ANNUAL REPORT
2018-2019

प्लाज़्मा अनुसंधान संस्थान

Institute for **Plasma Research**

Bhat, Gandhinagar 382428

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EXECUTIVE SUMMARY

The Institute continued its tradition of concurrent advances in the areas of basic research, technology development and broadening its societal applications portfolio in the year 2018-19. This year also saw the prestigious Fusion Energy Conference by the IAEA being hosted in Gandhinagar, for the first time. The institute actively pursued the other Govt. initiatives like Swachha Bharat and popularizing of the use of Hindi in its day-to-day activities.

RESEARCH

- ADITYA-U tokamak exceeded the design value (250 ms) for the pulse duration as a result of improved position control. It also demonstrated the Supersonic Molecular Beam Injection system to mitigate the multi-MeV "runaway" electrons, which can otherwise cause significant damage to the vacuum vessel.
- SST-1 tokamak TF magnets could achieve 90% of their design value of the magnetic field of 3 Tesla. Helium plasma experiments assisted by Electron Cyclotron Resonance and Lower Hybrid (both Radio frequency wave technologies) have been done. A Ka-Band reflectometer system for measuring radial electron density has been developed and tested.
- A simulation based on Molecular Dynamics has helped to understand the maximum power absorption in a laser driven nano-plasma which will be useful for developing compact multi-MeV ion accelerators.
- A stable dusty plasma Coulomb crystal was observed in a Direct Current (DC) glow discharge plasma which was experimentally challenging earlier. The work received accolades by becoming Editor's pick in Physics of Plasmas Dec. 2018

TECHNOLOGY DEVELOPMENT

- Deliveries to ITER under the ITER Agreement are progressing well. Major portions of CWS package have already been delivered. The criticality of IWS supply has been reduced as the manufacturing pace has increased. The Cryostat deliveries for the first 3 major sub-assemblies have already reached ITER site and are at various stages of welding completion.
- A 100 kV, 7.5 MW regulated high-voltage power supply (designed and developed by IPR and technology transferred) was delivered by ECIL to the Neutral Beam Test Facility in Padova, Italy, as part of India's in-kind contribution to ITER.
- An indigenously-developed 40 kW, 1 MHz solid state Radio Frequency (RF) generator has been integrated with an RF based negative ion source and power up to 40 kW was coupled to produce the plasma. In due course, such generators will be able to substitute imports.

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- Extreme heat flux handling technologies are making progress with the indigenous development of advanced materials like seven layered W/Cu.
- Development of high temperature superconductors for futuristic magnet and associated technologies like low resistance joints, shaping of coils are being done.
- Remote Handling and Robotics technologies will play a crucial role in high-tech reactor systems, e.g. maintenance, visualization of complex interfaces and issue resolution etc. At present, vacuum and high temperature compatible inspection arm with haptic force feedback, dexterous hyper redundant end-effector and a fully immersive virtual reality facility are being developed and are at various stages of demonstration.
- Nuclear modeling codes have a very detailed and complex way of specifying materials and geometry. A significant simplification is being brought about by writing an interface code for the convenience of several users. This work is progressing well at CPP-IPR.
- R&D on tritium breeding blanket technologies is progressing well. The corrosion studies on Indian Reduced Activation Ferritic Martensitic Steel (IN-RAFMS) is being done with lead lithium liquid. With the new constraints emerging at ITER, the testing strategy for our own materials needs to be revisited. In the meantime, the solid breeder and the liquid breeder studies are continuing and similarly the high pressure He-loop system (to demonstrate advanced coolants) is expected in the coming FY.

APPLICATIONS

- An environment-friendly de-scouring process by using Dielectric Barrier Discharge (DBD) plasma was successfully developed and tested for continuous operation.
- A planar magnetron system has been developed for deposition of thin metallic films on powder particles for changing thermochemical properties.
- A prototype pulsed dc plasma system of Ozone and Oxygen was developed to sterilize Medical devices, components etc.
- A rotatable magnetron has been developed indigenously for the sputter coating industry. The cost of 1m length rotatable magnetron is 3 times less than that of a commercial imported system.
- Atomistic simulations of turbulence in Yukawa liquids have shown ways to have a strong mixing of fuel and air in engines in automobiles.

OUTREACH

- Pride of India, Pagwara, Punjab 3-7 Jan. 2019
- Pravasi Bharatiya Diwas, Varanasi, 21-23 Jan. 2019
- Other regular activities, events at IPR and in various schools

DIRECTOR,
IPR.

ANNUAL REPORT

APRIL 2018 TO MARCH 2019

Since 1986 the institute has been involved in plasma physics research with fast growing facilities, trained man power and many fruitful national and international collaborations. Starting with small tokamak experiments and basic plasma experiments, the institute has been acquiring expertise in most of the relevant scientific and technological requirements for controlled thermonuclear fusion. Through the participation of the country in the ITER project, technologies related to fusion are being developed in the institute which are also being tested in the international arena. Also the technologies thus developed are being made available and being applied to many other societal problems benefiting the country.

CHAPTERS

CHAPTER A

SUMMARY OF SCIENTIFIC & TECHNOLOGICAL PROGRAMMES

A.1 Plasma Based Technologies & Applications

The fourth state of matter, Plasma, after solid, liquid and gas has enormous potential applications for societal benefits. Here it is being studied and developed though small projects. Some of these projects were also funded through various agencies. The developed systems have been commissioned at the respective locations all over the country.

A.1.1 Plasma Surface Engineering Applications

Development of a Plasma based coating system: The plasma based prototype system is developed in house for the metal thin film deposition on powder substrates. The metal target of three inch planar magnetron is sputtered by using low pressure argon plasma. The metallic thin film deposition up to thickness of 4-5 micron can be done. The substrate is water cooled to control the temperature of the powder during deposition process. Also the substrate is given vibratory motion in vacuum during the deposition in order to coat maximum surface area of the powder. The system has also a potential application for metal coating like aluminium, copper, titanium on energetic powder material of sizes 50-200 micron. The figure A.1.1 shows the plasma coating system unit during operation. This system is being used for preliminary coating experiments on powders at TBRL, Chandigarh.

Figure A.1.1 Photograph of the plasma based coating system

Titanium Nitride (TIN) / Titanium Aluminium Nitride(TiAlN) coating on cylindrical tubes for improving oxidation resistance: The zirconium based alloy tubes which are used in nuclear power reactors undergo waterside corrosion by the coolant water under normal operating condition. In the case of loss of coolant situation, the temperature may increase which can accelerate corrosion reaction and corresponding hydrogen generation. Multilayer coatings of TiN and TiAlN have been widely studied because they have good corrosion resistance at higher temperatures. In the study taken up in collaboration with BARC, TiN and TiAlN coating (01 micron thick) on cylindrical tubes (dia.1 cm, length 10 cm) has been developed by using plasma based cylindrical magnetron sputtering. The structural characterisation of the coatings on steel samples has been completed. The multilayer coatings (4 layers) of TiN and TiAlN will be deposited on zirconium alloy tubes.

Plasma Nitriding of CTC roller: The tea industry has been using the CTC process for the production of the tea in which a series of stainless steel rollers with hundreds of small sharp

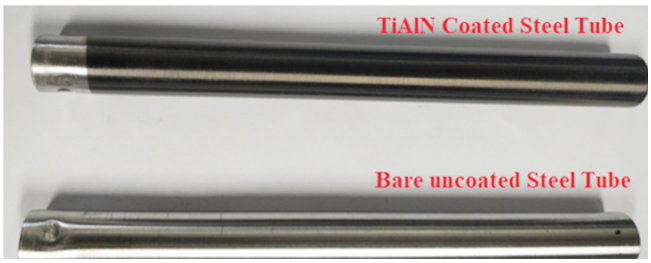

Figure A.1.2.Photograph showing the bare and TiAlN coated steel tubes

blades turn tea leaves into granules making them easy to brew and bag. The rollers are made of austenitic stainless steel. The chromium element present in this steel combines with oxygen and forms a thin layer of oxide on it. As the rollers need to be sharpened periodically, the passive film gets disrupted and leads to the release of chromium into the tea leaves. It is known that the heavy metals in tea are important indicators in the process of tea quality evaluation, as they can be transferred into tea infusions through the process of brewing tea, then enter the human body by means of tea consumption, and thus pose potential risks to human health. Chromium is one of those heavy metals which is carcinogenic and can cause cancer like diseases. According to the national food safety standard (GB 2762-2017) and the Ministry of Agriculture tea heavy metals limited standards (NY/T 288-2012, NY 659-2003) in China, the standard limit value is 5.0 mg/kg for Cr. Morever, a sharpened CTC roller survives for only 10 hrs and has to be re-sharpened immediately as it is unable to cut leaves in to fine granules. Both these problems can be eliminated if a hard coating preferably CrN is provided on the surface of the CTC rollers. This can reduce the contamination of chromium in tea after sharpening and also increase the service life. A feasibility study of plasma nitriding was initiated in IPR on four CTC rollers having a height ranging from 12 to 18 inch to resolve the above mentioned issues. This work was done in collaboration with Tocklai Tea Research Institute, Jorhat Assam and CPP, IPR. Figure A.1. 1 shows CTC roller loaded in the vacuum chamber before and after the treatment along and a uniform glow on it during the plasma nitriding treatment. A surface hardness of 1300 HV0.1 hardness was achieved on the CTC rollers after plasma nitriding which is about 4 times higher compared to the untreated stainless steel (359 HV0.1). These rollers will be sent for the field trials to Tocklai Tea Research Institute, Jorhat Assam for performance evaluation.

Plasma nitriding system installed & commissioned at Nagaland Science and Technology Council (NASTEC), Dimapur, Nagaland: In a DST sanctioned project, a plasma nitriding process was established by FCIPT-IPR to prolong the service life of hill agricultural tools and equipment. As a part of this project, a plasma nitriding system of 500 mm diameter and 500 mm height was installed & commissioned at NASTEC, Dimapur, Nagaland on 19th March 2018. This system will be used to treat all agricultural implements to enhance their service life.

A table with brief details about the external projects have been given below:

LIST OF EXTERNAL PROJECTS UNDER EXECUTION

Sr. No.	Project topic	Deliverables	Client/ collaborator
01	Advance nano-tracers for product life cycle assessment and product monitoring	Isotopic nano powders	IIT Gandhinagar
02	Development and supply of experimental plasma systems	Experimental plasma systems for students	CEBS-DAE, Mumbai University
03	Synthesis of zinc oxide nano powders	Zinc oxide nano powders	VEG Pvt. Ltd., Ahmedabad.
04	Space Plasma Interaction Experiments (SPIX-III)	Facility for testing of spacecraft charging induced electrostatic discharge on solar panels of satellite.	ISRO

LIST OF NEW EXTERNAL PROJECTS INITIATED

Sr. No.	Project topic	Deliverables	Client/ collaborator
01	Development and supply of vacuum system for up-gradation of installed plasma system	Vacuum system for demo of plasma treatment on agri items.	Anand Agricultural University, CFPTBE, Anand
02	Supply of atmospheric pressure Plasma Jet	Plasma jet system for bio-medical applications	Nirma University Ahmedabad.
03	Development of three layer geo-membrane using plasma technology for adverse environment application	A plasma treatment system for treatment of geo-membrane materials.	CIPET, Ahmedabad
04	Development of plasma nitriding technology for SS 17-4 PH and SS 410 materials	Plasma nitrided and nitro-carburized samples for increase in service life of nuclear reactor components	NPCIL
05	Development and supply of Cryo pump	Cryo-sorption cryo-pumps	ISRO
06	Development indigenous Technology for CZTS absorber based solar sell using industry friendly magnetron sputtering and RTP sulphurization Process	CZTS based Solar cell samples & project report on the outcome.	DST
07	Development and supply of Experimental plasma system	Experimental plasma system for students	Saurashtra University, Rajkot

A.1.2 Atmospheric Plasma Applications

Project on solvent waste disposal using thermal plasma technology: DST has sponsored a joint project between Institute for Plasma Research and CSIR- Central Salt and Marine Chemicals Research Institute, Bhavnagar (CSIR-CSMCRI) on "Feasibility study on safe disposal of industrial spent solvents and chemical waste using thermal plasma technology". Under this project, experiment trials were done successfully using acetone, hexane and mixed solvent wastes in the plasma pyrolysis system installed at CSIR-CSMCRI, Bhavnagar and partial objectives of the project have been achieved. A technical report is under preparation to be submitted to DST and experiments are underway to achieve the remaining objectives of this study.

Performance evaluation of primary chamber for 50 kg/hr plasma pyrolysis system: In collaboration with High Power ECRH and Blanket Materials Divisions work has carried out using CFD simulations for the primary chamber at two different arc powers 75 kW and 30 kW, by adopting similar process parameters and boundary conditions as considered during experiments conducted on upgraded 50 kg/hr plasma pyrolysis system. A suitable diagnostic tool has been mounted within the system for the purpose of measurement of temperature at a particular location of interest. The objective of this study is to establish the Computational Fluid Dynamics (CFD) simulation procedure to predict the temperature distribution in the chamber during pre-heating stage. A uniform temperature distribution inside primary chamber is a stringent requirement for waste pyrolysis in safe manner, since the cold pockets generated inside the primary chamber may assist in recombination reactions, resulting in the formation of toxic molecules. On the other hand, hot spots may damage the inner material which may assist in performance degradation and reduction of the service life of the system. The CAD design of primary chamber was prepared using CATIA software after verifying the dimensions of primary chamber. The CFD simulation was performed for simplified CAD design. The points created on the CAD model and the locations selected for mounting the thermocouples in primary chamber were kept same for comparison of temperature opted from CFD results and actual experiments. A Comparison for Computational Fluid Dynamics (CFD) simulation and experimental results were carried out. The cause of uncertainties has been identified. Corrective actions have been taken to eliminate the uncertainties. CFD simulation is a useful tool in the design and optimization of primary chamber conceptual design for future pyrolysis systems.

Plasma System for Inline Treatment of Textile: Under the financial support from DST, New Delhi, a plasma system has been successfully designed and developed for inline treatment of textile. In this system, uniform dielectric barrier discharge plasma (commonly known as DBD plasma) was generated using air as plasma generating gas. There were 72 numbers of plasma discharges with each discharge length of 2.5 meter. Each of DBD plasma was powered by individual and identical low cost power supply. This power supply architecture is very novel in context to generation of uniform plasma in air at atmospheric pressure. The system was demonstrated to industries during the workshop on "Applications of Plasma for Textile Processing". Later, the system has been successfully installed and commissioned at MANTRA (Manmade Textile Research Association), Surat. The system developed under this project activity is apparently the world's first large scale air plasma treatment system for inline processing of textile.

Project on Plasma Treatment of Geomembrane: A feasibility study project jointly with CIPET (Centre for Plastic Engineering and Technology), Ahmedabad with financial support from DST, New Delhi is under execution. A system has been designed for the treatment of HDPE (High Density Polyethylene) which is the main composition in the geo-membrane. It is expected that the plasma treatment will increase the adhesion between the HDPE and LDPE layer so as to increase the life of the geo-membrane. A system will be supplied to CIPET, Ahmedabad for detailed study on HDPE using DBD plasma in air.

Fly-ash project: The feasibility project of converting fly-ash into useful refractory material such as SiAlON using the thermal plasma technique was completed. It was found that the process was not very efficient due to incomplete combustion of carbon powder that acts as a carbo-thermal reduction agent. A new experimental setup has been established where the possibility of using methane, as a replacement of carbon powder, will be explored. A novel torch has also been designed for the experiments with a view to develop a viable commercial technology.

