Issue 106
May 2022

The Fourth State

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

Swachhta-Pakhwada @ IPR

"Swachhta-Pakhwada" was observed at IPR during 16-28 February, 2022. This year it has been observed under the umbrella of *Azadi ka Amrit Mahotsav*. As part of this drive, all IPR staff members actively participated with a lot of enthusiasm.

The following activities have been carried out during the Swachhta Pakhwada-2022 :

- Removal of all unwanted waste items collected from offices, laboratories and various open spaces of the institute, segregated and disposed of them properly.
- Survey of all the offices, laboratories, canteens, guest houses, kitchens, and lavatories to check proper cleaning and waste disposal.
- Clean Campus Initiative with "Best out of Waste": Using scapped oil drums for tree plantation.
- Online Quiz, Eloquence competition for school students from Ahmedabad and Gandhinagar
- Slogan and Video Making competition for IPR Staff members and their family
- A webinar on "*Cold plasma approach for reduction of waste in Chemicals manufacturing*" by Dr. K.S. Ganesh Prasad, Institute of Advanced Research, Gandhinagar
- 3 km Swachhata Walk (IPR to ITER-India): Collection of plastic waste on the road side (Plogging).

Swachhata posters displayed in IPR campus

Discarded oil drums were collected and modified and painted to be used to plant trees in the campus.

Swachhta-Pakhwada @ IPR

A Swachhata walk was conducted from IPR campus to the ITER-India campus and the participants of the walk picked up all the waste plastic materials along the path. Staff from IPR and ITER-India actively took part in this event to ensure that the road from IPR to ITER-India was free of plastic waste materials.



IPR staff undertaking the Swachhata walk from IPR to ITER-India campus

As part of the Swachhata Pakhwada, a lot of junk/garbage from various areas within the IPR campus was cleared and disposed off. These waste included waste paper, plastics, cardboard, thermocol etc .




Waste materials collected and being disposed at IPR



The clean IPR scrapyard after disposal of waste materials

Swachhta-Pakhwada @ IPR




As part of the Swachhata Pakhwada, sleeping mats were distributed to the housekeeping staff at IPR










Regulated High Voltage Power Supply for Accelerator Driven System of DAE

BARC has taken a major step in the development of LEHIPA – Low Energy High Intensity Proton Accelerator. This is a complex LINAC that would accelerate proton beams to 20 MeV energy, but with unusually high intensity, i.e. 30 mA.

Very recently, the Drift-Tube Linac of LEHIPA achieved acceleration level of > 6.8MeV. The accelerator system utilizing Klystrons is being supported by 100 kV, 25 A Regulated High Voltage Power Supplies (RHVPSs), indigenously developed by Institute for Plasma Research (IPR).

IPR delivered its patented system that was installed at BARC, Mumbai site in 2015 and delivered power to the first stage of the experiment. The in-house technology was then transferred to M/s. Electronics Corporation of India Ltd. (ECIL) for licensed production of RHVPSs.

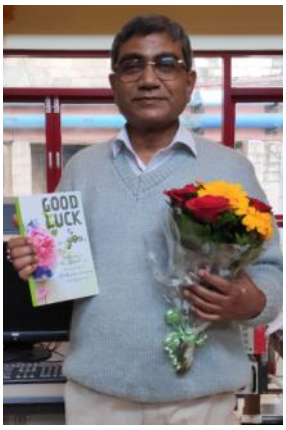
Remaining 2 stages are presently being supplied and commissioned by ECIL team. Special features of RHVPS include (a) fast dynamics, (b) regulated voltage at 100 kV level and (c) very low short circuit energy imparted to load. This achievement has opened a new horizon in independent sourcing of such power systems for the nation.

100kV, 25 A Regulated High Voltage Power Supplies (RHVPSs) installed at BARC site. Waveform shows 80kV application by RHVPS at repetition rate of 2Hz to Klystron cathode

Adieu

The following staff members of IPR superannuated during the period December 2021 to March 2022 after over 2-3 decades of distinguished service to the Institute.

On behalf of all the staff members of IPR, FCIPT, ITER-India and CPP-IPR, IPR newsletter wishes to thank them for their services rendered to IPR and wish them a happy, healthy and fruitful retired life!



Dr. Biswanath Sarkar

DOJ : 05-09-1995
Joined as : Sci-SD
Retired as : SO(H)
DOR : 31-12-2021

Dr. Amit Sircar

DOJ : 06-01-1997
Joined as : Sci.-SD
Retired as : SO(H)
DOR : 31-01-2022

Mr. Kanubhai R Rathod

DOJ : 07-07-1998
Joined: Draughtsman (A)
Retired: Draughtsman (E)
DOR : 28-Feb-2022

Ms. Ranjana Manchanda

DOJ : 23-03-1987
Joined as : : SAC
Retired as : SO(G)
DOR : 31-03-2022

Mr. Bharat Doshi

DOJ : 18-06-1989
Joined as : Eng-SC
Retired as : SO(H)
DOR : 31-03-2022

Outreach Activities @ IPR

After a gap of over two years, IPR has now started allowing campus visits as part of students' academic programme.

