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The Fourth State

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

LIGO – India and IPR

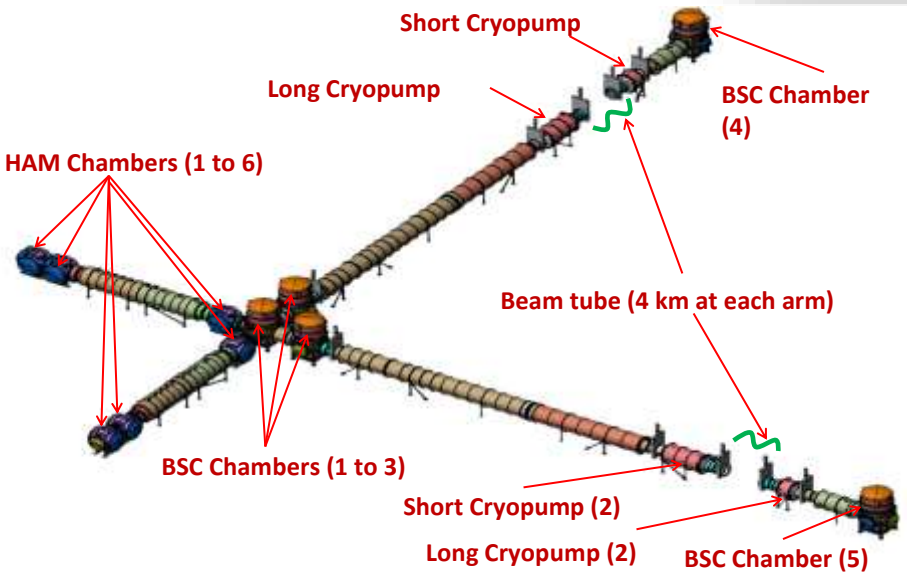
As soon as the discovery of gravitational wave due to merger of binary black hole was announced by LIGO scientific collaboration on 11th February 2016, our Honorable Prime Minister, Shri Narendra Modi tweeted the event as “The historic detection of gravitational waves will open up new frontier for understanding of universe”, “Immensely proud that Indian scientists played an important role in this challenging quest”, and “Hope to move forward to make even bigger contribution with an advanced gravitational wave detector in the country”.

On Wednesday 17th February 2016, the Indian Union Cabinet, Chaired by the Honorable Prime Minister has given in-principle approval to the Rs 1,300 crore LIGO-India project. With the recent path breaking advances in LIGO experiment, this will be a big boost for science in India.

IPR is part of a group consisting of IUCAA and RRCAT in India that will design, construct and operate the LIGO-India project. IPR’s major role will be ; (a) development of Infrastructure and building for the detector (b) Fabrication and commissioning the Vacuum System and its control (c) Development and implementation of Data Acquisition and supervisory control of the detector. The LIGO-India vacuum systems, which would be one of the largest in the world with a massive volume of almost 10^6 liters to be evacuated down to an ultra-high vacuum.

Specifics	Parameters
Area required to build the detector	415 acres
Vibration control	Power Spectral Density (PSD) < 4 times the natural background.
Acoustic requirement	Preferred Noise Criterion (PNC) ≤ 50 dB
Clean Room environment	Compatible to Class 50,000
Laser room	Class 100
Laboratory temperature	23 ± 1 ° C
Shape of detector	L-shape
Length of each arm of the detector	4 km
Material of construction	SS 304/304 L
Required vacuum	~ 10^{-9} mbar

The IPR LEGO team (L-R) : Mr. S. Sunil, Mr. Rakesh Kumar, Mr. Manoj Kumar Gupta, Dr. Ziauddin Khan, Mr. Amit Kumar Srivastava, Mr. Arnab Das Gupta, and Mr. Karmesh Mehta



Schematic of the LIGO-India system

On behalf of all IPR staff, we wish the LIGO-India team as well as IPR LIGO team all the very best in this scientific endeavor and we hope that we will soon be able to see gravitational waves detected right in our country !!