Development of experimental setup for very low pressure plasma spray coatings activity: The Very Low Pressure Plasma Spray (VLPPS) technique is a novel technique that offers to bridge the gap between Physical Vapour Deposition and Atmospheric Pressure Plasma Spray by combining the two techniques. Novel coatings can be formed by this technique to meet the demands of rapid advances made in sectors like electronics, automotive, aerospace, biomedical etc. that

Figure A.1.3 A photograph of the inline textile treatment facility

cannot be met by current technologies. A large volume experimental chamber has been set up with a view to carry out investigations in this field. A plasma torch compatible to low pressure has also been designed, developed and installed on the system and compatibility of torch under high throughput conditions has been tested successfully.

Nanomaterials Activities: A number of trial experiments were completed with the technology partner, M/s Vishal Engineers & Galvanizers Pvt. Ltd., Ahmedabad who will soon start commercial production of zinc oxide nanopowders. Since they will be supplying these nanopowders to Pharma industries, it was essential to estimate and control the level of impurities; the trial runs included these studies as well. Under the MHRD-GoG funded collaborative project with IIT-Gandhinagar, studies are being carried out on the leeching of nanoparticles from bone cement into various liquid media including bio-fluids. A preliminary study of implanting the stable isotope of silver in biocompatible steels was done at IUAC, N. Delhi. Two new exploratory activities related to preparation of nanoparticles have been initiated; one related to synthesis of metal nanoparticles in a liquid medium and the other related to preparation of alloy nanoparticles. Two small table top systems have been designed and fabricated in-house to carry out these studies. Creation of a cleaner laboratory area for nano-materials activity is under process.

Shock wave generation using pulsed plasma technology: Wire explosion methods are very well used for the nanopowder generation of various types of metal. In recent years, the electrical explosion of wire has a new application in the area of petroleum industries to enhance oil recovery. The electrical explosion is replacing the old conventional method of use of explosive to the recovery of oil from the reservoir, since it is an environmentally friendly method. The electrical explosion of wire gives enormous pressure in terms of MPa. These shock waves create a cavity in the oil bed and enhance oil recovery. In FCIPT, experiments were carried out to generate the shock wave using electrical explosion of wires. Into the very robust structure of the steel pipe, a very thin diameter of wire is attached along with a very high energy store device. As the high energy is transferred to the wire for a short duration in terms of micro seconds, the wire is immediately explodes and generates shock waves. The amplitude of shock waves depends on wire size, length and energy. This simulates the environment of a natural condition like in oil well.

Plasma jet system for denim fading: The plasma jet system for denim fading was demonstrated to the delegates. The system comprises of a low temperature plasma jet operating at atmospheric pressure, an X-Y translator and a controller to the PC though an interface. It can raster pre-programmed images loaded on the computer on to the denim to be faded. Depending upon the denim, the residence time of the jet, speed etc. can be programmed and adjusted to form faded patterns and avoid over-heating.

Microwave Disinfection of food grains with Gyrotron Power: An experiment on Microwave disinfection of food grains using Gyrotron power has been carried in association with Anand Agriculture University, Anand, Gujarat. In these experiments, effect of microwave power on infected grains is seen. The infected grains wheat and pulse are exposed to microwave power, approximately 150kW power at 42GHz is launched only for ~150ms, almost 100% mortality is observed for all insects (larvae and adults weevil). The same experiment has been carried out at lower power and at 2.45GHz frequency, in this case also the mortality is observed but at long time at higher temperature of grains which is not desirable. Hence Gyrotron power could be an option for the disinfection of food grains. It will be efficient and fast. These experiments are being carried out for various food gains.

A.1.3 Plasma Thrusters

Heliocon Plasma Thrusters: Helicon source is a device capable of high-efficiency plasma generation which produce high-density plasma by the use of a helical radio frequency antenna to ionise neutral gas (e.g. argon, krypton, xenon, etc.) in a source tube. The helical antenna excites the gas to dissociate electrons and generate highly energetic ions. By using solenoid coils or permanent magnets, surrounding the tube create a magnetic field inside to confine the plasma within

the tube and reach a high ion particle density. These dense plasma sources have been exploited for space propulsion application for Thrusters. A Helicon Plasma Thruster programme has been initiated to demonstrate feasibility towards high thrust generation capabilities. Inline to this, a mini proof of concept was demonstrated for the generation of Higher plasma densities (~$3X10^{12}$ cm^{-3}) is essential for the higher thrust requirements. In house developed system with seven coil electromagnets (~ 500G) using rf power of 600W with Helicon antenna within glass tube source is deployed and operational. Characterization studies are under way with simple diagnostics like Langmuir probe (SLP/DLP/TLP), Mach probes for flow measurements, non contact optical emission spectroscopy for temperature estimation(~ 7-9 eV) in antenna source zones as probes show some problems. In house developed Compound pendulum diagnostics with appropriate calibration is employed (capable of measuring upto ~10 mN) for plasma thrust (force) measurements. Plasma characterization with operational diagnostics is being studied to understand the underlying physical mechanism of magnetic fields interaction with rf waves for generating dense plasma and its control. The understanding of plasma flow mechanism and plasma wall load losses are critical challenges in building of higher density production and their holding. We are in process to realize higher order plasma density generation (< $5X10^{13}$ cm^{-3}) with higher RF powers, magnetic fields(in combination of permanent and electromagnets) and the advanced diagnostic techniques to achieve higher thrust generation.

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A.2 Fundamental Plasma Physics

Plasma is being created and characterized in various conditions so as to explore its fundamental properties which can be later used for applications. Here it is being studied in very small scale laboratory experiments as well as in moderately bigger size like Large Volume Plasma Device

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A.2.1 Basic Experiments

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Basic Experiments in Toroidal Assembly (BETA)

In BETA, the plasma discharge current is about 5 Amperes. Hence the magnetic field produced by plasma current is neglible. Thus the confinement of particles and energy is only due to external magnetic fields - toroidal and vertical fields. Experiments related to Toroidal Acoustic Wave for different ion masses Viz Neon, Argon and Krypton were performed to confirm the acoustic nature of the mode.A new set of experiments with simultaneously operated multiple plasma source - namely ECR and hot cathode discharges were conducted to control the nature of density profiles. Data analysis indicates possibility of control of mean profile gradients using multiple sources. More work is underway. Experimental methodology to determine the toroidal field off-set in BETA were used in SST1 Experiments. The plasma-beamlet was designed and operated first in BETA. Thus BETA served as a useful test facility for larger experiments.

Large Volume Plasma Device (LVPD)

In Large Volume Plasma Device (LVPD), efforts were primarily focused in developing an understanding on a) Electron Temperature Gradient (ETG) turbulence induced electron transport, which is considered presently a cause of great concern to fusion fraternity, b) identification of extinction mechanism of energetic electrons in source plasma of LVPD, where first detection of Quasi-Longitudinal (QL) whistlers is reported. Efforts were made in establishing energy scaling of QL whistlers, c) concept of control on plasma parameters is demonstrated in Double Plasma Device(DPD), augmented to LVPD and for the developmental work towards d) data acquisition, automation and procurement of two high current power supplies for long pulsed operation of LVPD and development of microwave interferometry diagnostics.

ETG driven turbulence induced electron transport: Pursuing this, we have observed that electrostatic particle flux is radially inward, suggesting a particle pinch like scenario as observed in fusion plasmas in the core region of target plasma of LVPD. Because of high beta conditions prevailing in LVPD and open field lines, the investigations of electromagnetic particle flux measurements assumes significance. Novel result in the form of observation of finite electromagnetic particle flux in ETG background, which is otherwise predicted as zero in tokamak has surprised us. A theoretical model is thus obtained for the EM flux in straight homogeneous magnetic field geometry using slab ETG turbulence model equations which identifies that sluggish parallel ion response is the key mechanism for the generation of small but finite electromagnetic (EM) flux in slab ETG turbulence.

Investigations on QL whistlers: The experiments are carried out in the energetic belt of source plasma region of LVPD. The energetic belt region embeds highly oblique, propagating electromagnetic whistler mode nomenclature as Quasi

Longitudinal (QL) whistler which is excited by the reflected energetic particles emanating from the loss cone (magnetic mirror) geometry in source plasma and electron energy filter boundary. The theoretical model for reflected particle driven whistlers suggest that the mode growth is directly proportional to the density of the plasma, population of reflected particles and inversely proportional to the energy of the particles. We investigated QL whistlers for energy scaling of reflected energetic particles. We varied the energy from 60- 90 eV but kept density constant. The results exhibits that the growth of whistler mode decreases with the energy of these electrons.

Investigations in Double Plasma Device: Double plasma device(DPD) is developed and is segmented with LVPD for plasma parameter control by using concept of selective biasing of a mesh separator The DPD consists of source and target region separated by a mesh grid, developed to control plasma parameters in the target region. Experiments demonstrated that cooling and heating of electrons takes place when the grid bias was varied between certain selected ranges of bias. Axial control of electron temperature indicates that electron cooling of ~35% was observed when the grid was biased between -25 V to 0 V for a grid with 45% transparency and electron heating from 4.8 to 7.3 eV is noticed when grid bias is varied from 0 V to 20 V. An effort to vary the effective transparency by realizing variation in sheath length across grid revealed that, the cooling/ heating phenomena are more effective when ratio of source to target density or flux is maximum.

Diagnostics- Triple Langmuir probe diagnostic development: This diagnostic is finally commissioned for real time measurement of high frequency electron temperature fluctuations in a pulsed plasma. A special floating probe biasing circuitry has been developed which exploits various capabilities of the above diagnostics scheme such as amplitude, pulse duration and other attributes. To validate, measurements are benchmarked against single and double Langmuir probe measurements and a good match has been observed

Non-Neutral Plasma Device

(SMARTEX-C) is a C – shaped trap for electrons in a toroidal vessel of low aspect ratio (R/a = 1.6). Studies on electron-plasma confinement, its progress and underlying physics, have been carried out in a systematic manner, eliminating the factors that degrade the confinement. Brief description of activities done are as follows:

Design and Developmental tasks: Several improvements in order to have better vacuum and easy access to the diagnostic sensors have been performed. We could achieve a base pressure of 2×10^{-10} mbar. New baking heaters based on silicone rubber encapsulation have been designed with drawings and power ratings at 230V AC. High impedance Langmuir probe diagnostics to measure the floating potential of electron plasma was designed and installed in the trap. LabVIEW code of RGA and has been integrated with existing DAQ code.

Experimental milestones : Confinement of toroidal electron plasma extending 10-second mark was observed in. This confinement is at present a new world record of confinement of electron plasma in any of the partial toroidal traps operated so far in the world. The confinement time was inferred using density evolution of electron plasma obtained using diocotron launch technique. Preliminary results of floating potential profile were obtained for which careful analysis and understanding of the results shall be developed.

Interaction of Low Energy Ion and Neutral Beams with Surfaces

Active screen plasma nitriding (ASPN) is a variation of the traditional DC plasma nitriding (DCPN) and was developed in Europe in 1999. It overcomes the main shortcoming of DCPN which suffers from what is called ‘edge effect’ due to stronger electric fields near edges. In this method voltage is applied on a screen which envelopes the components to be treated but is physically separated so the plasma is formed only on the screen. The screen consists of holes and is made of steel. The components are radiatively heated by the screen to the nitriding temperature and the surface process is carried out mainly by active neutrals or radicals. Unlike DCPN treated samples, no edge effects are observed for ASPN treated samples, hence coatings are more uniform. Since no voltage is applied on the components hence no hollow cathode effects exist which can cause local heating and damage surfaces. Because of this more samples can be accommodated in a given space or in other words, ASPN can provide better quality of coating at a reduced cost. At IPR we have developed a R&D reactor and successfully carried out ASPN on some steel samples and demonstrated the usefulness of this technology.

Dusty Plasma Experiments(DPEx)

In DPEx device, dusty plasma is produced by a DC glow discharge Argon plasma in background and spherical monodispersive MF particles serves as the dust particles. The dust

Figure A.2.1 Active screen plasma nitriding

system dynamics tracks using optical diagnostics system and the data analysis performs by different softwares. In DPEx device, a number of fundamental problems like phase transition, phase co-existence, void formations, cluster formation, crystal cracking, chaos etc. are investigating in kinetic level, whereas the linear and nonlinear waves/stucture are investigated in fluid level. The Void (particle free region) formation attains special attention since it lights information to the phase co-existence problem, micro-gravity experiments and it mimics astrophysical scenarios. Voids in dusty plasma are observed in RF as well as in DC glow discharge stratums. The basic reason behind the formation of voids in dusty plasma is the imbalance between the confinement electric force and the ion drag force. In experiments carried out in DPEx device, initially a large two dimensional crystal is produced and a dust void is found to be co-existing with a crystalline structure with the increase in neutral gas pressure and the discharge voltage. The void radius is found to be increasing with the neutral gas pressure and the discharge voltage, since both these changes results in increase of discharge current. Furthermore, the crystal layers at the void-crystal boundary is found to be going under a rotation, essentially points out towards a two dimensional vertices formation.

Multi-Cusp Plasma Device

The field free central region in multi-cusp magnetic field configuration has been identified for basic plasma studies a long time before. The property of good curvature -viz the fluctuations present outside the boundary is not affecting the region bounded (here the central field region), is an added advantage to study various basuc phenomena. In this Multi-Cusp Plasma device, perturbations were excited in the field free region at the Ion-Acountic Wave frequencies and it was found to get damped when the edge field values are increased. Though the exact physics is being studied in detail, preliminary analysis shows that the confinement of primary electrons by the edge magnetic field through magnetic mirror effects have been identified as one of the reasons. The experiment being continued to scale for the frequencies as well as edge magnetic field values.

Inertial Electrostatic Confinement Fusion (IECF) Device

Continuous operation of the cylindrical IECF device above 80 kV input voltage for a few tens of minutes has been success-

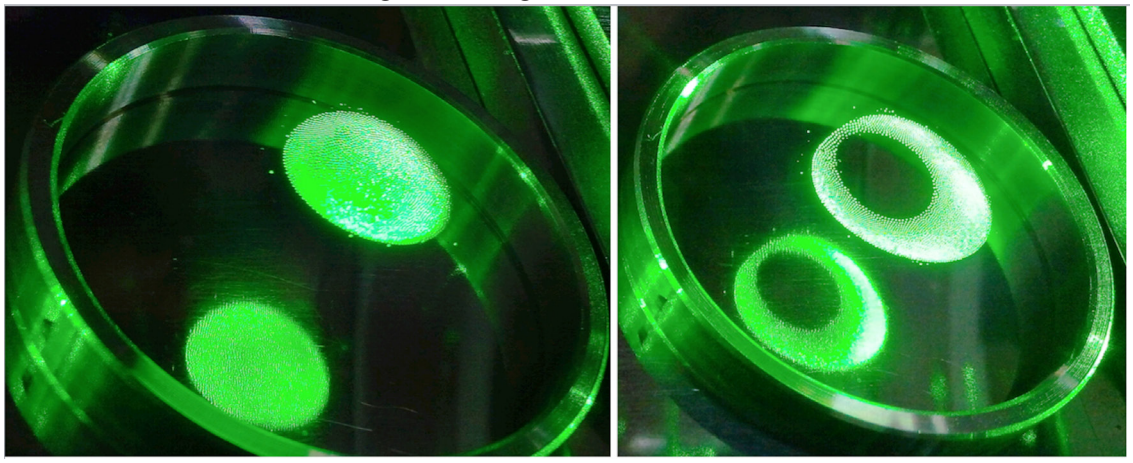

Figure A.2.2 . Images of dust plasma crystal along with the void structur. The smaller image is the reflection from the cathode

fully realized and the neutron counts are up to 10^6 neutrons per second has been recorded. Efforts were made mainly on developing pulsed power driver for pulsed operation of IECF device during last one year along with preliminary characterization of plasma in spherical IECF device. A high voltage pulse power driver has been constructed using two handmade spark gap switches and a 0.04μF, 100 kV NWL Capacitor. The switches are made up with the help of pneumatic cylinder, pneumatic valve and a compressor. While testing the pulsed power driver using those switches, we noticed that beyond 25 kV due to the effects of corona the switches did not function properly. Therefore, those switches were replaced by commercially available Zeonics make (Z/3T/100) High Voltage Spark Gap Switches. By doing so we have successfully operated our pulsed power driver at 60 kV applied voltage using IECF device as load. The output voltage signature confirms the successful operation of the homebuilt pulsed power driver. In addition, a spherical IECF device having diameter 40 cm has been successfully installed in our laboratory and deuterium plasma is being produced in it by making use of both hot and cold cathode discharges. A stable deuterium discharge occurred in the cathode region at the neutral gas pressure of 15 mTorr and discharge voltage and current of -2kV, 15mA respectively. To characterize the plasma, a planar Langmuir probe was employed which was interfaced with the automated circuit i.e. the Source Measurement Unit (SMU). Neutron emission from this spherical IECF device was carried out at a low applied voltage (~40 kV).