Date	Name of the Institution	Number of visitors
1-Apr-2022	Indus College of Engineering , Ahmedabad	22 students of BTech (Metallurgical)
4-Apr-2022	Indian Institute of Teacher's Education (IITE) Gandhinagar	9 B.Ed. (Science) students and 1
5-Apr-2022	Delegates from the Gujarat Power Research & Development Cell	7 persons

Students of Indian Institute of Teacher's Education (IITE) Gandhinagar , during their visit to FCIPT

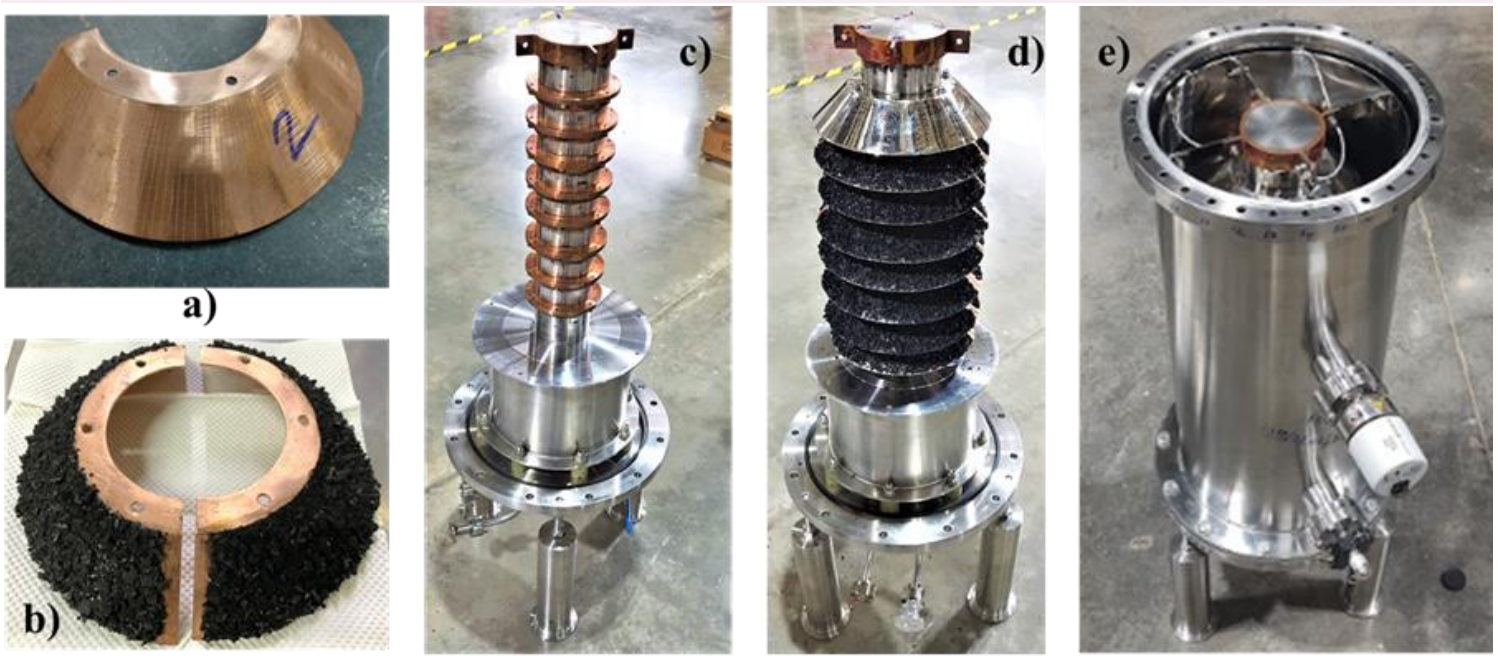
Students of Indus College of Engineering, Ahmedabad, during their visit to FCIPT

Delegates of Gujarat Power R&D cell during their visit to FCIPT for exploring solutions /collaborations for resolving power sector related problems, *viz*, specialized coatings, materials, HV insulation corrosion etc.

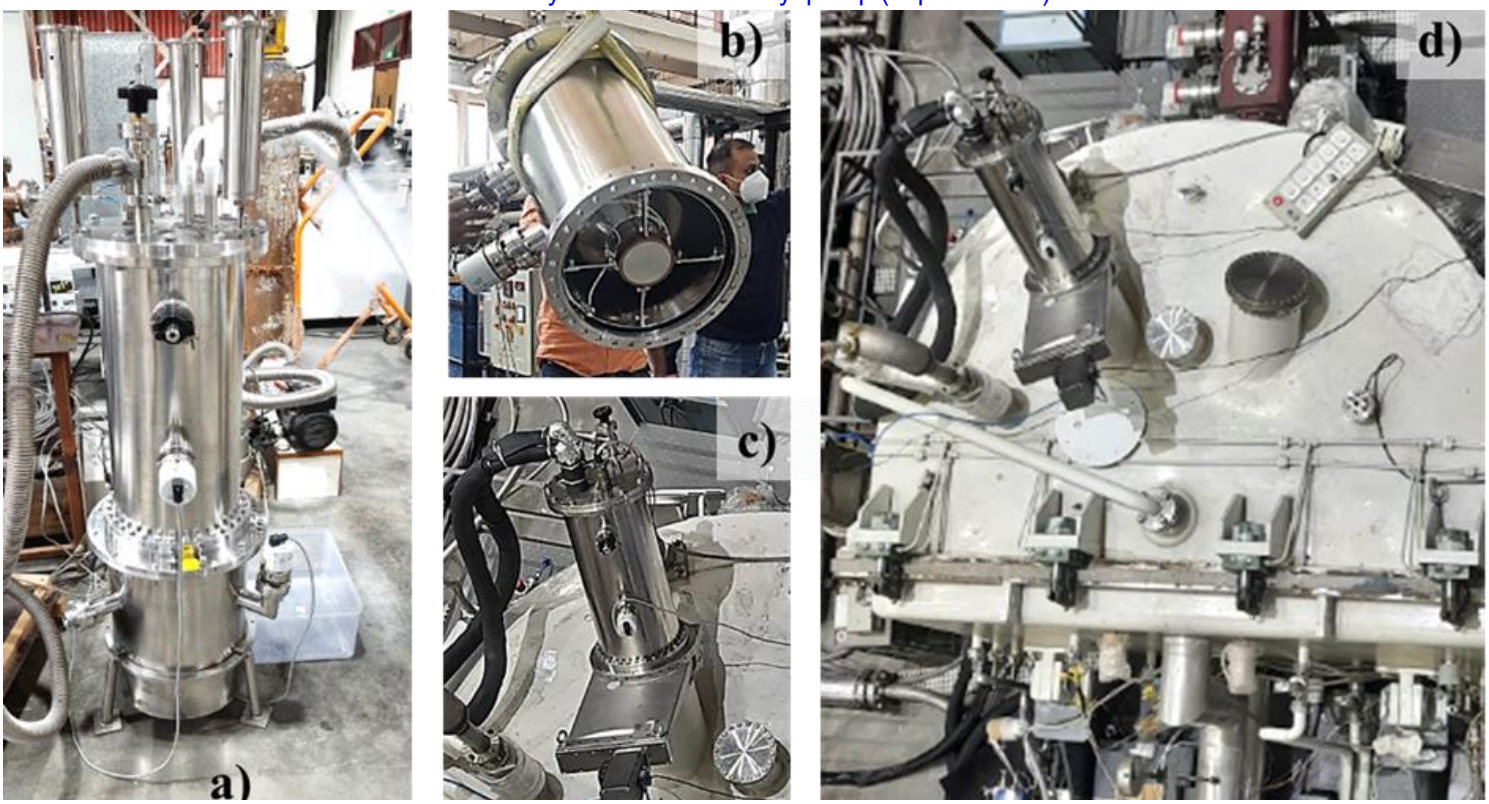
Development of LN_2 cooled Cryopump for the High Heat Flux Test Facility

