

Issue 10

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# The 4<sup>th</sup> State

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

## Technology Transfer - Plasma Pyrolysis

A technology transfer agreement (on a non-exclusive basis) was signed between IPR and M/s Bhakti Energy, Rajkot for transfer of plasma pyrolysis technology for solid organic waste (non-biomedical) on 29th August, 2016 at IPR main campus. M/s Bhakti Energy, a Rajkot based firm engaged in manufacturing gasifiers has now plans to setup waste disposal and gasification systems utilizing plasma pyrolysis technology. The picture shows the exchange of the technology transfer agreement between Mr. A. Varadarajulu, Chairman - SPC, representing IPR and Mr. Alpesh Vora, Proprietor - Bhakti Energy being exchanged in the presence of Dr. S. Chaturvedi, Director, IPR.



The technology transfer document being exchanged between Mr. Alpesh Vora, Proprietor - Bhakti Energy and Shri A. Varadarajulu, Chairman - SPC, in the presence of Director, IPR

## Aditya Upgrade - Update

After completing pumping line assembly and leak testing of Aditya vacuum system, the vessel was vented with nitrogen gas to install Phase-1 in-vessel components. All the rectangular ports were opened and the plasma facing material ; two limiters with graphite tiles were installed inside vacuum vessel, ie, the inner toroidal limiter and the outer poloidal limiter. Before assembly, all the installed graphite tiles were baked in vacuum furnace for 24 hours, at 1000 degree C in vacuum of  $\sim 1e-5$  mbar. The graphite baking activity in vacuum furnace was carried out in the SST1 vacuum lab, in collaboration with the SST-1 Vacuum and First Wall Groups. The installation of the other in-vessel components, viz.. toroidal loops, diamagnetic rings, Rogowski rings etc. are in progress.



Installation of the inner toroidal and the outer poloidal limiter in progress inside the Aditya vessel.



The 5th PSSI-Plasma Scholars' Colloquium (PSC-2016) was held at the Ravenshaw University, Cuttack on 27-28 August 2016. The event was presided by PSSI president Prof. R. N. Pal. This colloquium is basically meant for PhD and masters students working in the areas of plasma science & technologies. The meeting had four invited talks and oral / poster presentations by students. The colloquium was attended by 39 plasma scholars from all over India.

Among participants from IPR were Dr. Subhanarayan Sahoo, Mr. Prabhakar Srivastava and Mr. Amulya K Sanyasi. Dr. Subrata Pradhan and Dr. Joydeep Ghosh delivered invited talks on SST-1 experimental campaign and Aditya Upgrade tokamaks respectively. The PSSI best poster and best oral presentation awards were awarded to Mr. Neelanjan Bujabourah from CPP-IPR and Mr. Amulya Sanyasi from IPR respectively.



Clockwise : The group photo of the participants of PSC-2016 ; Mr. Neelanjan Bujabourah from CPP-IPR and Mr. Amulya Sanyasi from IPR respectively receiving the PSSI awards from PSSI President, Prof R N Pal.

### IPR-CEA Collaboration Report

Mr Hemant Joshi from Computer Center, IPR was deputed for working with Tore-Supra WEST project with Wall Monitoring System from 1<sup>st</sup> February 2016 to 1<sup>st</sup> August 2016. He was working with SI2P (Service d'ingenierie, des Interne et des Projets) group under the guidance of Dr Jean Marcel TRAVERE and CEA coordinator Dr Philippe MOREAU. He was assigned to develop application software for analysis of WMS (Wall Monitoring System) data using Linux based Python software at CEA for input to PLATO module. He developed and tested application interface to construct a waveform for available input data. The data is available in segments and signals. The developed application provided construction of waveform for single or multiple inputs in batch based on input parameters. Application supports execution in interactive mode or in background mode. The application software will be used by WMS group by Dr Jean TRAVERE, Cedric REUX and other scientists.