IPR - IRFM Collaboration Update

Institute for Plasma research (IPR) and Institute for Magnetic Fusion Research (IRFM) are collaboratively developing technologies for the long pulse operation of the magnetic fusion devices. In this context, the in-kind contribution of data acquisition hardware by IPR has been received at IRFM and software development is under progress. The challenge of software development with the help of IPR collaborators for 18 acquisition units with all tests are to be completed by end of 2016, not to miss 1st Plasma !!! 12 collaborators have already spent several months at the IRFM since the beginning of this collaboration in 2014. With the help of IPR collaborators, detailed specification of the system, placing orders for hardware and software, procedure to perform acceptance test of 18 acquisition units and real time network has been performed. Currently, the implementation of data acquisition units for ICRH and Wall monitoring system is under progress along with the new initiatives towards data acquisition units for various diagnostics systems such as calorimetry, MHD acquisition, Poloidal field coils, Visual spectroscopy antennas, magnetics Equilibrium and IR thermography. These developments are based on the Tore supra control software (TSDAQ). The IPR staff currently deputed to IRFM are ; Chhaya Chavda, Ritesh Sugandhi, Vishnu Chaudhary, Jignesh Soni, Shailesh Kanpara, Sunil Belsare, Yashshri Patil and Hemant Joshi. Dr. D. Raju and Dr. S. Pradhan are managing this collaboration from IPR end.

IPR staff on deputation to the Institute for Magnetic Fusion Research, France.

Name of Employee	Area of Work	Group (IPR/IRFM)	Tenure
Vishnu Chaudhari	Developing a real-time system taking into account all necessary measurements involved in the PFCs protection	Laser Diagnostic (LDG-IPR); Protection de la Première Paroi (GPPP)	April-2015 to April-2016
Jignesh Soni	1) Development of Acquisition unit for Poloidal diagnostic 2) Development of Acquisition unit for Poloidal Diverter Coil Control	Negative Iron Neutral Beam (NBI-IPR) Service Tokamak Exploitation et Pilotage (STEP)	January-2016 to December 2016
Ritesh Sugandhi	Acquisition unit development of Real time control loop for Power and Phase Control of ICRH system using PXIe bsed FPGA hardware.	Basic Science (BPP-IPR); Service Tokamak Exploitation et Pilotage (STEP)	Sept-2015 to July-2016
Hemant Joshi	Application / interface software development for Wall Monitoring System for protection of Plasma Facing Components during Plasma Pulse (including Pre and Post Plasma Pulse).	Computer Center (IPR) Service d'ingénierie, des Internes et des Projets(SI2P)	February-2016 to August-2016
Chhaya Chavda	1) Development of Acquisition unit for Calorimetry diagnostic 2) Management of IPR Team 3) Development of Acquisition unit for MHD unit	Aditya Data Acquisition and Control (ADAC-IPR) ; Service Tokamak Exploitation et Pilotage (STEP)	January-2016 to December 2016
Sunil Belsare	1) Development of Acquisition unit for Magnetics Equilibrium 2) IR Acquisition unit development for Diverter and Antennas 3) Development of Acquisition unit for IR Wide Angle view	Divertor and First-Wall Technology Development Division (DFD-IPR) Service Tokamak Exploitation et Pilotage (STEP)	January-2016 to December 2016
Shailesh Kanpara	1) Training for development of tungsten coating technologies for tungsten based plasma facing components. 2) Active participation for testing protocol for High Heat Flux (HHF), W coated mock-ups and/or samples on various substrates, Characterization, Functional Testing & Evaluation of W coated components.	Divertor & First Wall Technology Development Division (DFD-IPR); Plasma Facing Components & Materials Group (GCFP&M-IRFM, CEA)	January-2016 to May-2016
Yashshrii Patil	IR thermography of Tungsten based Plasma Facing components of WEST using SATIR facility and Preparation of Technical documentation on establishment of SATIR facility at IPR.	Divertor & First Wall Technology Development Division (DFD-IPR); Plasma Facing Components & Materials Group (GCFP&M-IRFM, CEA)	February-2016 to August-2016

Sports, Games & Athletics

In the month of January 2016, IPR Staff Club has conducted the three major sports events for the IPR staff - *Volleyball tournament, Badminton tournament and Plasma Trophy* as cricket tournament. The tennis ball cricket tournament "Plasma trophy 2015-16" was organised by the Staff club inviting 7 teams to participate and play the nation's most passionate game with full enthusiasm. 21 league matches were played and top four teams qualified for the semi-finals. Playing the 25th match, ITER– India Fighter, the defending champions emerged as the winner of Plasma Trophy 2015-16.