High Heat Flux Test Facility (HHFTF) at Institute for Plasma Research is established for testing thermal performance of Plasma Facing Components (PFC) & Plasma Facing Materials (PFM) that are expected to withstand steady-state and transient heat flux of the order of 10 MW/m^2 and 20 MW/m^2 respectively expected in plasma fusion devices. It mainly consists of the following subsystems like vacuum system, target handling system, high power electron beam system, diagnostic and calibration system, data acquisition & control system and high pressure high temperature water circulation system (HPHT-WCS). At present HHFTF is used for high heat flux testing of water cooled PFC's. A combination of a Turbomolecular pump and a Cryo -sorption pump (CP-1) having pumping capacity 1900 *l/s* and 4500 *l*/s for N_2 gas, respectively, are used for pumping vacuum chamber (5 m^3) of HHFTF to generate background pressure of the order of 10^{-6} mbar. During high heat flux testing of water cooled PFCs, water vapour and other trapped gases are released.

An indigenously developed liquid nitrogen cooled cryopump (CP-2) is attached to the 250 CF angle port (50°) of D-shaped vacuum chamber as shown in Fig. 2. The pump has integrated liquid nitrogen bath to provide stable cooling to the cryopanels and radiation shield. Cryopanels are made of copper and coated with micro-porous activated charcoal. The pump geometrical concept is novel because it provides ease of assembly, integration and trouble free operation in horizontal and vertical direction mounting. The pump offers pumping speed of ~ 5106.6 l/s for water vapour and ~1197 l/s for nitrogen using liquid nitrogen as coolant. The CP-2 is successfully installed and tested in HHFTF.



(a) Bare copper panel half (b) Pair of charcoal coated panel (c) SS bath and copper collar rings, (d) charcoal coated panels assembly and assembled cryopump (kept inverted)



(a) Pump test setup with AVS dome, (b) Lifting Pump for integration to HHF, (c) Showing mounted pump and the gate valve and (d) Top view of HHF chamber with the cryopumps integrated.

Outreach Activities at CPP-IPR

On 11th March, 2022, as part of *Azadi Ka Amrut Mahotsav* activities, around 15 students of Jawahar Navodaya Vidyalaya, Morigaon visited CPP-IPR along with their teachers and interacted with the scientists and scholars of various laboratories at CPP-IPR.

Students of Jawahar Navodaya Vidyalaya, Morigaon, during their visit to CPP-IPR

CPP-IPR also conducted a one-day workshop on Plasma Polarization at the St. Joseph's College (SJC), Jakhama, Nagaland on 19th March 2022. The event began with a welcome speech by the Principal, Fr. Dr. George K. Angami, and was followed by two scientific lecture sessions.

In the first session Dr. Rakesh Moulick, SO-D, CPP-IPR presented his talk on Fundamentals of Plasma Physics while in the second session, Dr. Ng. Aomoa, SO-D, CPP-IPR presented experimental perspectives of Plasma Physics. In addition, there was a live demonstration session in which students were able to visualize Plasma and interact with the scientists. The event ended with a valedictory from Fr. Peter Solo, Dean of Sciences, SJC.

Images from the one-day workshop conducted by CPP-IPR at St. Joseph's College (SJC), Jakhama, Nagaland