### VEDA Society Lifetime Achievement Award for Prof. Kaw

Prof P K Kaw, Prof. Baidyanath Basu, Retired Professor, IIT BHU, Shri N Divakar, former Director, DLRL, Hyderabad and Dr.P.I.Biradar, Ex- AGM, BEL, Bangalore, were conferred with the "VEDA Society Lifetime Achievement Award" for their distinguished services in the area of Vacuum Electronics and their Applications At the National Conference on "Emerging Trends in Vacuum Electronic Devices & Applications" (VEDA-2015) -at BEL Kalakshetra.



Prof. Kaw receiving the citation and award at his office at IPR on 23rd August 2016.



# High Pressure High Temperature Water Circulation System (HPHT-WCS) for High Heat Flux Test Facility (HHFTF)

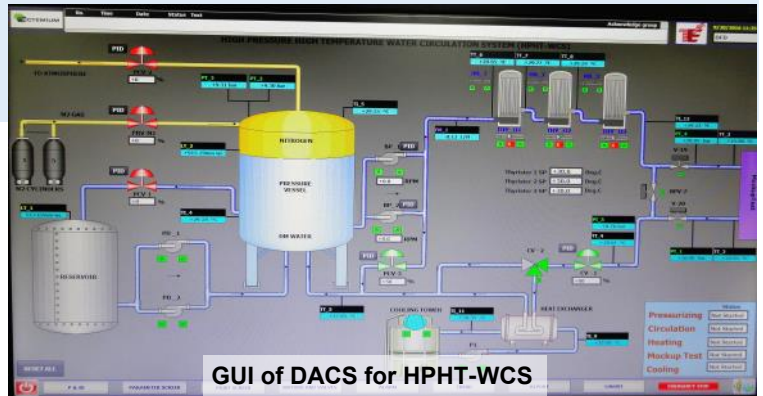
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High Heat Flux Test Facility (HHFTF) at IPR Extension lab was established for testing thermal performance of plasma facing materials and components under intense heat loads expected in plasma fusion devices. It mainly consists of sub-systems like vacuum system, high power electron beam system, diagnostic and calibration system, data acquisition & control system and high pressure high temperature water circulation system (HPHT-WCS). In order to test the water cooled test mock-ups or components at ITER-like relevant parameters in HHFTF, HPHT-WCS was established so that water at desired pressures, temperatures and flow rates can be supplied. HPHT-WCS is capable of providing de-mineralized water up to 160°C temperature, 60 bar pressure and 300LPM flow rate. The loop is designed on a skid base frame which has piping connected to various process components and the system is operated remotely through a data acquisition and control system. The system was successfully commissioned and integrated with target handling system of HHFTF, the testing of plasma facing components are currently going on using this system.

