Association of Physician of india.2012.	9789350-250747
20.	Chandrani, Pratik, and Amit Dutt. ACTREC, TMC	Domain Specific Targeting of Cancer.	In "Nuclear Signaling Pathways and Targeting Transcription in Cancer", edited by Rakesh Kumar. New York: Springer, 2014. Cancer Drug Discovery and Development.	9781461-480396

21.	S Basu, BARC	Impact of Current Medical Imaging Technologies on Individualized Patient-specific Cancer Management: A Clinical Perspective.	In Handbook of Personalized Medicine: Advances in Nanotechnology, Drug Delivery and Therapy. Pan Stanford Publishing 2014 (Pg 81-108)	9789814-411196
22.	Samuel A, Rajashekharrao B, Basu S.	Management of Differentiated Thyroid Cancer	In ITS Clinical Manual Of Thyroid Disorders. Elsevier Inc.	9788131-230442
23.	Basu S et al., BARC	Radionuclide Bone Marrow Imaging in Cancer Patients.	Radionuclide and Hybrid Bone Imaging. Springer-Verlag 2012. Pages 795-811	9783642-023996
24.	Basu S et al., BARC	Role of FDG-PET in Planning of Radiation Therapy.	PET and PET/CT: A Clinical Guide. 2nd edition. Thieme Medical Publishers.2009	9781604-061536
25.	Basu S et al., BARC	Role of FDG-PET in Infection and Inflammation.	PET and PET/CT: A Clinical Guide. 2nd edition. Thieme Medical Publishers.2009	9781604-061536
26.	Swapan K Ghosh, BARC	Chemical Reactivity Theory, Edited By P.K. Chattaraj	CRC Press (Taylor & Francis Group), Boca Raton, Florida, USA (Year-2009)	978-1-4200-6543-5
27.	Swapan K Ghosh, BARC	Aromaticity and Metal Clusters, Edited by P.K. Chattaraj	CRC Press (Taylor & Francis Group), Boca Raton, Florida, USA(Year-2011)	978-1-4398-1334-8
28.	Swapan K Ghosh, BARC	Quantum Trajectories, Edited by P.K. Chattaraj	CRC Press (Taylor & Francis Group), Boca Raton, Florida, USA(Year-2011)	978-1-4398-2561-7

29.	D. K. Maity, BARC	Role of computational chemistry in chemistry teaching	In "Chemical Education": Ed. S. Ladage and S. D. Samant (Narosha), 2012.	978-81-8487-197-5
30.	Susanta Lahiri , SINP	Advanced Trace Analysis	(2010) Alpha Science International	978-8184870299
31.	Debades Bandyopadhyay, SINP	Exploring Fundamental Issues in Nuclear Physics	World Scientific, Singapore (2012)	978-9814355728
32.	P. K. Sarkar, Samita Basu and Maitreyee Nandy, SINP	Accelerator and Radiation Physics	Narosa (2013)	978-8184871821
33.	Sitabhra Sinha, Arnab Chatterjee, Anirban Chakraborti and Bikas Chakrabarti, SINP	Econophysics: An Introduction	Wiley VCH (2010)	978-3527408153
34.	Bikas Chakrabarti, A. Chakraborti, S. R. Chakraborty and A. Chatterjee, SINP	Econophysics of Income & Wealth Distributions	Cambridge University Press (2013)	978-1107013445
35.	S. Suzuki, J.-I. Inoue and B. K. Chakrabarti, SINP	Quantum Ising Phases and Transitions in Transverse Ising Models,	Springer-Verlag, Heidelberg (2013)	978-3642330384
36.	Parongama sen and Bikas Chakrabarti, SINP	Sociophysics: An Introduction	Oxford University Press (2014)	978-0199662456
37.	P. Mitra, SINP	Symmetries and Symmetry Breaking in Field Theory	CRC Press, Taylor and Francis (2014)	978-1466581043
38.	Abhas Mitra, BARC	Einsteinian Revolution's Misinterpretation : No true black	In New Results and Actual Problems in Particle & Astroparticle Physics and Cosmology	978-981-4578-73-8