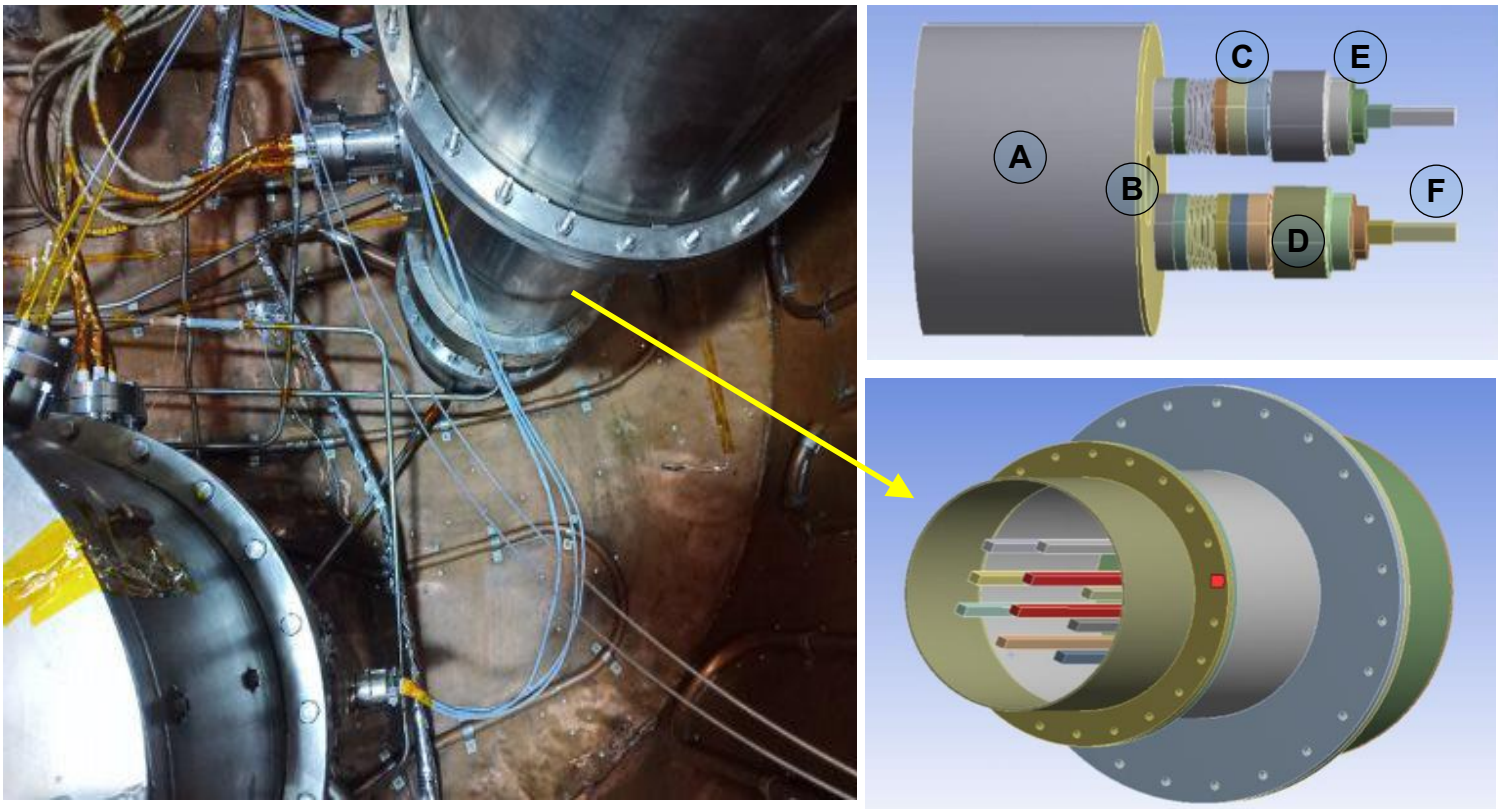
80K Thermal Anchoring of PF Bus-Bar Ducts in Current Feeder System of SST-1

While operating the PF-3 coils, higher temperatures near the PF bus bar joint box has been observed in the previous campaigns of SST-1. The joint box is there inside the Current Feeder System (CFS).

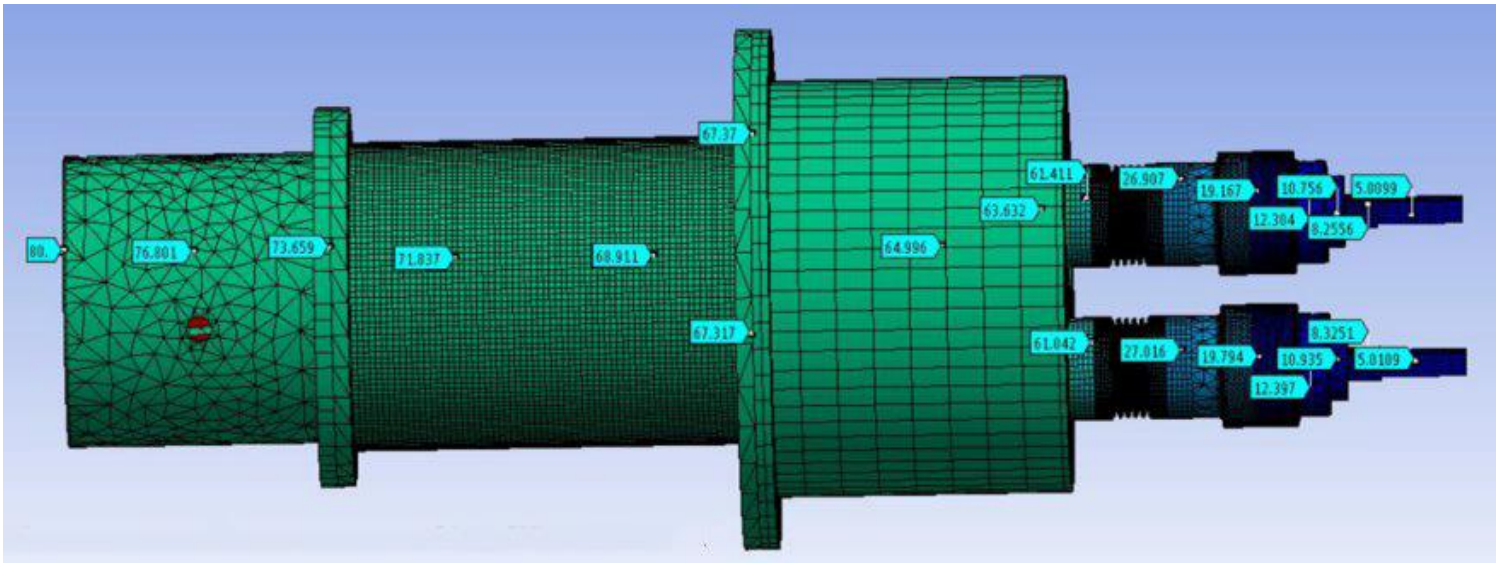
To deal with this issue, thermal anchoring of PF bus-bar Ducts at 80K has designed for reducing the temperatures of PF bus bar. This design is done in a way to create temperature gradients across the duct as well as its vicinity. The estimated heat load reduction up to 35W obtained through the thermal model worked out in CFD along with the detailed temperature distribution (Please refer Figure).