CPP-IPR Magnetized Plasma Experiment for Plasma Surface Interaction (CIMPLE-PSI)

CPP-IPR High Heat Flux (HHF) device could reproduce the extreme heat-flux that exists on the surface of the Sun. A complete magnetized plasma tokamak divertor simulator was commissioned more recently (CIMPLE-PSI: CPP-IPR Magnetized Plasma Experiment for Plasma Surface Interaction), which in addition to reproducing both the ion-flux and heat-flux at ITER tokamak divertor like extreme level, has also demonstrated extended, continuous, stable operation producing a mammoth fluence up to $0.3\times10^{-28}m^{-2}$. Temperature of the water-cooled material targets could be maintained beyond 1400K even under relatively lower plasma-power that indicates the device could be an ideal test bed to explore possible recrystallization of tungsten under high-temperature operations. To study the use of reduced activation ferritic martensitic steel (RAFM) as first wall material in future tokamaks like DEMO, India-developed RAFM was exposed under extreme fusion like helium plasma, very recently in CIMPLE-PSI. It demonstrated some exotic surface morphological changes and enrichment of tungsten on the exposed surface layer.

<u>*Single-step synthesis of tungsten-oxide nanomaterials:*</u> In CIMPLE-PSI laboratory, we have studied thermal plasma assisted techniques for experimental synthesis of nanomaterials, because they are often one-step, rapid methods with large rate of production that produces materials with fine crystallinity. In the CPP-IPR high heat flux (HHF) device, we have recently demonstrated controlled, single-step synthesis of tungsten-oxide nanoparticles at a very impressive rate of few hundred grams per hour. Before this, J. Liu et al. reported preparation of ultrathin W18O49 nanowires by solvo-thermal decomposition of tungstic acid leading to the production of about one gram of nanomaterial through an elaborate multi-step process. In our simple experimental configuration, a tungsten plate was heated up in presence of oxygen by a plasma beam with uniform profile that ensured controlled sublimation of tungsten-oxide, from which nanoparticles of WO3 and WO2.92 nucleated through gas phase condensation process, with a relatively narrow size distribution. A nanocomposite was made by mixing WO3 powder with carbon nanomaterial, which photo-catalytically degraded standard solution of Rhodamine-B within just few tens of minutes, which is extraordinary. The present plasma jet assisted experimental configuration shows much enhanced reactivity compared to when heating the metal in a neutral environment, which is attributed to the dominant presence of oxygen ions and meta-stables in the plasma jet.

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A.3 Tokamak Plasma Experiments

To realize the plasma fusion through magnetic confinement, tokamk experiments are bing continued. There are two tokamaks in operations for this purpose namely Aditya Tokamak and Steadystate Superconducting Tokamak (SST-1). A brief details about the expeirments conducted in those machine are given here.

A.3.1 Aditya Tokamak

In continuation with Phase-II operation of ADITYA Upgrade (ADITYA – U), Plasma discharge performance improvement along with several experiments such as the control of runaway electrons (REs) with Supersonic Molecular Beam Injection (SMBI) as well as H_2 gas puffing during current flattop, MHD modes studies using multiple periodic gas puffs, radiative improved modes using Neon gas puff, plasma pulse length enhancement with negative convertor operation, 42 GHz ECR assisted pre-ionization and low loop voltage start-up experiment along with the real time control of horizontal plasma position using FFPS have been performed. Before the commencement of Phase-II operation, the ADITYA-U vacuum vessel was successfully baked up to ~135 °C in subsequent baking cycles for the purpose of achieving a lower base vacuum. A base pressure of the order of ~6×10^{-9} Torr was achieved after removing all leaks. In addition to that appropriate wall conditioning techniques have been implemented in ADITYA-U, such as H_2 Glow Discharge Cleaning (GDC), H_2 Pulse Discharge Cleaning (PDC) in 2.45 GHz Electron Cyclotron Resonance (ECR) plasma background, and GDC with mixture of gases such as hydrogen and helium as well as hydrogen and argon. The continuous GDC in ADITYA-U, normally carried out at high gas pressure (10^{-3} Torr), loads the vessel wall. To overcome this issue, a novel concept of pulsed glow discharge wall conditioning (P-GDC) has been introduced. The lithium-assisted pulsed GDC (P-GDC) for controlling hydrogen wall loading and recycling were performed regularly for better surface conditioning. The partial pressures of various mass species (H_2, H_2O, CO, N_2 and O_2) were regularly monitored through a quadrupole mass analyser before starting the plasma operation. The partial pressures of H_2 (M#2), N_2/CO (M#28), O_2 (M#32) and water vapour (M#18) were reduced by a factor of 10. Discharges were attempted over a wider parameter range, along with real-time plasma position control, to carry out various experiments. Further, the discharges were tailored to different experiments in order to obtain better results in those experiments. Encouraging results obtained from different, meticulous experiments in ADITYA-U are described below. All the experiments were carried out in the toroidal limiter configuration.

Gas puff experiment: The chord averaged electron density of plasmas increased to ~4×10^{19} m^{-3} corresponding to central peak density of ~6.7×10^{19} m^{-3} for the first time in ADITYA-

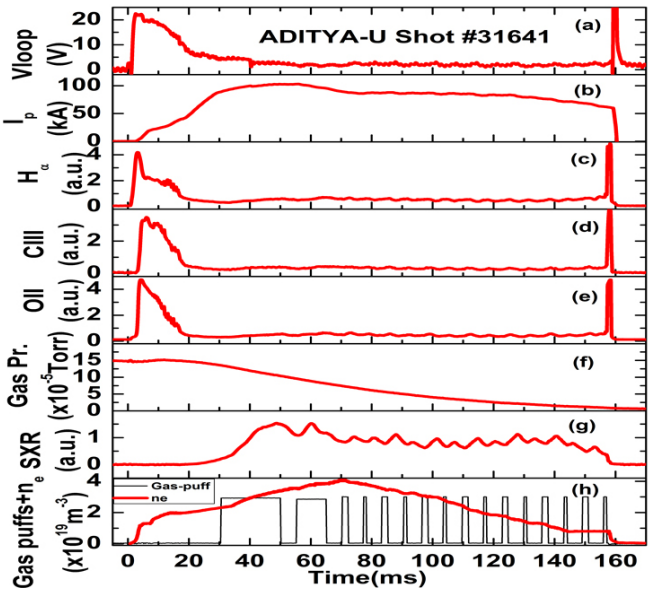

Figure A.3.1 Temporal evolution of ADITYA-U shot (# 31641): (a) loop voltage (V); (b) plasma current (kA); (c) H_α intensity ; (d) CIII impurity line emission ; (e) OII line emission ; (f) pre-filled gas pressure (Torr); (g) soft x-rays ; (h) electron density (n_e) (1×10^{19} m^{-3}) and H_2 gas pulses.

U by using sonic multiple H_2 gas puffing of varying pulse widths and amplitudes during current flat-top with proper interlocks. Figure A.2.3 shows the temporal evolution of ADITYA-U shot #31641 parameters, demonstrating density enhancement with sonic gas puffs. The typical discharge is obtained at a toroidal field (Bφ) ~ 1.05 T and a H_2 prefilled pressure of ~1.5×10^{-4} Torr, which is equivalent to ~9×10^{18} m^{-3} molecules of H_2 gas. The sonic multiple gas puffs of varying pulse width yielded a pressure increase of ~7.5×10^{-5} Torr in the vessel, which is equivalent to an addition of ≈ 4.5×10^{18} m^{-3} molecules of H_2 gas. The amount of injected gas was maintained in such a way that the plasma current and its equilibrium position remained steady. The figure also shows the rise in Soft X-Rays correlated with gas puffs in time and magnitude and the chord averaged electron density peaking at up to 4×10^{19} m^{-3}.

Real-time plasma position control: Plasma position measurement is crucial for controlling the quality of a plasma discharge. A plasma position signal is required for the post-discharge calculation of plasma parameters and real-time control of the plasma position. During Phase-I operation of ADITYA-U, the plasma position was stabilised by controlling the vertical field provided by BV coils in open loop mode, having a slow response because of the higher value of L/R. The new set of FFB coils having a faster response is connected with FFPS (±2 kA) to control the coarse motion of the plasma in the horizontal direction. The transfer function model for ADITYA-U's real-time horizontal plasma position control in a closed loop configuration was implemented. A field-programmable gate array-based PID controller was used for the operation of the real-time position control system. A model for the ADITYA-U horizontal plasma position control was implemented in a closed loop configuration. The stability of the system was checked in order to obtain a stable

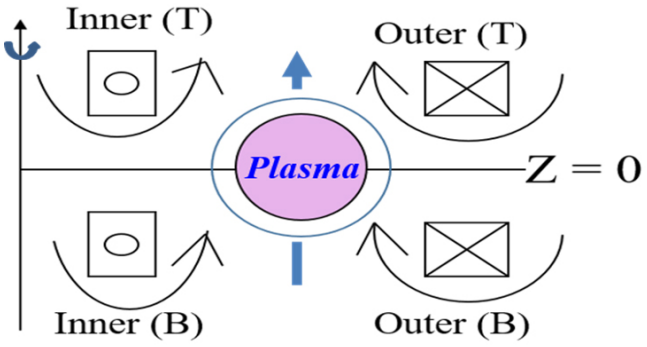

Figure A.3.2 Fast Feedback coils in vertical field mode configuration

position output of the plasma with zero steady state error, minimum oscillations, and a fast response. Different P, I and D values can be selected according to the requirement, so that desired plasma position can be obtained. Plasma discharges with different parameters are operated for real-time position control of the plasma. PID operation was initiated into the plasma discharge at 30 ms from the initiation of the loop voltage and fluctuations in the FFPS current could be observed according to the movement of the plasma position. Using the above-mentioned plasma position control system, the plasma position was maintained at the machine centre.

Runaway Electrons (REs) mitigation by SMBI: An SMBI (Supersonic Molecular Beam Injection) system, to enable deep penetration of neutrals inside the plasma, was installed on the low field side of the ADITYA-U tokamak. Theoretically, a gas injection speed of Mach 10 is achievable with this nozzle design. The plenum gas pressure can be varied to adjust the throughput of the beam. A particle flux of ~2.6×10^{22} particles s^{-1} is achievable at a plenum pressure of 1MPa. In an attempt towards primary RE mitigation, SMBI is fired at 40ms after the initiation of loop voltage. With the application of SMBI, the central chord averaged electron density, measured using a microwave interferometer, increases sharply, which is also reflected in the observed sudden jump in the SXR signal. With the rise in density, a significant reduction in the RE population is also evident from the HXR signals. Further, a ~5% decrease in Ip can be seen following the SMBI pulse. This is mostly due to the reduction in RE population and resultant loss of the fraction of Ip carried by them. RE mitigation has been observed in 80% of the discharges in which SMBI is employed.

Discharge duration enhancement with Negative converter operation: Ohmic converter provides the necessary loop voltage for plasma breakdown, start-up and current ramp-up. The required values of loop voltage for different phases has been obtained by inserting different resistors in the Ohmic circuit. To achieve a higher plasma current beyond 150 kA, the loop voltage was properly shaped. The available Volt-Sec (Vs) has been increased to 0.6 Vs by adding a negative converter to the positive converter having ~13.5 kA of operating current (0.4 Vs) in order to increase the discharge duration. The positive and negative converters are coupled using a thyristor based dual polarity converter with a circulating rectifier for the smooth transition from positive to negative converters. This will provide a constant flat-top loop voltage of ~2 V during the negative converter phase for above ~300 ms. The observed reduction in the loop voltage during flat-top was ≈2 V.

Figure A.3.3 ~75meter long transmission line is used to launch ECRH power from SST- hall to ADITYA-U tokamak, consistingof 63.5mm ID corrugated waveguide, bends, polarizer, DC breaks & bellows etc

The maximum discharge duration of ~307 ms was obtained in ADITYA-U. Multiple hydrogen gas puffing at the plasma edge are introduced in the vessel to increase the plasma density. The amount of injected gas is controlled in such a way that no significant change occurs in the plasma current and its equilibrium position. The chord averaged electron density of the order of ~4 × 10^{19} m-3 was obtained.

42 GHz ECR assisted pre-ionization and low loop voltage start-up experiment: The EC assisted low-loop voltage plasma start-up experiments has been carried in Tokamak ADITYA-U. The 42GHz (maximum power 500 kW) ECRH system is used for off-axis breakdown in ADITYA-U tokamak, which is operated at a toroidal magnetic field of ~ 1.2 T. Approximately 75meter long transmission line is used to launch power from SST- hall to ADITYA-U tokamak, the transmission line consists of 63.5mm ID corrugated waveguide, bends, polarizer, DC breaks & bellows. The system is directly connected to tokamak using a BN window and UHV gate valve. The fundamental O-mode is launched from low field side of the tokamak. The EC power and duration for breakdown are varied from 75kW to 150kW and from 50 ms to 100 ms respectively. The ECRH power is launched around 25ms before the start of the loop voltage and successful plasma start-up is achieved with almost 50% reduction in the peak loop voltage. For the typical discharges in ADITYA-U, the gas breakdown and successful plasma start-up is normally achieved with peak loop-voltage of ~ 19 – 20 V (Electric field ~ 4.5 V/m). In these experiments, the peak loop voltage is reduced by 50% to ~10 V by reducing the resistance values in the Ohmic circuit. Without the EC pulse, no successful plasma start-up has been achieved with ~10-15 V loop voltages. However, when a pre-ionization plasma is created with the help of EC, launched around 25ms before the start of the loop voltage, successful plasma start-up and current ramp-up has been achieved similar to those obtained at higher peak loop voltages without the EC pulse. Successful EC-assisted plasma discharges with maximum plasma current ~ 177kA and maximum discharge duration of ~ 334ms has been achieved with low (~10 V) peak loop-voltage.

