Evaluative Report of Institute of Physics

1 Name of the CI

Institute of Physics (IoP), Bhubaneswar

2 Year of establishment

Please see para 6 of the 'Profile'.

3 Is the CI part of the university

Yes

4 Names of programmes offered

IOP offers Ph.D. in Physical sciences. Please also see Appendix 1 of the profile, particularly with regard to IOP(NISER), which is function from the campus of IOP.

5 Interdisciplinary programmes

To encourage interdisciplinary research, all Physics disciplines at IOP are clubbed together under Physical sciences. 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, etc. Such cross-disciplinary works have led to novel insights and unexpected results. One such program 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, nano-science 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.

6 Courses in collaboration with other universities, industries, foreign institutions, etc.

For a list of collaborating institutions, please see Para 2.4.10 of 'Criteria-wise Inputs'. Occasionally, IOP faculty teach courses at other institutions, e.g. at Utkal University and IIT Bhubaneswar. Similarly, occasionally, short term courses are offered at IOP by faculty of other institutions, e.g. from Institute of Mathematics and Applications, Bhubaneswar.

7 Details of programmes discontinued, if any, with reasons

NIL

8 Examination System

Semester system

9 Participation of the department in the courses offered by other departments

CIs of HBNI have no rigid boundaries. Faculty and scholars of IOP occasionally attend courses offered by other CIs of HBNI, and vice versa.

10 **Number of teaching posts sanctioned, filled and actual (Professors/Associate Professors/Asst. Professors/others)**

Please see para 24 of the Profile.

11. Faculty profile with name, qualification, designation, area of specialization, experience and research under guidance

Please see Appendix 1

12. List of senior Visiting Fellows, adjunct faculty, emeritus professors

Please see para 26 of the 'Profile'.

13. Percentage of classes taken by temporary faculty – programme-wise information :

NIL

14. Programme-wise Student Teacher Ratio :

1:2.2 for delivering lectures courses forming a part of Ph. D programme. With regard to number of Ph.D. students per supervisor, UGC guidelines are strictly followed.

15. Number of academic support staff (technical) and administrative staff: sanctioned, filled and actual

Please see para 24 of the 'Profile'.

16. **Research thrust areas as recognized by major funding agencies**

IOP conducts basic research in Physics with possible applications to technology in several areas. The research is conducted at the frontiers of these areas. Conducting basic research on frontiers of science is a thrust area for the Department of atomic energy which is the main funding agency for IOP. Certain areas, such are nanotechnology, are also declared as thrust area for agencies such as DST which provides partial funding for IOP members, such as for conference support etc. There are ongoing projects under XIIth plan of DAE which are approved by Specialist Groups, and are at the frontier of respective areas. Funding in all these areas of R&D activities is provided by the Department of Atomic Energy.

For more details, please see para 3.1 of the 'Criteria-wise Inputs'.

17. Number of faculty with ongoing projects from a) national b) international funding agencies and c) Total grants received. Give the names of the funding agencies, project title and grants received project-wise.

Full funding is received from the Department of Atomic Energy and all the faculties are involved in one or more projects. Details of ongoing projects and

grants for IOP put together are given in Appendix 2.

In addition, there are following projects at IOP:

1) Prof. Sanjib Agarwalla, INSPIRE project of DST, project no: DST/INSPIR Faculty Awr/2012, IFA-PH-12, Amount Rs. 7 lakh for 2012-2013.

2) Prof. P.V. Satyam, DRDO Project: 2013 - 2015 (18 months)
Title: Micro-structural and compositional studies of GaN based thin Films and multi-layers by employing advanced electron microscopy, ion Scattering and X-ray methods techniques; Budget: Rs 10.0 lakh,

3) Prof. P.V. Satyam (PC), DAE-BRNS project with CSIR-Institute of Minerals and Materials Technology, Bhubaneswar,
Title: Graphene at metal and metal oxide interfaces; Budget: 25.0 lakh, PI: Prof. B. K. Jena, IMMT

4) Prof. P.V. Satyam (Co-PI), Indo US Science and Technology Forum - Joint Centers , Title: Nanostructure Genomics: Designing Functionality of 2-Dimensional Nanostructures and Nano-Bio Interfaces; Budget: 50 lakh, PI: Prof. S. K.Nayak, IIT BBSR

5) Prof. B.R. Sekhar, FLY Ash Utilization (DST)
FAU/DST/600(58)/2013-14, total project cost Rs. 15,71,697/

6) IOP is associated with several international projects such as LHC at CERN, FAIR (Germany), as well as INO project in India. These projects are coordinated at all-India level.