Additional temperature measurement of critical locations will be taken during the campaign for Optimization of thermal behavior of 80K thermal shield PF bus bar duct from CFS to SST-1.

Fabrication of an additional vacuum jacketed liquid nitrogen supply line has been done. A valve is installed to regulate the flow across new hydraulic network. During installation of the shields, all possible QA/QC aspects have also been followed in terms of NDT, helium leak tightness test. The cool down of the shields from RT condition to 80 K has successfully been achieved.



(L) New LN2 assembly inside the CFS chamber (Top) CAD model of the VB assembly (A) SS duct (B) base plate (C) Bellow and SS rings (D) S-glass (E) SS ring and end cap (F) E-glass insulation (Bottom) CAD model of the Busbar assembly.



Temperature distribution as obtained by ANSYS simulation

Visit of MSME Industry Delegation to FCIPT

An MSME industry delegation from Gujarat Chamber of Commerce & Industry (GCCI) comprising of around 20 industry members visited the FCIPT campus of IPR on 24th March 2022. The visit was aimed at promoting plasma technologies developed by IPR for industries and the services and technologies offered by IPR to industries. The delegation was led by Shri Tarachand Jain, Chairman - GCCI MSME committee and Shri Tejas Mehta, Co-chair of GCCI MSME committee. The delegation also included Shri Vikas Gupta, Jt. Director - MSME-DI and Shri K H Shah, Jt. Director - MSME-DI from the Ministry of Small and Medium Scale Enterprise (MSME). The delegation was demonstrated with different working models of plasma systems including plasma pyrolysis, plasma nitriding, plasma jet, plasma sterilizer, plasma activated water system, plasma PVD coating systems etc. The delegation had extensive interaction with the scientists of FCIPT, IPR on how technologies could be transferred to industries and how they can collaborate with IPR.

More than half of the delegates expressed interest to collaborate as they found their area of interest in the technologies demonstrated. Shri Vikas Gupta, Jt. Director, MSME also gave a talk on how the MSME industries can get benefited from different schemes and specifically emphasized on the incentives offered to MSME for adopting new technologies. Mr. Gupta also informed that upto 50% of tech transfer fee reimbursement is possible through state government scheme.

The delegation was excited to witness the progress and the advances in the field of plasma technology and conveyed that more such visits for sector specific industries was needed to facilitate transfer of technologies. The visit concluded with thanks by GCCI delegation for the visit to FCIPT-IPR. Few industries have already approached IPR and discussions are being worked out.

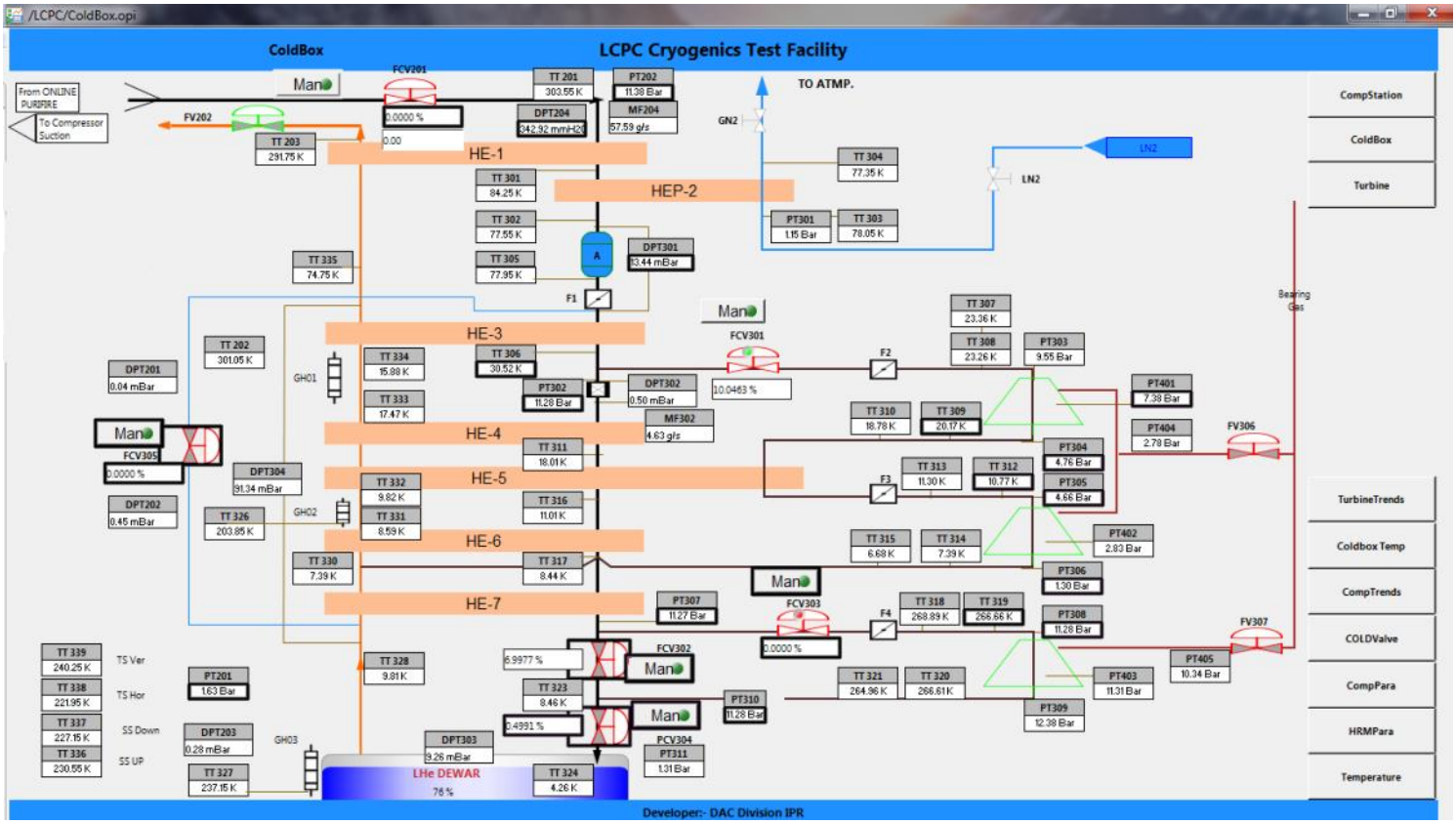
Images from the visit of MSME industry delegation from Gujarat Chamber of Commerce & Industry (GCCI) at FCIPT