ECR heating experiment in Aditya-U: The Electron Cyclotron Resonance Heating (ECRH) experiments also carried out on tokamak ADITYA-U using the 42GHz-500kW ECRH system. Since the tokamak is operated at toroidal magnetic field of 1.2T, the EC layer is located on the high field side (inboard) and off-axis ECR heating experiments are carried out at fundamental harmonic. In these experiments, the EC power in fundamental O-mode is launched from the low field side (outboard) at the flat-top of the plasma current. The typical plasma current in Aditya-U is in the range of ~ 100 - 115kA and the plasma discharge duration is more than 250 ms. The EC-power pulse is launched at 50 ms after the start of the loop voltage, when the plasma current reaches to its flat-top. The EC power is varied from 150 kW to 250 kW and the EC pulse duration is also varied from 50 ms to 150 ms in

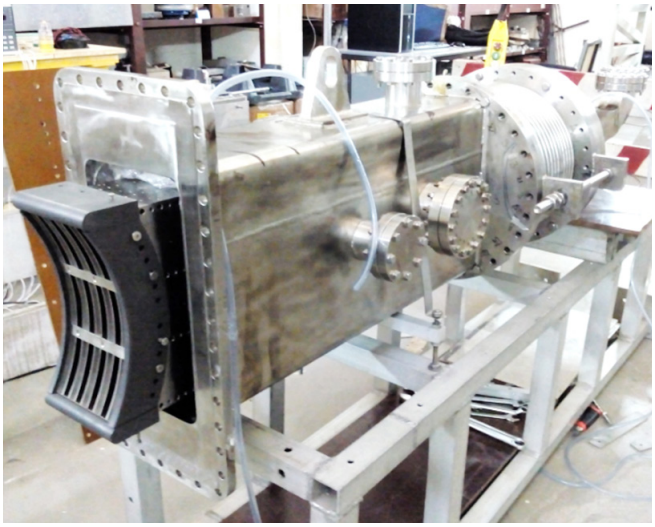

Figure A.3.4 Photo of passive-active-multijunction (PAM) antenna (*PAM) launcher*

various plasma discharges. The heating effect is observed by various diagnostics like the volume soft X-ray (SXR) signal gradually which is observed to be increased with EC-power.

Lower Hybrid Current Drive System: The passive-active-multijunction (PAM) antenna or launcher for ADITYA-U machine is fabricated and tested for its functional characteristics like Ultra-High Vacuum (UHV) with and without baking, low power rf characteristics and its linear movement. The PAM launcher is shown in the figure-1 and front view of antenna is shown in figure-A. During the vacuum test, ~5 x 10^{-8} mbar vacuum was achieved and leak rate measured at all the joints were below 1 x 10^{-9} mbar l/s with continuous pumping with 520 l/s using TMP. The linear movement of antenna using the bellow was checked for ±30mm. The baking cycle for launcher assembly under high vacuum testing is shown in figure-3. It shows the baking temperature of more than 180°C for 20 hours. The vacuum level falls during baking period due to degassing and release of moisture and eventually provides the required UHV condition after the baking.

A.3.2 Superconducting Steady-state Tokamak (SST-1)

One of the major technological targets for SST-1 was the use of Superconducting Poloidal Field (PF) coils. A major (and related) science target was to demonstrate operation with a shaped (non-circular) plasma. Since the PF coils were never cooled down to the superconducting state, neither of these major targets has been achieved so far.

(a) Hitherto, due to problems with high heat loads and pressure drops, it had not been possible to cool-down the PF coils to superconducting temperatures. Over the past few months, improvement in thermal insulation techniques and reduction in line-of-sight between 300 K and 4 K surfaces, have made it possible to cooldown all but one of the PF coil pairs to SC temperature.

(b) The above improvement in thermal insulation has allowed generation of 50 litres/hour of liquid Helium. This is important since LHe is required for operation of the cryogenic current leads.

(c) The high-current (10 kA), low-voltage (120 V) power supplies for driving PF coils, procured many years back, had never been made operational. That work was taken up in 2017, and is likely to be completed by end-2019. This includes the transformers, convertors, bus bars and safety/protection systems.

(d) The Toroidal field coils, which had earlier been used to produce a maximum field of 1.5 Tesla (and 1.8 Tesla for short durations), have now been driven with higher currents to yield 2.5 T at the plasma centre (80% of the design value).

(e) The SST team conducted several low loop-voltage Helium Plasma experiments assisted by ECR and LH. In addition, at the end of the experimental campaign, ICRH based wall conditioning experiments were successfully carried out at magnetic fields of 1.1T, 1.5T and 1.6T.

(f) Indigenous Development of prototype Cryogenic Flexible Hose: A prototype vacuum-jacketed cryogenic flexible line has been indigenously developed in association with Indian Industry. This is required on a daily basis for transfer of cryogens like LHe & LN2.. The item is not commercially readily available in Indian markets and imported lines are expensive. No vacuum degradation, leakage, frosting and condensation have been observed. The pressure drop and flow rate are found to be acceptable. Development & performance testing of a line with higher diameter & length, required for IPR's own cryo requirements, is now underway.

(g) Repair & reconfiguration of LN2 distribution in SST-1: LN2 leakage from this system would have posed a personnel safety issue; it was also reducing the performance of the LN2 phase separator. These problems were overcome by rerouting of pipes, welding and NDT. This was done in a challenging environment involving a congested piping network, and at 12

Figure A.3.5 Power supply for the SST-1 Poloidal Field (PF) coils have been commissioned Left - Transformer and Right - busbar connections to the PF coils inside the tokamak hall of SST-1

meter height.

(h) Current is fed from the power supplies to the PF coils through bus-bars, followed by flexbile bus-bars and finally the current leads. Mechanical analysis & design has been completed for 9 pairs of flexible bus-bar systems and their associated support structure. Fabrication is in progress.

(i) For the first time, the Toroidal magnetic field was raised to 2.7 Tesla, which is 90% of the design value (3 T). The toroidal field was raised in steps, and was kept above 2 T for more than 15 minutes. This is an important demonstration in terms of planned experiments in future campaigns, where long-pulse plasma operation above 2 T would be done with the assistance of Electron Cyclotron Resonance, Lower Hybrid and Ion Cyclotron Resonance systems.

(j) Bus bars have been installed in the cryogenics hall, above the current feeder chamber for one of the superconducting poloidal field coils (PF3) power supply (for 2 KA operation), except for the end connections.

(k) PF3 coil power-supply upgradation: Series connection of two half-wave three-phase rectifiers has been successfully demonstrated (uniform voltage sharing) on a 3A load and also at no-load full firing. This will allow higher PF coil voltages to drive time-varying currents in the PF3 coils, which is necessary for producing a shaped plasma.

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A.4 Fusion & Related Technologies

Under the purview of continuous progress related to fusion science and technologies , many technologies are being developed. A brief about the technologies developed under various heads are given here.

A.4.1 Magnet Technologies

This programme caters to the development of different magnets which will be used for confining plasmas in various configurations. Work is in progress on technological developments related with Nb_3Sn and high temperature superconductors (HTS). The heat treatment of Nb_3Sn superconducting strands and sub-cables carried out at 650°C. The metallurgical characterization of heat treated strands for Nb_3Sn phase formation and its superconducting transition temperature measurements also carried out. The superconductivity measurement of heat treated Nb_3Sn strands and electrical testing at 4.2 K @ self-field for the transport current more than 450 A. A small length of around 5m Nb_3Sn CICC wound for testing at high current at self-field, overhauling of heat treatment furnace and integration of the same in the this furnace for heat treatment. A laboratory scale Nb_3Sn solenoid coil which can produce magnetic field of ~1 T has been wound and heat treatment of the same is progress. The high voltage compatible electrical insulation system developed and Paschen test carried out at low temperature for SST-1 SC magnets current leads. The laboratory scale high temperature superconductor (HTS) based D-shaped magnet fabricated and tested for its cooling characteristics up to 77 K, current charging and magnetic field measurement. The low resistance joints of ~5 nΩ have been developed and tested at 77 K for HTS magnet applications. The quench detection and propagation experiments have also carried out on 2 G-HTS tapes up to 90 % of the critical current of this tape. The commercially available 2G-tapes tested up to the transport current of more than 500 A at 77 K and self-field.

A.4.2 High Temperature Technologies

Seven-layered W/Cu functionally graded material (FGM) (100 W, 80W-20Cu, 60W-40Cu, 50W-50Cu, 40W-60Cu, 20W-80Cu, 100Cu, by wt %) were fabricated by a spark plasma sintering process (SPS). The influences of sintering temperature on microstructure, physical and mechanical properties of the sintered bulk FGM were investigated. Results indicate that the graded structure of the composite densification after the SPS process and interfaces of the layers also are clearly visible. All of the layers have a very high relative density, thereby indicating their densification and excellent sintering behavior. SEM and EDX study of the bulk sample cross-section reveal that the graded structure can be retained up to sintering temperature of 1050 °C. In addition, fine microstructure within each layer with good interface bonding was also observed. Sample sintered at 1050 °C exhibited excellent mechanical and physical properties (hardness 239 ± 5 Hv and relative density of 90.5%). The result demonstrates that SPS is a promising and perhaps a more suitable process for fabrication of W-Cu functionally graded materials.

A.4.3 Fusion Blanket Technologies

This caters to the indigenous development of blanket technologies required for a future fusion reactor as well as to the development of Test Blanket Module to be tested in the ITER project.

Numerical and Experimental MHD Studies of Lead-Lithium Liquid Metal Flows in Multichannel Test-Section at

High Magnetic Fields: Numerical simulation and experiments have been performed at high magnetic fields (1–3T) to study the MHD assisted molten Lead-Lithium (PbLi) flow in a model test-section which has typical features of multiple parallel channel flows as foreseen in various blanket module of ITER.

Corrosion Behavior of IN-RAFM Steel with Stagnant Lead-Lithium at 550°C up to 9000 h: Corrosion study of IN-RAFM (India specific reduced activation ferritic martensitic) steel with static lead-lithium, Pb-16Li has been carried out at 550 °C for different time durations, 2500, 5000 and 9000 h. Flat and tensile INRAFM samples were exposed to liquid metal. Exposed samples were analyzed for micro structural observation and chemical composition by scanning electron microscope equipped with EDX (energy dispersive X-ray spectrometer). Hardness reduction was observed up to a depth of ~15 μm after exposure to liquid metal. There was no significant reduction in the tensile strength. Dimpled ductile fracture was observed after exposure to liquid metal up to 9000 h.

Neutronic Design Optimization of ITER TBM Port#2 Bio-Shield Plug: In order to serve the requirement of TBM system, a Bio-Shield Plug (BSP) is placed at biological shielding location of the equatorial port. The neutronic design of BSP is important because it serves the purpose of biological shield boundary of ITER port. The neutronic analyses have been performed using the MCNP radiation transport code and FENDL-2.1 nuclear cross section data library. The Activation code FISPACT2007 has been employed to estimate the contact dose rates. The outcome suggests that B4C and Ferroboron would be better candidate materials for the bio-shield plug of TBM port.

A.4.4 Remote Handling & Robotics Technology

Remote Handling operations strive to perform inspection and maintenance tasks at remote locations without being physically present at the workspace. These are executed using a synergistic combination of specialized robotics and virtual reality. Unlike conventional industrial robotic systems, which are pre-programmed to do a certain task, robotic requirement in tokamak are much more complex and require man-in-the-loop operations. The RHRTD division has been involved in conceptualizing new remote handling systems and upgrading the existing manipulators. Below are some of the developments that were taken up during the report period:

Using Artificial Intelligence (AI) for automatic control of robot: When a long cantilevered robotic system enters the tokamak, it is very difficult for the operator to correct the position of the robot's end point using only a few camera input. In such cases AI can be used to take a camera input and move the robot joints to correct the robot's end point. Such an AI algorithm based on neural network has been developed and tested.

Developing various Virtual and Augmented Reality applications: Work is in progress in developing various Virtual Reality (VR) and Augmented Reality (AR) applications. A VR application is similar to a computer game where a person interacts with a simulated environment. The major difference between a normal game and VR applications is that here we use the simulated environment to either train an operator who will actually conduct a specific task or use VR to control an actual hardware. Some of the developed VR applications as highlighted below.

Graphical User Interface (GUI) and operator training for control of a SCARA Robot: A VR application is developed that can be used to control an SCARA robot. The operator can use the onscreen control or keyboard arrows to move the robot. The GUI gives feedback of the various robot joint positions to the operator. The VR application also incorporates Inverse Kinematics, i.e. , the operator can use keyboard arrow to move the bottom tip of the Red linear bar and the inbuilt algorithm will calculate the required joint positions to achieve that tip position.

An operator training platform for critical environments: When an operator is asked to enter a critical environment, say for example a building with some radio-active systems, it is required that the operator is well trained and completely aware of the surroundings before entering. The operator can move in the environment and carry out task like taking gauge readings, replacing a component etc. The total time elapsed for completing the task is displayed and recorded. A special feature of this application is that it can also calculate the total radiation dose imparted on the operator during completion of the task. The operator can train many times and optimize time and route before entering the actual building.

Augmented Reality based Welding Simulator: Unlike VR, augmented reality (AR) integrates both the real world and the virtual components in a single screen using a camera feedback. A preliminary application for training a person for conducting welding procedures is developed and demonstrated.

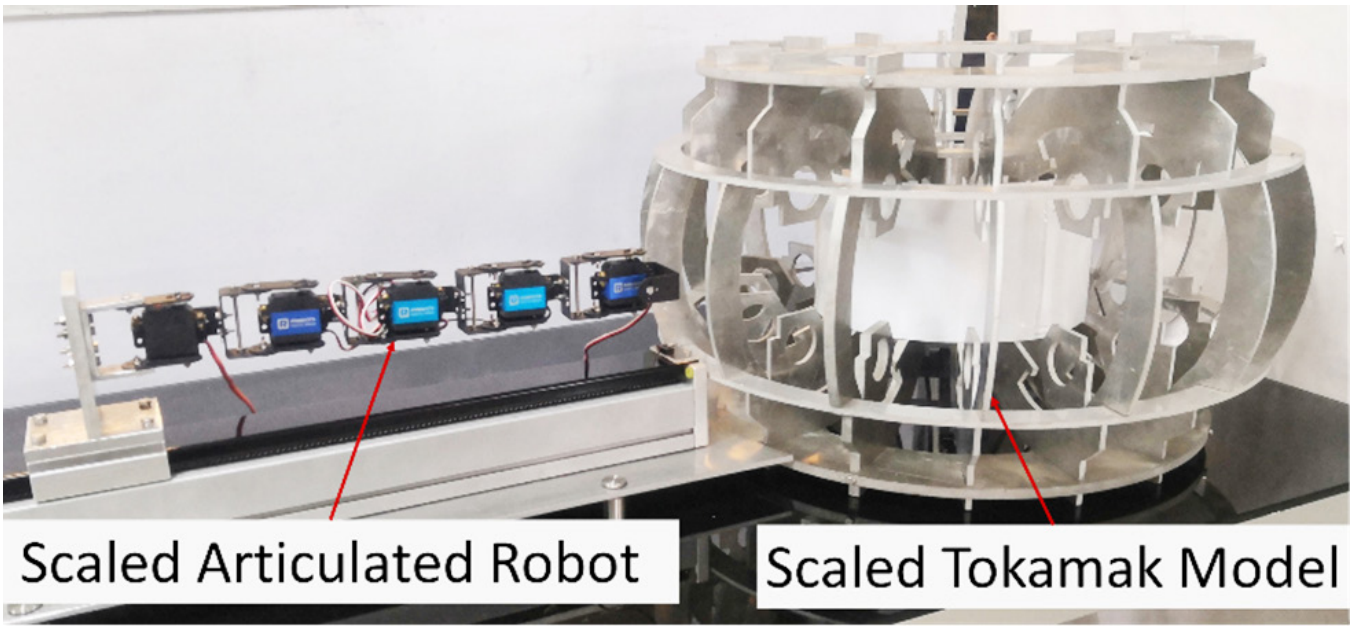

Figure A.4.1 Prototype of In-Vessel Inspection System

The simulator uses camera inputs to project a virtual welding fixture and rod onto a dummy hardware with markers. When the trainee brings the welding rod at the junction of the two plates, a deposition of particles with welding smoke and sparks. Such an application is extremely helpful for initial training a large number of students as no actual material is wasted and also safety is guaranteed. Once the students have a fair amount of practice on the simulator, they can easily work using actual welding machines.