18. Inter-institutional collaborative projects and associated grants received

Pl. see para 17 above (No. 3 and No. 4)

19. **Projects funded by DST-FIST; UGC-SAP/CAS, DPE; DBT, ICSSR, AICTE, etc.; total grants received**.

It is worthwhile to mention that DAE supports research in universities through its own extramural funding agencies and HBNI faculty acts as collaborators.

For IOP, DST projects are listed in para 17 above (No. 1 and No. 5).

20. Research facility / centre with

- **state recognition**
- **national recognition**
- **international recognition**

IOP has no formal recognition from any agency.

21. Special research laboratories sponsored by / created by industry or corporate bodies

HBNI is essentially a research university and all research laboratories in IOP are sponsored by the Government.

22. Publications:

Please see para 3.3 of the 'Criteria-wise inputs'.

23. Details of patents

IOP has one patent. Please see Appendix 3. .

24. Areas of consultancy and income generated

Not Applicable. Please see para 3.4 of the 'Criteria-wise Inputs'.

25. Faculty selected nationally / internationally to visit other laboratories/ institutions industries in India and abroad

Visits by IOP faculty within India are very large. For international visits of IOP faculty members, please see Appendix 4.

26. Faculty serving in

a) National committees b) International committees c) Editorial Boards d) any other (please specify) 10 national Constituted Institutes

Please see Appendix 3 of the 'Criteria-wise Inputs.

27. Faculty recharging strategies (UGC, ASC, Refresher / orientation programs, workshops, training programs and similar programs).

HBNI encourages faculty to participate in and organise national and

international workshop and conferences, go to universities abroad for post doctoral fellowships and short term research assignments, act as consultants for developing countries under programmes sponsored by IAEA, participate in collaborative projects with universities in India funded by BRNS, participate in collaborative projects with laboratories abroad under various MOUs. Faculty also go on sabbatical to various institutions in India and abroad. All this helps to recharge the faculty.

28. Student projects :

- **percentage of students who have done in-house projects:** 100%
- **percentage of students doing projects in collaboration with other universities/ industry/ institutes:** 0%.

About 10-12 students from universities and other institutions carry out summer project works every year at IOP with various faculty members.

29. Awards / recognitions received at the national and international level by

- **Faculty**
- **Doctoral / post doctoral fellows**
- **Students**

Please see Appendix 1 and Appendix 4 of the 'Criteria-wise Inputs'.

30. Seminars/ Conferences/ Workshops organized and the source of funding (national/ international) with details of outstanding participants, if any.

Please see Appendix 5.

31. Code of ethics for research followed by IOP

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. In accordance with the guidelines of the DAE, adhering to highest ethical standards is one of the guiding values of IOP. Every complaint of malpractice or plagiarism received is investigated and appropriate action is taken.

32. Student profile programme-wise

Please see para 15 and para 28 of the 'Profile.'

33. Diversity of students

Please see Para 2.1 of the 'Criteria-wise Inputs'.

34. How many students have cleared Civil Services and Defence Services examinations, NET, SET, GATE and other competitive examinations? Give details category-wise.

Please see para 1.1.3 of the 'Criteria-wise Inputs. This question is not applicable to HBNI.

35. Student progression

Students join IOP for a Ph.D. and take up employment after completing the programme.

36. Diversity of staff

Please see para 2.4.3 of the 'Criteria-wise Inputs.'

37. Number of faculty who were awarded M.Phil., Ph.D., D.Sc. and D.Litt. during the assessment period

Nil

38. Present details of infrastructural facilities with regard to

a) Library: Please see para 4.2 of the 'Criteria-wise Inputs'. The library has adequate physical facilities such as reading-rooms, repography, internet and is stocked with number of books (15284) and other library resources (i.e. CDs/ cassettes, etc.). In addition the Department of Atomic Energy (DAE) has set up a consortium to subscribe 2405 journals through Science Direct and these are available to IOP.

b) Extensive internet facilities are available to staff and students

c) Total number of class rooms: 2 Lecture Halls. Class rooms are equipped with ICT facility. ICT available consists of the hardware, software, networks and media for the collection, storage, processing, transmission and presentation of information (voice, data, text, images) as well as related services.

