

Issue 072

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

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

## Yoga Day @ IPR

International Day of Yoga, or commonly and unofficially referred to as Yoga Day, is celebrated annually on 21 June since its inception in 2015. IPR celebrated this event on 21 June 2019 by organizing a yoga session in the lawns of IPR campus. Many of the IPR staff participated in the event where a yoga expert Mr. Vivek Sharam (Art of Living) conducted the session for the benefit of IPR staff.

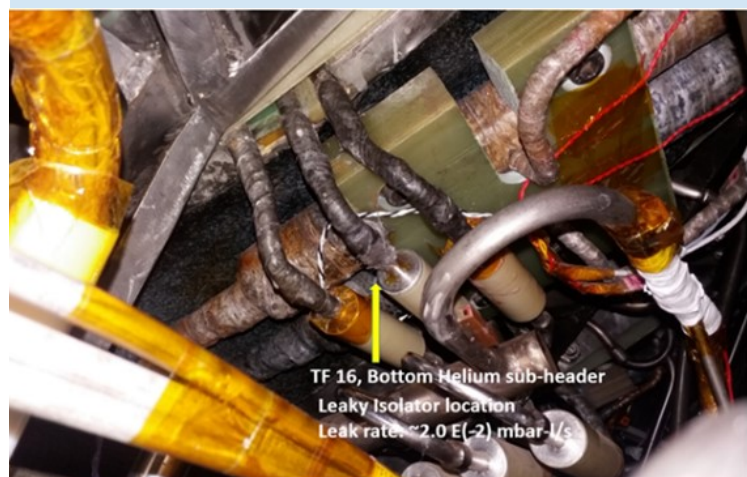




## Helium Leak Detection & Repair of Electrical Break in SST-1 Cryostat

During the cool-down of SST-1 experimental campaign, a gradual degradation in the cryostat vacuum was observed and considering it to be the significant leak, warm up decision was made! After reaching room temperature (RT) condition, a few SST-1 cryostat ports were opened to identify the probable Helium leak location(s) by keeping the pressure up to 8 Bar. This well-coordinated effort by the Vacuum, Cryogenics, Magnets and Assembly divisions led to the detection of Helium leak of the order of  $1.5\text{--}2.0 \times 10^{-2}$  mbar-l/s in the manifold of TF-16 coil, located at the SST-1 Cryostat Manhole Port -15. The exact location of leak was finally identified at the electrical break in SS to GFRP interface joint.

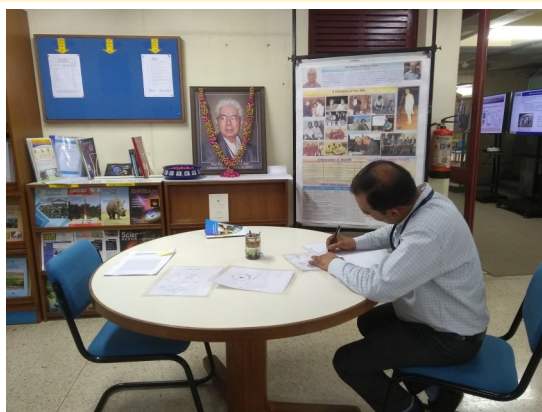
Fortunately, the location of Helium leak was accessible for repair. However, it was not possible to replace the interface joint as there is not sufficient space available to perform a cut and re-weld. The only option left was to repair the leak using in-house developed cryo-compatible epoxy resin. The repair and subsequent tests were carried out successfully with the Helium leak tightness of  $2.7 \times 10^{-5}$  mbar-l/s at the RT conditions (under the pressure of 7.8 Bar).



(L) Location of Helium leak at Electrical Break interface (R) Repaired Electrical Break interface

## IPR Library - Activities

On 18th June 2017, homage was paid by IPR staff on the occasion of the second death anniversary of late Prof. P. K. Kaw. While floral tributes were offered by staff members, other staff members also expressed themselves by writing down their thoughts. IPR Library arranged orientation program for the SSP-2019 students on 27 May 2019. The SSP students were given a tour of the library, and were briefed about the various services and facilities. The students were also introduced to the library collection, both, the physical and electronic resources available at IPR library. A photo session was carried out for the membership process and students were given library membership.