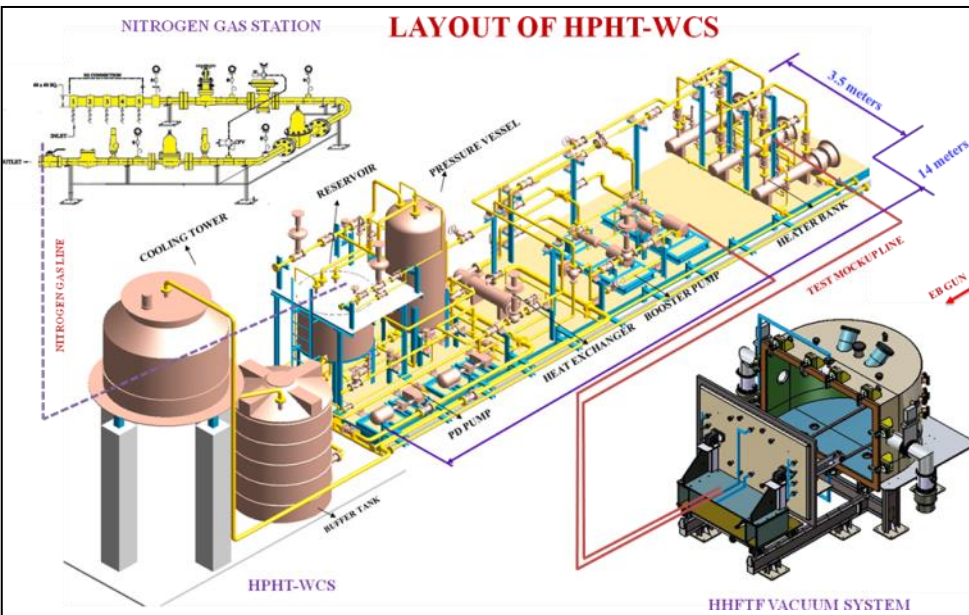


Assembly of HPHT-WCS

| Operating Parameters        |               |
|-----------------------------|---------------|
| Temperature at test mock-up | 30 to 160 °C  |
| Coolant pressure (Water),   | 5 to 60 bar   |
| Coolant flow rate (Water)   | 50 to 300 LPM |