d) Students' laboratories

Following laboratory experiments are available for students at IOP: Gamma-ray spectroscopy (Energy calibration, Identifying unknown source, Identification of spectral features, Attenuation experiment), Compton scattering - angle dependence , Temperature dependence of resistivity of metals and semiconductors , Muon life time measurement, Charged particle spectroscopy with semiconductor detectors , Thin film deposition, Experimental control through computers , Workshop training. In addition, students are also introduced to advanced research level experiments at the research facilities of IOP. This involves students visiting advance experimental laboratories of IOP (as mentioned below) where the methods are demonstrated.

e) Research laboratories

Experimental research facilities available at IOP:

i. Ion Beam Facilities: 3.0 MV Pelletron Accelerator (NEC-make) – MCSNICS ion sourc: Ion Beam Laboratory: Beam lines for RBS/Channeling, ERDA (End Station from NEC), PIXE, Implantation, and AMS are available, Surface science beamline, micro PIXE, 50 keV Low Energy Ion implanter – SNICS ion source, Focused Ion Beam (FIB) (Zeiss-make): 2 keV – 30 keV (in combination with FEGSEM) , Low Energy Broad Beam Ion Source (Tectra GmbH-make): 50 eV – 2 keV for ion etching work (ion source coupled with Prevac-make chamber) , Electron Cyclotron Resonance (ECR) ion source.

ii. **Microscopy Facilities:** 200 keV Transmission Electron Microscope (Jeol, Ultra high resolution), PP resolution: 0.19 nm , 2 – 30 keV Field Emission Gun based Secondary Electron Microscope with FIB attachment. Best resolution: 1.2 nm; attachment: EDS, GIS, Liftout, Raith, UHV–STM (this is an integral part of Omicrom MBE system), Scanning Probe Microscopes (VEECO-make), Large-area, High-precision Atomic Force Microscope (Asylum Research-make).

iii. Spectroscopy Facilities: X-Ray photoelctron Spectroscopy Facility (VG Scienta-make), Angle Resolved UPS facility (Omicron GmbH-make) , Ti:sapphire laser based up-conversion system (CDP-make), He-Cd laser (Kimon Koha-make) based Photoluminescence System (Edinburgh Instruments-make) with low temperature facility (Oxford Instruments-make), UV-VIS-NIR Spectrophotometer (Shimadzu-make), Fourier Transform Infrared Spectrophotometer (FTIR) (Thermo Nicole-make), Micro-Raman System (Jobin Yvon-make).

iv. Magnetic Characterization: SQUID–VSM based MPMS System (Quantum Design-make)

v. Thin Film Growth Facilities: CVD set-up (indigenously built), HV thin film deposition unit (Hind Hivac-make), UHV e-beam evaporation (Telemark-make 2×5.5 KW guns integrated with Excel Instruments-make UHV chamber), DC/RF magnetron sputtering (Excel Instruments-make coupled with Advanced Energy-make pulsed DC and RF power supplies), Molecular Beam Epitaxy (MBE) with RHEED, STM, 3 Knudsen Cells for evaporation of Ge, Au and Ag; e-beam evaporator (Omicron GmbH-make),Pulsed laser deposition unit (Coherent GmbH-make laser coupled with Excel Instruments-make chamber and optics), Langmuir Boldgett, Cluster Deposition Facility

vi: X-ray Based Analyzing Methods: Grazing Angle X-ray Diffractometer (GAXRD), Powder Diffractometer (Bruker-make), High-resolution XRD system with reciprocal space mapping (Bruker-make), 18 kW Rotating Anode based X-ray Reflectometry and X-ray Standing wave facility (with Rigaku-make X-ray system and a Huber-make 4-circle diffractometer), X-ray Fluorescence set-up

vii. Other Facilities:

Chemical Labs (with ductless fumehood (Esco-make), centrifuge, LB film deposition set-up (Nima-make), Spin coater, Milli Pore Water purifiers, LCR Meter), Furnaces: Rapid Thermal Annealing Unit, Low Vacuum Furnace, high vacuum furnace, Surface Profilometer (Ambios-make), Cyclic Voltameter set-up (Ecochemie B.V.-make) , Low energy Ion Milling Station , Probe-station, Transport Facilities , Plasma, Cleaner , Spectral Response Set-up, Physical Property Measurement System (PPMS).