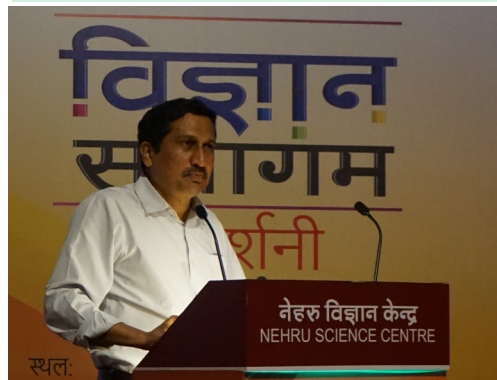
Homage being paid to late Prof P K Kaw on his 2nd death anniversary



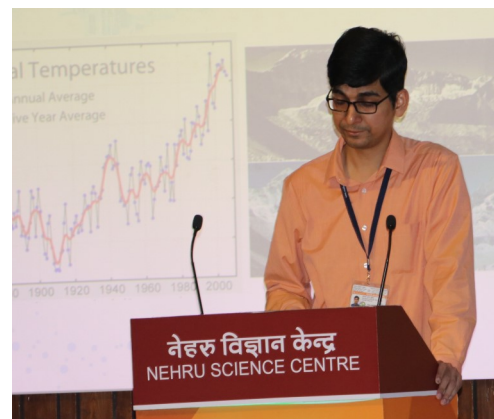
Orientation programme for the SSP-2019 students at IPR library



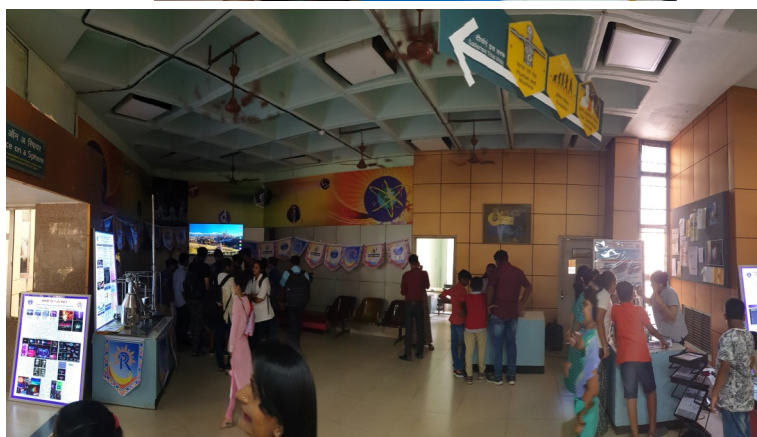
As part of the **Vigyan Samagam** exhibition, which is currently on at the Nehru Science Center, Mumbai, all the participating projects get a week each to carry out outreach activities related to the project. The ITER week was organized during 20-26th May, 2019. As part of this programme, IPR and ITER-India organized popular talks, quiz programmes and hands-on demonstrations of plasma and its applications at the venue. Popular talks on Plasma and its applications were given by Dr. Ravi A.V. Kumar and Ms. Chhaya Chavda. Dr. Shishir Deshpande, Dr. Mahendrajit Singh, Ms. Abha Maheshwari, Mr. Dilshad Sulaiman and Mr. Rohit Anand talked about the ITER project, its technical challenges and India's contribution to the project. There was also a one-day technical interaction programme for students and faculty from the academia. IPR Outreach Division exhibited several live demonstrations of plasma at the venue, for visitors to the exhibition.



(L-R) Dr. S. P. Deshpande, Dr. M. J. Singh, Ms. Abha Maheshwari delivering their popular talks



(L-R) Mr. Rohit Anand, Dr. Ravi A V Kumar, Mr. Dilshad Sulaiman delivering their popular talks



Images from the hands-on demonstrations held during the ITER Week of the Vigyan Samagam at Mumbai



The ITER-scale negative ion source - **SPIDER** was officially launched at NBTf facility Padua in June'2018. Recently it achieved another milestone. SPIDER was operated while applying extraction and acceleration voltages, obtaining the first SPIDER hydrogen beam.

