

Issue 08  
August 2016

# The Fourth State

Newsletter of the Institute For Plasma Research, Gandhinagar, Gujarat (India)

3rd Anniversary Issue

## DAE Group Achievement Award (2014-15)

IPR (TBM Group) & IGCAR (Materials Group) was jointly conferred with the **DAE Group Achievement Award (2014-15)** for the joint group activity titled **"Development of Indian Reduced Activation Ferritic Martensitic (IN-RAFM) Steel for India's Test Blanket Module (TBM) Program in ITER"**. This award was conferred in recognition of this Group's outstanding contributions to the Departmental programme under DAE (Excellence in Science, Engineering and Technology) Award Scheme. In view of this, a small function was arranged at IPR Seminar Hall to felicitate the team members from IPR for this DAE Group Achievement Award. There were 31 members in the group of which eight members were from IPR. The team from IPR comprised of Chandra Sekhar Sasmal, Shiju Sam, Atikkumar N Mistry, Narender Singh, Atul Kumar Prajapati, Jignesh Chauhan and Hardik Tailor who worked under the leadership of Dr. E. Rajendrakumar.

During the function Director, IPR distributed awards to them which consisted of a memento and a citation. The Director while congratulating the team said that this function was organised so that it could excite and motivate other groups in IPR. Professor Kaw also congratulated the whole group for their achievement. Shri. E. Rajendra Kumar, Apex-3 leader, took the opportunity to thank Prof. Kaw, Prof. Bora, the technical staff as well non-technical staff of IPR for their constant support.



## SST-1 News

As a part of routine maintenance of SST-1 subsystems, a double walled vacuum insulated LN<sub>2</sub> cryogenic lines of various sizes used for LN<sub>2</sub> thermal shield, cold box LN<sub>2</sub> heat exchanger, Purifier, Current feeder 80 K shield and IFDC sub-systems of SST-1 was in-house fabricated, tested and installed. The vacuum/evacuation, MLI wrapping, welding and assembly of this line was done at about 12 meter of height. Due to aging and thermal cycles experienced, many leaks were developed in old transfer lines. This resulted frosting on outer surface of transfer line and excessive loss of LN<sub>2</sub>. Replacement of new lines will reduce the LN<sub>2</sub> loss and ice formation on the outer surface. In parallel to this, in-house developed electrical isolators for liquid Helium hydraulics were also successfully operated in the previous experimental campaign of SST-1.



(L-R) Frosted cryogenic lines, Puppet valve assembly and In-house developed isolators



Gleeble 3800 is a thermomechanical simulator system used for high temperature material testing and material process simulation studies. Gleeble mechanical system is a complete, fully integrated hydraulic servo system capable of exerting as much as 10 tons of force in tension and 20 tons in compression.

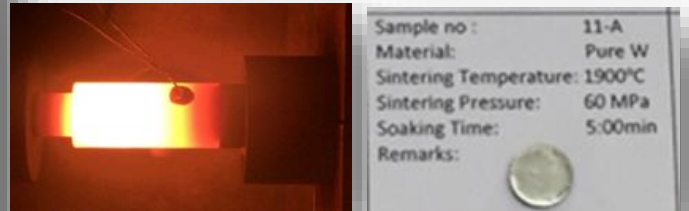
Displacement rates as fast as 2000 mm/sec can be achieved in a Gleeble 3800 system. The Gleeble direct resistance heating system can heat the specimen at rates of upto 10000 °C/sec, or can hold steady-state equilibrium temperatures. Experiments up to 2300°C temperature can be performed using this system. Gleeble 3800 system at IPR is extensively used for diffusion bonding studies, brazing studies, thermal fatigue tests, sintering Studies, hot deformation tests, high temperature tensile tests, miniature tensile tests, welding studies, etc.



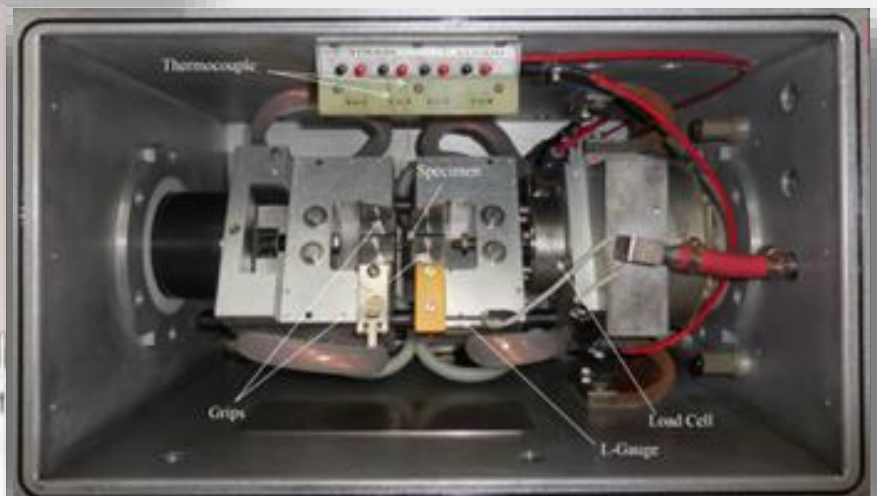
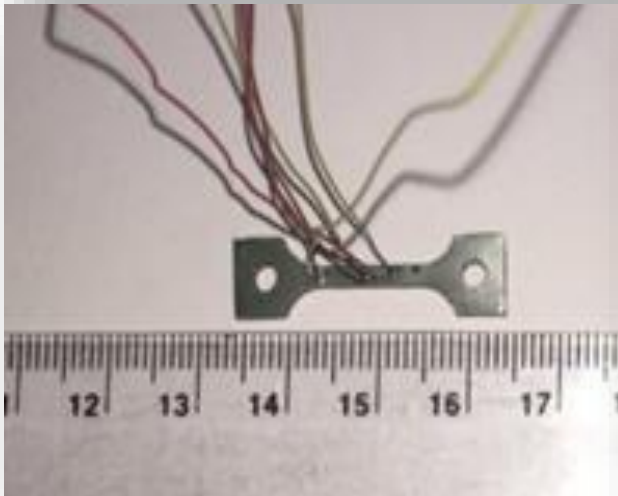
The Gleeble 3800 thermomechanical simulator system