39. List of doctoral, post-doctoral students and Research Associates

Please see Appendix 6.

40. Number of post graduate students getting financial assistance from the university.

All students pursuing Ph. D programme get financial assistance from the university.

41. Was any need assessment exercise undertaken before the development of new programme(s)? If so, highlight the methodology.

The syllabus for the course work for the Doctoral Program is decided with the aim of imparting a broad based education in advanced physics and reserach methodology. It is also planned that it will help a student not only in his/her doctoral reserach, but also enables him/her to become a good physics teacher irrespective of whether or not he/she takes up doctoral research. The syllabus is regularly discussed and revised depending on interaction with peers and feedbacks received from faculty and students.

Research topics for Ph.D. are chosen by the faculty and students keeping in view what are important in the relevant field, and what problems are of significance from basic research point of view as well as for possible technological applications.

42. Does IOP obtain feedback from

a. Faculty on curriculum as well as teaching-learning-evaluation? If yes, how does IOP utilize the feedback?

b. Students on staff, curriculum and teaching-learning-evaluation and how does IOP utilize the feedback?

c. Alumni and employers on the programmes offered and how does IOP utilize the feedback?

Obtaining feedback from faculty, alumni and employees is a continuous process. Feedback from students is obtained once every year at the end of the academic session. All feedbacks received is analysed for deliberation and decision. Introduction of new programmes and changes in syllabus are decided as needed.

43. List the distinguished alumni of the CI (maximum 10)

The list below includes those, who received a Ph.D. based on the work done at IOP, but prior to the setting up of HBNI.

Sl. No	Name
1.	Prof. Sudhakar Panda
2.	Prof. Bedanga Das Mohanty
3.	Prof D. Gaitonde
4.	Prof H. Mishra
5.	Prof. S. Naik
6.	Prof. D. Jatkar
7.	Prof. D. P. Mohapatra
8.	Prof. B. Dey
9.	Prof. L. Maharana
10.	Prof S. Mohapatra

44. Give details of student enrichment programmes (special lectures/ workshops/ seminars) involving external experts.

The lecture halls are equipped with modern audio-visual aids which help students in active communications with collaborators and other scientists. Web-seminars and online lectures are regularly used by students for their learning. The laboratories are modern, with frontier area research going on in many areas, allowing students to get trained in sophisticated techniques of advanced experimentation. Students regularly visit other laboratories and interact/ collaborate with experts in other institutions which helps in increasing their exposure to different areas of experiments. There are regular visits by experts in different areas from India and abroad, who give seminar/colloquia on current topics of frontier research. Conferences and workshops are regularly arranged where students get opportunities to interact with reputed scientists in different areas. Special advanced schools are arranged on topics of frontier research where students from IOP as well as students from other institutions (from India and abroad) attend extended lectures (for 1-2 weeks). These schools not only serve to train students in advanced topics of research, they also provide opportunities for students to have extended interactions with scientists of international repute. IOP students also attend important schools on advanced topics in India and abroad.

45. List the teaching methods adopted by the faculty for different programmes.

The first year course work involves lectures, home works, tutorials, and

examinations. In several courses projects are part of teaching. Laboratory course consists of standard experiments to teach basic techniques of experimentation along with advanced experiments to expose the students to research level experiments. A one month project is carried out by students, with each student getting attached to individual faculty members. These are meant to expose students to the research areas in different fields. Along with this course work, the teaching continues throughout the Ph.D. period of scholars in terms of various advanced courses offered by faculty members. There are also series of lectures given by visiting scientists on advanced topics. Journal clubs are arranged where students read up important papers from literature and present seminars. This helps in students getting exposed to new important topics and also improves communication abilities of students. Discussions over e-mails and Skype are regularly carried out, and with web-seminars, students are linked to the global network of learning process.

46. How does IOP ensure that programme objectives are constantly met and learning outcomes are monitored?

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.

47. Highlight the participation of students and faculty in extension activities.

Please see para 3.5 of the 'Criteria-wise Inputs'. Further, faculty and students at IOP are also involved in various outrerach programs. Some of these activities are described below.