Control System for Large Cryogenics Plant

A 200W cryogenics plant is being developed in-house at IPR. The LCPC Cryogenics plant has three main components, (a) Helium Compressor (b) Coldbox (c) Turbines. The in-house developed software is based on EPICS with CS-Studio tools, Apache servlet and MySQL which features live data monitoring and history data availability.

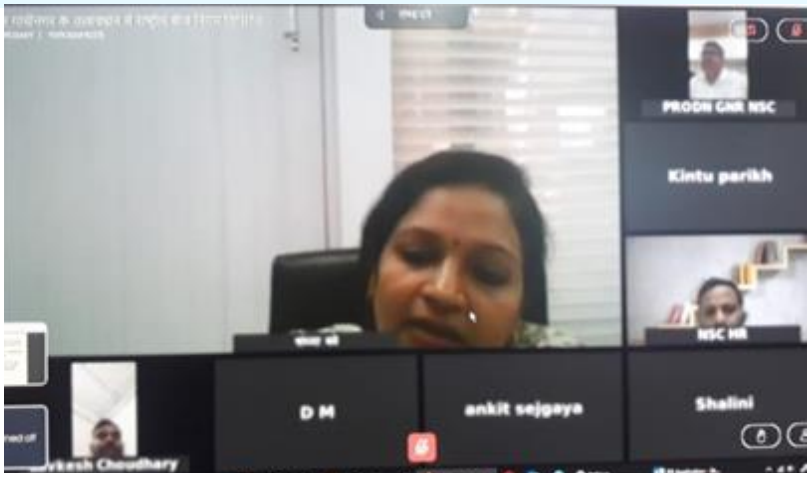
The plant control system is designed using PLC. The control system variables have been grouped based on control functions, their criticality and measurement-only parameters. The control system has over 150 data channels. Different types of PLCs and measurement devices have been selected considering cost optimization and functionalities offered. The plant has been commissioned in phases and hence the control system also evolved step-by-step in each phase. The compressor close loop control was the first to be implemented, followed by cold-box and turbine control.

In the first phase, Data Acquisition and Control (DAC) Division of IPR implemented semi-automated control for turbines. Control engineers brought the first phase control system to the industrial level using knowledge gained from other cryogenics plant in the IPR. The cryogenics plant demonstrated cool down @ 4.3K Helium successfully in last two operations. Fully automated turbine control will be developed in the coming phase with experience gained from first phase plant operation and functions.



हिंदी व्याख्यान

नगर राजभाषा कार्यान्वयन समिति, गांधीनगर के तत्वावधान में राष्ट्रीय बीज निगम लिमिटेड, गांधीनगर द्वारा 25 मार्च 2022 को हिंदी वेबिनार का आयोजन किया गया। इस अवसर पर डॉ. संध्या दवे, हिंदी अधिकारी, प्लाज्मा अनुसंधान संस्थान द्वारा 'कार्यालयों में राजभाषा कार्यान्वयन' विषय पर व्याख्यान दिया गया। राजभाषा नीति एवं नियमों पर चर्चा करते हुए कार्यालयों में राजभाषा के कार्यान्वयन में आ रही कठिनाईयों पर विस्तार से चर्चा की गई एवं सुझाव प्रदान किये गये। नगर राजभाषा कार्यान्वयन समिति, गांधीनगर के सदस्य कार्यालयों के कार्मिकों ने इस कार्यक्रम में उत्साहपूर्वक भाग लिया।