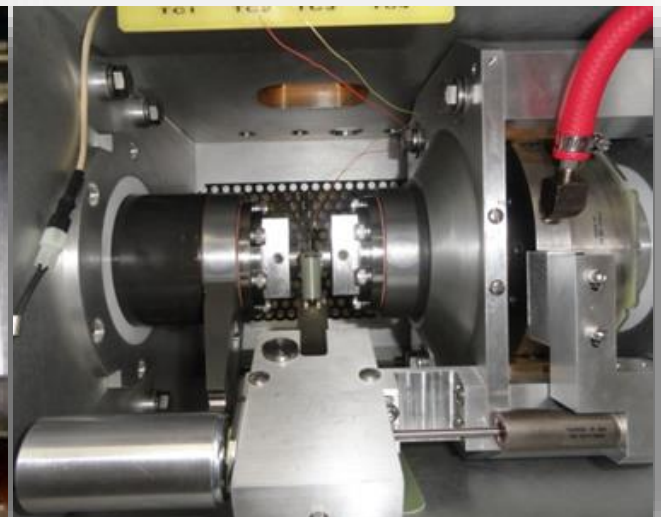
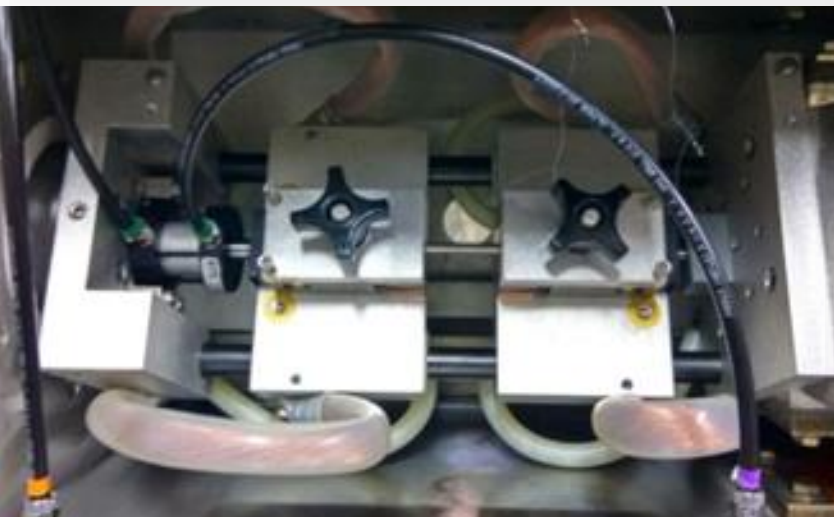
(L) Diffusion bonding experiment at Gleeble machine (R) Diffusion bonded specimen



(L) Tungsten sintering experiment and (R) the sintered pellet



(L) Thermocouple Welded Tungsten Miniature Sample (R) Miniature Tensile Tests Setup



(L) Nil Strength Tests Setup (R) Hot Compression Setup



At the onset of the monsoon season, welcoming the drizzling, the Environment day was celebrated at IPR on 7th July 2016. The tree-plantation drive and distribution of saplings was inaugurated by Prof. Bora, followed by plantation by employees from various groups of the institute. Approximately 1500 saplings of common as well as medicinal plants were distributed to the employees of IPR at the campuses of ITER-India, FCIPT and IPR. There was whole-hearted participation from the staff in the tree plantation event at IPR campus as well as for carrying home saplings to make their own gardens ! Below are a few images from the event.





Mr. Laban Coblenz, Head of Communication at ITER Organization, France visited India during 27-29 June 2016. He visited IPR/ITER-India on 27 June 2016 and a press conference was held at IPR where Mr. Coblenz gave an overview on the progress of ITER project and Director, IPR conveyed the progress in the Indian participation to the ITER project. Mr. Coblenz said during a press briefing at IPR that India has been one of the most valuable partners among consortium members -- US, China, European Union, Japan, Russia and South Korea -- who have been delivering components on time.