Overall Points Table

Team	Matches played	Won	Lost	Points
ITER India fighter	6	5	1	10
TTP united	6	4	2	8
NBI warriors	6	4	2	8
Motera Indians	6	3	3	6

Title	Name	Team	Highlights
Man of the series	Vipul More	ITER-India Lions	8 Wickets & 134 runs
Best Bowler	Mohit Jackson	ITER-India Fighters	12 wickets
Best Batsman	Hardik Mistry	TTP United	191 runs
Best Umpire	Vinit Shukla	ITER-India	10 Matches

Highlights of the "Plasma Trophy" Cricket tournament.

ITER– Fighters, Champions of the "Plasma Trophy 2015-16"

		Player name			Player name
Men's singles	Winner	Pratik Patel	Women's single	Winner	Manjit Kaur
	Runner up	Roopendra		Runner up	Garima
Men's doubles	Winner	Pratik & Siddhartha	Women's doubles	Winner	Manjit & Pramila
	Runner up	Sonu & Atul		Runner up	Priti & Garima
Mixed doubles	Winner	Pratima & Aakash			
	Runner up	Vara & Garima			

Results of the Badminton tournament

Under IPR Sports Week, a number of Athletic events were organized at IPR on Feb 6, 2016 by the IPR Staff club. These events included- Slow Cycling, Fast cycling, Running, Discus throw, Shot put throw, Ring throw. Various sports activities **like** Ring throw, *Discus* throw was also organized for persons with physical disability ("Divyang").

Winners of the Athletics tournaments

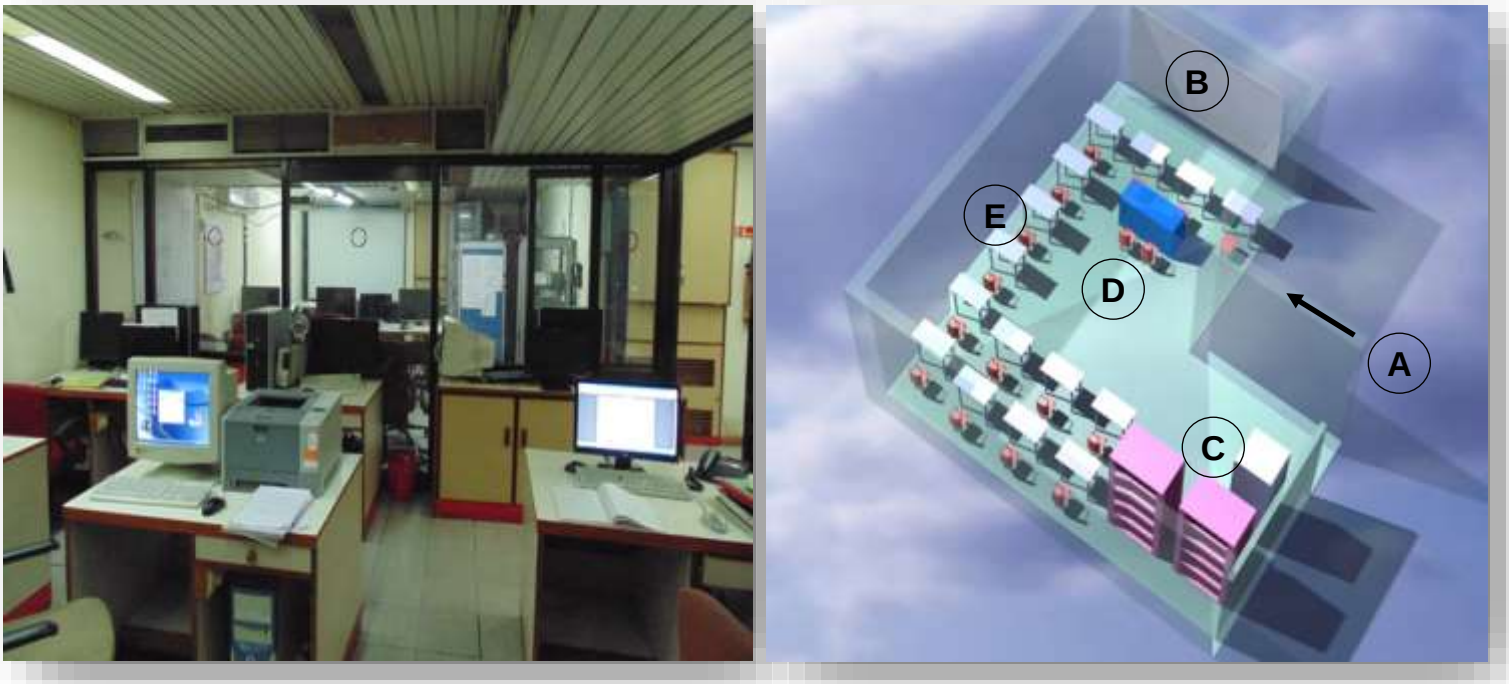
Event	Winner	2nd	3rd
Slow Cycle Race (Men)	Jagbandhu	Navratan	-
Fast Cycle Race (Men)	Jagbandhu	Rohit	--
Discus Throw (Men)	Sumeet	Chaitanya	Rohit
Discus Throw (Women)	Ms. Shirin	-	-
Shot Put (Men)	Chandan	Rohit	Nitin

