Evaluative Report of Institute for Plasma Research

1 Name of the CI

Institute for Plasma Research (IPR), Gandhinagar.

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

IPR offers Ph.D. in physical sciences and engineering sciences. Please also see Appendix 1 of the profile.

5 Interdisciplinary programmes

Subject of research leading to Ph.D. is inter-disciplinary in many cases.

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

Ph. D. students can have two guides with one of them from a collaborating institution with whom HBNI has a formal MoU. For a list of collaborating institutions, please see Para 2.4.10 of 'Criteria-wise Inputs'. Additionally IPR has MoU with Gujarat Technological University, Nirma University and Devi Ahilya University.

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

This question is not applicable to IPR. CIs of HBNI have no rigid boundaries. Development of advanced technologies being pursued at IPR involves inter-disciplinary teams.

10 Number of teaching posts sanctioned, filled and actual (Professors/ Associate professor/ 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 (enclosed)

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

UGC guidelines with regard to maximum number of students, a teacher can guide are strictly followed. For course work forming a part of the Ph.D. programme, Student: Teacher ratio is 1:4.

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

The research areas at IPR can be broadly categorized into three activities:

- Studies on high temperature magnetically confined plasmas,
- Fusion reactor relevant Science and Technology development
- Basic experiments in plasma physics including Free electron laser, dusty plasmas and other nonlinear phenomena
- Industrial plasma processing and application

ADITYA is the first indigenously built tokamak of the country commissioned in 1989. Current work on high temperature magnetically confined plasmas is being conducted in tokamak **Aditya**. The plasma is formed by an electrical breakdown in an ultra high vacuum toroidal vessel and a current is inductively driven in the plasma. One has to use auxiliary heating schemes, since the efficiency to heat plasmas drops as the plasma temperature rises. Diagnostics like Thomson scattering for electron temperature measurement, ECE diagnostic for temperature profile measurement, soft X-ray camera and laser blow-off, are carried out on Aditya. Initial experiments led to the discovery of "Intermittency" at the plasma edge of tokamak machines which later was confirmed in many tokamaks around the globe. Aditya is currently getting upgraded

A steady state tokamak **SST-1**- the first of it's kind in India, has been just set up, to study issues related to energy, particle and impurity confinement during steady state operation. Plasma disruptions and vertical displacement episodes will be studied. Non-inductive current drive would sustain the plasma current, and different aspects of the current drive would be studied. The prototype fabrication of the components of the various subsystems of the tokamak has been completed, tested and integrated. SST1 magnets have been activated and the 1st plasma in SST1 was obtained in June 2013. Subsequent plasma experiments in SST1 relates to extending the plasma duration with enhanced current and magnetic field. With the plasma formation in SST1, India is put in the list of six nations globally, that have an operational superconducting tokamak.

Fusion reactor relevant science and Technology development is being pursued in IPR to augment technologies that are needed for converting energy in fusion neutrons to thermal energy. These reactor relevant studies deal with development of fusion grade material and coatings, development of loops having molten metallic liquid flowing through it, studying neutron interaction with materials and predicting life of these materials in neutron environment thorough modelling.

Basic experiments, involving relatively cooler, rarer and less complicated plasmas are being carried out to understand the various facets of plasma that are difficult to study in bigger systems. Stability and equilibrium of toroidal plasma in the presence of radio frequency waves and new current drive mechanism with these waves is being studied. Issues related to excitation, propagation and linear, nonlinear interaction of whistler and helicon waves are being studied in a Large volume plasma device -**LVPD**. Free electron laser experiments and experiments to study dusty plasmas are also conducted.

Equilibrium and non-equilibrium plasma properties can be exploited for societal

benefit. A multi disciplinary team of physicists, engineers and material scientists are working together to generate advanced material processing technologies. Commercial prototype of medical waste pyrolysis system, plasma nitriding system installation at IGCAR, supply of implantation system to IIT Kharagpur, are some of the major activities concluded by the group at the **FCIPT** (Facilitation Centre for Industrial Plasma Technologies) centre of IPR. A large number of technologies developed in FCIPT are transferred to private technology transfer partners for benefitting the society.

Funding in all these areas of R&D activities is provided by the Department of Atomic Energy.