Mr. Coblenz further visited Bangalore on 28th June to see the In-wall shielding manufacturing at Avasarala Technologies Ltd. as well as to address a press conference. He also visited L&T Heavy Engineering, Hazira on 29 June 2016 to see the progress in Cryostat Manufacturing. Mr. Coblenz was quite impressed with the developments at ITER-India lab and the manufacturing progress in Indian Industries. Mr. Coblenz said during the press briefing at IPR that India has been one of the most valuable partners among consortium members -- US, China, European Union, Japan, Russia and South Korea -- who have been delivering components on time.



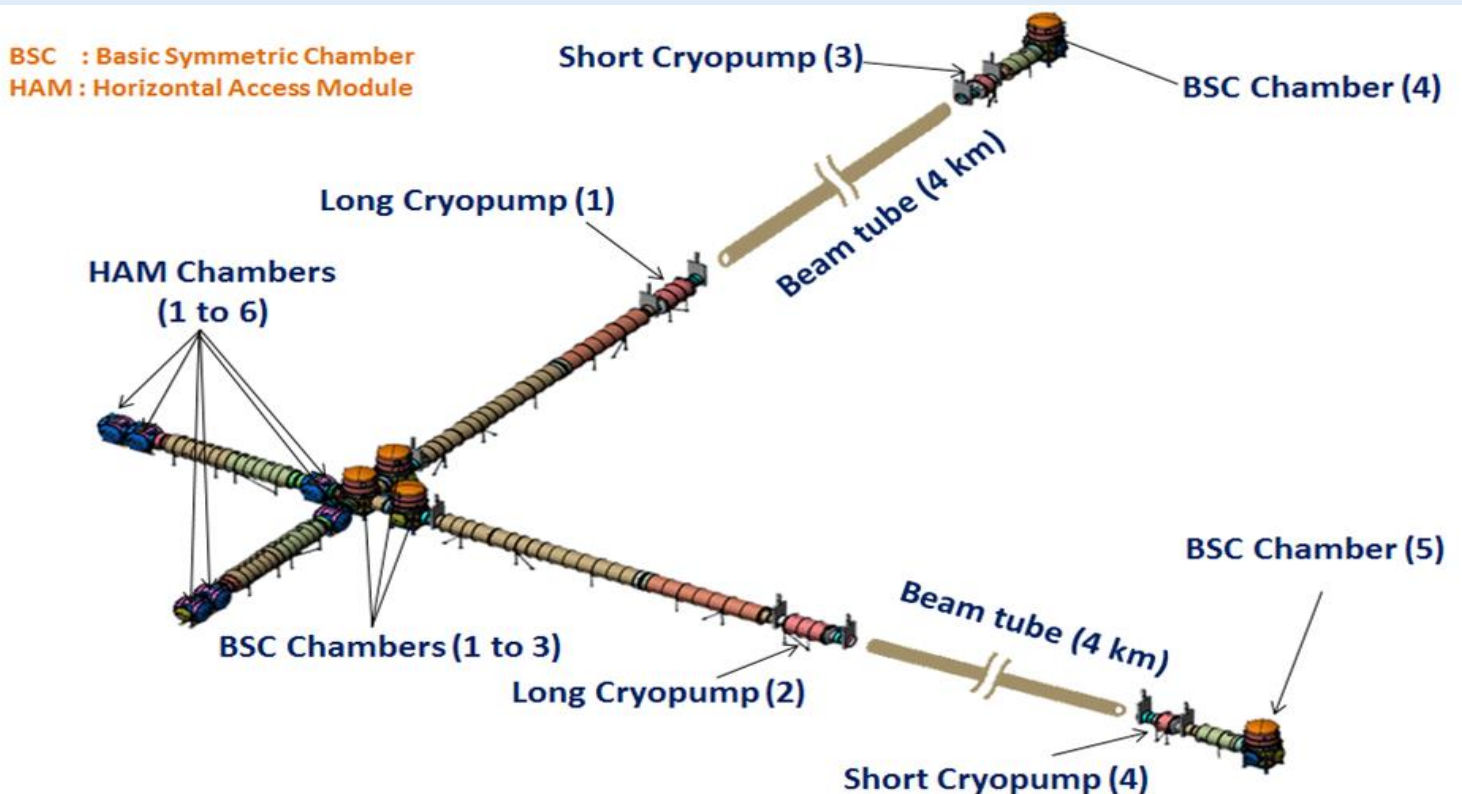
The press conference conducted by ITER-India during the visit of Head of Communication of ITER Organization to IPR.

## LIGO-India Project

AEC Chairman, Dr. Sekhar Basu had invited the major participant institutes (IPR, RRCAT & IUCAA) on 5th July 2016 at DAE office to review the current status of preparedness of the LIGO-India project.

From IPR, Prof. Dhiraj Bora (Director IPR), Dr. Ziauddin Khan (Project coordination, LIGO-India IPR) and Mr. Karmesh Mehta (Civil engineer) participated in the meeting. Apart from few presentations from IUCAA and RRCAT, IPR had presented the activities carried out in last three years. IPR presented the activities carried out in the field of Infrastructure, Vacuum system and DAC system.

