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The Fourth State

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



77th Independence Day Celebrations @ IPR

The 77th Independence Day was celebrated at IPR on 15th August 2023 with a lot of enthusiasm. On this occasion, Director IPR received the guard of honour from the security staff and unfurled the national flag, followed by the national anthem. Following this, he addressed the gathering of IPR staff and family members. During his speech, he emphasized the scientific accomplishments of IPR over the past year. This event was followed by various cultural and sports activities for the children and staff members, including a magic show that was organized for the children. The programme concluded with prize distribution and lunch.



Images from the independence day celebration at IPR



Images from the independence day celebration at IPR



Dr. B. K. Saikia, Acting Centre Director, CPP-IPR hoisting the national flag in presence of the employees and security staff

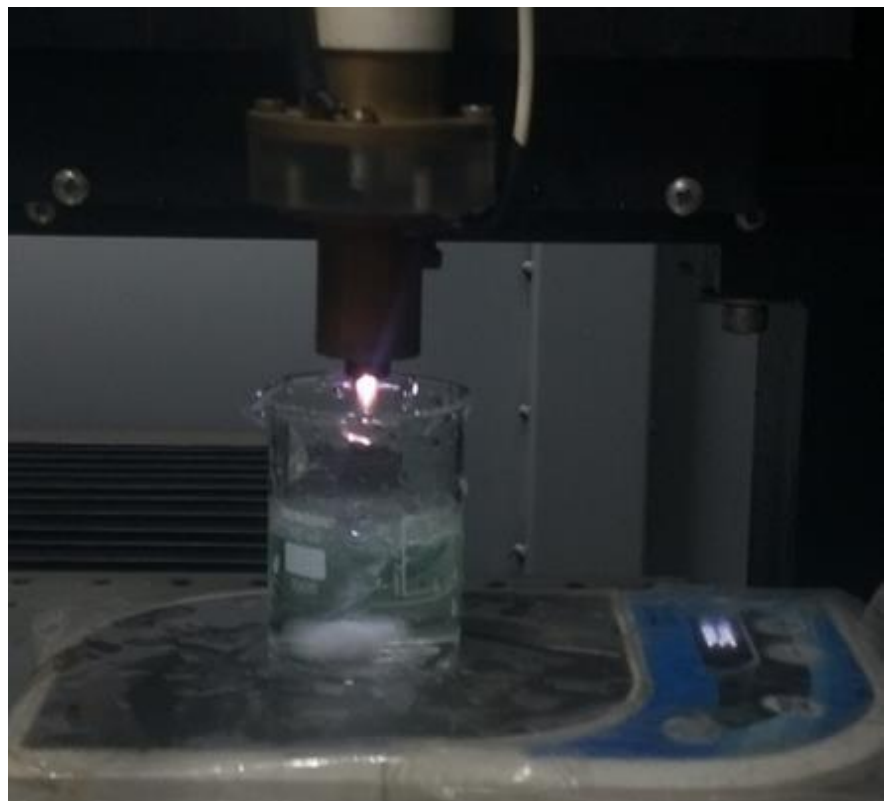
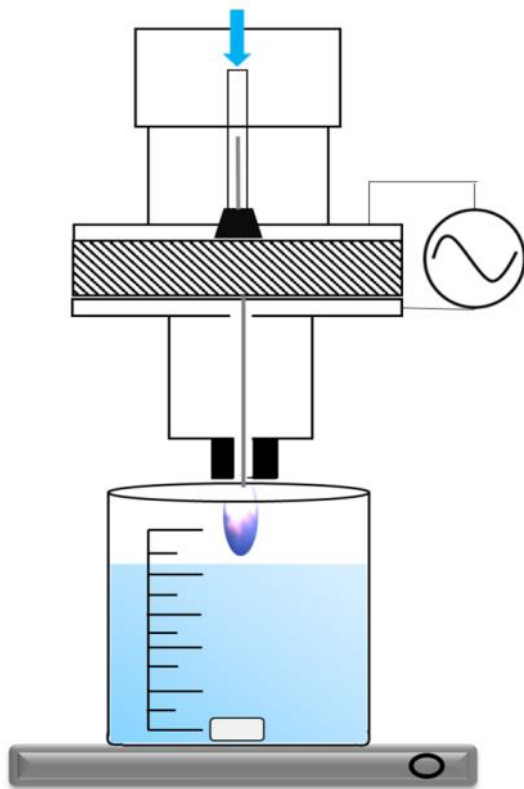
Activities of CPP-IPR Outreach Cell