		holes, no information paradox, just quasi-static balls of quark gluon plasma	World Scientific (2014)	
39.	Abhas Mitra, BARC	Einsteinian Revolution's Wrong Turn: Lumpy interacting cosmos assumed as smooth perfect fluid, no dark energy, Debades Bandyopadhyay and eternal universe?	In New Results and Actual Problems in Particle & Astroparticle Physics and Cosmology World Scientific (2014)	978-981-4578-73-8
40.	S.R. Bharadwaj R. Mishra, M. Basu and D. Das , BARC	Thermochemistry of Thoria-based Fuel and Fission Products Interactions	Book 'Thoria –based Nuclear Fuels' edited by Dasarathi Das Springer-Verlag London 2013	978-1-4471-5588-1
41.	S.R.Bharadwaj, S. Varma, B.N. Wani, BARC	Electroceramics for Fuel Cells, Batteries and Sensors	Book 'Functional Materials' Edited by S. Banerjee and A.K. Tyagi Elsevier, London, 2012	978-0-12-385142-0
42.	E.M.V. Hoek and Asim K. Ghosh, BARC	Nanotechnology-based membranes for water purification	Edited book entitled, "Nanotechnology Applications for Clean Water"), William Andrew Publishers, 2009	978-0-8155-1578-4
43.	Asim K. Ghosh and P.K. Tewari, BARC	Next Generation Nanocomposite Ultrafiltration Membranes for Water Purification	Edited book entitled, "Nanotechnology: Recent Trends, Emerging Issues & Future Directions"Nova Publishers, New York, 2014	978-1-63117-567-1

Edited books excluding conference proceedings				
1.	P.K. Sahu, S.C. Phatak and Y.P. Viyogi	Quark Gluon Plasma and Hadron Physics	Narosa Publishing House Pvt. Ltd. 2009	9788173-199578
2.	T. Som and D. Kanjilal	Nanofabrication by Ion-Beam Sputtering: Fundamentals and Applications	Pan Stanford, Singapore, 2012	9789814-303750
3.	Gautam I. Menon and Purusattam	Computational Statistical Physics.	Texts and Readings in the Physical Sciences. Hindustan Book Agency, P 19 Green Park Extension New Delhi 110 016, 2011.	10: 9380250320 13: 9789380250328
4.	Sitangshu B. Santra∗ and Purusattam Ray Sitangshu B. Santra∗ and Purusattam Ray	Computational Statistical Physics	Texts and Readings in the Physical Sciences. Hindustan Book Agency, P 19 Green Park Extension New Delhi 110 016, 2011.	10: 9380250150 13: 9789380250151
5.	Sujata Ghosh∗ and R. Ramanujam	Logic and social interaction Logic and social interaction	Volume 177 of Synthese. Springer, Heidelburg, 2011. (Special Supplement No. 1)	0039-7857 (Print) 1573-0964 (Online)
6.	Hans van Ditmarsch, Rohit Parikh, and R. Ramanujam	Logic in India	Volume 40 of Journal of Philosophical Logic. Springer, Heidelberg, 2011.	0022-3611 (Print) 1573-0433 (Online)
7.	S.R. Shimjith, A.P. Tiwari and B. Bandyopadhyay,	Modeling and Control of a Large Nuclear Reactor - A Three Time Scale Approach	Springer Germany, Lecture Notes in Control and Information Sciences Series, 2012.	9783642-305887

8.	A.K. Tyagi	Advanced techniques for materials characterization	Trans Tech Publications, 2009	9780878-493791
9.	Kaushik, T.C.; Saxena, A.K. Ray, A.K.	Opening switch technology for pulsed power systems	Power Beam Society of India, New Mumbai (India); Bhabha Atomic Research Centre, Mumbai (India), 2010	81837-20579
10.	S. Banerjee and A.K. Tyagi	Functional materials: preparation, processing and applications	Elsevier publishers, 2012	9780123-851420
11.	Aggarwal, S.K.; Jaison, P.G.; Telmore, V.M	Elemental mass spectrometry in health sciences: current status and future needs	Bhabha Atomic Research Centre, Mumbai (India)	9788190-444231
12.	Swapan K Ghosh & Pratim K. Chattaraj (Editors)	Concepts and Methods in Modern Theoretical Chemistry: Electronic Structure and Reactivity	CRC Press (Taylor & Francis Group), Boca Raton, Florida, USA (Year-2013)	978-1-4665-0528-5
13.	Swapan K Ghosh & Pratim K. Chattaraj (Editors)	Concepts and Methods in Modern Theoretical Chemistry: Statistical Mechanics	CRC Press (Taylor & Francis Group), Boca Raton, Florida, USA (Year-2013)	978-1-4665-0620-6
14.	J.K.Sonber, T.S.R.Ch.Murthy, C. Subramanian R.C. Hubli and A.K. Suri, BARC	Novel processing methods for Ultra High Temperature Ceramics	IGI Global; (2013)	9781466640665
15.	Mrinal R. Pai, Atindra M. Banerjee, A. K. Tripathi and Shyamala R. Bharadwaj	“Fundamentals and appplications of the photoctalytic water splitting reaction”, in book Functional Materials: preparations, Processing and Applications	Edited by S. Banerjee and A. K. Tyagi, published by Elsevier, London, 2012.	978-0-12-385142-0