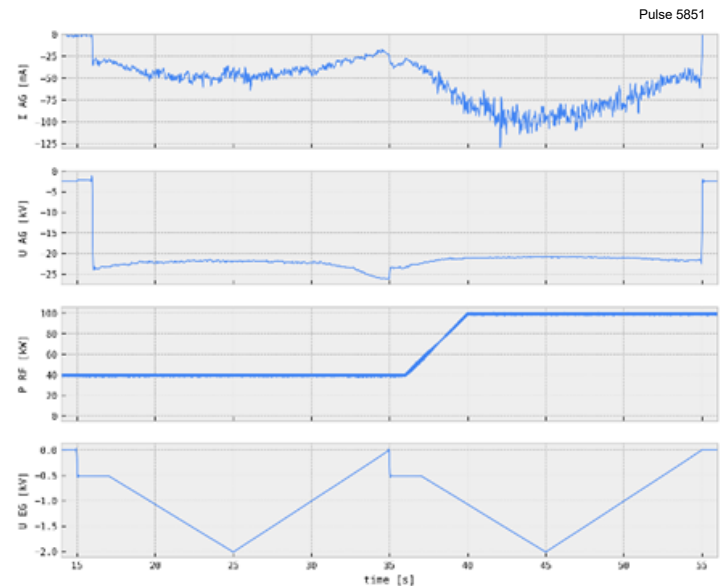
ITER-India contributed the Accelerator Grid Power Supply (AGPS) for SPIDER facility. AGPS provides 8MW power at (-) 96kV to the beam source of SPIDER for acceleration of negative ions with specific modulation. PSM based 96kV/75A AGPS has been developed with design redundancy of 15% which allows for tolerating SPS modules failure without leaving the on-going campaign. The AGPS is designed to turn-off in a time much lower than 100  $\mu$ s to minimize the energy (20 J) delivered to the arc in case of short circuit or breakdown.

AGPS mainly composed of Multi-Secondary Transformers (3nos. 2.8MVA each), Switched Power Supply (SPS) Modules (150nos., 60kW each), FPGA/Real Time based controller and other auxiliaries including passive protection devices. Novel, state of the art technologies for HV insulation such as multiple bushings integrated on large resin insulators and building feedthroughs have been developed.

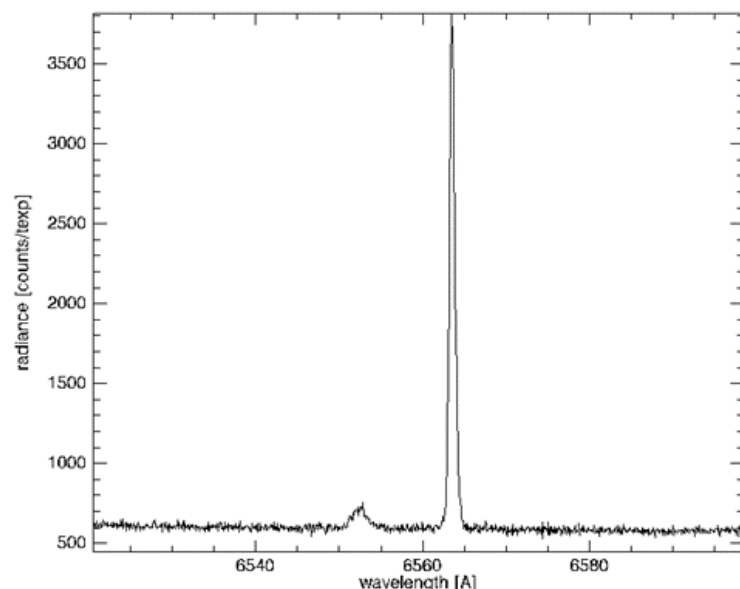
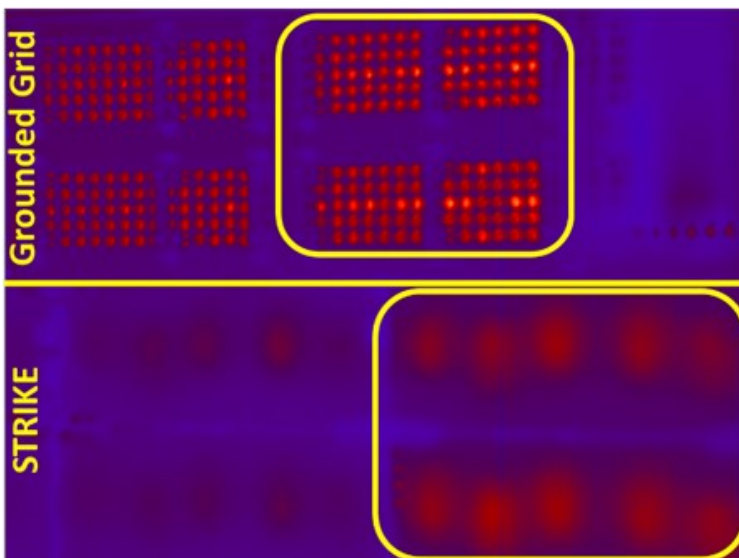
To ensure described functionalities a single AGPS is controlled by 9 powerful synchronous FPGAs managed by real time controller which support high performance requirement of PSM based HVPS like low ripple, high resolution, programmable rise time, fast dynamics, full depth modulation, fast switching off and fast (~few milliseconds) re-application in case of breakdowns.