Every year, National Science Day is celebrated at the Institute of Physics on a suitable day. The program is typically attended by about 150 school students from Bhubaneswar (both English medium and Oriya medium schools). The program consists of 2-3 popular level talks given by eminent scientists on frontier science topics at the Institute Auditorium. Following the popular talks, students visit IOP experimental facilities, as well as Demonstration Experiments at NISER Labs. A program of conducting Physics Open Discussions (POD) for school children as well as IOP(NISER) students is

carried out at the Institute of Physics. The aim of the program is to help the students discover the true spirit of "creative thinking" and develop the 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 is being carried out. Under this program, members of SCAAA along with participating scientists from IOP, visit villages of Odisha, where people and even students do not have access to modern educational facilities. Popular lectures are given at the villages (for village students as well as for other members of the community) using multimedia system with portable screen, generator etc. The programs end with night sky viewing sessions with two portable telescopes.

The Institute also regularly receives requests from various schools in Odisha and outside for visits to IOP. During the visits students are taken (in small batches) to different laboratories where faculty members, Research scholars, and Lab assistants join them for explanations of various facilities. Depending on time constraints, a discussion session and/or a popular lecture in science is also arranged for the students.

Several IOP members regularly give popular talks on frontier science topics at various colleges/schools in the country. This program is very active in the state of Odisha, in particular in Bhubaneswar Cuttack area. There are also regular joint popular talks in the rural children nurturing program of IMA (Institute of Mathematics and Applications) at Bhubaneswar which are also combined with night sky viewing with telescope. IOP Alumni association every year conducts science modeling competitions and occasionally also science quiz competitions for schools students, and debate competitions for college students.

48. Give details of “beyond syllabus scholarly activities”.

The faculty is continuously engaged in research necessary for meeting the mandate of the DAE. A significant percentage of this engagement is scholarly and results in good publications in peer reviewed journals. The students and faculty give lectures very frequently in various fora like national and international symposia, workshops, awareness programmes and colloquia. They interact on a regular basis with scientist and technologists of repute from the country and from abroad. They organise high level knowledge dissemination activities like organization of advanced schools under the aegis

of BRNS/ DST and other similar bodies.

49. State whether the programme/ CI is accredited/ graded by other agencies? If yes, give details.

Yes, by UGC

50. Briefly highlight the contributions of IOP in generating new knowledge, basic or applied.

Due to a very large volume of very high quality basic and applied research being carried out by the faculty and the students, the research output is excellent and this gets documented in the form of publications in international journals, patents and reports. A brief summary of some important scientific developments is provided below.

At the Institute of Physics, Bhubaneswar, front line research is carried out in the areas of theoretical and experimental condensed matter physics, theoretical high energy physics, quantum information, theoretical nuclear physics, and in relativistic heavy-ion collision experiments. The Institute is actively involved in the International collaborations at The Large Hadron Collider (CERN, Switzerland), Relativistic Heavy-Ion Collider (BNL, USA), at GSI (Germany), and other laboratories abroad. It is also participating in the India-based neutrino observatory (INO) program. Specific research achievements in different areas are as follows.

Theoretical Physics:

In theoretical condensed matter physics, certain important aspects of DNA replication process are studied using principles of physics. Constructive role of random noise is studied where it is shown that a feeble input signal can be magnified using noise in a suitable way. Studies of mesoscopic systems have been carried out, e.g. theoretical treatments of machines/engines at nanoscales have been developed from microscopic considerations. In theoretical Nuclear Physics, structure of nucleus with strange baryons is shown to be very different from normal nucleus. The gravitational waves from rotating neutron stars have been calculated. Various probes of quark-gluon plasma (QGP) studies in heavy ion collisions have been carried out, and implications of such a phase in the early universe and in astro-physics have been studied. In theoretical particle physics, studies of the Higgs Boson and searches for new physics in accelerators have been carried out. Understanding microscopic structure of matter in terms of strings is developed. Investigations have been

carried out of black hole physics as well as gravity and gauge theory correspondence. Evolution of universe and cosmic microwave radiation has been studied using recent data on microwave background. Experimental test of certain aspects of cosmic string formation theories have been carried out in table top experiments using liquid crystals. In quantum information, deeply conceptual aspects of quantum nature of particles have been explored and utilized for quantum information and quantum computation.