16.	Kant, T., Swaminathan, K. and Jha, D.K.	Laminates: Static Strength	Editrd by L. Nicolais and A. Borzacchiello John Wiley and Sons, New Jersey. Year: 2011.	978-0-470-12828-2.
17.	V. Grover and A. K. Tyagi	Inert Matrix Fuels: Materials for futuristic nuclear reactors	Nuclear Materials: New Research; Ed. Joseph N. Geddes Nova Publishers, New York	978-1-60456-131-9
18.	J. Prakash, S. K. Ghosh and D. Sathiyamoorthy	Silicon-based nanomaterials	Springer, 2013	978-1-4614-8168-3
19.	A. K. Tangirala, Siddhartha Mukhopadhyay, A. P. Tiwari	Wavelets Applications in Modeling and Control, Chapter 3, Volume 43, Control and Optimisation of Process Systems, Advances in Chemical Engineering	Ed. S. Pushpavanam, Academic Press, 2013	978-0-12-396524-0
20.	G.R. Dey	Transformation of Carbon Dioxide to useable Products through Free Radical Induced Reactions	Green Carbon dioxide: Advances in CO_2 UTILIZATION, G. Centi and S. Perathoner (Eds) John Wiley, USA, February (2014)	978-1-118-59088-1

Appendix 3: Involvement of faculty in editorial boards of journals; professional societies, important academic, scientific and policy making forums; and organization of conferences

In addition to information included in the two tables below, many from the faculty are actively engaged reviewing papers for National & International journal publications and in organization of National & International conferences.

Table 1: Details of Faculty Members serving in Editorial Boards at National / International Journals Publications

S. No.	Name of faculty	Role and journal	Period of service
1.	Arvind, V., IMSc	Editor of Computational Complexity Column of the Bulletin of the European Assoc. of Theoretical Computer Science	Jun 2011 – Mar 2014.
		Associate Editor of ACM Transactions on Comptation Theory	Feb – Mar, 2014
2.	Balasubramanian, R., IMSc	Chairman of Peer Review for the project SANKYA of SAG	Jan – Jan, 2014
3.	Geetha, T., IMSc	Reviewer of Mathematical Reviews	Oct 2012 – Apr 2013.
4.	Gun, S., IMSc	Reviewer of Mathematical Reviews	Jul 2008 – Mar 2014.
		Reviewer of Zentralblatt Reviews	Apr 2011 – Mar 2014.
5.	Kesavan, S., IMSc	Fellow of Forum d' Analystes Member of Editorial Board, Journal of the Kerala Mathematical Association	For life
	Kesavan, S., IMSc	Member of Editorial Board, Mathematics Newsletter,	Sep 2013 – Mar 2014