The activities carried out till now for realization of LIGO-India project was highly appreciated by Chairman himself followed by other participants. Chairman has assigned Infrastructure activities to DCSEM, an infrastructure unit of DAE followed with coordination from IPR in design and finalizing the activities. The overall LIGO-India vacuum system is shown in the figure below.





The vacuum chamber for plasma production was installed at Pulsed Plasma Accelerator Laboratory at CPP-IPR. The chamber consists of an electrode chamber having a co-axial electrode assembly, and a target chamber where the material study will be carried out. Thereafter, we have installed the vacuum pumping system, which consists of a Turbo-Molecular pump (TMP) backed by a rotary pump and another rotary pump at a distant port from the TMP. We have achieved a pressure of  $2 \times 10^{-6}$  mbar. Very recently, we have successfully connected a 100 kJ bank to this system and generated plasma.



Images of the Pulsed Plasma Accelerator system at CPP

## Technology Transfer - Nano Powder

Metal oxide nano powders have immense applications especially in pharmaceutical, paint, automobile industry etc. These are high value powders (over 10 times the value of micron size powders) and are in high demand for specific applications. In consequence to the Workshop on Thermal Plasma Technology conducted at FCIPT in April 2016, FCIPT had received technology transfer requests for different applications, one of which was for metal oxide nano powder production by plasma processing. Eventually, IPR had transferred the nano-powder production technology (patent pending) on a non-exclusive basis to an Ahmedabad based company, M/s Plasma & Vacuum Technologies (PlasVac).

The agreement was signed on 8th July 2016 between IPR and PlasVac at Director's office, IPR, Bhat, Gandhinagar. PlasVac has plans for immediate commercialization of this product in order to make this technology penetrate into the market within the next couple of years.



The nano-powder technology transfer documents being exchanged between Dr. S Mukherjee and Dr. Venkat Ramani



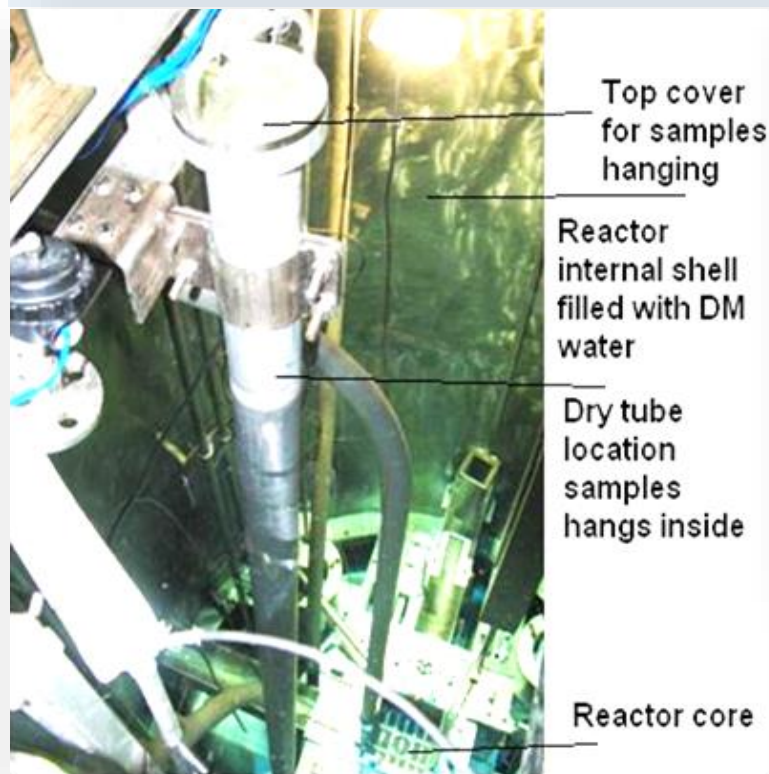
Dr. N Ramasubramanian, Dr. Mukesh Ranjan and Dr. Balasubramanian delivered lectures on "Application of Plasma in Life Sciences and climate change" to various university faculties at the Human Resource Development Centre at Saurashtra University, Rajkot. These lectures were delivered under the UGC-HRDC refresher course 212 in Life Sciences for faculty from various universities and colleges from all over India. The motivation was to upgrade the faculties with current interdisciplinary science research. Prof. Kaladhar Arya (Director UGC centre) thanked the speakers from IPR and the lectures and their interaction with the participating faculties was also appreciated.



Dr. Balasubramanian (L) and Dr. Ranjan (R) delivering lectures at the refresher course at Saurashtra University

### Development of Indigenous Insulation Materials for HTC Magnets

As a part of Research and development activity an indigenous insulation materials (GFRP) applicable for future fusion superconducting machines under high neutron resistance withstand capability, a joint collaboration with IGCAR, Kalpakkam has been established. Under this collaboration, GFRP (Glass Fiber Reinforced Plastic) material G-10 CR grade was irradiated in the KAMINI fission Reactor at IGCAR, Kalpakkam, India. Neutron flux level at irradiation point was kept as  $2.40 \times 10^8 \text{ n/cm}^2\text{s}$  (distance from reactor core  $\sim 18 \text{ cm}$ , dry tube location). Total Dose rate (mR/hr) measured during irradiation in Breakdown strength samples: 195.05, in tensile samples: 24.82 and & in Shear samples: 34.11. No significant degradation were observed in mechanical (2 -3 %) and electrical (2 %) properties in developed neutron irradiated GFRP insulation system. An indigenous Glass fiber composite insulation material has been experimentally validated up to  $10^{17} \text{ n/m}^2$  neutron fluence and radiation resistance up to a dose of  $6 \times 10^4 \text{ R/hr}$ .