CPP-IPR's Outreach Cell conducted a **"One Day Seminar cum Workshop on Plasma Physics"** on 17th August, 2023 at Pragjyotish College, Guwahati. The programme was attended by 5 teachers and 72 students of the college, including the principal of the college, Dr. Manoj Kumar Mahanta, an alumnus of CPP-IPR. 6 students from Pandu College, Guwahati also attended the programme. During the technical session, Dr. Rakesh Moulick gave a talk on introduction to plasma physics, followed by a talk on basics of experimental plasma physics by Dr. Ngangom Aomoa. After the talks, the participants were shown a glow discharge plasma, arc plasma (Jacob's ladder) and a plasma globe, and working principle of the setups and their various components were explained to them.

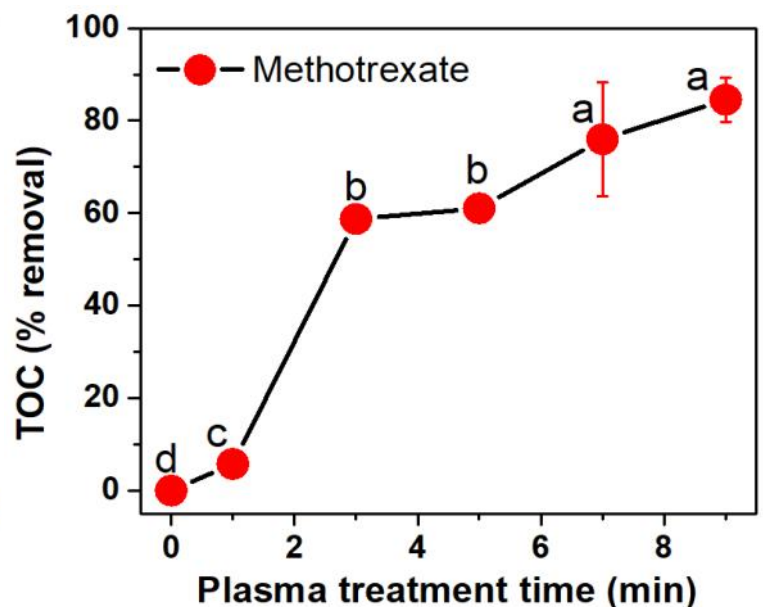
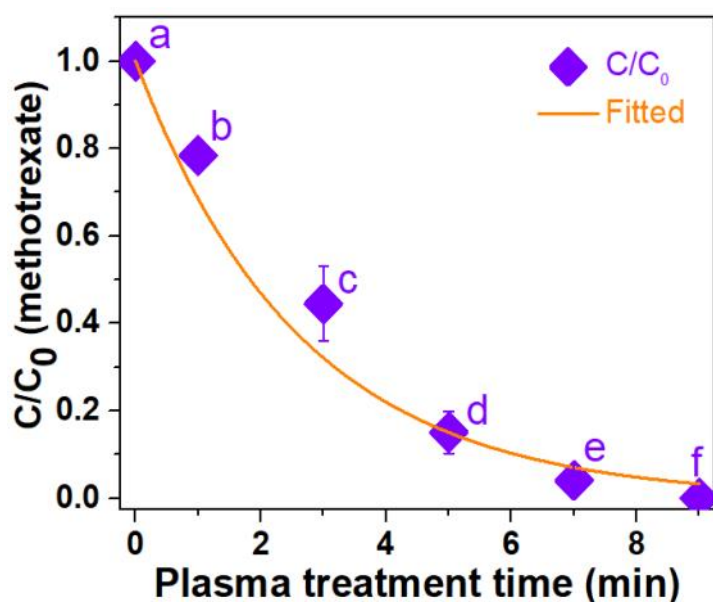