		Ramanujan Mathematical Society	
6.	Sinha, Sitabhra, IMSc	Member of Editorial Board of Frontiers in Fractal Physiology	July 2011-till date.
7.	D K Srivastava, VECC	Reviewer Physics Review Letters, Physics Review C and D, Physics Letters B, Nuclear Physics A, Journal of Physics G, Modern Physics, Indian Journal of Physics, Pramana,. Member-, Editorial Board, Physical Review C, January 2010-December 2012	For last 25 years. January 2010-December 2012
8.	P. Karmakar, VECC	Reviewer, Applied Physics Letters, Applied Surface Science, Radiation Effects and Defects, Advanced Materials Letters	2011-till date
9.	MukeshRanjan, IPR	Editorial Board Member of Journal of Materials Science and Surface Engineering	2013-till date
10.	Amita Das, IPR	Member of Editorial Board of Pramana	2013-till date
11.	S. D. Adhikari, HRI	Member of the editorial board of the periodical "Mathematics Newsletter" published by Ramanujan Mathematical Society. Member, Editorial board of the Journal of Indian Mathematical Society. Member, Editorial board of the Bulletin of Calcutta Mathematical Society.	2010 – till date January 2014 –till date 2013-till date
12.	Tapas Das, HRI	Member, Editorial Board of the Journal of Astronomy and Space Sciences, an International Journal published by Korean Space Science Society.	Early 2011 – till date

13.	Rukmini Dey, HRI	Member of Editorial Board of the International Journal of Physics and Mathematical Sciences, Centre for Info Bio Technology (CIBTech).2012	2012 - till date
14.	Arun K. Pati, HRI	Guest Editor for Special Issue for Quantum Information Processing (June 2012) Springer, Vol 11. Editorial Board Member of Journal ISRN Mathematical Physics (2011) Chief Editor of Journal of Quantum Information Science (JQIS) (2011).	June 2012 2011-till date. 2011-till date.
15.	Prasenjit Sen, HRI	Member of Editorial board for Journal "Physica Scripta."	2013-till date.
16.	Vaidya M. M., TMC-ACTREC	Editorial board member for Paediatric Biochemistry and World Journal of Stomatology	Since 2012
17.	Mahimkar M. B., TMC-ACTREC	Editorial Board member of Oral Oncology	Since 2011
18.	Gupta S., TMC-ACTREC	Associate Editor of the Journal "Journal of Integrated Omics- A Methodological Journal"	Since 2011
19.	Chilkapati M. TMC-ACTREC	Member international advisory board : SPEC 2014 , Karakow, Poland Member Scientific Advisory Committee 37th Annual meeting of Indian biophysics Society (IBS), Mumbai University	2014 2013
20.	Sandip Basu, BARC	**1.** European Journal of Nuclear Medicine and Molecular Imaging (Official journal of European Association of Nuclear Medicine) **2.** Nuclear Medicine	2008-till date. 2010-till date.

		Communications (Official journal of British Nuclear Medicine Society) **3.** Hellenic Journal of Nuclear Medicine: Joined on Invitation, as the Editorial Board Member of the journal **4.** American Journal of Nuclear Medicine and Molecular Imaging (Senior Editorial Board Member) **5.** Invited Guest Editor, PET Clinics of North America **6.** World Journal of Radiology **7.** World Journal of Gastrointestinal Pharmacology and Therapeutics **8.** The Scientific World Journal (Molecular Imaging Category) **9.** Current Molecular Imaging (Associate Editor) **10.** Invited Guest Editor, Indian Journal of Cancer **11.** Editor, Indian Journal of Nuclear Medicine	2010-till date. 2011-till date. October 2009 issue, April 2011 issue, April 2013 issue 2010-till date. 2011-till date. 2011-till date. 2012-till date. April-June 2010 issue 2010-till date.
21.	G Malhotra	1. Editorial Board Member, Clinical Nuclear Medicine 2. Editorial Board Member, BMJ Case Reports 3. Editorial Board Member, Medicine (Open access) 4. Editorial Board Member, Indian Journal of Nuclear	2010 -till date. 2012 -till date. 2014 -till date. 2014 -till date.