व्याख्यान की तस्वीरें

Past Events @ IPR

- ***Mr. A. Abhishek,*** gave a talk on "*Artificial Intelligence tool for Cancer Detection*" at 1st International Cancer Congress-2022, Applied Computer Technology, Kolkata, on 06th March 2022
- ***Mr. Soumen De Karmakar,*** gave a talk on "*Kelvin-Helmholtz Instability in Two Dimensional Semi-bounded Active Yukawa Liquids*" at American Physical Society Meeting, Chicago, 14-18 March 2022
- ***Dr. Abin Rejeesh,*** Indian Institute of Technology Bombay, gave a talk on "*MHD flow inside ducts: two phase flow analysis*" on 21st March 2022
- ***Mr. Shishir Biswas,*** gave a talk on "*Multi-GPU Acceleration of 3D Pseudo-spectral Magnetohydrodynamic Code for Large-scale Plasma Simulation: G-MHD3D*" at GPU Technology Conference, organised by NVIDIA, 21-24 March 2022
- ***Mr. Rakesh Moulick,*** gave an invited talk on "*Numerical Analysis Using Python*" at University of Science & Technology, Meghalaya on 22nd March 2022
- ***Dr. Vishakha Baghel,*** gave a talk on "*Water Droplet Motion Dynamics on Linear Wettability Graded Surface for Microgravity Applications*" at International Conference on Thermo-Fluids and System Design (ICTFSD 2022), Birla Institute of Technology, Mesra, 22-23 March 2022
- ***Dr. S. R. Mohanty,*** gave a talk on "*An application based table-top neutron source*" at Indian Particle Accelerator Conference (InPAC, 2022), VECC, Kolkota, 23rd March 2022
- ***Dr. Sheena TS,*** Bharathidasan University, Tiruchirappalli, gave a talk on "*Raman Spectroscopy for biological application: A promising tool for molecular discrimination of cells*" on 25th March 2022
- ***Mr. Abhishek Saraswat,*** gave a talk on "*Development of a two-phase detection probe for high temperature lead-lithium liquid metal applications*" on 30th March 2022
- ***Mr. Sudhirsinh Vala,*** gave a talk on "*Development of a rotating tritium target based D-T Neutron generator system for fusion neutronics studies*" on 31st March 2022
- ***Dr. Poonam Gawali,*** University of Bombay, Maharashtra, gave a talk on "*Flavonoid mediated gold and silver nanoparticle's synthesis and characterization and checked the efficacy by antioxidant, anti-inflammatory, and anticancer activities*" on 1st April 2022
- ***Dr. Dhyey Raval,*** PDPU, Gandhinagar, gave a talk on "*Development of plasma process based photoelectrode and process control applications*" on 08th April 2022
- ***Dr. Supriya More,*** Savitribai Phule Pune University, Pune, gave a talk on "*Plasma-surface: Interaction, Optimization and Applications*" on 22nd April 2022

Upcoming Events

- Workshop on "Frontiers in Low Temperature Plasma Diagnostics " Italy, 1-5 May 2022. https://event.unitn.it/fltpd2022/
- 9th Runaway Electron Modelling (REM) meeting, Germany, 2-6 May 2022. https://ft.nephy.chalmers.se/?p=conference&id=3
- High Temperature Plasma Diagnostics Conference 2022, Rochester, US, 15-19 May 2022. https://htpd.lle.rochester.edu/
- International Conference on Physics of Reactors (PHYSOR 2022), Pittsburgh, 15-20 May 2022. https://www.ans.org/meetings/physor2022/
- 23rd Meeting of the IFRC Subcommittee on Atomic and Molecular Data for Fusion, IAEA, 16-17 May 2022. https://amdis.iaea.org/meetings/ifrc-2022/
- 49th IEEE International Conference on Plasma Science (ICOPS), Seattle, USA, 22-26 May 2022. http://icops2022.org/
- 3rd URSI Atlantic/Asia-Pacific Radio Science Meeting (AT-AP-RASC 2022), Gran Canaria, Spain, 29 May - 3 June 2022. https://www.atrasc.com/home.php

Know Your Colleague

Mr Roopesh. G, Mechanical Engineer, started his career at the Combat Vehicles Research and Development Establishment of DRDO in Chennai. He joined IPR as Engineer-SC in 2008. Soon he was deputed to ITER-India Diagnostic Neutral Beam (DNB) group.

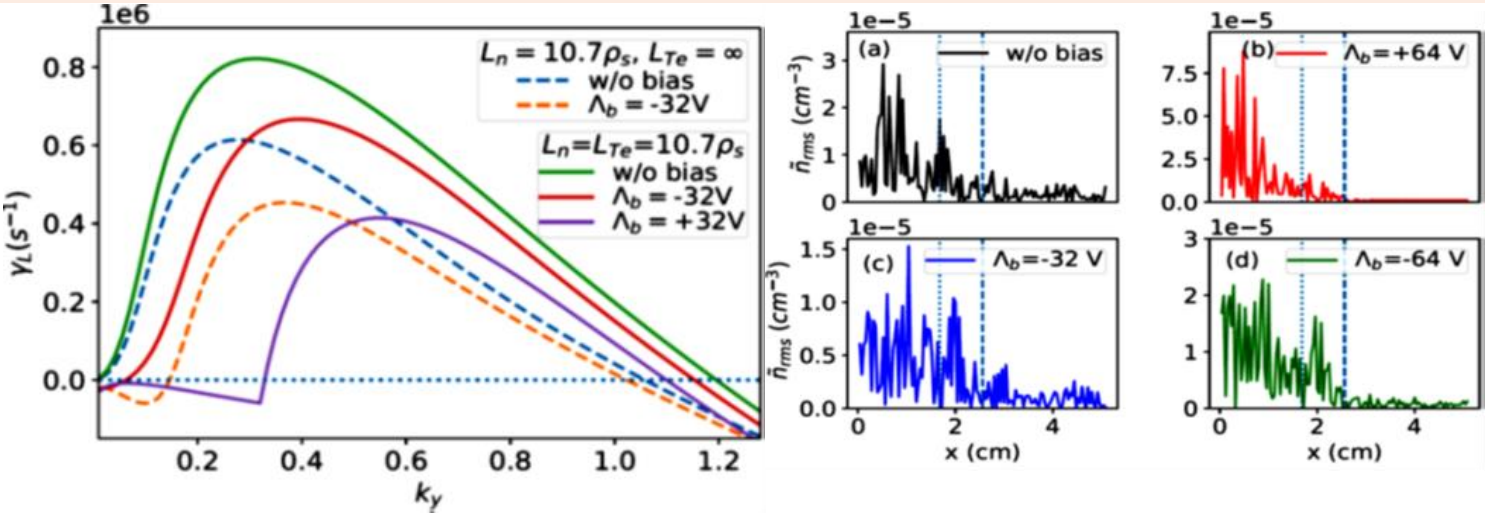
He was responsible for the design of Drift Duct, Exit scraper and Remote Handling compatibility of DNB Components. He joined ITER Organization in 2016 as Neutral Beam Mechanical Engineer. There he was responsible for the design, interface management, RH compatibility and RAMI analysis of various DNB and HNB components. He has contributed in finalizing the mechanical design of many NB components. His interests are Structural design, Machine Integration, Project management and system engineering. He rejoined IPR in November 2021 after completing his tenure in ITER IO. Currently he is working with MESD.