Experimental Physics:

In experimental condensed matter physics, patterning of Titanium oxide surfaces by ion irradiation is shown to produce nanostructures useful in efficient capture of solar energy. Interaction with circular DNA with these nano patterned surface is shown to give better surface bio-implant and increased DNA stiffness. Studies of electronic properties of superconductors and colossal magneto resistance materials have been carried out. High resolution photoelectron spectroscopy is used to show a temperature induced change from a metallic state to a Mott insulator phase in certain superconductors. Self assembly of nanostructures under ultra-high vacuum is studied using ultra-clean surfaces created by molecular beam epitaxy system. Embedded silver nanostructures are studied. Nanoscale pattern formation on semiconducting materials and their functionalization are investigated for use in solar cells, spintronics, photonics, and bio-physics. A physical property measurement system (PPMS) as well as a confocal micro photoluminescence Raman spectroscopy facility has been established at the Institute. An electron cyclotron resonance (ECR) facility dedicated for materials research is also being developed. In relativistic heavy-ion collision experiments, the STAR, ALICE and CBM collaborations are continued where investigations of QGP signals and searches for antimatter are carried out. Participation is continued in R & D for photon multiplicity detector (PMD) and time projection chamber (TPC).

Overall scientific contributions of the Institute can be summarized as follows. During the period of 2012-14, number of research papers published is about 160. Number of Ph.D.s awarded during this period is 15. The Institute has been contributing in a significant way towards quality human resource development in the form of a one year pre-doctoral course followed by the Ph.D. program. By now, more than sixty students (out of a total exceeding 150 students) who have done their Ph.D. at the Institute, are occupying faculty positions in almost all the leading research centers, IITs, Central and State Universities in the country.

51. Detail five major Strengths, Weaknesses, Opportunities and Challenges (SWOC) of IOP.

Strengths

1. The quality of students is very good because of very rigorous selection process adopted.
2. After a tough selection, the initial training imparted to the students in terms of one year rigorous course work is of very high standard.
3. The quality of facilities available is excellent, and the funding is very generous.
4. A large number of IOP graduates occupy faculty positions in various leading Institutions and Universities in India.
5. Besides the students, the faculty is also very strong, nationally and internationally known, and there is very strong peer pressure on both the sides to do better.

Weaknesses:

1. Ensuring very high quality sometimes leads to very low number of students.
2. Purchase of experimental equipments/repairs usually takes very long time due to the lengthy process of paper work involved. This leads to serious delays in research, especially in frontier areas.
3. In many important areas of research, faculty strength is sub-critical in IOP (due to limited faculty positions).
4. Number of faculty positions available in India is still not large enough to give a sense of security to students pursuing research, especially in basic sciences and mathematics. Due to this students sometimes leave Ph.D. program (or soon after it) to take other non-academic permanent jobs.
5. Percentage of women scientists is still very low, despite the fact that number of women getting into Ph.D. program is not that small. This is usually due to conflicting requirements of family care and highly demanding research career.

Opportunities

1. Opportunity to do high level research in frontier areas of basic sciences.
2. Opportunity to interact with scientist at national level and international level
3. Opportunity to get various forms of national and international recognitions in the form of fellowships and awards
4. Opportunity to develop various types of skills

5. Opportunity to do interdisciplinary research

Challenges:

1. To balance various types of responsibilities for the faculty
2. To ensure superiority in quality of research while doing doctoral research on large scale set ups.
3. To promote quality of research while maintaining a reasonable output of publications for researchers, especially, promoting leadership in research.
4. To strengthen Interface with industries in research areas. This requires initiatives from industries as well as a national initiative.
5. To evolve strategies for making research programs and research jobs more compatible with requirements of family care to promote gender equality in research so that qualified women can get appropriate jobs.

52. Future plans of the IOP

Expand the doctoral programme so as to utilise the full potential of the faculty and research infrastructure. Strengthen research activities in the existing areas while expanding in new frontier areas, especially promoting interdisciplinary research. Explore establishing connections with industries in experimental areas such as nano-technology, nano-bio-physics etc.

List of appendices (to be made available to the assessment team during their visit)

1. IOP: Appendix 1: Faculty profile referred to at para 11.
2. IOP: Appendix 2: Ongoing projects referred to at para 17.
3. IOP: Appendix 3: List of patents referred to at para 23.
4. IOP: Appendix 4: Visits of faculties to International Laboratories/ Institutions referred to at para 25.
5. IOP: Appendix 5: Seminar/ Meetings/ Conferences/ Colloquia referred to at para 30.
6. IOP: Appendix 6: List of doctoral students referred to at para 39.