		Medicine	
22.	B L Malpani	Editorial Board Member, Indian Journal of Nuclear Medicine	2014-till date.
23.	Bikas Chakrabarti, SINP	Editorial Board Memember, European Physical Journal B: Condensed Matter & Complex Systems	2011-till date.
24.	Bikas Chakrabarti, SINP	Editorial Board Memember, Indian Journal of Physics	2010-till date.
25.	Bikas Chakrabarti, SINP	Editorial Board Memember, Journal of Economic Interaction and Coordination	2010-till date.
26.	Bikas Chakrabarti, SINP	Editorial Board Memember, Natural Science, Scientific Research Publishing	2009-till date.
27.	Anjan Kundu, SINP	Editorial Board Memember, Proceedings of Royal Society A	2012-2014
28.	Anand Badigannavar, BARC	Editorial Board Member of Electronic Journal of Plant Breeding	2012-till date.
29.	Jayshree Ramkumar, BARC	Editor Chinese Journal of clinical Medicine	2010-till date.
30.	Jayshree Ramkumar, BARC	Editor in Indian journal of advances in chemical sciences	2010-till date.
31.	S.R. Bharadwaj, BARC	Regional Editor Journal of Thermal Analysis and Calorimetry (Springer, Budapest)	2011-till date.
32.	A.K. Nayak, BARC	Editorial board member – Life Cycle Reliability and Safety Engineering	2012-till date.
33.	Asim K.Ghosh, BARC	Editorial Board Member, Journal of Polymer Materials	2014-till date
34.	Asim K.Ghosh, BARC	Editorial Board Member, International Journal of NanoScience and Nanotechnology	2012- till date
35.	Asim K.Ghosh, BARC	Editorial Board Member, International Journal of Nanotechnology and	2012- till date

		Applications	
36.	Asim K.Ghosh, BARC	Editorial Board Member, International Journal of Chemistry and Chemical Engineering	2012-till date
37.	Asim K.Ghosh, BARC	Editorial Board Member, International Journal of Chemistry and Applications	2012-till date
38.	Dipak K. Palit, BARC	Member, Editorial board, Journal of Chemical Sciences.	2008 - 2011.
39.	R. J. Kshirsagar, BARC	Member, Editorial Board, Indian Journal of Pure & Applied Physics	Jan. 2011 onwards

Table 2: Details regarding involvement of faculty in professional societies and other important academic, scientific and policy making forums

S. No.	Name of Faculty	Professional society or other forum
1.	R.B. Grover	Member, Atomic Energy Commission since 2011; President, Indian Society of Heat and Mass Transfer for the period 2009-13; Member, Board of Research in Nuclear Sciences since 2007; Member, DAE Science Research Council since 2014; Head of India's delegation to ITER Council since 2006; Sous-Sherpa to the Government of India for the Nuclear Security Summits in 2010, 2012 and 2014.
2.	Balasubramanian, R., IMSc	Chairman, National Board for Higher Mathematics; President of Cryptology Research Society of India, Kolkata; Chairman, Research Council of SAG during Nov 2013 – Mar 2014;. Member, Governing Council of Indian Statistical Institute , Kolkata during Nov 2013 – Mar 2014.
3.	Date, G., IMSc	President, The Indian Association for General Relativity and Gravitation during March 2014 – March 2016.
4.	Kesavan, S., IMSc.	Member, National Board for Higher Mathematics; Secretary (Grants) of Commission for Developing Countries (CDC) of the International Mathematical Union (IMU); Member, Steering Board, Indo-French Centre for Applied Mathematics (IFCAM); Member, Selection Committee, Abel Visiting Scholars Programme, International Mathematical Union during Aug 2013 – Mar 2014; Chair, Selection Committee, NANUM Travel Scheme for ICM 2014: West Asia and the Indian Subcontinent during Nov – Dec, 2013.

5.	Rajasekaran, G., IMSc.	Chairman, Board of Studies in Physics, CMI; Member, Academic Council of CMI; Convener, Indian National Science Academy (Chennai Chapter)
6.	Sinha, Sitabhra, IMSc	Adjunct Faculty, National Institute of Advanced Studies.
7.	Sunder, V. S., IMSc.	Member, Committee to conduct Peer Review of the Dept. of Mathematics at IIT, Madras in November 2013; Member, Sectional Committee of INSA for Math. Sciences during Jan – Mar, 2014.
8.	D K Srivastava, VECC	Member, Planning Committee, Science and Engineering Research Council, Department of Science Technology, for Schools on Nuclear Physics, 2010- now; Chairman – Member, Governing Board, UGC-DAE Consortium for Scientific Research, Indore, July 2012- ; Member, Committee to Review and Extension of Academic Autonomy of P. G. Department of Physics, Samabalpur University; Member, Peer Review Committee for IPR VISION on National Fusion Programme; Member, Project Management Board, India based Neutrino Observatory, 2013- ; Member, Selection Committee, KSKRA, 2000-, DAE BRNS; Member, Selection cum Search Committee for Vice Chancellor of Central University; Member, Apex Committee on Accelerator Science and Technology (ACAST), DAE, 2013; Member, Scientific Advisory Council, Raja