AGPS was successfully transferred to IO after completing the Site acceptance test in Sept'2018. Subsequently it was integrated with Ion source in Feb'2019 and delivered the first beam on 24<sup>th</sup> May'2019. Integrated demonstration of indigenously developed AGPS on actual load boosts the confidence for home-grown projects.

Image Courtesy: Consorzio RFX , Padua , Italy



(L) Installed AGPS at SPIDER facility (R ) AGPS voltage and current waveforms along with RF and extraction voltage



(L) Beam footprint on the diagnostic calorimeter (R) Beam Emission Spectroscopy



The “Advanced B.Sc. (Physics) Programme”, was first initiated in 2003 as a joint effort of the Gujarat Science Academy and Vikram A Sarabhai Community Science Centre (VASCSC), Ahmedabad under the guidance of experts from Institute for Plasma Research (IPR), Physical Research Laboratory (PRL), Indian Space Research Organization (ISRO), etc. This year, the course was conducted from May 11 to June 1, 2019 at St. Xavier’s College, Ahmedabad. The 35 students selected for this programme from across Gujarat visited IPR on 21 May 2019. These students were shown the various labs in IPR as well as FCIPT.



Participants of the Advanced BSc Course during their visit to IPR

A scientific outreach and interaction activity was conducted for around 125 students of 11th and 12th (science stream) of the Ramseth Thakur Public School at Kharghar, Navi Mumbai on 18th June, 2019. Popular talks on “What is plasma” and “Applications of Plasma” were delivered by Dr. Ravi A V Kumar which was followed by interaction with students regarding the topics of the talk as well as career options in plasma science & technology.





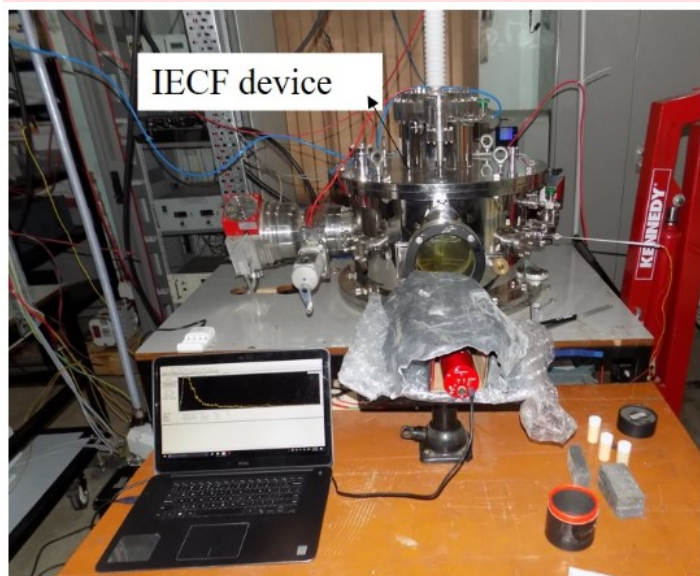
IPR participated in the DAE-CII event “ParamanuExpo-2019” held at the DAE convention center in Anushakti Nagar, Mumbai on 17th June, 2019. This exhibition showcased various technologies of DAE institutions under “Food Security”, Healthcare”, “Water purification”, “Waste management & Environment” “Industrial Applications of Radioisotopes” and “Engineering Technologies”. IPR exhibited models of Plasma Pyrolysis, Nitriding, plasma treatment of wool, etching of textiles, and robotics. Participants from IPR were Mr. K K Mohandas, Ms. Harsha Machchhar, Mr. Narendra Chauhan and Mr. Anand Vasani.