Winners of the Athletics- Person with Physically Disability - Divyang

Event	Winner
Ring Throw (Men)	Parag Panchal
Ring Throw (Women)	Ms. Nita
Disc Throw (Men)	Parag Panchal
Disc Throw (Women)	Ms. Nita

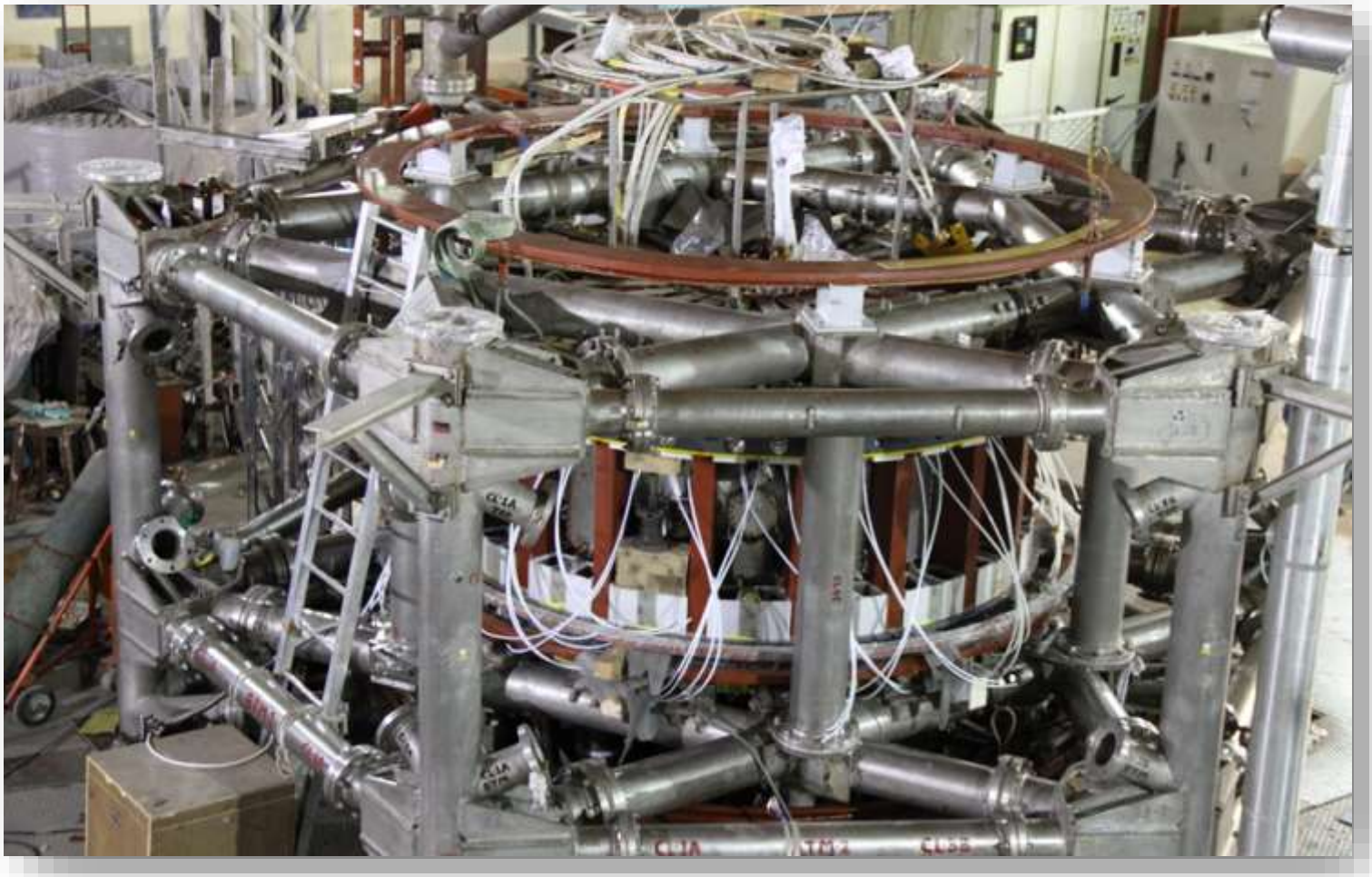
Results of the athletics events

During the Aditya System Upgrade, the control room for Aditya Tokamak will also be upgraded. In this context, the control room will be modified to optimize the available space. The control room will have large video wall to display shot details, security camera feed as well as text messages from shot manager. Seating arrangement for users and networking the terminals to the Aditya server will also be carried out. The data acquisition system will be moved to the Aditya hall in order to reduce the cabling length.



(L) the existing control room of Aditya. (R) The layout design for the Aditya Upgrade Control Room **(A)** Entrance **(B)** Video wall **(C)** Aditya Network and Server **(D)** Aditya Shot manager & DAC **(E)** Seating arrangement