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 IPR put together are given in Appendix 2.

18. Inter-institutional collaborative projects and associated grants received

India is participating in the ITER project coming up at Cadarache, France as an equal partner. India could become a member of ITER project on the basis of technologies developed at IPR and now IPR is the lead Institution for India's participation in ITER. In order to meet ITER deliverables, ITER - India is a special project of IPR under an Empowered Board, which is the domestic agency to procure the in-kind packages for ITER and deliver.

IPR is also associated with several other international projects including LIGO – USA.

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

Nil.

20. Research facility / centre with

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

IPR houses Aditya and SST-1, which are national facilities. In addition there are several state of the art research facilities in the areas of plasma physics at IPR, which are being used by researchers form Universities and Academic Institutions in India. Developing of new materials and processes needed for fusion, modern materials characterization facilities, development of plasma based technologies for societal benefit, etc., are also being pursued at IPR.

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

HBNI is essentially a research university and research output of its CIs including IPR is deployed in IPR itself for setting up advanced facilities. Based on research done at IPR, India has been able to join ITER and now IPR is using its expert base to design and manufacture equipment for ITER.

IPR has also set up **FCIPT** and this centre spearheads IPR's efforts for transfer of technologies for societal benefit.

All research laboratories in IPR are sponsored by the Government for the purpose of deployment in the industry.

22. Publications:

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

23. Details of patents

A number of inventions have been patented. Please see Appendix 3 for a list.

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

IPR faculties are well known for their work both nationally and internationally. Please see Appendix 4 for visits abroad. Vists within India are very large and are not reported here.

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 and BRFST, participate in collaborative projects with laboratories abroad under various MOUs. 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/ institute:** 0%

Situation in IPR is actually reverse of what is there in other universities. More than 200 UG/PG students from other universities come every year to IPR for carrying out their project works.

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

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

Please see Appendix 1 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 IPR

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 IPR. 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 Defense 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

IPR offers Ph.D. and after Ph.D. students find employment elsewhere. Students joining Technical Training Programme at IPR join IPR as employees and some of them come back to enroll for Ph.D.

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 (24369) 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 IPR.

b) Extensive internet facilities are available to staff and students

d) One Seminar Hall, Two lecture halls with all ICT facilities, Six Video Conference Facilities, and Two class rooms.

e) Students' laboratories Yes

f) Research laboratories Yes

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 perusing TTP and Ph. D programme get financial assistance from the university. After completing TTP, students become employees and get salary.

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

Please see para 1.1.2 of the 'Criteria-wise Inputs.

42. Does IPR obtain feedback from
a. faculty on curriculum as well as teaching-learning-evaluation? If yes, how does IPR utilize the feedback?
b. students on staff, curriculum and teaching-learning-evaluation and how does IPR utilize the feedback?
c. alumni and employers on the programmes offered and how does IPR 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 and fed to an apex committee 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 IPR, or are from the Technical Training Programme, but prior to the setting up

of HBNI.

Sl. No	Name	Designation
1.	Prof Dhiraj Bora (PRL/IPR-PhD)	Director – IPR
2.	Prof Shishir Deshpande (PRL/IPR-PhD)	Project Director – ITER India
3.	Prof Ratneshwar Jha (PRL/IPR-PhD)	Dean - IPR
4.	Dr. D Chennareddy (PRL/IPR-PhD)	Associate Dean – Infrastructure
5.	Prof Subroto Mukherjee (IPR-TTP/PhD)	Associate Dean – Academics
6.	Dr Subrat Pradhan (IPR-TTP/PhD)	Team Leader – SST1
7.	Prof Sudip Sengupta (IPR-PHD)	Member – Theory Group
8	Dr Rajaram Ganesh (IPR-PhD)	Member – Theory Group
9.	Dr N Venkatramani (PRL/IPR-PhD)	Entrepreneur
10.	Dr KS Ganesh Prasad (PRL/IPR-PhD)	Entrepreneur

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

IPR regularly hosts international experts to give seminars in their field of specializations. Several interaction meetings/workshops have been organized at IPR during last five years for utilization of the various state-of-the-art facilities. In addition IPR has hosted the prestigious ITER School on RF, Non-Linear Dynamics workshop, NEEM 2013, etc. where several renowned international experts gave lectures to the selected students in the School.