		Ramanna Centre for Advanced Technology, Indore, 2013-.
9.	Alok Chakraborti, VECC	Member, Board of Research in Nuclear Sciences (BRNS) – Advanced Technology Committee on Accelerators, Lasers, Nuclear Fusion, Cryogenics, Computers and Other Technologies; Member, Asian Committee for Future Accelerators (AFAD); Member, Standing Committee, Asian Forum for Accelerators and Detectors (ACFA); Member, Research Advisory Committee (RAC) SAMEER, Dept of IT, Govt. of India,;
10.	D Sarkar, VECC	Member of Senate, National Institute of Technology, Patna
11.	Sandip Pal, VECC	Member of Electronic measuring instruments, systems and accessories sectional committee, LITD 08 of Bureau of Indian Standard, 2013- ; Member of Indian Cryogenics Council, Eastern zone.
12.	G Mukherjee, VECC	Member, Nuclear Data Physics Centre of India (NDPCI); Adviser, International Network of Nuclear Structure and Decay Data Evaluators (NSDD).
13	S. Chattopadhyay VECC	Deputy-spokesman, International collaboration of the Compressed Baryonic Matter (CBM) experiment at GSI, Germany; Chairperson and member of several 'God-Parent Committees (GPC)", the topmost review committee of publications from STAR experiment, BNL, USA.
14.	S K Bandyopadhyay VECC	Member of Project Review Committee in UGC-DAE Consortium for basic sciences
15.	S Bhattacharya, VECC	Member, Pelletron-LINAC user committee; Member, DST evaluation committee for NAND Array; Member, DST evaluation committee for INGA array.

16.	Abhijit Sen, IPR	Fellow of American Physical Society; Member of Science and Technology Advisory Committee of ITER; Chair of International Tokamak Physics Activity Coordinating Committee; Member, Program Advisory Committee of KSTAR tokamak, S. Korea; Vice President, Div. of Plasma Physics, Association of Asia Pacific Physical Societies.
17.	M. Kakati, IPR	Executive Member, Power Beam Society of India
18.	Suryakant B. Gupta, IPR	Founder executive committee member - Indian society of particle accelerator [ISPA].
19.	Amita Das, IPR	Member of Program Advisory Committee of SERB, DST.
20.	S. Mukherjee, IPR	Vice-President; Plasma Science Society of India (2012-14); Member of Program Advisory Comm, DST-Instrumentation Development program
21.	Rao, Sumathi, HRI	Member, Board of Studies, School of Physics, Jawaharlal Nehru University, New Delhi Member, Academic council, IIIT, Allahabad Member, Academic council, MNIIT, Allahabad
22.	Gopakumar, R., HRI	Member, National Steering Committee for SERC School in theoretical High Physics (2011-Present) Member, Commission on Mathematical Physics, IUPAP, (2012). Member, External Review Committee, Physics Dept., NISER Bhubaneshwar, Feb. 2011.
23.	Dey, Rukmini, HRI	Adjunct Faculty of ICTS Bangalore (2011-2013)
24.	Adhikari, S. D. HRI	Adjunct Faculty of RKMV University, Belur (2012)
25.	Panda S. (Now at IOP)	Member, Board of Studies, CTP, Jamia Millia University, New Delhi Member, Executive Council, Central University of Orissa
26.	Gandhi,Raj, HRI	Member, Program Management Committee of Indian Neutrino Observatory Coordinator, Neutrino Physics Working Group of the Indo-US Project X Collaboration
27.	Sen, Ashoke, HRI	Member, International Advisory Board of ICTS-TIFR