(Above) GFRP insulation material samples for testing (1) Breakdown strength (2) Shear strength (3) Tensile strength.

(Left) Experimental setup in the KAMINI Reactor

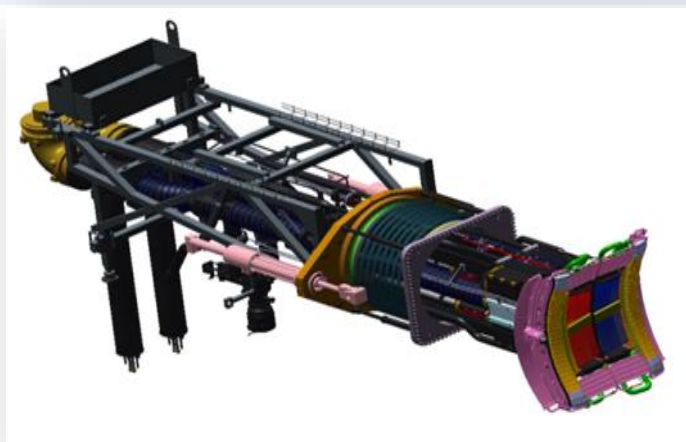
### Past Events @ IPR

- ♦ **Mr. G. Veda Prakash**, Institute for Plasma Research, Gandhinagar, gave a talk on "Compact Pulsed Power using Liquid Dielectrics" on 28th June 2016
- ♦ **Mr. Shrichand Jakhar**, Institute for Plasma Research, Gandhinagar, gave a talk on "Neutronics Benchmark Studies for the Tritium Breeding Blankets" on 11th July 2016
- ♦ **Dr. Ritu Dey**, Institute for Plasma Research, Gandhinagar, gave a talk on "Studies of neutral particle behaviour in ADITYA tokamak with DEGAS2 code" on 20th July 2016

The Ion Cyclotron Resonance Heating (ICRH) system on WEST tokamak is derived from existing system on Tore Supra. The system is equipped with three new load resilient antennas. The measurement and control requirements are based on (1) RF measurement and control signals (45 nos.) and (2) internal diagnostics signals (50 nos). Real time measurement and control of the amplitude and phase signals is required for the efficient operation of ICRH and also for the power coupling to the plasma. The internal diagnostic signals provide the characteristics of the various sub-systems during operation.

The data acquisition unit has been developed by Mr. Ritesh Sugandhi of Basic Sciences Group of IPR under IPR-CEA collaboration agreement (CEA/DAE/14463) on the "Implementation of WEST real time data acquisition unit", under the guidance of Supervisor Dr. Philippe MOREAU and IRFM group (Mr. Benjamin SANTRAINE and Ms. Nathalie RAVENEL) for acquiring data at 1 KHz sampling rate during the plasma operation. The new AU comprises of PXIe based instrumentation system (FPGA based CRIO boards, DAQMx board and timing board) and industrial PC. The development work was carried out on the tore supra development framework namely TSDAQ. The developed software does the configuration, triggering, acquisition and transfer of the data to the centralized database (Tsbse). Matlab and Python scripts have been used to develop data visualization.

The novelty of the work is : (1) the use of the TSDAQ architecture for latest PXIe boards, (2) handling of FPGA and DAQMx architecture boards and (3) development of software for specialized and safety critical systems. The testing of the data acquisition unit (tagged as DFCI in French) is completed with the simulated signals under centralized supervision test at tore supra control room. This development will be used for antenna testing before and after introduction of the system to the plasmas.



(L) ICRH antenna assembly (Curtsey: G. Lombard) (R) ICRH system (DFCI) GUI during supervision test along with other diagnostic systems.

## IPR Groups - Library

Library is core to any research institution. It facilitates the flow of knowledge and accomplishes the intellectual curiosity of researchers. IPR Library acts as a Gateway to Plasma Physics and Fusion Science and Technology information. It supports the scientific and technical programmes of the Institute by providing physical and intellectual access to scholarly information. In accordance with the objectives of the Institute. It aims to develop a comprehensive collection of documents/resources valuable to the users community of the Institute. IPR library has a huge collection of resources in the areas of institutional research, both in Print and Electronic format. It also uses modern technological tools to efficiently provide information. IPR library collaborates with many National and International libraries and provides information services not only to the researches within the institute but also globally. The young team of library professionals at IPR always strive to excel in the information organization and dissemination process.