Images from the plasma workshop

Hospitals, pharmaceutical factories, and home chemotherapy patients contribute significantly to the presence of these anti-cancer drugs in wastewater. In a major development to combat the rising environmental pollution and cancer cases, researchers and scientists have successfully utilized a non-thermal air plasmas to degrade organic pollutants found in wastewater. The current study conducted at FCIPT, IPR focuses on degradation of the anticancer drug methotrexate, a drug commonly used in chemotherapy, which often ends up in wastewater due to poor metabolism and excretion from the human body. This technique, developed by IPR, employed a non-thermal pencil plasma jet (NT- PPJ) to study the degradation process of methotrexate in water. The plasma treatment showed promising results, with a continuous decrease in the concentration of methotrexate observed as the plasma treatment time is increased. The degradation of methotrexate followed first-order degradation kinetics, with a rate constant of 0.38 /min. After only 9 minutes of plasma treatment, the methotrexate drug in the solution was completely degraded. Additionally, total organic carbon (TOC) analysis further confirmed the degradation, with an impressive 84.54% mineralization of the methotrexate drug observed after the same 9-minute plasma treatment. The study also highlighted a significant increase in the physicochemical properties of the methotrexate solution, indicating that the drug was broken down into smaller compounds. The positive outcome extended to the toxicity test on freshwater chlorella algae, where the plasma-treated methotrexate solution showed lower toxicity compared to the untreated one. This advanced non-thermal air plasma jet treatment technology shows promise in effectively degrading complex resistive anticancer drugs from wastewater. This could be a significant step forward in eliminating cancer drugs and enhancing water quality for the well-being of human health.



(L) Schematic of methotrexate degradation using a non-thermal arc pencil plasma jet (R) The experimental setup



(L) Degradation of methotrexate solution after treatment with plasma (R) The total organic carbon (TOC) analysis of a methotrexate solution after treatment with this plasma.

Date	Institution	Visitors
20-Jul-23	Smt. S.J. Varmora BBA and BCA Mahila College, Wadhwan	52 students of class 9
31-Jul-23	Swaminarayan Dham International, School, Gandhinagar	21 students of classes 11-12 Science
01-Aug-23	Pragati English Medium High School, Ahmedabad	70 students of class 9
02-Aug-23	Silver Oak University, Ahmedabad	38 students of BTech (Electrical)
03-Aug-23	Saint Kabir School, Ahmedabad	42 students of classes 10-12
4-Aug-23	D. N. Polytechnic, Ahmedabad	62 students of Diploma in Electrical
7-Aug-23	Hiramani Higher Secondary School, Ahmedabad	66 students of classes 11-12 Science
14-Aug-23	Pragati English Medium High School, Ahmedabad	45 students of class 10
14-Aug-23	Indian Institute of Science Education and Research, Pune	4 faculty members
16-Aug-23	Delhi Public School, Bopal	90 students of class 12 science
17-Aug-23	Pragati English Medium High School, Ahmedabad	44 students of class 11 and 12 science
18-Aug-23	Atmiya University, Rajkot	56 students of BTech (IT)
18-Aug-23	Amrita Vidyalaya, Ahmedabad	32 students of 10-12 std



Students and teachers from D. N. Polytechnic, Ahmedabad during their visit to IPR



Students and teachers from Silver Oak University, Ahmedabad during their visit to IPR

IPR Outreach conducted a week-long scientific outreach programme at the Periyar Science & Technology Centre, Chennai in collaboration with IGCAR Kalpakkam during 3-7 July, 2023. This is IPR's first outreach activity in the state of Tamil Nadu. The programme consisted of an exhibition on plasma, its applications as well as introductory talks on plasma for visiting students.

The event was inaugurated by Prof. Nilesh J. Vasa, Dean, IIT Madras and Dr. V Subramanian Head RESD, SQRMG (IGCAR) was the Guest of Honour. The event was coordinated by Shri. I. K. Lenin Tamilkovan, Executive Director, Tamil Nadu Science & Technology Centre, Chennai.

For this exhibition, 72 UG and PG (Physics/Mathematics) students volunteers from various colleges in Chennai such as Dwaraka Doss Goverdhan Doss Vaishnav College, Ethiraj College for Women, Loyola College, University of Madras and the Madras Christian College were trained by IPR team to explain the exhibits to visiting students in their local language. Over 3500 students and general public visited the exhibition at Chennai. More details [HERE](#).



The Plasma exhibition at Periyar Science & Technology Centre, Chennai



Inauguration of the exhibition (L-R) Shri. I. K. Lenin Tamilkovan (TNSTC), Dr. V Subramanian (IGCAR), Dr A V Ravi Kumar (IPR) and Prof. Nilesh J. Vasa (IIT-M)



Introducing plasma to visiting students



Student volunteers explaining the exhibits to visitors



School students at the Plasma exhibition



On 23rd August, 2023, India joined the elite group of countries that achieved a soft landing on the moon. Further, India's lander "Vikram" of the Chandrayan-3 mission is the first spacecraft in the world to land in the south pole region of the moon. The small rover named "Pragyan"



was also rolled off the lander hours after the soft landing. The six-wheel, 26-kg rover, which can move up to 500 meters, will explore the lunar surface for the next 14 days. IPR newsletter, on behalf of all IPR staff members congratulate ISRO and the Chandrayan-3 team for successfully achieving this stupendous feat !