Wireless GUI for omnidirectional wheeled platform: While remotely controlling a moving robotic platform, it is necessary to provide the operator with accurate data coming from the various onboard sensors. A VR based GUI has been developed that can be used to display the incoming data like robot speed, acceleration, angle of the robot, environment temperature etc. The GUI also displays the live feed from the

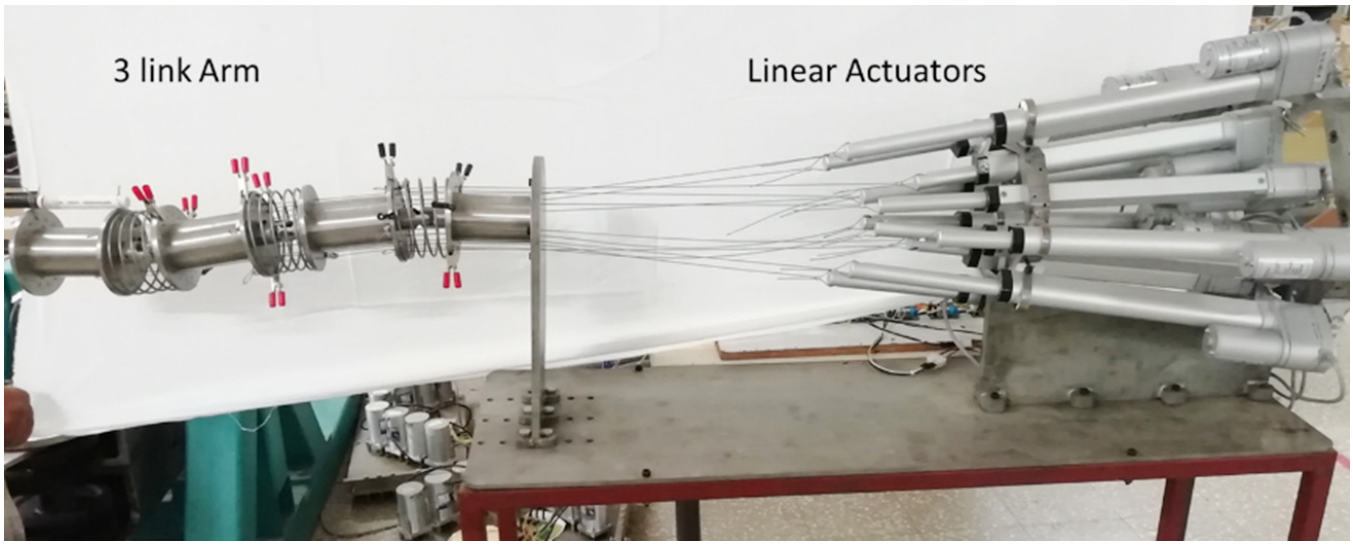

Figure A.4.2 High dexterity Hyper-redundant manipulator model

camera installed on the robotic platform. All GUI can also wirelessly send the robot movement commands from a joystick to the onboard controller.

A demonstrative model for Tokamak RH Systems: As a part of IPR outreach activities, RHRTD division has developed a scaled portable model that demonstrate the basic RH system utilized for visual inspection tasks. The model comprises of a scaled model of SST-1 tokamak along with a typical RH system that can slowly enter the tokamak model and provide live video.

Gravity Compensation Arm: An articulated RH arm with multiple links will spend most of its energy on carrying its own weight when it works against gravity. A gravitational torque occurs due to the mass of the links and the payload, but most of the gravitational torque is caused by the self-weight. RHRTD is involved in design and development of a gravity compensated RH arm with sufficient dexterity that can compensate its own weight and reduce the load on the actuating joints.

Progress on In-Vessel Inspection System: IVIS system will be used inside SST-1 tokamak under High Vacuum (UHV) (1e-7 mbar) and High Temperature (80ºC) conditions, to carry out visual inspection tasks without breaking the machine conditioning. The designed IVIS manipulator is ~2m long with 04- Degrees of Freedom (DOF), comprising of three rotary joints and one linear motion for deployment within the tokamak. The scenario has to be rehearsed under the vacuum and temperature operating conditions to achieve the complete feasibility demonstration of a close inspection under real operating conditions. The high vacuum chamber is a prototype work cell for demonstrating IVIS operation in a vacuum environment of ~1e-7 mbar and high temperature.

Progress on Dual Arm Manipulator: Dual arm manipulator is a multi-body system, each arm has ~1 m length, which comprises of six degree of freedom rotary joints that performs tasks that would be difficult or impossible doer a single arm robot like pull components apart, remove captive bolts from tiles, lift heavier components with two arms and brace components with one arm while performing task with the other arm– in harsh environment.

Progress on Hyper-redundant manipulator development: Work is in progress for designing a state of the art high dexterity Hyper-redundant manipulator. This system uses steel wires to control the actuation of the robot, which is similar to a puppet dance. The control of a robot is highly challenging as the algorithm needs to determine the push and pull of each wire simultaneously to robustly move each of the joints. Some initial experiments show extremely stable operations. Such robots can enter very narrow spaces and conduct inspection and manipulation tasks.

***Progress on prototype force feedback haptic arm for tele-manipulation*:** Typically, master-slave based tele-manipulation systems are used for inspection and maintenance of the tokamak devices. These systems consist of a dexterous manipulator as a slave working inside the device and a scaled down kinematically similar arm as a master commanded by a skilled RH operator. To give a better perception and tactile feeling to the RH operator, haptic technology is employed. With the haptic, the slave arm controller calculates the forces experienced by the slave arm and pass these values to the master arm controller which provides the proportional torques on the coreless motors in the master arm. These torques are felt by the RH operator as feedback of the forces experienced by the slave to precisely and accurately manipulate the slave arm. In this work, a 3 axis haptic device has been developed consisting of Maxon make coreless DC motors.

A.4.5 Negative Ion Neutral Beam Technologies

Here a single driver-based inductively coupled negative ion source ROBIN is already operational and issues related to plasma production, negative ion formation, and extraction are being studied. The next important step in the IPR program is to operate the eight-driver ITER ion source for the extraction of currents ~60 A. To meet this important objective, there is a need to address the issues related to multi-driver source operation under vacuum immersed condition, and a two driver source, which couples RF power from the same RFG emerges as the most simplified configuration to initiate the learning process. The updates on the each facility and on diagnostics are as follows:

The single driver RF based negative ion source facility ROBIN: The ROBIN source (single driver rf based negative hydrogen ion source) operated with Cesium (Cs) for a long time. The enhanced source performance in terms of negative ion current density and electron to ion ratio obtained with Cs in ROBIN. However impurities of the source resulted in high Cs consumption due to Cs compound formation. To establish the consistent and optimum source performance; it was necessary to clean the Cs compounds. The source cleaning procedure / methodology established for the same. The source

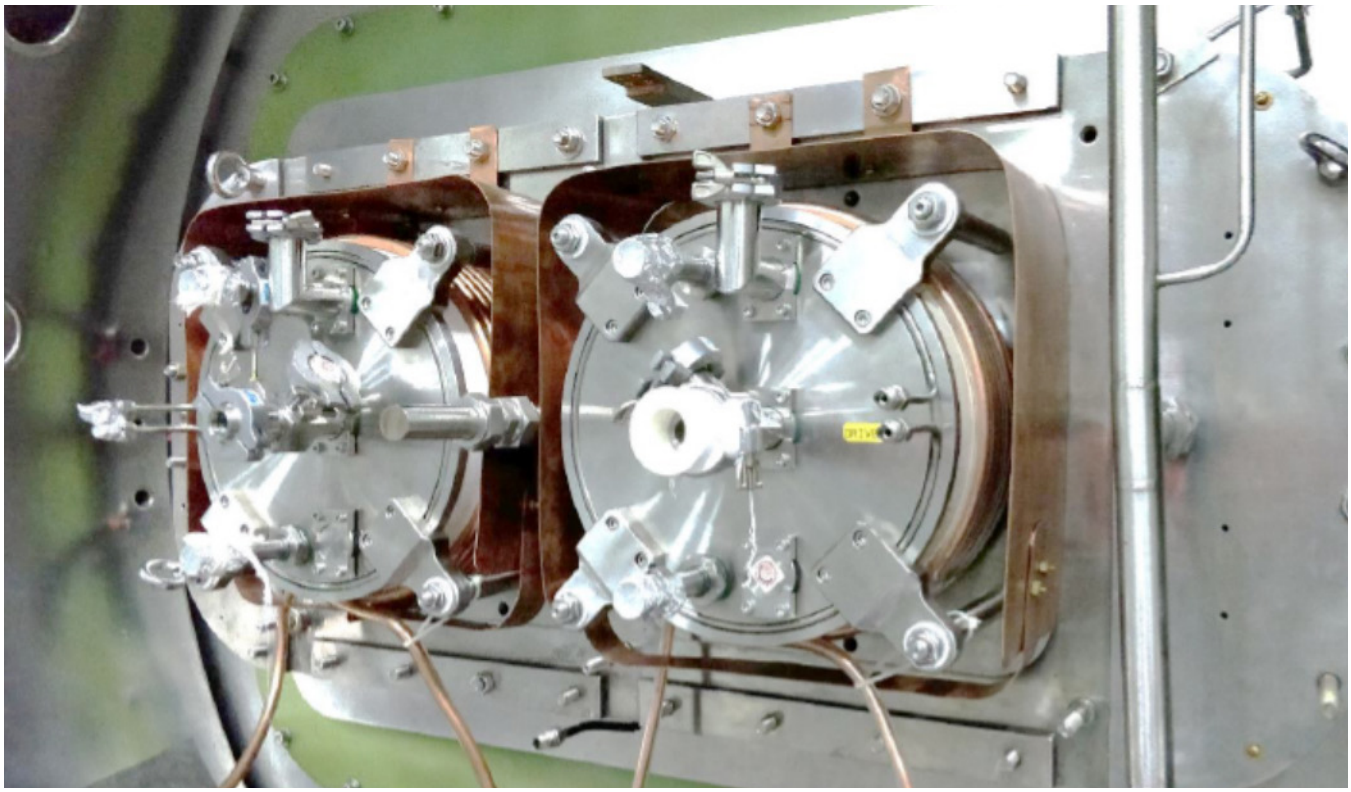

Figure A.4.3 Two driver RF based negative ion source - Twin Source operational in IPR

cleaning area is prepared with necessary material, tools and tackles. The necessary safety measures are implemented prior to start the cleaning activity. The Cesiated source components cleaned with acid. The cleanliness of the source components have been ensured by performing the litmus test. The necessary tests i.e. pressure holding of the extraction and grounded grids, sniffer, grid alignments, high voltage, integral helium leak test etc. of the source and accelerator carried out. The source has re-assembled with auxiliary systems i.e. vacuum, gas feed, cooling water, pneumatic, filament and grid heating and bias power supplies etc. The functionality of the auxiliary systems is ensured. The high voltage conditioning of the source carried out with actual extraction and acceleration power supplies. The plasma operation has initiated in ROBIN. The diagnostics are repositioned. Three moveable Langmuir probes are installed in extraction area to characterize the plasma in extraction region. The target is to re-establish the negative ion beam extraction in ROBIN. Try to optimize the source performance with minimal Cesium consumption and get insight for beam control parameters.

The two driver rf based negative ion source facility TWIN Source: TWIN source is a step between single driver ROBIN source and multi driver DNB source. The facility will provide the platform to learn and experience the multi driver rf coupling, vacuum immersed source operation, time varying filter filed and beam extraction from DNB like accelerator.
The auxiliary systems i.e. vacuum, gas feed, cooling water, filament heating and bias etc. implemented and tested for functionality in TWIN source. TWIN source operations carried out in single driver mode and twin mode in air. The rf power up to 50kW coupled in single driver for maximum 2 second plasma on time. The plasma produced in twin mode configuration. Matching in TWIN mode (two drivers fed by 1 generator) achieved up to 35kW. However breakdown observed at 40kW. The anticipated reasons for breakdowns could be loose winding of coil and electrical field strength at triple point (coil does not have a proper contact with ceramic cylinder) however further reasoning for breakdowns being done. The emphasis is being put on establishing the plasma diagnostics. The target is to achieve the matching at high rf power and characterize the plasma.

Indian Neutral beam test facility: Preparations for the setting up of the Indian neutral beam test facility are underway. This facility has the mandate to produce, characterize and transport 100 keV hydrogen neutral beams over transport lengths of 21 m. Once commissioned this facility would be the one of its kind on an international platform. Various components of the facility are in different stages of production.
One of the most important component is the 8 driver RF based negative H ion source capable of producing 1280 beamlets @ 100 keV with a total accelerated current of 60 amps. The beam line components under manufacture are the neutralizer, the electrostatic residual ion dump and the calorimeter. The neutralizer is a gas cell to help neutralize the accelerated ion beams from the source. However, the neutralization efficiencies are limited to 60% and the exiting beam from the neutralizer cell consists of a mixture ion and neutrals. The ions are separated from the neutrals using electrostatic residual ion dump which is the first of its kind in neutral beam lines and is expected to supersede the magnetic deflection systems used conventionally. The neutral beam is diagnosed using a beam dump called the calorimeter which consists of a stack of water cooled heat transfer elements with a heat rejection capability to the tune of 10 MW/m^2. The manufacturing is critical from the areas of precision machining, OFCu milling followed by 1-1.5 mm thick Copper electro deposition to close the milled channels and similar (Cu-Cu) and dissimilar (CuCrZr-SS with Ni interface) metal welding using electron beam welding. A good example of the precision machining is the 3 grid system for extracting and accelerating –ve ions from the source to obtain the desired current and energy mentioned above. The grid system is the only element which helps control the beam optics unlike accelerator systems which have multiple optics controlling elements over long paths. For the present grid system in order obtain beamlets with minimal divergence to ensure maximum beam transport it is desirable to achieve <50 micron in the positioning of apertures from which the beamlet is extracted and accelerated, 40 microns in terms of flatness and the +/-0.002^o in terms of the angles to achieve the desired beam focusing at 20 m from the source. Prototype development of the grid segment has established the best possible tolerances which can be achieved with the machining limitations on the best possible machines existing globally. The various components of the source are in different stages of manufacturing.

Material development has also been a crucial aspect of this project. CuCrZr material development with controlled Cr and Zr concentrations is another highlight of the development made possible through active collaborations with NFTDC Hyderabad. The developed material has been accepted by ITER and India therefore becomes one of the very few centres where materials of such grades are produced. This material is extensively used in several heat facing ITER components. Similar to the ion source, prototype developments have cleared the path to obtaining process parameters required for other critical areas like the welding, deep drilling etc. applicable for the beam line components mentioned above. The beam line components are also under various stages of fabrication.