L-R : Smita K. Parmar, Shravan Kumar, Saroj Das and Shilpa Khandker



Aditya-U has four pumping lines. In recent development, Aditya-U vacuum vessel is being integrated with its pumping system. Each of the associated pumping line components were cleaned ultrasonically before the installation of lines #1 (PL-1) and #3 (PL-3) out of the total four pumping lines has been successfully completed, including their helium leak testing. During installation, the electrical insulation was also tested satisfactorily between vessel and pumping lines as well as between the pumping lines and its support structure. Installation work of other two pumping lines PL-2 and PL-4 is currently in progress. Two turbo molecular pumping systems have been installed successfully on PL-1 and PL-3 as shown in photograph. Aditya-U vacuum vessel pumping was started on 22<sup>nd</sup> July 2016 from PL-1 turbo pumping system for testing purpose.



The pumping lines PL1 and PL3 and turbo-molecular pumps installed on the Aditya-U device

### When Everyday Is A Celebration of Environment !

When one plants a tree, one also has to take responsibility of the sapling and see to it that it is taken care of till it grows and flowers and even bears fruits ! Amongst the many beneficiaries of this act of planting and nurturing a tree are the winged and tailed beings that nest on them. They ensure that the cycle of nature is kept moving in all its rhythm and beauty. A tough but delicate task but for Shri Raj Singh, it is a very routine act as he has proved time and again ! Seen here is the row of jamun trees (*Syzygium Cumini*) at the IPR campus which were planted and nurtured by him!



The lawn facing Director's office has this beautiful sight during summer days. An example for how small gestures by human beings can bring about harmony among all living beings around us. The different birds and animals take turn to enjoy the cool comfort of the water pots hanging on the trees in this area. Squirrels, fork tailed drongos, crows, babblers etc. seem to happily share this haven during the hot summer days. Maybe, we need to provide more such watering holes to these birds and animals in our campus as part of our ways to celebrate environmental day everyday !





This year's Summer School Program (SSP-2016) began on the 30<sup>th</sup> May. Students from both physics and engineering backgrounds from all over India (37) participated in this program. Apart from lectures by experts from IPR, the SSP students were also taken on a scientific visit to ISRO-SAC, Ahmedabad. The students also carried out a short project during the course of SSP at IPR. A Poster presentation of the projects carried out by the SSP students was held on 7<sup>th</sup> July. The students were awarded prizes based on their poster presentations. The concluding session of the programme was held on 8<sup>th</sup> July 2016 and was presided over by the Director IPR, who also gave away the participation certificates as well as the prizes to the award winning posters to the SSP participants.



(L) The poster presentation underway (R ) Prof. D Bora giving away the prizes to the SSP students.



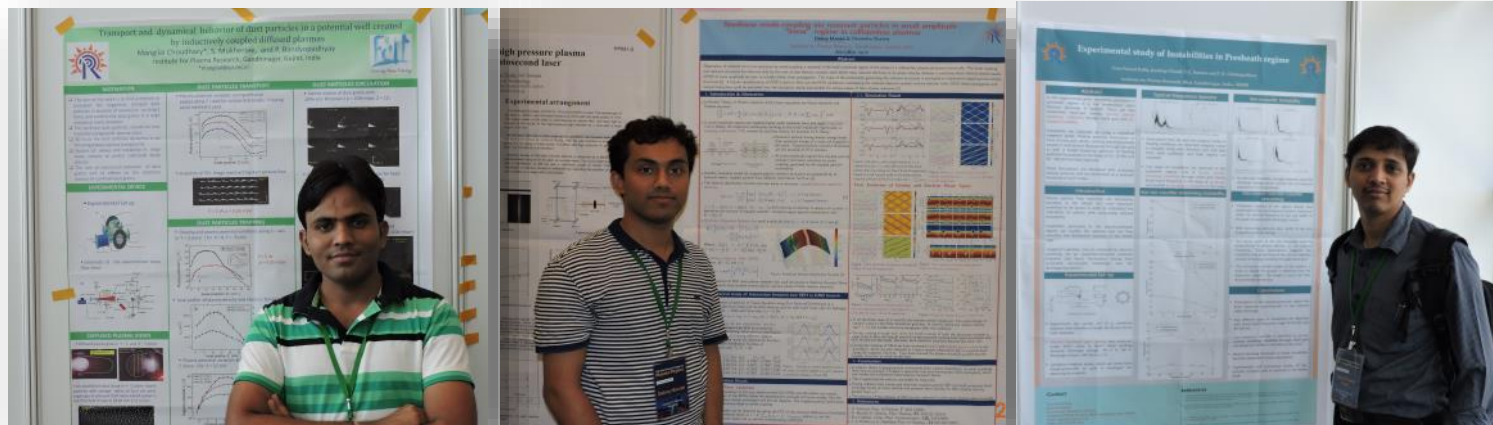
Group photo of the participants and organizing team of SSP-2016

Poster Prize awarded	Name of the recipient student and affiliation
1 <sup>st</sup> Prize	Ms. Monika, Kurukshetra University, Kurukshetra
2 <sup>nd</sup> Prize	Ms. Deepika Thakur, Amity University, Noida
Appreciation Prizes	Ms. Sikha Sarmah, NIT Shillong Mr. Shubham Singh, The ICFAI University, Ahmedabad Mr. Smit Kapadia, Nirma University, Ahmedabad Ms. Shaina Rani, Panjabi University, Patiala Ms. Anju Jolly, Manipal University, Manipal

The IPR SSP 2016 Committee members are ; Dr. P. Bandyopadhyay, Jinto Thomas, Varsha Siju, Mitul Abhangi, Hardik Mistry, Hiral Joshi, Jagabandhu Kumar and Bhargav Choksi.