All 20 toroidal field coils (inner big –C & Outer small –C) assembly with inter connecting and return bus-bars have been installed. The coils were accurately positioned with ECDS. The electrical parameters (Inductance, resistance and coil insulation) of complete TF coil assembly are measured and found to be the same as design values within tolerances. The TF coils structural components, *viz.,* top I-beams, top and bottom Wedge Blocks, inner & outer fishplates, top & Bottom Compression rings, Intermediate columns and top inverter triangle are installed one by one with maintaining the required electrical isolations. The installation of magnetic field coils cooling connection work is underway. The main Diverter coils (Inner top & bottom, outer top & bottom), Auxiliary Diverter coils (Inner top & Bottom) and Fast Feedback coils are assembled and clamped with supports. The TR and BV circular coil assembly is under way.

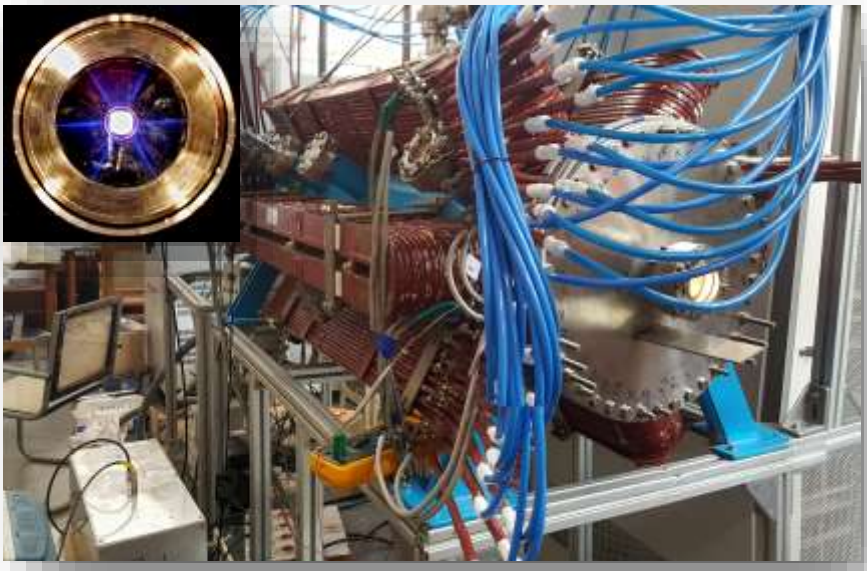


Construction Update

The construction of Laboratory & Auxiliary Buildings is going on as per schedule. The foundation pillars are currently being laid and the work on some of the pre-fabricated metal structures has also begun at the site.