Another important development is the performance testing of in-house developed charcoal coated panels to be used as H2cryosorption pumps cooled using cryocoolers and radiation protected by a stack of LN2 cooled panels. Initial experimental results look promising and efforts are underway to characterize the panels before moving on to full scale production and procurement of the necessary cryocoolers. Other important prototype developments include establishing leak tight porcelain insulators with SS end flanges for the high voltage bushing. In addition procurements have been launched for auxiliary systems like the hydraulics, gas feed and 150 kW 1 MHz RF generators. Detailed assembly plans, setting up of clean room and procurement of desired tools etc. is underway to perform enable assembly of the different components of the beam line after they have been acceptance tested as per established procedures and protocols at site. Parallel, several development programs have been launched with national industry and institutes like RRCAT and BARC to develop critical technologies required for source and component manufacturing.

Non-invasive diagnostics development for NNBI: Various non-invasive diagnostics of versatile in nature are being developed under NNBI R&D program for Indian Test Facility (INTF) to characteristics and monitor ITER-DNB negative hydrogen ion (H-) source and its beam, ensuring its safe operation as a complete NNBI system. For INTF beam source, plasma characterization using Optical Emission Spectroscopy (OES) and Cavity Ring down Spectroscopy (CRDS) diagnostics are envisaged and developed. Multi-channel Doppler Shift Spectroscopy (DSS) and Optical Emission Tomography (TOMO) are developed for beam characterization. All these diagnostic systems are tested as prototype on existing test beds. .

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A.5 Theoretical, modeling and Computational Plasma Physics

Plasma physics requires a very intense computational capability for its modelling and simulation program. The institute has developed a versatile computational facility in many years. At present work is being done in the the following heads:

A.5.1 Nonlinear Plasma Theory & Simulation

Influence of driving frequency on the metastable atoms and electron energy distribution function in a capacitively coupled argon discharge: One-dimensional particle-in-cell simulation is used to simulate the capacitively coupled argon plasma for a range of driving frequency from 13.56 MHz to 100 MHz. The argon chemistry set can, selectively, include two metastable levels enabling multi-step ionization and metastable pooling. The results show that the plasma density decreases when metastable atoms are included with higher discrepancy at higher excitation frequency. The contribution of multistep ionization to overall density increases with excitation frequency. The electron temperature increases with the inclusion of metastable atoms and decreases with excitation frequency. At lower excitation frequency, the density of Ar** (3p5 4p, 13.1 eV) is higher than Ar* (3p5 4s, 11.6 eV), whereas, at higher excitation frequencies the Ar* (3p5 4s, 11.6 eV) is the dominant metastable atom. The metastable profile and electron temperature evolve from a parabolic profile at lower excitation frequency to a saddle type profile at higher excitation frequency. With metastable, the electron energy distribution function (EEDF) changes its shape from Druyvesteyn type, at low excitation frequency, to bi-Maxwellian, at high frequency plasma excitation, however a three-temperature EEDF is observed without metastable atoms.

A magnetic field augmented single frequency capacitively coupled plasma device: An independent control of the flux and energy of ions impacting on an object immersed in a plasma is often desirable for many industrial processes like microelectronics manufacturing. We demonstrate that a simultaneous control of these quantities is possible by a suitable choice of a static magnetic field applied parallel to the electrodes (i.e. perpendicular to the direction of the gap between electrodes) in a standard single frequency capacitively coupled plasma device. Our particle-in-cell simulations show a 60% reduction in the sheath width (that improves control of ion energy) and a fourfold increase in the ion flux at the electrode as a consequence of the altered ion and electron dynamics due to the ambient magnetic field. A detailed analysis of the particle dynamics is presented and the optimized operating parameters of the device are discussed. The present technique offers a simple and attractive alternative to conventional dual frequency based devices that often suffer from undesirable limitations arising from frequency coupling and electromagnetic effects.

Parametric control of the plasma density and temperature in low pressure capacitively coupled plasma discharges: The dynamical characteristics of a low pressure capacitively coupled plasma (CCP) device under varying applied RF voltages and frequencies are studied using particle-in-cell/ Monte Carlo collision simulations. For a given voltage the plasma density is found to remain constant over a range of applied frequencies and to then increase linearly as a function of the frequency. The threshold frequency for this mode transition in the behavior of the density as well as the value of the constant density is found to increase with an increase in the applied voltage. The electron bulk temperature is found to increase with the frequency till the transition point and thereafter to decrease with the frequency. Such a behavior is related to the nature and propagation characteristics of transient electric field structures emanating from the sheath region. Over the constant density range, for a given voltage, the sheath width is seen to increase as a function

of the increasing frequency, thereby changing the ion energy without affecting the ion density. Our parametric study thus indicates that the twin knobs of the applied voltage and applied frequency offer a means of independently controlling the density (ion flux) and the sheath width (ion energy) in a CCP device that can be conveniently exploited for plasma processing applications.

Phase-mixing of large amplitude electron oscillations in a cold inhomogeneous plasma: Phase-mixing of large amplitude non-relativistic electron oscillations around an inhomogeneous background of massive ions has been studied in a cold plasma. For our purpose, a space periodic but time independent ion density profile along with a perturbation in the electron density is considered. An exact space-time dependent solution is presented in the parametric form by using Lagrangian coordinates. An inhomogeneity in the ion density causes the characteristic plasma frequency to acquire spatial dependency, leading to phase-mixing and thus breaking of excited oscillations at arbitrary amplitudes.

Particle-in-cell simulation of Buneman instability beyond quasilinear saturation: Spatio-temporal evolution of Buneman instability has been followed numerically till its quasilinear quenching and beyond, using an in house developed electrostatic 1D particle-in-cell (PIC) simulation code. For different initial drift velocities and for a wide range of electron to ion mass ratios, the growth rate obtained from simulation agrees well with the numerical solution of the fourth order dispersion relation. Quasi-linear saturation of Buneman instability occurs when the ratio of electrostatic field energy density to initial electron drift kinetic energy density reaches up to a constant value, is independent of initial electron drift velocity but varies with the electron to ion mass ratio (m/M). This result stands verified in our simulations. The growth of the instability beyond the first saturation (quasilinear saturation) till its final saturation follows an algebraic scaling with time. In contrast to the quasilinear saturation, the ratio of final saturated electrostatic field energy density to initial kinetic energy density is relatively independent of the electron to ion mass ratio and is found from simulation to depend only on the initial drift velocity. Beyond the final saturation, electron phase space holes coupled to large amplitude ion solitary waves, a state known as coupled hole-soliton, have been identified in our simulations. The propagation characteristics (amplitude–speed relation) of these coherent modes, as measured from present simulation, are found to be consistent with the theory of Saeki et al. [PRL 80, 1224 (1998)]. Our studies thus represent the first extensive quantitative comparison between PIC simulation and the fluid/kinetic model of Buneman instability

Plasma Wakefield excitation in a cold magnetized plasma for particle acceleration: A numerical study has been done to find a travelling wave solution for a highly relativistic electron beam driven cold magnetized plasma. The presence of magnetic field has an effect to reduce the transformer ratio (the ratio of energy gain to the drive beam energy) from its unmagnetized value. The effects of the beam shape on the nonlinear structures of different dynamical variables are also discussed. The results owe its significance in the laboratory context of particle acceleration or in the study of generation of ultrahigh accelerating charged particles by strong plasma waves in astrophysical situations.

A.5.2 Tokamak & Fusion Reactor Studies

Evolution of equilibrium of Aditya-Upgrade: To predict the experimental performance of Aditya-upgrade plasma, a full discharge simulation for plasma duration of 290 ms has been carried out in which circular limited plasma is evolved into divertor plasma using the proposed divertor coils. In this study, the temperature of ions and electrons are evolved self-consistently. The snap shot at t=143 ms shows the formation of divertor configuration. The magnetic field calculation along with test particle approach is carried out to compare this with recent SST-1 experiment and quantify the error field. The preliminary results are encouraging and detailed comparison is in progress. The magnetic null due to poloidal field coils in SST-1 was revisited and to improve the null quality, a modification in the existing TR4 coil was suggested after optimizing the magnetic null using EFFI code. A basic tomography code based on maximum entropy method is developed to study the dynamics of inductively coupled plasma with the help of emission spectra. A solenoid made of Nb3Sn is under fabrication. This has to be tested for its thermal, structural and magnetic performance. A modeling study has been initiated to quantify the performance before the experiment. The numerical model for tokamak burning plasma with alpha particle heating and for dielectric barrier discharge is in progress.

Particle In Cell (PIC) simulations: We report on nonlinear PIC simulations of wave-wave and wave particle phenomena relevant for RF heating and current drive schemes in tokamaks. For this we have developed a new nonlinear kinetic simulation model based on the global toroidal code GTC. In this model, the ions are considered as fully kinetic particles

obeying the Vlasov equation and the electrons are treated as guiding centers that are evolved by the drift kinetic equation. We have benchmarked this numerical model to verify the linear physics of normal modes, conversion of slow and fast waves and its propagation in the core region of the tokamak using Boozer coordinates. In the nonlinear simulation of Ion Bernstein Wave (IBW) in a tokamak, parametric decay instability is observed where a large amplitude pump wave decays into an IBW sideband and an ion cyclotron quasi-mode (ICQM). The ICQM induces an ion perpendicular heating, with a heating rate proportional to the pump wave intensity. Finally, in the electromagnetic lower hybrid wave simulation, nonlinear wave trapping of electrons is verified and plasma current is nonlinearly driven in the core region. However, in many experiments, parametric decay instability is usually observed in the scrape-off layer (SOL). We have upgraded GTC to enable global toroidal simulations that couple the core and SOL across the separatrix by using cylindrical coordinates with field-aligned particle-grid interpolations. Using this new tokamak geometry model, we have implemented the fully kinetic particle pusher to capture the high frequency (ion cyclotron frequency and beyond), and the particle dynamics of guiding center associated with the low frequency waves. To verify the new simulation model, we have carried out simulations to study ion orbit loss at the edge of the tokamak plasma with single null magnetic separatrix for DIII-D tokamak. The ion loss conditions are examined as a function of pitch angle for cases both with and without an electric field.

Simulation of ELMs in presence of RMPs and pellets: To understand the mitigation and control of ELMs by resonant magnetic perturbations and pellet injections, simulations were performed using 2fluid MHD code CUTIE which show repetitive of ELMs. In an earlier work, significant reductions of ELMs amplitudes in presence of RMPs was observed. Presently, simulations in presence of pellets suggest significant change in ELMs dynamics.

Study of Internal Kink in visco-resistive regimes: m=1/n=1 internal kink modes with flows have been studied for a wide range of resistivity and viscosity values. It has been observed a significant difference in the nature of flow effects with higher viscosity as compared to lower one. In higher viscosity regime, there is strong symmetry breaking effect in presence of helical flows i.e. when we have changed the direction of axial flows without changing the poloidal flows then there is significant change in linear growth rates and the island saturation of the modes though pure axial or poloidal flows are always symmetric. It has also been observed that the new scaling relation of growth rate for higher viscosity regimes and as well in presence of axial flows.

Study of Tearing Modes: As a part of Joint Activity 2 (JA-2) of International Tokamak Physics Activity (ITPA) MHD Topical Group, the linear benchmarking of various global codes such as M3DC1, NIMROD, FAR etc. were satisfactory. Presently, a set of nonlinear benchmarking of tearing modes among various codes in absence of flows with a new current profile as proposed by Prof Tim Hender has been completed.

Role of neutral gas in Scrap-off Layer of Tokamaks and study of ELM-PB models: Influence of hot and cold neutrals on scrape-off layer tokamak plasma turbulence has been studied using multi-field drift-fluid solver. Experimental observation of thick toroidal filaments during the disruptive phase of Aditya Tokamak Plasma has been investigated. A related work on modification of plasma flows in edge and SOL by influence of neutral gas for Aditya Tokamak is under review Dynamics of Neon gas in seeding and puffing in Tokamak plasmas is being investigated. Work on reduction of diamagnetic frequency using neutral gas in Aditya Tokamak plasma is also underway along with a Code benchmarking study using CENTORI code

A.5.3. Fundamental Plasma Studies

Supersonic flow past an obstacle - a Molecular Dynamics study: Yukawa liquids in 2D when subject external flow head (or pressure head) in the presence of obstacle is shown to lead to formation of von Karman vortices for subsonic flows and blow shocks for supersonic flows. In this work, particular focus on supersonic flows resulted in the following findings (1) In transonic regime ($0.8 < M < 1.2$ where M is the Mach speed), bow-shocks were found to travel in the upstream region in the direction opposite to the incoming fluid (2) The phase velocity of the bow shocks was to found to scale inversely to the screening parameter for a given coupling strength (3) For $1 < M < 2.5$, stationary bow shocks and secondary bow shock structures were seen. A manuscript has been submitted for publication. Statistical properties of fluctuations in Rayleigh Benard convection in 2D Yukawa liquids using MD simulations was addressed during this period.

Study of Kolmogorov Flow in Strongly Coupled 2D Yukawa liquids: A new compressible 2D generalized hydrodynamics code AG-Spect was developed and benchmarked extensively during this period. The problem of stability of shear flows in

strongly coupled plasmas modeled as a Visco-elastic liquid is addressed for various visco-elastic response times. In a second part, a quantitative comparison between AG-Spect and a Molecular Dynamics code MPMD was performed for the same set of parameters except the initial density.

Studies in Pure Electron, Pure Ion and mixed species non-neutral plasmas: A 2D PIC-MCC code PEC2PIC developed as a part of a PhD work was generalized to 3D3V to study devices such as Plasma Thrusters, 3D Toroidal Electron Cloud Devices and other cross-field plasma devices. Preliminary work on thrusters and 3D electron clouds were presented in various conferences. Using PEC2PIC a numerical study of merger of very high density pure electron vortices with applied axial magnetic field in the plane perpendicular the applied magnetic field is studied. These simulations are unique because of their large Brillouin values. The merger times and its dependency of inter vortex and vortex sizes were studied.

Driven phase-space vortices: 1D Vlasov-Poisson Studies: 1D Vlasov-Plasma solver based on Piece-wise Parabolic Method - VPPM1D was used to study the physics of weakly driven chirp systems and formation of giant phase space structures. This code is now generalized to include the effect of ion dynamics. Using this new code, it demonstrated that the electron thumb curve dispersion and the ion tear drop dispersions can be shown to be continually connected curves. This was demonstrated using species of different electron to ion mass ratios and temperatures. In a related development, to study only the ion dynamics and the effect of chirp on ions at ion time scales, a new Vlasov-Yukawa model was developed where electrons were considered as Boltzmann. Using this model several new and interesting findings have been made.VPPM1D with electrons and ions has also been generalized to include a simple Crook like collisional dissipation to model dissipatory effects on non-linear structures.

3D Magneto-Hydrodynamics in conducting fluids with finite angular momentum: A new 3D weakly compressible, MHD solver which numerically solves for flow field, magnetic field and energy using self-consistent set of MHD equations in conservating form, in Cartesian periodic boundaries. The code is OpenMP parallelized and also works in GPUs. Using this solver, four different aspects of MHD are probed, namely Dynamo (which converts flow energy to magnetic energy), Reconnection processes (which converts magnetic energy into flow field), cyclic or recurrence processes (where both flow and magnetic energy change into each other nearly reversibly) and MHD turbulence. Motivation is to identify under what conditions, which process dominates.

Plasma Thrusters: Computer simulation and modeling: A new suite of 1D PIC-MCC simplified but efficient codes for steady state plasma thruster modelling has been developed. Starting from 1D1V code, 1D2V and 1D3V PIC code with both stationary and dynamic ions have been developed and extensively tested. Arbitrary external magnetic field profile is included, along with separate MCC module for electron neutral and ion neutral collisions. Results in 1D1V have been extensively compared with a 1D Vlasov solver.