Twelve faculties and students from IPR attended the 18<sup>th</sup> International Congress on Plasma Physics (ICPP -2016), which was held at Kaohsiung, Taiwan during June 26<sup>th</sup> to July 1<sup>st</sup> 2016. Prof. P. K. Kaw, Prof. A. Sen, Prof. A. Das, Dr. Joydeep Ghosh, Dr. Pintu Bandyopadhyay, Mr. Rakesh Tanna, Dr. Sharad Yadav, Ms. Surabhi Jaiswal, Mr. Mangilal Choudhary, Mr. Vara Prasad Kella, Mr. Debraj Mandal and Mr. Arghya Mukherjee were among them. One Invited talk, five contributory talks and six posters were presented by participants from IPR in this congress. Dr. Joydeep Ghosh delivered an invited talk entitled “Disruption Mitigation Experiments in Aditya Tokamak” at this meeting.



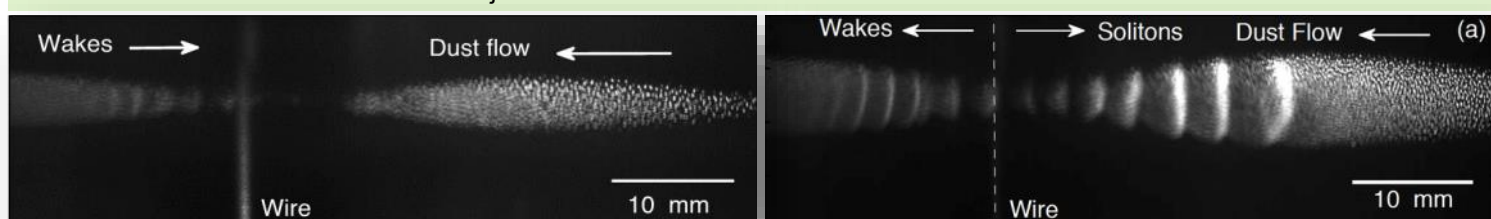
(L) Mangilal Choudhary (M) Debraj Mandal (R) Vara Prasad Kella with their respective posters at ICPP-2016



Contingent from IPR at the ICPP-2016

## Observation of Plasma Waves That Could Help Prevent Space Debris Collisions

The scientists of Institute for Plasma Research recently report the first experimental observation of *precursor* solitons (nonlinear pulse shaped wave excitations) that travel ahead of a supersonically moving charged object in a plasma (S. Jaiswal, P. Bandyopadhyay and A. Sen, *Phys Rev. E*, 2016). Like wakes behind a moving object these upstream fore-wake excitations have been known for some time in hydrodynamics but have surprisingly received no attention in plasmas and other charged soft condensates. Supersonic flows of plasmas occur in many natural situations such as in astrophysical jets, plasmas created by laser blow-off of targets, solar winds etc. The encounter of such flows with a stationary charged object can recreate the situation discussed in this experiment. Likewise, the occurrence of charged objects moving at supersonic speeds in a plasma can be commonly found in situations like satellites (which naturally acquire surface charges) orbiting the earth in the ionospheric region, high energy ion beams impinging on targets in inertial fusion schemes etc. The excitation of precursor solitons in such situations can have significant practical implications. For example, in particle beam fusion applications they could impact the heating and or compression dynamics of the target pellet. In the satellite orbital regions above the earth, the detection of such solitonic excitations from charged debris objects could help provide an early warning scheme for satellites to avoid collisions with such objects.



Experimental images of the excited solitons and wakes. The dusty plasma is flowing to the left over the object whose location is indicated by the dashed line. (Left): Excitation of wakes only when the flow of fluid is subsonic, (Right): Excitation of precursor solitons along with the wakes for supersonic flow.



On the 3rd anniversary of the revival of the IPR newsletter, we the members of the newsletter committee can look back with a lot of pride and happiness in having had the opportunity to document the events unfolding at IPR in the last three years. The first issue of the new IPR Newsletter was brought out on the Independence day of 2013 by Prof. Dhiraj Bora, who was also instrumental in reviving the IPR newsletter which was last published in the mid 90's.

Over the last three years, it has been a pleasure to record the activities, both scientific as well as non-scientific, for the future generations of IPR to look back and remember. On this occasion, The IPR Newsletter wishes to thank all the members (past & present) of the Newsletter Committee, IPR staff who graciously contributed to the contents of the newsletter, as well as to the readers who gave us their valuable comments and suggestions to improve the Newsletter, and of course, the encouragement to carry on. **Thank you one and all !**



### From the IPR Archives



**Then and now.....** The image on the left was taken in 1984 during the construction of the IPR main building. The old fountain system was part of the comfort cooling system of IPR. It was indeed a very pretty sight to see the fountains in full flow along with the lighting at night. Due to the change in the cooling system, the fountain system became redundant and hence was removed in 2006 to make way for the three smaller fountains and the lush green lawns that we have today.