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

Besides standard class room teaching, interaction though discussions in laboratories.

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

Technical Training Programme prepares students for a lifelong career in IPR. Their successful outcome is demonstrated by the success of development of technologies which has enabled India to set up SST-1 and join ITER. The programme has seen continuous evolution over the years in terms of updating of syllabus. 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. The expected outcome of TTP is to equip its graduates to apply fundamental knowledge of fusion science and engineering in day to day working in units of the IPR.

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.

IPR celebrates Science Day with full enthusiasm. Children of local schools are being brought to IPR and IPR faculties and students spend their day in interacting with them by showing them small experiments, models, showing laboratories, etc. to arise in them interest in science. IPR also has frequent student visitors from schools and colleges which and they spend the entire day interacting with the students. IPR faculties take part in refresher courses which makes physics teachers of colleges in Gujarat aware of recent advances plasma sciences and allied subjects. Through Board of Research in Fusion Science and Technology (BRFST), IPR faculties go to various institute/university in the country and give talks related with popularizing plasma science and research. IPR students are encouraged to go to their parent university (from where they graduated) and talk about plasma research. Please also see para 3.5 of the 'Criteria-wise Inputs'.

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 BRFST/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 IPR 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. This has led to development of reactor and reactor relevant technologies, technologies benefitting the society and trained manpower.

Trained manpower generated at IPR is from the HBNI supported research scholars and DGFS scholars program. Research scholars primarily come with degree in MSc (Physics) and MTech. They undergo a rigorous coursework followed by research leading to PhD degree. IPR has an inhouse technical training program where fresh graduates are trained for one year leading to a job. IPR faculties also collaborate with faculties of other universities for projects funded by BRNS, BRFST, DST, etc., and help the university faculty with their research at the university. This leads to trained manpower generation in various places across the country.

Some of the notable contributions of IPR towards excellence in plasma research are in discovery of intermittency in tokamak plasma – first time observed in Aditya tokamak; Spread F (ionosphere) and Electro jet simulation in lab; Electron Temperature Gradient modes in Large Volume Plasma Device. In the field of super conducting magnet technology, SST1 magnet joints have the lowest value in world and first time two phase cooling of superconducting toroidal field coils in tokamak is shown. Theory of laser matter interaction, dust levitation, toroidal non-neutral plasma confinement are other major contributions to plasma science. Creation of FCIPT to transfer IPR knowhow in plasmas for benefitting the society are other novel contributions of the institute.

The notable contribution of IPR towards fusion science and technology got further acknowledged when the international fusion communities flagship program ITER made India join as a full partner with IPR being the domestic

agency. In order to meet ITER deliverables, ITER - India is a special project of IPR under an Empowered Board, which is the domestic agency to procure the in-kind packages for ITER and deliver. This also paves way for India's forthcoming domestic program towards building a DEMO.

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

Strengths

1. The quality of students is very good because of very rigorous selection process adopted. Since a vast majority of the students are scientists recruited by a tough selection process, a very high level of research output is ensured. This is contrary to the general trend seen elsewhere where students not finding employment are taking up research.
2. After a tough selection, the initial training imparted to the students is of very high standard.
3. The quality of research and infrastructural facilities available is very good.
4. The funding is very generous.
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 in some of the disciplines.
2. The embargo on supply of some items has resulted in lack of some of the sophisticated analytical equipment. This results in delays in research as alternate equipment has to be developed or innovative techniques have to be used for getting results.
3. Doctoral programme in engineering sciences has started expanding only in recent years. Faculty looks at themselves as scientists first and give lower priority to mentoring students. This is expected to improve over the years as faculty takes more and more students.

Opportunities

1. Opportunity to do high level research having immediate application in national programmes.
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 balance between various types of responsibilities for the employees enrolled as students.
3. To publish results of research on strategic topics without compromising classified nature of information.
4. To ensure superiority in quality of research while doing doctoral research on large scale set ups.

52. Future plans of the IPR.

Expand the doctoral programme so as to utilise the full potential of the faculties and research infrastructure. 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.

Particular emphasis will be given to develop qualified human resources (both scientists and engineers) required for the rapidly developing field of Fusion science and engineering in the country.

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

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