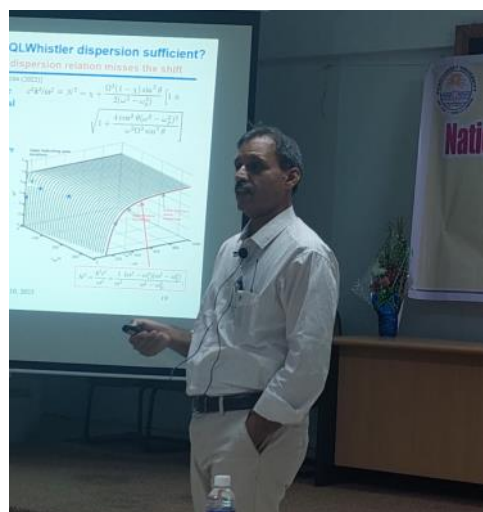
(L) The rover exiting the lander
(R) First image of the lunar surface after the soft landing.

Past Events @ IPR

- ◆ **Talks presented at 49th European Conference on plasma physics, Bordeaux, France 03-07 July 2023**
 - ◆ **Mr. Akshaya Kumar Shaw**, gave a talk on "Behaviour of multi-component plasma sheath in presence of charged dust particles in an oblique magnetic field: Fluid picture"
 - ◆ **Ms. Arzoo Malwal**, gave a talk on "Poloidal gradient driven off-target circulation and upstream density shoulder in EMC3-Eirene simulations of inboard limited circular scrape off-layer plasma"
 - ◆ **Mr. Tulchhi Ram**, gave a talk on "Vertical charge separation characteristic of ECR plasma in low aspect ratio toroidal plasma"
 - ◆ **Mr. Ankit Dhaka**, gave a talk on "Thermal fluctuations of Strongly Coupled Dusty Plasmas: A Theoretical and Experimental Study"
- ◆ **Talks presented at 30th IEEE Symposium on Fusion Engineering (SOFE 2023), Oxford, United Kingdom, 9-13 July 2023**
 - ◆ **Ms. Bhoomi S. Gajjar**, gave a talk on "Thermo-Physical properties and Characterization studies for Vacuum Hot-Pressed Boron Carbide (B4C) Ceramics"
 - ◆ **Dr. Jyoti Shankar Mishra**, gave a talk on "Development of piston-driven mechanical pellet launcher for hydrogen pellets"
- ◆ **Dr. S.K. Nema**, gave an invited talk on "Management of Pharmaceutical & Medical Waste by Environment friendly Plasma Technologies" at Nirma University, Ahmedabad under Faculty Development Programme on "Integration of Sustainable Practices in Pharmaceutical Industries and Public Health" on 13 July 2023
- ◆ **Talks presented at 3rd Conference on Plasma Simulation (CPS), Raman Science Centre, Indian Institute of Astrophysics, Leh, Ladakh, 13-15 July 2023**
 - ◆ **Dr. Sudip Sengupta**, gave an invited talk on "Fluid Simulation of Relativistically intense Wake Waves in a Cold Homogeneous Plasma"
 - ◆ **Ms. Kalyani Swain**, gave a talk on "A weakly relativistic electron beam from laser-cluster interaction in an ambient magnetic field"
 - ◆ **Mr. Kushagra Nigam**, gave a talk on "Parametric study on EM field simulations of MPCVD cavity"
- ◆ **Ms. Sukriti Hans**, gave a talk on "Self-organized nanopatterning of Ge (100) surface under low-energy ion beam sputtering" at Focused Ion Technology for Nanomaterials – fit4nano, Lisbon, Portugal, 17-19 July 2023
- ◆ **Talks presented at 9th PSSI - Plasma Scholars Colloquium (PSC 2023), IIT Kanpur, 20-21 July 2023**
 - ◆ **Dr. Tejendra Patel**, gave a talk on "3D Computational Fluid Dynamics Analysis of PINI Ion Source Back Plate under high heat flux condition"
 - ◆ **Mr. Ashok Kumar Kumawat**, gave a talk on "Metal Foil IR Bolometer development to Measure the Toroidal Radiation Asymmetry during Disruptions in Aditya-U Tokamak"
 - ◆ **Ms. Kalyani Swain**, gave a talk on "Laser-cluster interaction in an ambient magnetic field"
- ◆ **Dr. Vangalla Veera Babu**, Indian Institute of Technology (BHU), Varanasi, gave a talk on "Design and Performance Improvement Studies of Millimeter Wave Gyro-Twyston Amplifiers" on 21st July 2023
- ◆ **Dr. Dinesh Rathod**, University of Petroleum & Energy Studies (UPES), Dehradun, gave a talk on "Complex Plasma: Studies of Microparticle Charge, Drag Force and Associated Non-Linear Phenomena" on 27th July 2023
- ◆ **Mr. Raj Singh**, gave an invited talk on "RF and Microwaves for Fusion Reactors" at Two Days Workshop on Emerging Research in Microwave and RF Technologies, Banasthali Vidyapith, Rajasthan, 29-30 July 2023
- ◆ **Ms. Swarnima Singh**, gave a talk on "Experimental Study of a Quasi two-dimensional Complex Plasma" on 04th August 2023
- ◆ **Dr. Vivek Patel**, Motilal Nehru National Institute of Technology, Allahabad, gave a talk on "Control Techniques For Frequency Regulation in Hybrid Power Systems" on 04th August 2023
- ◆ **Ms. P.Bharathi**, gave a plenary talk on "Optical Emission Spectroscopy- A Plasma Spectroscopy Diagnostics Toolbox" at National Symposium on Gaseous Discharges (NSGD-2023), Pondicherry University, Puducherry, 09-11 August 2023
- ◆ **Dr. Prashant Sharma**, CNRS, Orleans, France, gave a talk on "Materials in Extreme Conditions: High Temperature and Radiation Environment" on 11th August 2023
- ◆ **Mr. Ram Krushna Mohanta**, gave talk on "Investigation of Thermal Plasma Jet for Low - Pressure Plasma Spraying" on 16th August 2023
- ◆ **Ms. Nandini Yadav**, Nirma University, Ahmedabad & Institute for Plasma Research, Gandhinagar, gave a talk on "Spectroscopic Investigation of Neutral and Impurity Dynamics in the Edge Region of ADITYA-U Tokamak" on 17th August 2023
- ◆ **Dr. Shubham Singh Baghel**, Indian Institute of Technology (IIT), Roorkee, gave a talk on "Optical diagnostics of different plasmas through collisional radiative models with the self-calculated fine structure resolved electron impact excitation cross-sections" on 18th August 2023