GUI of DACS for HPHT-WCS



Target handling system



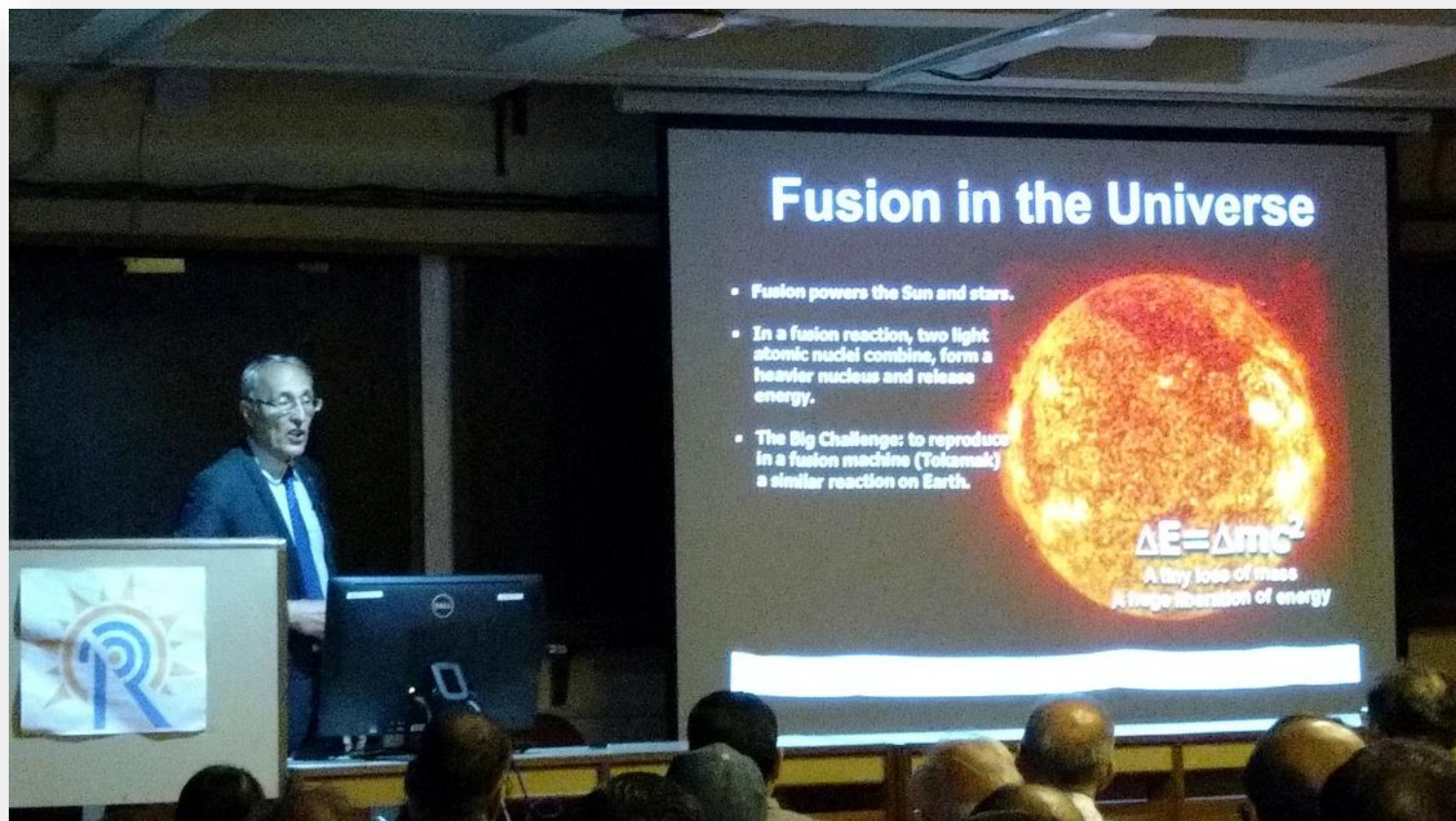
Booster pumps



Pressurizing system



During 22-23 August 2016, the Director General of ITER, Dr. Bernard Bigot visited India. During his visit to IPR, he addressed the staff regarding the progress of ITER project and also participated in technical meetings. Dr. Bigot also had the opportunity to visit Bengaluru and witness the manufacturing activities on ITER In-wall Shielding.



Dr. Bernard Bigot, Director General, ITER addressing the staff of IPR / ITER-India



Dr. Bernard Bigot and other members of ITER-India during the visit to M/s Avasarala Technologies Limited, Bangalore to witness the fabrication of ITER in-wall shielding components.





With the advent of monsoons, the dampness in the air and soil gives rise to mushroom blooms. IPR campus was seen dotted with several kinds of lichens and mushrooms. High in nutrients and protein, mushrooms, which are essentially fungi, do not require sunlight to make energy for themselves unlike plants. A single Portabella mushroom can contain more potassium than a banana. For every edible mushroom out there in the wild, there could be several hundreds of them which look beautiful in their colour and shape, but are highly toxic for consumption. Extreme caution needs to be exercised while picking mushrooms for consumption. At least 30 species of mushrooms are known to be bioluminescent.

## IPR Divisions & Groups - Microwave & ECE Diagnostics

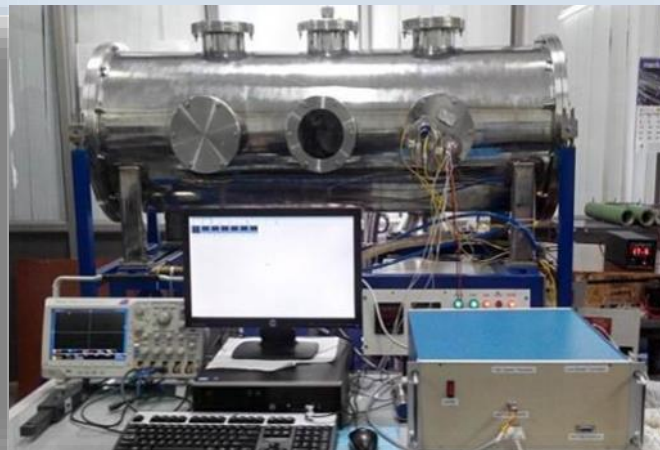
Laboratory/ Fusion plasma diagnostics requires non-destructive and non-invasive measurement techniques using microwave –THz frequency spectrum techniques and at the same time, millimeter-submillimeter domain instrumentation and measurements remain technological challenges yet to be devised and perfected. The Microwave & ECE Diagnostics group was established in 2014 to cater to these measurement issues. This group has developed and is in the process of developing different techniques in this frontier area. These include (1) 7 channel 100 GHz and 1- Channel 140 GHz Interferometry system for real time plasma density measurement (2) 24-40 GHz FMCW Radar based Reflectometry System for Plasma Density Profile Measurement (3) 60- 90 GHz and 142-204 GHz radiometry system for Electron Cyclotron Emission Measurement for electron temperature measurement. (4) 75-1000 GHz Fast Scan Fourier-Transform Michelson Interferometer system for plasma electron temperature dynamics measurement.