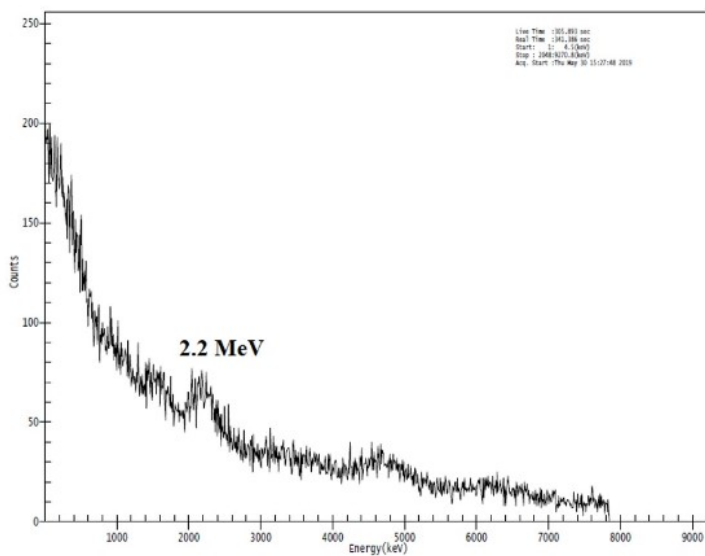
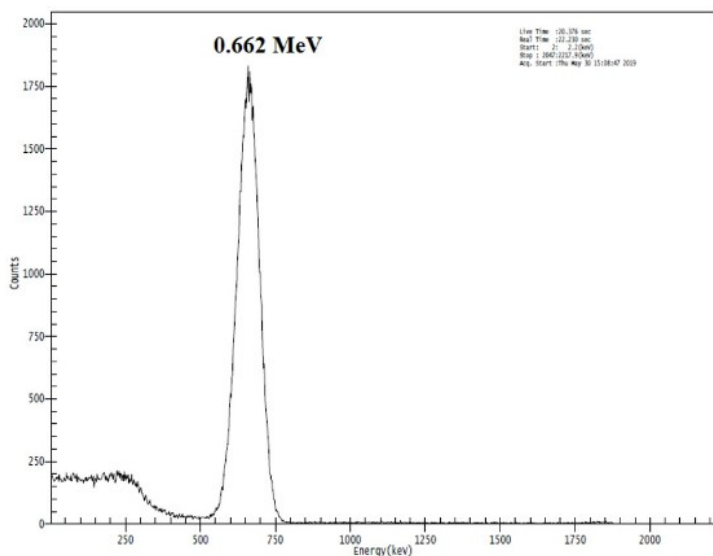
Images from the ParamanuExpo-2019



The fusion neutrons of CPP-IPR Inertial Electrostatic Confinement Fusion (IECF) device has been used for the detection of explosive materials. The neutrons activate the low Z elements of the explosives that generally contain C, H, O, and N. Usually, explosives are made of trinitrotoluene (TNT;  $C_7H_5N_3O_6$ ) or cyclotrimethylene-trinitramine (RDX;  $C_3H_6N_6O_6$ ) and ammonium nitrate ( $H_4N_2O_3$ ). For this experiment, urea nitrate ( $(NH_2)_2COHNO_3$ ) was used, which resembles the chemical content of ammonium nitrate. The emitted neutrons of the IECF device were first thermalized (0.025 eV) and then allowed to interact with the H and N nuclei of the explosives material to emit gamma radiation of corresponding energies (2.2 MeV & 10.83 MeV). The experimental arrangement is shown in Fig. 1, where the urea samples are placed in plastic vials and put in front of a scintillator detector. The detector was calibrated by using the known source Cs-137 that emits 0.662 MeV gamma ray. The thermal neutrons (0.025 eV) on activating hydrogen nuclei of urea emit characteristic gamma rays of 2.2 MeV as shown in Fig. 2. Although, the higher energy gamma radiation at 10.83 MeV couldn't be detected due to the detection limit of the sensor, the gamma radiation at 2.2 MeV confirms the feasibility of use of the IECF device for explosive detection.