Active Matter Physics: Modelling effects of self-propulsion using Molecular Dynamics: A new and interesting area of statistical physics of active matter has been initiated. An existing MD code has been extended to include a self-propulsion force to mimic the effect of active particles such as bacteria or fish. To begin with the Viscek model was studied and using MD simulation, some of the published results of the Viscek model were reproduced. A new drift-MD solver including the Langevin-Brownian model with and without including the standard mass term or in the limit of large dissipation has also been developed and the results compared with the regular MD results.

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CHAPTER B

Activities of ITER-India

In the past one year ITER-India made significant progress in the ITER project. During this period, the ITER-India project has entered into the manufacturing for few packages. The details of the activities completed under different packages/ heads are given below.

B.1. In-Wall Shielding (IWS)

The In-Wall Shielding (IWS) blocks shall be placed between outer and inner shells of ITER Vacuum Vessel (VV) which is a double wall structure. The main function IWS is to stop escaping the neutrons and to reduce the toroidal magnetic field ripple. These shielding blocks are made of SS 304B4, SS 304B7, SS 430 and SS 316L (N)-IG and Fasteners (Bolts, Nuts, Spacers, Washers etc.) are made from XM-19 and Inconel-625. Rigorous Factory Acceptance Tests (FAT) of (i) IWS blocks, (ii) Support Rib+Lower Bracket welded and machined assemblies, to check actual assembly issues were carried out. Assembly of IWS blocks with different shapes and high accuracy and vacuum packing for high cleanliness during transportation and storage were carried out. Large numbers of blocks and components have been successfully manufactured, assembled, inspected, packed and shipped to Europe and Korea. More than half of the IWS deliveries have been completed. Rest of the components are under manufacturing at Avasarala Technologies, Bengaluru and Larsen & Toubro Heavy Engineering, Hazira, Gujarat.

B.2. Cryostat

The ITER cryostat—the largest stainless steel high-vacuum pressure ever built (16,000 m3)—provides the high vacuum, super-cool environment for the ITER vacuum vessel and the superconducting magnets. Nearly 30 metres each in diameter and height and manufactured from stainless steel, the cryostat weighs 3,850 tonnes. The Cryostat will be manufactured in about 54 pieces that will form 4 main sections – Base Section, Lower Cylinder, Upper Cylinder and Top Lid. The base section—1,250 tonnes—will be the single largest load of ITER Tokamak assembly Manufacturing of ITER Cryostat components is progressing at Larsen & Toubro Heavy Engineering, Hazira, Gujarat. An important milestone was achieved about the completion of Lower Cylinder in the workshop at ITER

Figure B.1 Cryostat Lower cylinder completed in the workshop at ITER site

site. The Upper Cylinder (Tier-1 and Tier-2) sectors have been manufactured in India and being shipped to ITER site. The sub-assembly of the Base section is in advanced stage at ITER site workshop. The Top Lid sectors are also under fabrication in India and expected to be ready for shipment to ITER site by end of the year 2019. Factory Acceptance test and packing for 3 blocks of outer shielding and 18 Female lugs were also completed. Lower cylinder and its transporter frame & support structure were delivered to IO site. Base Section Tier-1 assembly at ITER Site Workshop has been completed and that of Tier-2 assembly is in progress. Set-up of Lower Cylinder Tier-1 & Tier-2 has been done in the Cryostat workshop at ITER site. Welding of these sectors is in progress.

B.3 Cooling Water system

Cooling water system is needed to take away heat from the various components/systems and reject this in to the atmosphere. Piping fabrication progressed further and approx. 3500 pipe spools have been delivered to ITER site. Manufacturing Readiness Reviews were conducted for E-House and Water Polishing Units. Several batches of Piping supports, horizontal and vertical pump-motors, Chillers, Plate Heat Exchangers, Manual & Electrical Valves, Caustic Addition system, Cooling Tower components, Electrical and Instrumentation & Control components, Insulation materials etc. have been shipped and delivered to ITER site which comprises about 90% piping and 80% equipment deliveries of Cooling Water System components to ITER. Close coordination and

Figure B.2 One of the chillers shipped and delivered to ITER site

integrated efforts by the team were made in addressing the technical and logistical challenges in executing the manufacturing, inspection, factory testing and shipping.

B.4. Cryodistribution & Cryolines

The ITER cryogenic system has a main function to cool the superconducting magnets and cryopumps at various temperature levels of 4 K, 50 K and 80 K for successful plasma operation. This system includes Indian in-kind contributions of cryodistribution system and system of cryolines, have progressed in the next level from conceptual design and prototype/qualification test phase to the final design, manufacturing, installation and acceptance test.

Cryolines and warm lines: Detailed design of the group X, group-Y cryolines and warmlines required for the ITER cryoplant has been completed and are currently under manufacturing stage at M/s. Air Liquide Advanced Technologies and M/s. INOX India Pvt. Ltd respectively. In depth reviews such as final design review (FDR) of Lot X1, X5, Quench (SQx) cryolines and manufacturing readiness review (MRR) for lot X1, X5, Quench (SQx) lines, Lot W2 lines have been successfully completed last year. Test Readiness Review (TRR) of Nitrogen cryolines and few Warmlines located inside cryoplant area has been successfully completed. In order to dispatch and install the lines in a systematic manner, the lines are divided in several 'elements'. Substantial activities related to dispatches and installation have been carried out in last year. About 60% of the elements are manufactured, 50% delivered at ITER site and 15% installed at ITER site. The site activities of group-Y cryolines and warmlines are being

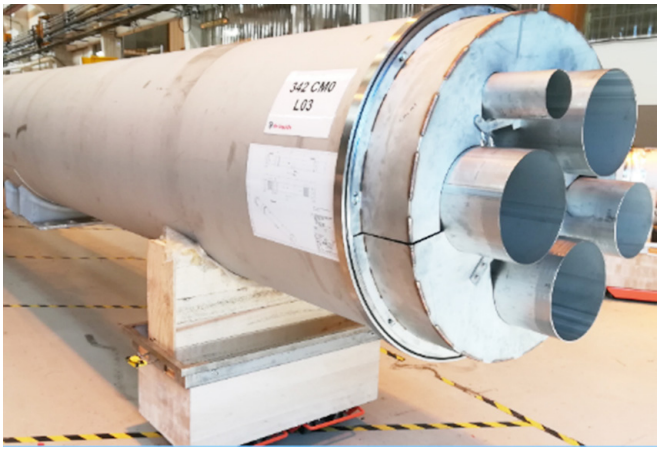

Figure B.3 Cryoline elements, having one of the biggest diameters (DN1000 and locally increases to ~1320mm) under manufacturing at factory

carried out at full swing in cryoplant area. The first pressure test of cryolines has been carried out for Nitrogen liquid supply cryolines in adverse atmospheric conditions, after completion of its installation.

Cryodistribution system: ITER cryodistribution system (CD) comprises of a cryoplant termination cold box (CTCB), five auxiliary cold box (ACBs) and a thermal shield cooling system (TSCS). CTCB is an interfacing cryogenic distribution box between cryogenic plant (75 kW helium refrigerator/liquefier, 1,75,000 liter liquid helium tank and 1300 kW 80 K plant) and cryogenic distribution boxes (ACBs and TSCS). The Integrated Factory acceptance test of CTCB with electrical and instrumentation cubicles has been successfully com-

Figure B.4 Cryoplant Termination Cold Box (CTCB) transportation to the ITER site

pleted. The configuration of CTCB and its components has been arranged comparable to the actual configuration as per installation at site. CTCB has successfully delivered through Road/small channel/Road to the ITER inside B52 building at temporary position. ITER cold circulators, which are designed for circulating supercritical helium in the superconductor of magnets and panels of cryopumps of ITER at required mass flow rate (2-3 kg/s) and pressure head will be integrated in the ACBs. The factory acceptance test of Cold circulators has been successfully completed with all tests such as pressure test, helium leak test, mechanical running test etc. The cold circulator is now ready for transportation.

B.5. Ion Cyclotron Heating & Current Drive Sources

One of the important auxiliary heating and current drive methods for ITER plasma is by using radio frequency waves in the Ion Cyclotron Resonant Frequency (ICRF) range. Total 20 MW of ICRF power will be launched using 8 nos. of sources, each unit of having 2.5 MW/Continuous Wave (CW) capabilities. India is responsible for supplying total 9 (1 Prototype and 8 series production) complete ICRF sources for ITER project. A Prototype unit is also included in this package for demonstrating the technology prior to series production. To identify the best high power vacuum tube (Diacrode/ Tetrode) and other critical components for ITER application, an R&D program has been initiated. Two major contracts have been launched with Thales Electron Devices, France for Diacrode technology and with Continental Electronics Corporation, USA for Tetrode technology, to finalize technical choices of vacuum tube technologies for final stage amplifier. A dedicated 3MW test facility has been developed at ITER-India site for testing the system at full capacity on matched and mis-matched load condition. A chain of high power cascaded amplifiers, i.e. pre-driver, driver and final stage amplifiers using Tetrode technology, were integrated with auxiliary and high voltage power supplies, transmission line components, low power RF components, dedicated control system, cooling etc. and were tested for 1.5 MW at 55MHz for 2000s on matched load condition. The system was tested on mismatched load condition for output power level of 1.5 MW at 55 MHz. To establish the design capability of the system, test was performed at 36MHz/1.7MW/3600s with 1.5:1 VSWR. The Amplitude Control Loop (ACL), which is one of the important controls for ITER operation using ICRF power, was tested successfully using tetrode based amplifier up to 1 MW power level (corresponds to requested power), keeping all major currents/dissipation within the limit by adjusting anode voltage and drive reference of pre-driver amplifier. Further, ACL was also tested with dynamic load condition. In the experiment, it was clearly seen that the anode voltage was continuously changed on-line to bring down different currents/dissipation within the operational limit and successfully stabilized the output power as per requirement. Direct Digital sampling method for RF measurement is explored as it improves measurement reliability and accuracy. Logic for implementing this method is conceptualised by using mathematical computational tool OCTAVE for getting proof of concept. Expertise has been developed in high power RF design and fabrication methodology. 6-port Directional Couplers (DC) and Single Pole Double Throw (SPDT) RF switches of different sizes were developed. High power test was performed on 12 inch SPDT switch, by installing it in between the RF source and high power load, in the configuration to connect the ports between RF source and load, as shown in figure,. The SPDT switch was tested at frequencies 36MHz, 40MHz, 45MHz, 50MHz and 55MHz with power level of 500kW, 750kW, 1MW, 1.25MW and 1.5MW for around 500s successfully, establishing the designed performance at MW level in CW mode. The measured power in the isolated port of the switch was 82.95W which provides an isolation level of -42.5dB at 55MHz, as per design value

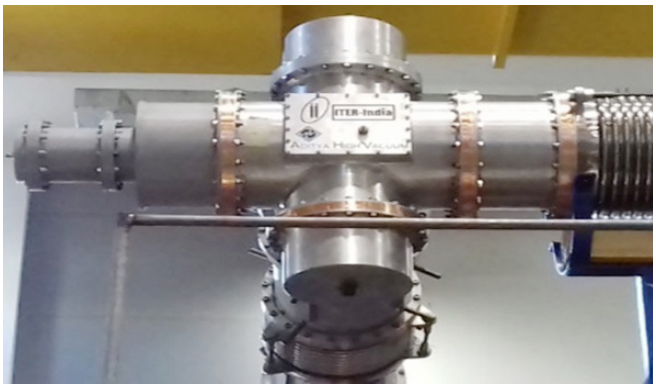

Figure B.5 Single Pole Double Throw (SPDT) RF switch developed

B.6. Electron Cyclotron Heating (ECH) system

The ITER Electron Cyclotron Heating & Current Drive (EC H&CD) system will be used for plasma heating and current drive applications including plasma start up. In this context, the Indian Domestic Agency (ITER-India) has a procurement package (EC Gyrotron Source Package) whose main scope is to supply a set of two high power state of the art Gyrotron sources (170 GHz/1MW/3600s) including their auxiliary

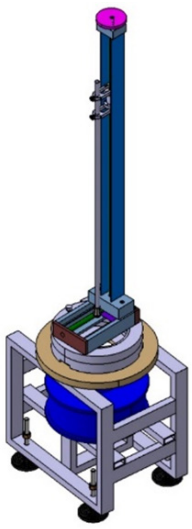

Figure B.6 3D translational stage setup for Gyrotron magnetic field mapping

systems. The procurement package is being executed in two phases. In phase-1, a Gyrotron Test Facility is being established at ITER-India (IIGTF), IPR campus to enable the system integration and integrated performance testing with the help of a Test Gyrotron and prototype auxiliary systems. In phase-2, the actual ITER deliverables will be taken up. Currently the Phase-1 activities are being actively pursued. Following are some of the main progress highlights carried out during the current year. Tender process for the Test Gyrotron and waveguide component set which is one of the major long lead procurement package for the ITER-India Gyrotron test facility has been completed and a contract has been awarded. Contract follow up activities are currently ongoing. Towards the auxiliary systems for the IIGTF various developmental and procurement activities have been carried out.

Some of the auxiliary power supplies that are required for the Gyrotron operation have been procured and for others the procurement process has been initiated. Also towards the magnet test setup, testing of a magnetic probe up to 5T has been carried out in collaboration with IUAC, New Delhi. A cost effective metal vacuum seal has also been prepared for the EC RF corrugated waveguide transmission line and has been successfully tested for its vacuum compatibility. Towards an indigenous Gyrotron design & development program at 170 GHz, a design task for a short pulse pre-prototype Gyrotron is under progress in collaboration with CSIR-CEERI. The conceptual design has been completed and a Conceptual Design Review has been conducted by a national level review panel committee.

B.7. Diagnostic Neutral Beam (DNB)

The Diagnostic Neutral Beam (DNB) (3 Seconds ON/20 Seconds OFF with 5 Hz modulation) in ITER is mandated to provide 100 kV, ~18-20 Amperes Hydrogen beam to support the Charge Exchange Recombination Spectroscopy (CXRS) for the measurement of Helium ash in the ITER machine. DNB Beam Source, first of its kind RF Ion source with 8 driver configuration and accelerator with the focusing requirements, is in advanced stage of manufacturing. These components are presently undergoing their sub-component level final inspections and tests before they are assembled together. Beam Line components (Neutralizer, Residual Ion Dump and Calorimeter) are in advance stage of manufacturing. Major subcomponents (~90%) of BLCs are realized up to nearly finalized stage. Assembly of the components are planned following to successful realization of sub-component and their intermediate test. To demonstrate the remote welding with the Interactive Tool path correction system based on Camera feedback, weld with penetration depth of >3mm over a size of 1m length, 1.2m dia., has been successfully performed with an achieved the leak rate of $\sim 10^{-9}$ mbarl/s. Lip seal welding is being explored for use in neutral beam vessels for ITER. As a first step a working prototype was made & tested, and overall error was found to be less than 0.2 mm for maximum speed. SS304 metallic attachment for INTF High Voltage Bushing (designed for 100kV isolation) has been designed and realized indigenously. This involves circumferential precision welding of large diameter (of ~750mm) thin metal ring (1.5mm) with thick metal flanges (~20mm) at both ends. A feasibility study has been carried out to apply Mo coating on CuCrZr substrate by a novel technique of Laser Assisted

Figure B.7 Beam-line Components - Calorimeter Heat Transfer element

Material Deposition. The above study (in collaboration with RRCAT) has established the process parameters to produce a coating of thickness of ~1mm with Ni as a transition layer, free from any kind of base / interface / coating layer discontinuities.