L to R : Mr. Janmejy U Buch , Mr. Abhishek Sinha, Dr. Surya Kumar Pathak, Ms. Varsha Siju, and Mr. Umeshkumar C. Nagora



FCIPT/IPR has successfully completed a 3 years MoU about Material Characterisation of Hall Effect Thruster with Liquid Propulsion System Centre (LPSC/ISRO). Hall Effect Thrusters are used in satellites due to their longer stability and reproducible thrust efficiency. The MoU was focused to investigate the erosion behaviour of the anode liner materials of Hall Effect Thruster at various ion energies and angle of incidence, change in magnetic permeability of the material at elevated temperature, change in magnetic field topology of the magnetic circuit at elevated temperatures and surface flash over effects. For conducting such experiments two in-situ facilities were developed equipped with ion sources, Movable Quartz Crystal Microbalance (QCM) sensors, fast magnetic probes and data acquisition systems. Under this work, FCIPT Team has produced lots of useful results, such as observation of sharp rise in the sputtering yield of BN as the angle of incidence exceeds above  $55^\circ$  for ion energy of 500 eV. Magnetic field topology showed changes with increasing temperature. It is seen that the peak field shifts outward from the exit with temperature, indicating that the acceleration zone, and in turn the ionization zone, shifts outward that may affect the performance of the thruster. Magnetic permeability has shown dependency on the temperature. Saturated magnetic field in the B-H curve shifts to lower magnetic field with increasing temperature. LPSC/ISRO has appreciated the work carried out by the FCIPT team stating that "The Joint Review Board (JRB) noted that scientific data generated in MoU is very much useful for LPSC programme. JRB appreciated the FCIPT/IPR team consisting of Dr. Mukesh Ranjan (Project Manager), Dr. G. Ravi, Mr. Ramakrishna Rane, Mr. A. Vaid, Mr. Sagar Agrawal, Mr. Chirayu Patil, Mr. Adam Sangharyat, Mr. Bhupendra K. Patel, Mr. Ashok Sharma and Ms. Kanchan for their sincere efforts in completing the objective of the MoU in timely manner"



Clockwise, from top : The FCIPT team who worked on this project, Images of the experimental setup

## Sadhbhavana Diwas

"Sadhbhavana Diwas" is observed across the nation on 20<sup>th</sup> of August every year. The theme of Sadhbhavana is to promote National Integration and communal harmony among people. Since 20<sup>th</sup> August was a Saturday, this year, it was observed on 19<sup>th</sup> August 2016 at IPR. The pledge ceremony was held near the Administration block. The Director and the ACAO administered the pledge to the staff members in English and Hindi respectively. The pledge was taken to work for the oneness and harmony of all people, regardless of caste, region or religion.