Views of the ongoing construction work of the Laboratory and auxiliary buildings at IPR

Multi-Cusp Plasma Device - Argon Plasma



The figure shows argon plasma in a multi-cusp magnetic field with six cusp regions. The attractive feature of this machine is the variability of the magnetic field from 0-0.2 Tesla using electromagnets and hence the gradient of the magnetic field can be varied.

The field due to the electromagnets have been profiled with high curie temperature core material so that the field at the cusp region has a controlled profile without any sharp gradients in the edges. Also because of the multi-cusp the axial region will be having almost zero field, which can be used to study the thermodynamic fluctuations which was not possible in old classical Q-machines. Facilities to produce alkali (like cesium, barium, potassium *etc.*) have also been planned and is ready to be operated.

The multi-cusp plasma device. (Inset) Argon plasma observed in this device as seen from through the lateral view-port of the device.

IPR Divisions & Groups - Accelerator Division

Dear Readers, Starting from this issue, the IPR Newsletter is beginning a new series called "IPR Divisions & Groups" with the aim of introducing the various R&D and Services groups of IPR to the readers - Newsletter Committee.

The Accelerator Division of IPR was established in 2009, under the Basic Plasma Group with the mandate of developing and carrying out plasma based charged particle acceleration experiments. The group is currently developing a laser photo-ionized lithium plasma source for the Plasma Wakefield Acceleration (PWFA) experiment. A short pulse, high brightness 50 MeV electron Linac is also planned to be setup at IPR campus to carry out the PWFA and other beam-plasma interaction experiments.

L-R : Dr. Sivakumaran V, Mr. K.K. Mohandas, Dr. Lalit Gupta, Ms. Sneha Singh, Dr. Ravi A V Kumar (Head) and Mr. Vikrant Baxi

http://www.ipr.res.in/accel

PLC Training at IPR

A training program for TIA (Totally Integrated Automation) with S7-300 & STEP7 training of SIEMENS PLC was organized in IPR Feb 1-9, 2016. There were 12 IPR staff from different groups who participated in this training session, which also has hands-on sessions.

Different topics including STEP7 programming language, Configuration of system, Analog and digital input & output accessing methods and communication protocols (Industrial Profibus, Profinet, Ethernet) with remote devices. An introduction to HMI and Drive for automation and control was also given to the participants. Actual scenario of different plants and control applications were also discussed with experts from SEIMENS during the course of the training.

The TIA training session in progress at IPR

ITER-India Moves to New Premises

On 1st February 2016, the new premises of ITER-India was inaugurated. The new premises is located at Motera, which is around 3 kms from the IPR main campus at Bhat. The inauguration was done by Prof Dhiraj Bora, Prof, Abhijit Sen, Prof Y C Saxena and ITER-India Director, Dr. Shishir Deshpande.

This new premises, spread over 1767 Sq.Mtrs. will provide office space for the 153 ITER-India staff and 40 HR staff associated with ITER-India. The close proximity to IPR now ensures that they can access the ITER-India Laboratories located in IPR main campus more easily.

(L-R) Prof. Sen lighting the ceremonial lamp. Prof. Bora and Prof. Deshpande cutting the ribbon to inaugurate the new premises.