HPC Corner : Effect of Edge Biasing in the Edge and SOL Regions of a Tokamak

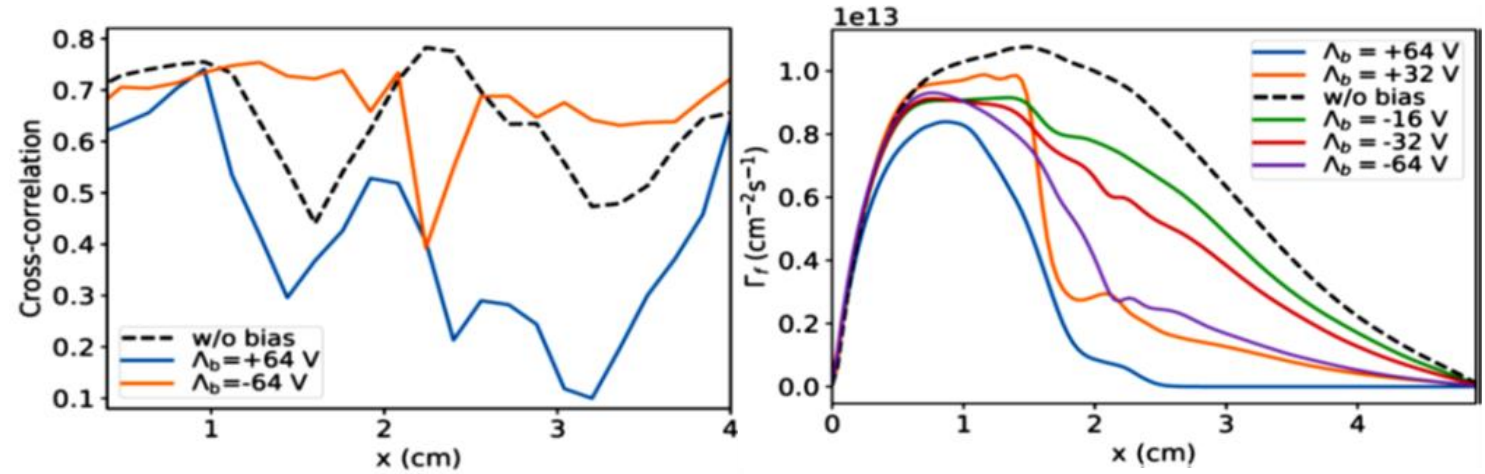
The boundary region (Edge and SOL) of a tokamak is highly turbulent due to mainly unstable interchange modes. The presence of such turbulence is suspected to be the primary cause for the occurrence of anomalous radial transport in this region. Therefore, to control this transport and to improve the confinement time, we need to control the interchange instability. Edge Biasing with the help of electrodes is one of the ways to control the interchange instability. The edge biasing imposes an external electric field shear in the radial direction, which causes higherzonal flows and hence stabilizes plasma turbulence and reduces the anomalous plasma transport in the edge and SOL regions.

Our study is based on a two-dimensional (2D) fluid model of the edge and SOL regions that support unstable interchange modes. A perturbative analysis using a FORTRAN-based code is first carried out to determine the linear growth rates (γ_L) and assess the influence of the bias voltage on them. This indicates that the biasing gives stabilization to lower k_y. Also, it can be seen that the peak of γ_L in biasing case shifted towards higher k_y or small scale modes. This indicates that biasing induces turbulence on smaller scales.

We have used flux-driven model equations for nonlinear simulations. Results are obtained for both positive and negative biasing and compared in the absence of bias (w/o bias). The numerical simulations using this model show that radially outward flux decreases in both the cases of biasing. The reduction of flux in case of positive bias is mainly due to the decrease of cross-correlation between the plasma density and poloidal electric field fluctuations. And the reduction of flux in the case of negative biasing is attributed to a decrease in root means square (rms) of density fluctuations. The full article is available here.



(L) The linear growth rate γL vs x fordifferent Ln using ky =0.2 (R) The radial profile of root means square (rms) of density fluctuations.



(L) Radial variation of cross-correlation coefficient between fluctuations of n and E_y (R) The radial profile of flux (Γf) for different bias voltages.

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One-day workshop on Plasma Polarization conducted by CPP-IPR as a part of Azadi Ka Amrit Mahotsav at St. Joseph's College (SJC), Jakhama, Nagaland on 19th March 2022.

Emerging Scientist Award

Mr. Abhishek Saraswat was awarded the **Institute Research Award 2021-22** (Jul-Nov) by the Indian Institute of Technology Madras, for quality research work done by him during his M.S. study at IIT Madras. This award is one of the 50 awards given to M.S. scholars from research institutes in recognition of their excellent journal publications. The award consisted of a merit certificate and a cash award of Rs.10000.

In 2019, he joined the Department of Mechanical Engineering, IIT Madras, as an external M.S. scholar under the supervision of Dr. Sateesh Gedupudi (IITM) and Dr. Paritosh Chaudhuri (IPR). His research focused on the development of a two-phase detection probe for lead-lithium liquid metal environment, relevant to applications in nuclear fusion power plants. His work has been disseminated as journal articles, a book chapter, and presentations at international conferences. Abhishek has an active interest in the interdisciplinary domain of breeding blanket technology development.

On behalf of IPR, we congratulate **Mr. Saraswat** for this achievement.

The IPR Newsletter Team

Ritesh Srivastava	Tejas Parekh	Ravi A. V. Kumar	Priyanka Patel	Dharmesh P	Mohandas K.K.	Supriya R
Suryakant Gupta	Ramasubramanian N.	Chhaya Chavda	Shravan Kumar	B. J. Saikia	Harsha Machchhar	

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