प्लाज्मा अनुसंधान संस्थान में 1 सितम्बर, 2016 से 14 सितम्बर, 2016 तक हिन्दी पखवाड़ा समारोह का आयोजन किया गया। इस दौरान कर्मचारियों के बीच हिन्दी भाषा को बढ़ावा देने एवं जागरूकता लाने हेतु कुल 11 प्रतियोगिताओं का आयोजन किया गया – वैज्ञानिक एवं प्रशासनिक लेखन, हिन्दी पोस्टर, समाचार पत्र वाचन, हिन्दी ज्ञान प्रश्नावली, नारा लेखन, निबन्ध लेखन, अनुवाद, हिन्दी टाइपिंग, तात्कालिक भाषण, वाद-विवाद और हास्य कविता-पाठ। 1 सितम्बर को नारा लेखन एवं निबन्ध लेखन प्रतियोगिता आयोजित की गई। हिन्दी टाइपिंग प्रतियोगिता 2 सितम्बर को रखी गई जिसमें कार्यालय लिपिक एवं कार्यालय सहायकों के अलावा वैज्ञानिक/तकनीकी वर्ग के कर्मचारियों ने भी भाग लिया। 6 सितम्बर को समाचार पत्र वाचन प्रतियोगिता के पश्चात् राजभाषा कार्यान्वयन समिति के सदस्य श्री हरीशचन्द्र खण्डूरी द्वारा हिन्दी प्रश्नोत्तरी प्रतियोगिता का संचालन किया गया। पखवाड़ा समारोह के अंतर्गत 9 सितम्बर को प्रशासनिक अधिकारी, श्री हर्षद चामुण्डे द्वारा हिन्दी में व्याख्यान दिया गया। 14 सितम्बर, 2016 को मुख्य समारोह में कार्यकारी मुख्य प्रशासनिक अधिकारी श्री प्रवीण कुमार आत्रेय ने कार्यक्रम के आरंभ में हिन्दी दिवस के अवसर पर शुभकामना देते हुए गृह मंत्री के संदेश के वाचन के पश्चात् परमाणु ऊर्जा आयोग के अध्यक्ष एवं परमाणु ऊर्जा विभाग के सचिव के संदेश का वाचन किया। हिन्दी अनुवादक डॉ. संध्या पी. दवे ने संस्थान में हिन्दी अनुभाग की प्रमुख गतिविधियों पर प्रकाश डालते हुए हिन्दी के क्षेत्र में संस्थान की उपलब्धियों से श्रोतागणों को अवगत कराया। इसके बाद शुरू हुई तात्कालिक भाषण, वाद-विवाद एवं कविता-पाठ प्रतियोगिताओं में प्रतिभागियों का प्रदर्शन काफी सराहनीय रहा। वरिष्ठ सदस्य प्रो. अमीता दास, श्री प्रवीण कुमार आत्रेय एवं श्री राजसिंह के कविता पाठ से प्रतिभागियों का मनोबल बढ़ा। 14 सितम्बर, 2016 को पुरस्कार वितरण समारोह में श्री प्रवीण कुमार आत्रेय एवं श्री राजसिंह ने विजेताओं को और हिन्दी में उत्कृष्ट कार्य करने वाले सदस्यों को पुरस्कार प्रदान किये। प्रो. अमीता दास, श्री प्रवीण कुमार आत्रेय, श्री राज सिंह, डॉ. सुनील कुमार, डॉ. मनोज कुमार, डॉ. अजय कुमार, श्री भरत दोशी, श्री हितेश गुलाटी, श्री अनुज हार्वे, श्री रेमश डी, श्री हर्षद चामुण्डे, श्री हरीश चन्द खण्डूरी, श्री सरोज दास, श्री श्रवण कुमार एवं डॉ. संध्या पी. दवे हिन्दी पखवाड़ा समारोह की विभिन्न प्रतियोगिताओं के निर्णायक रहें।