- ◆ 16th European Conference on Applied Superconductivity, Bologna, Italy, 3-7 September 2023; <https://ieeecsc.org/event/16th-european-conference-applied-superconductivity>
- ◆ Electrostatics 2023, United Kingdom, 4-7 Sept 2023; <https://www.iop.org/events/electrostatics-2023>
- ◆ JT-60SA International Fusion School, Naka, Japan, 4-15 Sept 2023; <https://fusenet.eu/event/jt-60sa-international-fusion-school-2023>
- ◆ 20th International Symposium on Laser-Aided Plasma Diagnostics, Kyoto, Japan, 10-14 September 2023; <https://lapd20.nifs.ac.jp/>
- ◆ 15th International Symposium on Fusion Nuclear Technology, Las Palmas de Gran Canaria, Spain, 10-15 Sept, 2023; <https://isfnt2023.com/>
- ◆ 28th International Conference on Magnet Technology, Aix-en-Provence, France, 10-15 Sept 2023; <https://mt28.aoscongres.com/>
- ◆ 23rd International Conference on Gas Discharges and their Applications, Greifswald, Germany, 10-15 Sept 2023; <https://www.gd2023.org/>
- ◆ IPP Summer University for Plasma Physics and Fusion Research, Garching, Germany, 11-15 Sept 2023; <https://www.ipp.mpg.de/summeruni>
- ◆ 23rd International Conference on Ion Sources, Victoria, Canada, 17-22 September 2023; <https://icis2023.triumf.ca/>
- ◆ International Conference on Research and Applications of Plasmas (PLASMA 2023), Warsaw, Poland, 18-22 September 2023; <https://plasma2023.ipplm.pl/>
- ◆ Technical Meeting on Emerging Applications of Plasma Science and Technology, IAEA's Headquarters in Vienna, Austria, 19-22 September 2023; <https://conferences.iaea.org/event/336/>
- ◆ 3rd International Conference on Plasma Theory and Simulations (PTS-2023), Jawaharlal Nehru University, New Delhi, 21-23 September 2023; <https://www.pts2023.org/>
- ◆ Fusion Centre for Doctoral Training/UKAEA Fusion Industry School Week 2, Oxfordshire, Great Britain, 25-28 September 2023; <https://fusion-cdt.ac.uk/fusion-industry-school/>
- ◆ Radiation and its Effects on Components and Systems Conference (RADECS), Toulouse, France, 25-29 September 2023; <https://radecs2023.com/>
- ◆ 15th Mega Symposium on Electric Power Transformation: Energy, Environment, Policy, Technology, Pittsburgh, United States, 26-27 September 2023; <https://www.awma.org/MEGA>