Experimental arrangement for explosive detection.



(L) Calibrated energy spectrum and (R) detected 2.2 MeV gamma radiation.

## हिंदी कार्यशाला

परमाणु ऊर्जा विभाग की राजभाषा कार्यान्वयन संबंधी प्रोत्साहन योजना से संस्थान के पदाधिकारियों को परिचित कराने के उद्देश्य से 20 जून, 2019 को एक हिंदी कार्यशाला का आयोजन किया गया। इस कार्यशाला के अंतर्गत दो सत्र आयोजित किये गये, एक सत्र प्रशासनिक वर्ग हेतु एवं दूसरा सत्र तकनीकी/वैज्ञानिकी वर्ग हेतु। कुल 58 प्रतिभागियों ने इस कार्यशाला में भाग लिया। कार्यशाला के दो सत्रों में पऊवि की अटॉलिस – परमाणु ऊर्जा राजभाषा कार्यान्वयन योजना से संबंधित विस्तृत जानकारी प्रदान की गई एवं राजभाषा नीति संबंधी प्रमुख निर्देश दिये गये। इसके अलावा तिमाही प्रगति रिपोर्ट को भरते समय मुख्य बिन्दुओं को ध्यान में रखने के साथ अपने अनुभागों में हिंदी कार्य की प्रगति हेतु विशेष प्रयास करने के सुझाव दिये गये। कार्यशाला के अंत में नई संशोधित योजना से संबंधित प्रतिभागियों के संदेहों को दूर किया गया।



## Upgraded Access to Helium Storage Tanks @ IPR As Per CCOE Guidelines

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In order to comply with the requirement of the Chief Controller of Explosive (CCOE), Nagpur w.r.t. the six numbers of helium gas high pressure vessels installed of gas storage for operation of SST-1, IPR has to carry out periodic tests for hydraulic pressure and other inspections under rule 19 SMPV (U). Apart from the hydro test, the safety valves which have installed on the top of the vessel also have to pass the performance test under Rule 18. To carry out these mandatory tests, regular and breakdown maintenance of safety valve, rupture disc and helium leak testing job, cryo division crew members have to go along with instruments at the middle and top of the vessels. CCOE had recommended installation of a separate ladder with bridge type platform between vessels was mandatory to get renewal of license to operate the storage vessels. This CCOE approved spiral ladder and joint platform structure which facilitate movement of personnel on to any one of the four vessels by a single spiral ladder was designed, fabricated and installed. *(Rajiv Sharma, V. L. Tanna, SST-1 Cryogenic division)*



(L) Foundation of Structure (M) Installation of I-beam structure (R) Completed vessels joint platform structure

## Yoga Day @ IPR





The Summer School programme for the year 2019 is being held at IPR from May 27- July 5, 2019. For this 6 week programme, 32 students of science (22) and engineering streams (10) have been selected. The students will first have a week of class room lectures on various domains of plasma physics and applications by IPR faculty, followed by a five week project work. The students' projects will be evaluated based on the presentations made on their projects at the end of the School. As part of the programme, the students visited the ICRH facility of ITER-India laboratory located at the IPR campus. In the course of the school, the students will visit most of the labs in IPR, FCIPT, ITER-India and IPR extension labs at Gandhinagar.

The SSP-2019 students were also taken for a leisure-cum-adventure trip to the Orsang Camp Resort located in Vadodara.



Dr. Shashank Chaturvedi, Director IPR, addressing the students of SSP 2019. His talk introduced the students to various aspects of plasma & science & technology, its applications from fusion to day-to-day societal applications.



(L) Mr. Lavkesh Lachwani delivering a lecture on "Basic plasma experiments at IPR". (R) Students at the ICRH facility of ITER-India laboratory.