		Member, Presidency Mentor Group, Presidency University. Kolkata
28.	Chiplunkar, S.V., TMC-ACTREC	Internal Expert Member, Research and Recognition Committee for Board of Studies in Bio-Chemistry, Mumbai University, 2009-10; Member, Research and Recognition Committee for Board of Studies in Biotechnology, Mumbai University, 2009-2014. Member BOS Life Sciences Mumbai University 2006-till date.
29.	Vaidya MM, TMC-ACTREC	Executive committee member for Indian Association of Cell Biology from 2013 to 2015;
30.	Dalal, S, TMC-ACTREC	Research Fellow of the Leukemia Society of America
31.	S. K. Apte, BARC	Member, Genetic Engineering Appraisal Committee, MoE&F, since 2009; Member, DBT Task Force on Environmental Biotechnology, since 2008; Member, DST-PAC Plant Sciences (2003-2012); Chairman, DBT Expert Group on Bio-fertilsers (2002-2006); Member RAP-SAC of CDFD, Hyderabad, Bose Institute, Kolkata, ARI, Pune; Member, INSA-Council (2006-2008); Member, NASI-Council (2009-2012); Convener, INSA Sectional Committee-VII (2009-2012) , Member INSA-SC-VI (2002-2005); Member, IASc Sectional Committee on General Biology, since 2013; India's Representative to UNSCEAR from 2014.
32.	G Malhotra, BARC	Secretary, Society of Nuclear Medicine, India 2012 -2013 Vice-President, Nuclear Cardiological Society of India 2014 onwards
33.	B L Malpani, BARC	Secretary, Society of Nuclear Medicine, India 2014-2015 Member, Safety Committee for Nuclear Medicine Facilities (SACNUM) since 2010

34.	Sandip Basu, BARC	Member of the RRMC-CCWHRI Steering Council constituted by the VECC, Calcutta (2008-till date)
35.	Swapan K. Ghosh, BARC	Member, Sectional Committee, Indian Academy of Sciences, Bangalore (2013-2015)
36.	Swapan K. Ghosh, BARC	Member, Sectional Committee, Indian National Science Academy, New Delhi (2011-2013)
37.	Swapan K. Ghosh, BARC	Member, CSIR Shanti Swarup Bhatnagar Prize Selection Committee (2013)
38.	Swapan K. Ghosh, BARC	Convener, Mumbai Local Chapter, Indian National Science Academy, New Delhi (2010-2012)
39.	Swapan K. Ghosh, BARC	Member, Academic Board & Adjunct Professor, University of Mumbai-Department of Atomic Energy Centre for Excellence in Basic Sciences (UM-DAE-CBS), Mumbai
40.	Swapan K. Ghosh, BARC	Vice President, Chemical Research Society of India, Bangalore (2009-2014)
41.	Swapan K. Ghosh, BARC	Member, Academic Council, Jawaharlal Nehru University, New Delhi (2009-14)
42.	Swapan K. Ghosh, BARC	Member, Board of Studies in Chemistry, University of Hyderabad (2010-2012)
43.	Swapan K. Ghosh, BARC	External Member of Senate, Indian Institute of Technology, Bombay (2013-2015)
44.	D. K. Maity, BARC	Member, Research and Recognition Committee for Board of Studies in Scientific Computing, University of Pune, till 2009.
45.	Dr. S. Mazumder, BARC	Served on the International Advisory Committee for SAS-2009 in Oxford
46.	Dr. S. Mazumder, BARC	Served on the International Advisory Committee for SAS-2012 in Sydney
47.	Abhas Mitra, BARC	Member of Scientific Advisory Committee Institute for Theoretical Physics and Advanced Mathematics Einstein-Galilei (Prato, Italy)
48.	Abhas Mitra, BARC	Member of International Astronomical Union (IAU), Life Member, Astronomical Soc. India, Indian Physics Association, Indian Nuclear Society.
49.	Dipak K. Palit, BARC	Member, Expert Committee of Women Scientists Scheme, DST (2008 – 2012).