Conference Presentations



(L-R) Dr. Devendra Sharma "*Nonlinear Steepening of Quasi-Longitudinal Whistlers in resonant regime*" (M) Dr. Subrato Mukherjee "*Overview of LIGO India and its commitments*" (R) Dr. Mukesh Ranjan "*Plasma Material Interactions and its applications*" delivering their talks at the National Symposium on Gaseous Discharges (NSGD-2023), which was held at the Department of Physics, Pondicherry University during 8-11 August, 2023.



(L) Dr. Ramakrishna Rane who gave a talk entitled "*Probe diagnostics-Langmuir probe*" (M) Dr. Suryakant Gupta who gave a talk entitled "*An indigenously developed ISO test facility for ESD (arc) detection on satellite solar panels*" and Dr. Devendra Sharma (being felicitated at the National Symposium on Gaseous Discharges (NSGD-2023), which was held at the Department of Physics, Pondicherry University during 8-11 August, 2023.



Dr. Ranjana Gangradey delivered a talk entitled "Cryopumps and it's applications Journey of Indigenous Cryopump AGAS-TYA, its Development & Applications, An initiative towards *Atma Nirbhar Bharat*" at the SSME- Ansys Seminar Series 2022-23 organized by the Space Society of Mechanical Engineers (SSME) during 27 July, 2023 at the Yashpal Auditorium at Space Application Centre (SAC), Ahmedabad.

Roof Top Solar power Plant at Institute for Plasma Research

As a part of Intended Nationally Determined Contributions (INDCs), India has committed to increase the share of installed capacity of electric power from renewable energy (Non-conventional energy sources). In line with the same, as of today, two nos. of 100 KW on-grid, solar roof top power plants have been successfully installed on the terrace of the New Office building in IPR, Bhat, Gandhinagar campus and on the terrace of Admin building at FCIPT, Sector-25, Gandhinagar campus. The generated Solar power can then be used either for captive consumption of the premises or can be fed into the grid and be adjusted in the electricity bill.

No.		Solar Roof Top installation	
	Technical details	AT IPR	At FCIPT
1	Solar PV Modules	Polycrystalline	Mono Perc Half cut cell
3	Wp capacity of PV modules	340 Wp	545 Wp
4	Nos. of Solar PV module installed	295 Nos.	184 Nos.
5	Total capacity of Solar power plant	100 KW	100 KW



Solar power plant installed at (L) IPR main campus (R) FCIPT

Tech-Transfer of Plasma Pyrolysis Technology for Safe Disposal Of Biomedical Waste

IPR has successfully transferred the know-how of plasma pyrolysis technology (RAUDRA™) for safe disposal of biomedical waste on non-exclusive basis to M/s Bhakti Energy, Rajkot on July 10, 2023. This know-how transfer and licensing enables M/s. Bhakti Energy to do marketing and deploy plasma pyrolysis systems (RAUDRA™) as per the need of end users across India.



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Know Your Colleague



Vijaykumar Bharatbhai Vadher joined IPR through the Technical Training Programme (TTP) batch of 2008 after completing his bachelor's degree in 2008 in Electronics from Birla Vishvakarma Mahavidyalaya College, affiliated to the Sardar Patel University, Vallabh Vidyanagar. After completing his TTP, he joined as an Engineer-SC with the Neutral Beam Injector Group in 2009. He is part of the team which is assigned to design and develop a VME-based data acquisition and control system for neutral beam injector (NBI) system. He is also involved in beam operation of NBI and maintenance of power supply (AC-AC power supply and AC-DC power supply) for NBI. He has developed microcontroller based DAQ board and developed LabVIEW based GUI, data archiving and monitor system for temperature of NBI cryo plant.

Plasma Exhibition @ Chennai



IPR team with the volunteers from colleges in Chennai during the exhibition at PSTC, Chennai

The IPR Newsletter Team

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