- ♦ Summer School on Plasma Medicine, 1-3 September 2016, and 6th International Conference on Plasma Medicine (ICPM-6), Bratislava, Slovakia, 4-9 September 2016 <http://www.icpm6.com/>
- ♦ 29th Symposium on Fusion Technology (SOFT 2016), Prague, Czech Republic, 5-9 September 2016 <http://www.soft2016.eu/>
- ♦ 12th European Conference on Atoms, Molecules and Photons (ECAMP 2016), Frankfurt, Germany, 5-9 September 2016 <http://www.ecamp.uni-frankfurt.de/>
- ♦ International Symposium on High Power Laser Systems and Applications (HPLS&A), Gmunden, Austria, 6-9 September 2016 <http://www.hpls2016.org/>
- ♦ 18th International Conferences on the Physics of Highly Charged Ions (HCI 2016), Kielce, Poland, 11-16 September 2016 <http://www.ujk.edu.pl/hci2016/>
- ♦ 15th High Pressure Low Temperature Plasma Chemistry Symposium (HAKONE XV), Brno, Czech Republic, 11-16 September 2016 <http://hakone.physics.muni.cz/>
- ♦ International Conference and School on Plasma Physics and Controlled Fusion, Kharkiv, Ukraine, 12-15 September 2016 <http://www.kipt.kharkov.ua/conferences/ipp/2016/>
- ♦ 15th International Conference on Plasma Surface Engineering (PSE 2016), Garmisch-Partenkirchen, Germany, 12-16 September 2016 <http://www.pse-conferences.net/pse2016.html>
- ♦ 5th Joint Workshop on High Pressure, Planetary and Plasma Physics (HP4), Hamburg, Germany, 14-16 September 2016 <https://indico.desy.de/conferenceDisplay.py?confId=14266>
- ♦ 6th Euro-Asian Pulsed Power Conference and 21st International Conference on High-Power Particle Beams and 15th International Conference on Megagauss Magnetic Field Generation, Lisbon, Portugal, 18-22 September 2016 <http://eappc-beams2016.org/>
- ♦ 27th International Symposium on Discharges and Electrical Insulation in Vacuum (ISDEIV-2016), Suzhou, China, 18-23 September 2016 <http://isdeiv2016.xjtu.edu.cn/>
- ♦ 34th European Conference on Laser Interaction with Matter (34th ECLIM), Moscow, Russia, 18-23 September 2016 <http://plasma.mephi.ru/ru/ECLIM2016en.html>
- ♦ International Conference on Actual Problems of Electron Devices Engineering (APEDE-2016), Saratov, Russia, 22-23 September 2016 [http://apede.sstu.ru/apede2016\\_eng.html](http://apede.sstu.ru/apede2016_eng.html)
- ♦ 10th International Conference on Atomic and Molecular Data and Their Applications (ICAMDATA 2016), Gunsan, Korea, 25-29 September 2016 <https://icamdata2016.nfri.re.kr/>

## Know Our Colleagues



**Mr. B K B S Rao** joined the Institute in 1996 as Assistant Purchase Officer after serving Directorate of Purchase & Stores, DAE for about 13 and half Years at various capacities. As APO he has been taking care of the indigenous procurement part of the purchase division and high value contracts. Since 2005 he has been serving as Purchase Officer-I assigned with the Foreign Procurement division. Shri. Rao is also discharging his duties as member of various committees like Tender Award Committees, Purchase Sub-Committees and the Stores Committee. He is also Secretary to Tender Opening and Negotiation committees and to the Junior Purchase Committee for the past several years. Since 2014 he is heading the Foreign Purchase Section in the capacity of Purchase Officer-II and is taking care of all shipments of the Institute involving in various deliberations with Indian Customs Officers, Insurance Companies, and other Governmental agencies for the smooth functioning of the procurement cycle of the Institute.

**Dr. Aashoo N. Sharma** joined IPR in 1997 as Scientist-SC in SST-1 Magnet Group. He made strong contributions from year 1997 to 2009, in the development of quench detection system, signal condition system for cryogenic instrumentations, development of VME based data acquisition system, instrumentation prototyping & validation experiments and low resistance joint development for SST-1 magnets. During this period, he also worked on an international collaboration between CEA Cadarache and IPR on quench simulation studies of fusion grade magnets. As Responsible Officer of SST-1 Magnet Division from year 2009 to 2014, he played instrumental role in cryogenic testing of TF and PF magnets, magnet assembly and commissioning activities. As a core member of SST-1 Mission working group, he made strong contributions to the SST-1 refurbishment activities and the first plasma experiments. He worked as Visiting Researcher in ITER TF coil section from June 2014 to June 2016. As a member of Fusion Reactor Study Group he is contributing to initial design studies of magnets for future tokamak of IPR.



## The IPR Newsletter Team

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