- ◆ **Dr. Bernard Bigot**, Director-General, ITER Organization, gave a talk on "Progress of the ITER Project" on 24th August 2016
- ◆ **Prof. Jayanta Bhattacharjee**, Harish-Chandra Research Institute, Allahabad, gave a talk on "Scaling Law for Turbulence in Stratified Fluids: Kolmogorov or Bolgiano?" on 29th August 2016 (Colloquium #261)
- ◆ **Dr. Sayak Bose**, Institute for Plasma Research, Gandhinagar, gave a talk on "Study of waves and instabilities in IMPED plasma" 30th August 2016
- ◆ **Dr. A. K. Patra**, National Atmospheric Research Laboratory, Gadanki, Andhra Pradesh, gave a talk on "The puzzling daytime 150-km echoes: Are they due to plasma instability or naturally enhanced plasma waves?" on 1st September 2016
- ◆ **Mr. G. Veda Prakash**, Institute for Plasma Research, Gandhinagar, gave a talk on "Development of a Sub-nanosecond Impulse Generator for High Frequency E.M. Excitations" on 5th September 2016
- ◆ **Dr. Nirmal Kumar Bisai**, Institute for Plasma Research, Gandhinagar, Gujarat, gave a talk on "Role of neutral gas in Scrape-off Layer of tokamak plasmas in the presence of finite electron temperature gradient" on 7th September 2016 (Colloquium #262)
- ◆ **Mr. Aditya Krishna Swamy**, Institute for Plasma Research, Gandhinagar, gave a talk on "Linear and nonlinear global gyrokinetic study of microinstabilities and development of tools for EM-GLOGYSTO" on 14th September 2016
- ◆ **Ms. Surabhi Jaiswal**, Institute for Plasma Research, Gandhinagar, gave a talk on "Excitation of Nonlinear Coherent Structures in Flowing Complex Plasmas" on 23rd September 2016
- ◆ **Dr. Tapan Barman**, Institute of Advanced Study in Science and Technology, Guwahati, Assam, gave a talk on "Synthesis of polyaniline-Au nanocomposite thin films by plasma-based techniques for flexible self-powered photodetectors" on 26th September 2016

## Upcoming Events

- ◆ International Conference for High Performance Computing, Networking, Storage and Analysis (SC16), Salt Lake City, Utah, USA, 13-18 November 2016 <http://sc16.supercomputing.org/>
- ◆ 9th International Conference on Plasma Science and Applications (ICPSA), Langkawi Island, Malaysia, 28-30 November 2016 <http://laser.utm.my/icpsa2016/>

## Know Our Colleagues



**Dr. Anitha V. P.** completed her post-graduation in Physics from IIT Madras and received her Ph.D in Physics from IIT Mumbai in 1995. She joined IPR in 1997 as an experimentalist in basic plasma physics with the Large Volume Plasma Division (LVPD) group and contributed actively for ten years in the development of the LVPD system and on experiments in electromagnetic wave excitation. She subsequently initiated an experimental project on "High Power Microwave (HPM) and plasma" which resulted in the formation of "Microwave-Plasma Division" under Basic Plasma Research with her being the Head of the division. Development of a new system named SYMPLE (SYstem for Microwave PLasma Experiments) is presently underway. In order to meet one of the critical requirements of this project, an HPM source of ~ 1 GW power, collaborative efforts are on between IPR and BARC. She is a member of the Academic Committee and also chairs the SHWW committee. She has been teaching Electromagnetic Theory to the PhD students at the Institute for the past five years and is a recognized Academician at the Homi Bhabha National Institute (HBNI), Mumbai and the Gujarat Technological University (GTU).

**Mr. Ch.Chakrapani** joined IPR as a technical trainee in 1996 and later on in 1997 as an Engineer. He started his career with engineering design of large scale cryopumps for Neutral Beam Injector (NBI). He played major role and put enormous efforts not only for the successful indigenous development but also for the long pulse testing of cryopumps with hydrogen and deuterium. His other major contribution to NBI was 3.8 K Helium Refrigerator system working from concept to final operation. The Helium Refrigerator plant was successfully erected, installed, commissioned and tested for its performance at 3.8 K in 2007. Between 2007 and 2008, he contributed, in a short period, to the assigned task of conceptual engineering design of Indian Test Blanket Module for ITER. He continued his work in NBI as a lead mechanical engineer from 2008 to 2010 till he was deputed to ITER-IO for a period of 5 years. At ITER-IO, he worked on the process design of second largest cryogenic system in the world after CERN. Presently, he is working in NBI towards integration with SST-1. In this regard, in 2015, tests were successfully carried out for parallel cool down and operation of six cryopumps with liquid nitrogen.



## The IPR Newsletter Team

|                   |                    |                  |                |            |                 |
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