The participants of SSP-2019 during their leisure trip to Orsang Camp Resort, Vadodara



- ♦ **Ms. Priti Kanth**, Institute for Plasma Research, Gandhinagar, gave a talk on "*Nuclear Activation Code Development and Analysis for Fusion Systems*" on 3rd June 2019
- ♦ **Mr. Ramkrishna Rane**, Institute for Plasma Research, Gandhinagar, gave a talk on "*Experimental study of near anode plasma in hollow cathode cross field discharges*" on 7th June 2019
- ♦ **Ms. Janki Shah**, Sardar Vallabhbhai National Institute of Technology, Surat, gave a talk on "*Morphological and Thermophysical Properties of Metal- Oxide Nanofluids*" on 7th June 2019
- ♦ **Dr. Narayan Behera**, Institute for Plasma Research, Gandhinagar, gave a talk on "*Dynamics of Plasma Plume in a Magnetic Field using Two- Directional Imaging*" on 12th June 2019
- ♦ **Mr. Prabhakar Srivastav**, Institute for Plasma Research, Gandhinagar, gave a talk on "*Experimental Study on ETG Turbulence Induced Plasma Transport in Large Volume Plasma Device*" on 12th June 2019
- ♦ **Dr. Rudrodip Majumdar**, IIT Bombay, gave a talk on "*Modelling of Flow Patterns of Impurity Particulates following a Disruption in the Fusion Reactor Chamber*" on 17th June 2019

### Upcoming Events

- ♦ 7th Annual Theory and Simulation of Disruptions Workshop, Princeton, New Jersey, USA, 5-7 August 2019 <https://pppltsdw.princeton.edu/>
- ♦ 2019 Pacific Symposium on Pulsed Power and Applications, Kauai, Hawaii, USA, 6-9 August 2019 <http://www.p3e.ttu.edu/symp2019/>
- ♦ 17th International Workshop on Plasma Edge Theory in Fusion Devices, California, USA, 19-21 August 2019 <https://pet2019.eng.ucsd.edu/>
- ♦ 11th International Conference on Dense Z-Pinches (DZP2019), Beijing, China, 19-23 August 2019 <http://conference.iapcm.ac.cn/dzp2019/>
- ♦ Workshop on Materials Characterization: Structure, Spectroscopy, and Microscopy, IITRAM, Ahmedabad, 19-24 August 2019 [http://iitram.in/workshop/20190429\\_Workshop\\_31.pdf](http://iitram.in/workshop/20190429_Workshop_31.pdf)

### Know Our Colleagues



**Mr. Pradip N. Panchal** joined IPR as a Technical Trainee in 2001 and was subsequently appointed as Engineer - SC in SST-1 Cryogenics Division in 2002. He holds a B. E. degree in Instrumentation & Control from Nirma Institute of Technology, Ahmedabad and a M. Tech. degree in Electrical Engineering with specialization in Control & Computing from IITB Mumbai. In the initial years of his career, he was actively involved in the installation & commissioning of 1.3kW Helium refrigeration cum liquefier plant, IFDCS and WGM. He was responsible for installation, commissioning, maintenance of various process instrumentations for cryogenic system. He developed SCADA based system with historian for storage and exchange of necessary process data among cryogenics system. He played crucial role in the development of instrumentation set-up for various cryogenic experiments with Helium plant & IFDCS such as TF coil tests, 10kA vapour cooled current leads (VCCL) tests and developed their data acquisition system / SCADA and PLC programs. He also acquired experience in the area of switch mode programmable power supply for current lead tests and cryocooler based Helium circulation system. He carried out PLC / SCADA upgradation tasks for LN2 Management System and Helium Plant. He is actively involved for operation, maintenance and control of 1.3kW Helium plant with other cryogenic system for various SST-1 campaigns.

**Mr. Mitesh Patel** joined IPR as a technical trainee in 2001 and was subsequently appointed as Engineer - SC in Electronics group. In his early days, he worked on PCB design for various diagnostics related to Aditya and SST-1. In 2004, he was transferred to Instrumentation group where he carried out maintenance and calibration of various instruments. Apart from that, he was involved in upgradation of PBX system in IPR, as well as maintenance of cluster computers and the Cray system. In 2011, he moved to the non-linear physics group where he designed and developed various electronic circuits for study of chaotic phenomena. He was a co-faculty at the hands-on school on "Non-linear and complex system" supported by ICTP. During 2016-17, he developed code for Wall Monitoring System to protect Tungsten based Plasma Facing Component in WEST at Cadarache, France. Currently he is working with the Electronics & Instrumentation Division.



### The IPR Newsletter Team

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