IPR @ Conferences

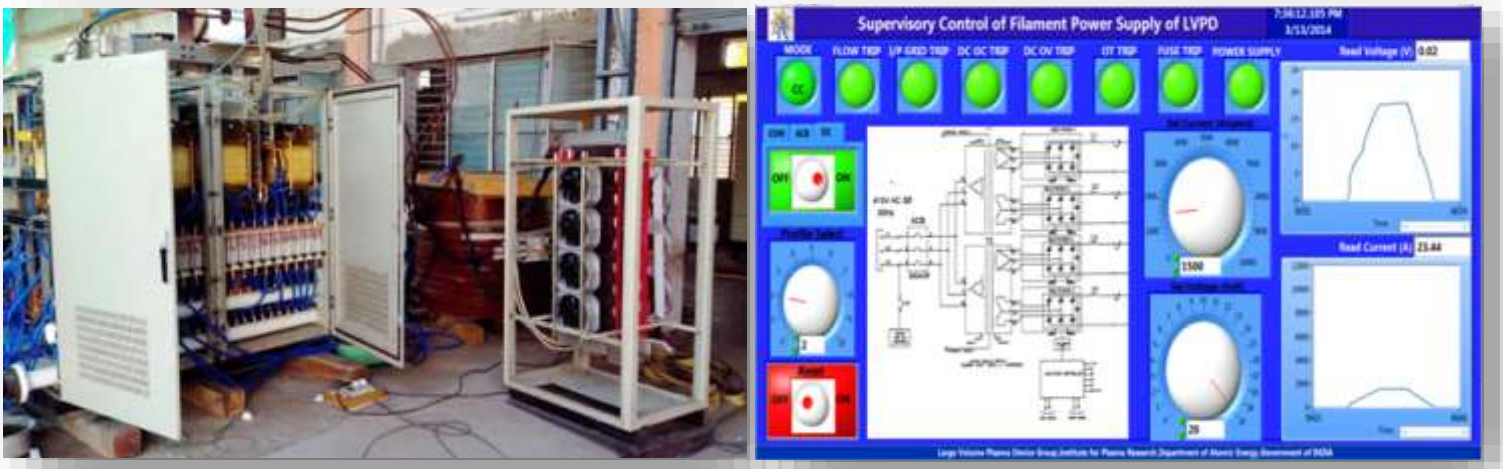
Dr. Mukesh Ranjan (FCIPT/IPR) had participated in a theme workshop on 'Nano-Scaled Systems for Energy Harvesting' held at VIT University, Chennai from 1-3 Feb 2016. There were 34 participants from both India and France. The meeting was organised by Centre Franco-Indien la Promotion de la Recherche Avancee (CEFIPRA) with an objective to initiate collaborative research in the area of Energy Harvesting through Nano-Science.

Topics discussed in the meeting included advanced fabrication techniques, optical properties, plasmonics, and devices for energy harvesting such as photovoltaics, MEMS were discussed. Dr. Ranjan gave an invited talk entitled "Dense Nanoparticles Arrays for Plasmonic Solar Cells and Sensors" .

Dr. Mukesh Ranjan being felicitated by the VC of VIT University, Chennai.

Integration of High Current Power Supply in Large Volume Plasma Device

Large Volume Plasma Device (LVPD) is undertaking major up gradation in its capacity by augmenting new auxiliary systems. The latest among them is high current, low voltage DC power supply (10kA/20V) for feeding power to the newly designed large area, uniform emission plasma source (Tungsten filaments, n=188, ϕ = 1.6mm, L=18cm). The operation of Filament Power Supply (FPS) is critical because of large power (~450kW) associated with its heating cycle of (~30-40s). The plasma discharges, each of duration (Δt=10ms) are undertaken in single or burst mode (n~10). The power supply is based on 24 thyrister controlled rectifier stack with less than 1% regulation, operable in CV/CC mode and in pulsed or continuous fashion. The power supply is interfaced using in-house developed software in open loop control mode on LabVIEW platform. User can remotely configure and monitors the readout and alarms using standard Modbus communication protocol. Power supply is protected against internal components failures. The alarm notification and latching is facilitated in the software as well as on front panel of the power supply. The performance of the power supply is tested for specified ratings during factory acceptance test. It is tested with the existing plasma source during commissioning with the machine.



(L) The power supply during factory test (R) The software control interface of the power supply

Safety Training @ IPR

Fire Propagation is generally very fast and each minute is valuable for fighting the fire in its initial stage. Trained personnel would respond to the fire immediately and will be able to control the situation. It is also a mandatory requirement that fire fighting training should be imparted periodically. In this context, Safety Division has organized practical demonstration of various types of fire extinguishers for the personnel of security agency at IPR on 21.01.2016. A total of 46 security personnel have attended.

The construction of laboratory and auxiliary building has begun at IPR. Construction safety is a prime concern as it will involve huge numbers of manpower and other resources. To create safety awareness and understanding of safety requirements, Safety Division of IPR conducted Safety Orientation Program for the contractor and PMC employees in the month of November-2015 and January 2016. A total of 33 personnel have attended the same.

IPR Safety Division also organized a first-aid training program by the Indian Red Cross Society, Gujarat State Branch, Ahmedabad at IPR for the employees on 22nd December 2015. A total of 26 participants attended the training. The training including practical demonstration for different kind of bandages and Cardio Pulmonary Resuscitation (CPR).