Appendix 4: Awards and recognitions for students since 2009

CI	Name of the students	Award details
IoP	Bidisha Chakarbarty	India-Ireland FEMS student exchange fellowship, 2013
IoP	Sandip Garg	Best Poster Award in the 18thInternational Conference on Ion Beam Modification in Materials (IBMM), Qingdao, China, 2012
IoP	A. Ghosh	Best Micrograph Award (EMSI2012 meeting)
IoP	R.R. Juluri	Best Micrograph Award (EMSI2012 meeting)
IoP	Mamata Sahoo	DST Inspire Faculty fellowship: 2013
HRI	Nishita Desai	MCnet Short-Term Studentship, 2010
TMC-ACTREC	Richa Tiwari	Cell Signalling /Labmate excellence Award : The XXXVII All IndIa Cell Biology Conference on Cell Dynamics & Cell Fate, 2013
TMC-ACTREC	Mohd. Yasser	Best Essay Award, Indian Association for Cancer Research, 2011.
TMC-ACTREC	Ratika Kunder	Best poster award Global Cancer Genome Consortium, 2011
TMC-ACTREC	Crismita D'Mello	Carl Storm International Diversity (CSID) Fellowship, 2014
TMC-ACTREC	Ekjot Kaur	Best oral presentation Indian Association for Cancer Research, 2014
TMC-ACTREC	Shafqat Ali Khan	Best Oral Presentation Award at DBT-JRF Meet, 2013
TMC-ACTREC	Tanmoy Bhattacharjee	Best poster: Indo-US symposium Trends in Macromolecular Structures, 2011
TMC-ACTREC	Madhura Bhave	1st Prize in poster presentation : Indian Association for Cancer Research, 2012
TMC-ACTREC	Srikanta Basu	Best poster award Global Cancer Genome Consortium, 2012.
TMC-ACTREC	Ponam Kakade	Best Poster : National Conference on Glycobiology of Cancer; Lectins as Tool and Targets,2013
BARC	Deepa Rani	Dr. N. Ramadas Award for Best Paper in Nuclear Thyroidology in the 45th Annual conference of Society of

		Nuclear Medicine (India), 2013
BARC	Himal Bhatt	Award received in International synchrotron infrared workshop WIRMS 2013 held in Australia during Nov.2013.
BARC	Vinay Jain	Best poster award in 7th International conference on High Levels of Natural Radiation and Radon Areas. (7HLNRRA), Navi Mumbai, Nov 24-26, 2010.
BARC	Debes Ray	IUCr Young Scientist Award by International Union of Crystallography (IUCr) at International Conference on Neutron & X-ray Scattering (ICNX) 2009, held at Kuala Lumpur, Malaysia.
BARC	Debes Ray	Young Microscopy Scholar Award by International Federation of Societies for Microscopy (IFSM) at International Microscopy Conference (IMC17) 2010, held at Brazil.
BARC	Saurav K. Guin	Best Poster Presentation Award in the 64th Annual Meeting of International Society of Electrochemistry (ISE) held at Santiago de Queretaro in Mexico during September 8-13, 2013.
BARC	Saurav K. Guin	Best Poster Presentation Award in "ECHEMS 2014: Electrochemistry in Molecular Understanding" held at Wells in United Kingdom during June 17-20, 2014.
BARC	Ankur Saha	Awarded first poster prize in 14th ISMAS-WS 2011 at Tea County Munnar during November 7- 11, 2011.
BARC	Ankur Saha	Awarded Best poster award at the Twenty First DAE-BRNS National Laser Symposium (NLS-21), Feb. 6-8, 2013, B.A.R.C., Mumbai.
BARC	Ankur Saha	Awarded silver prize at DAE BRNS Symposium on Current Trends in Theoretical Chemistry (CTTC-2013), 26- 28 sep 2013, BARC, Mumbai.
BARC	Ankur Saha	Awarded Best poster award at DAE BRNS Twelfth Biennial Trombay Symposium on Radiation &

		Photochemistry (TSRP–2014), 06-09 January 2014 held at BARC, Mumbai
BARC	A.M. Banerjee	Best Paper Award ISMC 2010 (3rd International Symposium on Materials Chemistry) December 7-11, 2010 at BARC, Mumbai
BARC	A.M. Banerjee	Best Paper Award ISMC 2012(4th Interdisciplinary Symposium on Materials Chemistry) December 11-15, 2012 at BARC, Mumbai
BARC	Smt Jhimli Paul Guin	Received Dr. Hari Mohan Memorial Award for the best poster presentation in TSRP-2012, 4th-7th January, Mumbai
BARC	T L PRASAD	Received Chinnamaul Memorail prize and MH Shukla 1st prize for the best technical paper in International symposium (December 27-29, 2010) CHEMCON-2010 organized by Indian Institute of Chemical Engineers.