(L-R) Training in (a) firefighting for the security staff at IPR. (b) construction safety for the construction staff. (c) CPR training for IPR staff

SCOPUS Training at IPR

SCOPUS database training was organized by IPR Library on 17th February 2016 in two sessions. Library is subscribing to SCOPUS and the training provided in-depth understanding of the features to use the database optimally.

The training also included introduction to Mendeley (a Reference Manager tool), for better organizing and annotating references.

Past Events @ IPR

- ***Dr. Nitya Hariharan,*** Intel Technology Private Ltd, Bangalore, gave a talk on "High Performance Computing (HPC) – Applications in Computational Physics" on 05th February 2016
- ***Dr. Huw Leggate,*** Dublin City University, Ireland, gave a talk on "Studies into Capacitively Coupled Plasmas in the Presence of Grazing Angle Magnetic Fields" on 19th February 2016

Upcoming Events

- International Tokamak Physics Activity (ITPA) Transport & Confinement Topical Group (T&C) and Pedestal & Edge Physics Topical Group (P&EP) Meetings, Institute for Plasma Research, Gandhinagar, 16-18 March 2016 http://www.ipr.res.in/itpa-2016/contact/contact.html
- 26th Annual Conference of the Indian Nuclear Society (INS), Convention Centre, Anushakti Nagar, Mumbai, 17-18 March 2016 http://indiannuclearsociety.in/insac-2015/
- 19th Joint workshop (EC-19) on Electron Cyclotron Emission (ECE) and Electron Cyclotron Resonance Heating (ECRH), Institute for Plasma Research, Gandhinagar, 04-07 April 2016 http://www.ipr.res.in/ec19/index.html
- 19th International Conference on Atomic Processes in Plasmas, Paris, France, 04-08 April 2016 http://apip2016.sciencesconf.org
- Workshop on Complex Systems of Charged Particles and their Interactions with Electromagnetic Radiation, A.M. Prokhorov General Physics Institute, Moscow, Russia, 13-15 April 2016 http://www.gpi.ru/CSCP/CSCP_2015.html
- IEEE International Vacuum Electronics Conference (IVEC 2016), Monterey, California, United States, 19-21 April 2016 http://ivec2016.org
- Joint International Conference on Mathematics and Computation (M&C), Supercomputing in Nuclear Applications (SNA) and the Monte Carlo (MC) Method, Nashville, Tennessee, United States, 19-23 April 2015 http://mc2015.org
- Centre of Plasma Physics - Institute for Plasma Research (CPP-IPR) Silver Jubilee Symposium, Nazirakhat, Tepesia, Sonapur, Kamrup, Assam, 21-22 April 2016 http://www.cppipr.res.in/
- INS National Workshop on Machinery Vibration Monitoring and Analysis, Indian Nuclear Society, Project Square, Anushakti Nagar, Mumbai, 25-29 April 2016 http://indiannuclearsociety.in/

Know Our Colleagues

Dr. Sanjeev Varshney joined IPR in 1991 as a research scholar and then as a scientist in 1995. He worked on Thomson Scattering diagnostics for Aditya and SST-1 tokamaks. He studied MHD instabilities in TEXTOR plasmas for his doctoral thesis (TU/e, The Netherlands) while developing a state-of-the-art 10 kHz Thomson scattering system. Since 2008, he has been a member of ITPA specialist working group, and chairs the passive spectroscopy SWG since 2014. He is currently responsible for the development of ITER X-ray Crystal spectrometers for the measurement of plasma impurities.

Mr. Braj Kishore Shukla joined IPR in 1995 as technical trainee and later as a scientist in 1996. He started his carrier in the RF Group working on the Electron Cyclotron Resonance Heating (ECRH) system and was actively involved in the 28GHz ECRH system on Aditya and the 82.6GHz ECRH system for SST-1. He has designed and developed the launchers for ECRH systems in Aditya and SST-1. Mr. Shukla was also involved in other activities related to ECRH including installation and in the commissioning of Gyrotron systems. In 2006, he was given the responsibility of ECRH Division and presently serving as the Division Head for High Power ECRH systems at IPR. He was responsible for the commissioning of ECRH system (42GHz/500kW) on tokamaks SST-1 and Aditya. This 42GHz system is currently being used for plasma start-up in SST-1. Mr. Shukla's area of research interest includes quasi-optical launchers for ECRH systems. He is a member of EC international committee, AAPPS-DPP, PSSI and Vice President for VEDA society.

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