B. 8. Power Supples

Power Supply Group at ITER-India has indigenously developed Mega-Watt high voltage power supplies with involvement of domestic Industry and delivered to ITER facilities. These power supplies are also utilised for R&D programs at Indian lab. Site acceptance test for SPIDER Acceleration Grid power supply (7MW, 100kV) is successfully completed at NBTF (Neutral Beam Test Facility) site, Padua, Italy. Functional specification and protection parameters are demonstrated. Ownership is transferred from IN-DA to ITER Organization. Power supply is now operational with SPIDER. RIDPS (Residual Ion Dump Power Supply, 8kV, 60A) is being tested along with in-house developed controller using Zync- ZC702. The power supply is to be used for domestic R&D programme. 40kW, 1MHz solid state RF generator successfully coupled with Plasma source achieving 90% power coupling. Multiple sources/vendors for SPS modules were established, enhanced competition among Industry for SPS modules which comprises 40% of component cost of typical HVPS. Development program for MHVPS is going forward with SPS modules received from the suppliers. MHVPS integration activities started at ITER-India lab. 7MW, 100kV DNB AGPS installed at ITER-India lab is integrated with cooling plant for uninterrupted operations. Integrated operation of 3MW IC HVPS with RF sources concluded with optimised value of driver/end stage amplifiers.

B.9. Diagnostics

Activities are progressing towards the Preliminary Design Review (PDR) of XRCS Survey System. Further experimental activities are also ongoing at ITER-India lab. The Preliminary Design Review of ECE Diagnostic Transmission and Receiver systems was successfully completed. Simulation of effects of atmospheric absorption have been carried out. Preliminary measurements performed for transmission attenuation of the transmission line in atmosphere; gives absorption of the millimeter wave radiation by the atmospheric gases. Atmospheric modelling software, BTRAM is used to simulate the spectrum to account for the effects of atmospheric absorption. Very good agreement is seen both in the width of the water vapor lines and the continuum, which supports that the atmosphere is playing a significant role. Diagnostics Port Integration-Project Team was established for enhancement of the coordination for port integration activities and Standardization and rationalization of the diagnostics ports. Modular Diagnostics shield module manufacturing study is completed. Design development and Integration of tenant diagnostics are in progress towards the PDR.

B. 10. Activities common to all packages, Neutronics, QA and project office

A novel method is developed to optimize the isotopic as well

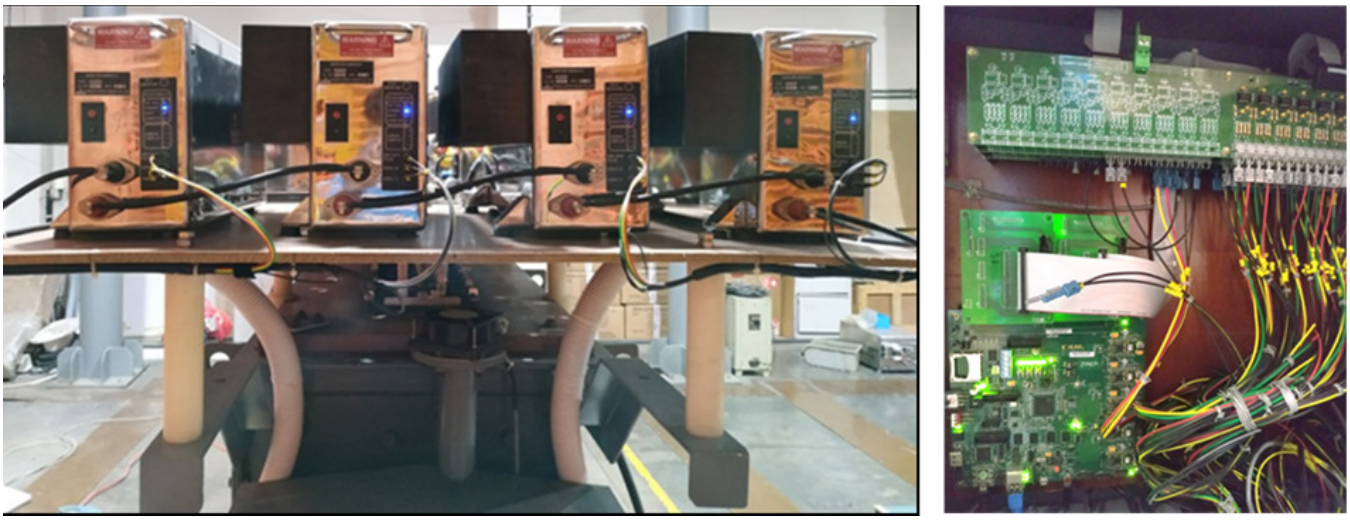

Figure B.8 (a) RIDPS SPS Modules installed at Lab (b) RIDPS Controller

as elemental composition of a material placed in a neutron environment i.e. fusion reactors, fission reactor etc. in a single run. The optimized composition ensures least radiological responses like contact activity, doserate, radwaste etc. for a specific irradiation scenario. The present method eliminates the general practice of lengthy, calculative and iterative procedure to identify parent elements/isotopes of dominating radionuclides. This code is used to optimize Stainless steel used in the ITER shutdown benchmark study. For SS316, with optimized composition, all radiological quantities are reduced by about more than 90% at 100 years after shutdown. Apart from this, new useful visualization techniques to represent contributions to radiological responses is also developed. As an example problem SS316L(N)-IG is used. Such a tool provides the insight into the material responses and gives a clear picture of optimization on basis of the responses. Such a tool can be helpful for selecting best materials for equipment and structural material in the fusion devices and also to optimize the material in accordance with the radiological parameters.

ITER-India successfully passed the QA audit by ITER Organization. Liaising with IO for Quality and Safety requirement by regular participation in SQAWG (Safety & Quality Assurance working group), IO MQP working group meetings etc. ITER-India participated in the audit of ITER-Japan as part of ITER Organization Quality Audit Team. Database of NCRs was maintained and tracked. Internal Audit for Fire Safety was conducted. Participation was made in third-party inspection agency selection procedure, inspector interview, supplier evaluation, internal audit and surveillance activities. Quality Plans and Manufacturing & Inspection Plans were reviewed. Inspection of piping spools and equipment manufactured were carried out the supplier premises. Special processes like welder qualification, NDE qualification etc. were witnessed by the ITER-India QA Team

Due to peak of manufacturing activities, the Logistics team under direction and coordination from Project Office carried out activities for shipment of large number of consignments to ITER site related to CWS, IWS, Cryostat and Cryolines/ Warmlines. Successful on-time deliveries were made to ITER site in line with the urgent requirements and the supply chain was maintained. Close and integrated coordination with various teams were made to ensure the items were dispatched on time. Participation in Risk Management activities and related working groups were made that included updating the project risk register and mitigation plans. Reporting of the developments to the public was also done through ITER Newsline and ITER Annual Report. ITER-India also supported implementation of Project Lifecycle Management (PLM) system in ITER and is participating in PLM working groups. Participation was made in Configuration Management related working groups. Facilitation for Intellectual Property identification & related proposals were made and patent filing was done in liaison with the DAE-IPR cell.

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CHAPTER C, D, E, & F

C. Academic Programme

D. Technical Services

E. Publications and Presentations

F. Other Activities

C. ACADEMIC PROGRAMMES

C.1 DOCTORATE PROGRAMME

In this programme, currently there are 120 students have been enrolled at Homi Bhabha National Institute (HBNI). In this year 33 new student (19 are from physics background and 14 have background from engineering disciplines) have joined the programme. After successful completion of this course work, they will also be enrolled for their Ph.D in HBNI.

Ph.D. Thesis Submitted in 2018

Study of the Breaking of Relativistically Intense Longitudinal Waves in a Homogeneous Plasma
Arghya Mukherjee
Homi Bhabha National Institute, 2018

Fluid Simulation of Electron Beam Driven Wakefield in a Cold Plasma
Ratan Kumar Bera
Homi Bhabha National Institute, 2018

Study of Electrostatic Instabilities in Current Carrying Cold Plasmas
Roopendra Singh Rajawat
Homi Bhabha National Institute, 2018

Experimental Study on Force Balance in Thermal Plasma Torch
Vidhi Goyal
Homi Bhabha National Institute, 2018

Investigation of Diamagnetism in Laser-Produced Plasma
Narayan Behera
Homi Bhabha National Institute, 2018

Effect of Controlling Toroidal Field Topology in a Simple Toroidal Plasma: An Experimental Study
Umesh Kumar
Homi Bhabha National Institute, 2018

C.2 SUMMER SCHOOL PROGRAMME (SSP)

The Summer School Programme (SSP)-2018 at IPR commenced on 28th May 2018 and ended on 6th July 2018. This year a total of 51 students joined the programme, of which 31 were from M.Sc. Physics and 20 were from Engineering streams (Mechanical and Electrical). During the six week long residential program, the participants of SSP-2018 were exposed to lectures on plasma science, scientific project work in various laboratories in IPR. A poster presentation of the projects undertaken by the SSP-2018 participants was also arranged as evaluation of their performance

C.3 ACADEMIC PROJECTS FOR EXTERNAL STUDENTS

Around 104 students of B.E./B.Tech/M.Sc./M.E./M.Tech are engaged to do various academic projects under their course curriculum in different fields of science and technology from various colleges/universities/Institutes in IPR during April 2018 to March 2019.

D. TECHNICAL SERVICES

D.1 Computer Services

ANTYA HPC System: Institute for Plasma Research, has recently procured ANTYA HPC system, a 1 PETA FLOPS HPC system with more than 10000 cores. Its commissioning is underway in IPR Data Center shown in Figure D.1, where all the components of ANTYA will be housed for 24x7 operations. This system can perform 10^{15} FLoating-point Operations Per Second (FLOPS). In Sanskrit, ANTYA implies $10^{15.}$ ANTYA HPC cluster consists head nodes, login nodes, CPU compute nodes, CPUGPU compute nodes, high memory compute nodes and visualization node, 2 PetaByte (PB) Data Direct Networks (DDN) Storage and Single Interconnect Switch. All the nodes have latest Intel 64 bit processor capable of performing 32 Double Precision Floating Point Operations per cycle. For the computational and management traffic, a 100Gbps high throughput and low latency, Enhanced Data Rate (EDR) InfiniBand (IB) network and 1Gbps admin and console network respectively have been configured.

Performance Tests performed during PDI: Prior to dispatch of ANTYA HPC system to IPR, several tests were carried out to evaluate the performance and hardware consistency during PDI at factory site in presence of IPR personnel's. The Pre-dispatch Inspection (PDI) set-up was comprised of 2 Head nodes, 2 Login nodes, 60 CPU compute nodes (~25% of total CPU nodes), 6 CPUGPU compute nodes (~25% of total CPUGPU nodes), 1 High Memory Node, 100Gb/s EDR

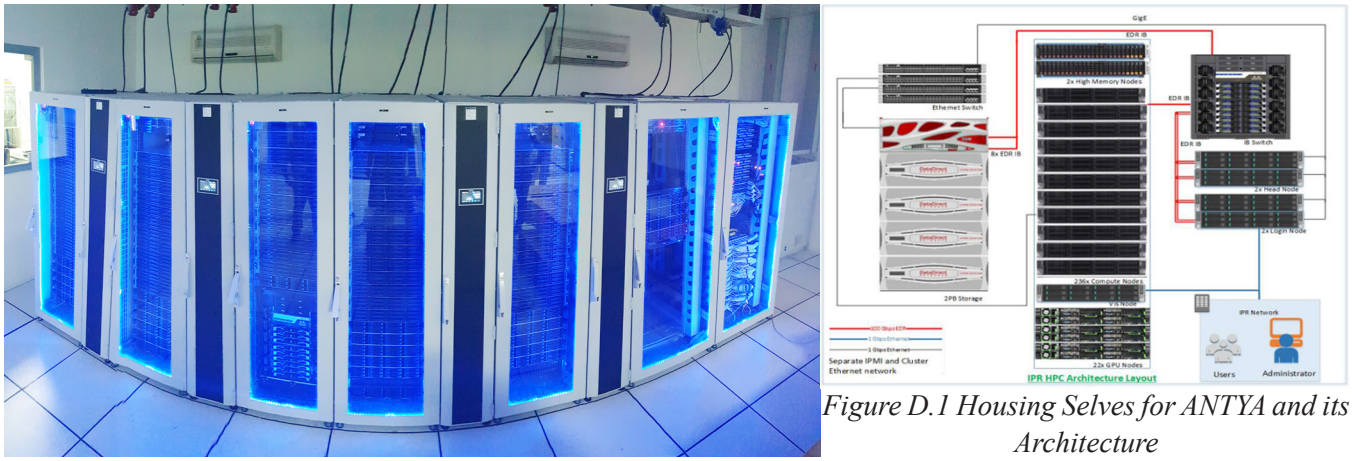

Figure D.1 Housing Selves for ANTYA and its Architecture

IB Smart Director Switch, 1 Gb/s Ethernet Switch and 2 PB Storage solution. HPL benchmark performance tests were performed on 60 CPU compute nodes and 6 CPUGPU compute nodes respectively for six hours with turbo off. More than 60% sustained performance was obtained in both the HPL tests. IOR and MDTEST benchmarks were conducted to measure the data read/write and the metadata performance respectively of the storage file system. The tests were conducted for 72 hours to evaluate the consistency of the storage subsystem. The average read and write performance obtained for the storage are 29.03 GiB/s and 27.43 GiB/s respectively with capacity of creating on an average 117873 files/s with 1 MB block size. In-house developed codes (CPU as well as GPU codes) at IPR have also been successfully compiled and executed for at least six hours and their performances were found to be satisfactorily with output data consistency.

D.2 Library Services

Institute for Plasma Research (IPR) Library continues to act as a core center for dissemination of specialized information services using modern tools to the scientific community involved in the Research and Development activities of Plasma Physics and Fusion Science and Technology.

During the year 2018-19 a total of Rs. 33722305.00 budget was utilized. The Library is maintaining user-driven focused collection development strategy and it added about 344 books and back volumes, 34 research reports received from other research institutes, 179 reprints, 42 pamphlets and 25 software to the library collection. The library continued to subscribe 114 periodicals. This year a total of 3 journal titles were migrated to only online and 2 new online journal titles were added to the e-collection. Library also continued to subscribe to major databases such as SCOPUS, APS-ALL, Online Archives of core journals, and it has access to SCIENCEDIRECT as part of the DAE Consortium.

During the reporting year library carried out Physical Verification of documents for IPR and ITER-India libraries.

Library continued to provide current awareness services by delivering current contents to plasma physicists at national level. Total 280 News items were displayed and archived as an Alerting Service. Library continued to provide the email based REcent Articles to Discover (READ) service to IPR and CPP users.

Library continued to provide Inter-Library Loan services by collaborating with DAE units and other National and International libraries to provide Article Delivery Services. 88.54% of the requests made by staff members were satisfied through Inter Library Loan (ILL) service. IPR Library provided documents to other institutes against their queries and 100% of the total need were satisfied.

Library continued to provide Institutional Publications Management services to manage internal publications and abstracts for International Conferences. During the year 2018-19, 106 internal research reports, 67 technical reports and 156 IPR Publications were published in journals and 33 publications in Conference proceedings. Library subscribed to anti-plagiarism software tool for checking similarity index of the publications during the year 2018-19.

All e-resources, both subscribed and internal including Research and Technical reports are made available through the library website (http://www.ipr.res.in/library/) and the website is continuously updated with latest information.

Library replaced 04 new users PC, and two new multi-functional devices for photocopying and scanning were installed in the library. Total 8174 photocopies supplied to users. 4622 scanned copies were provided to the users.

Library is actively carrying out Information Literacy and Training programmes for its users and conducted trainings on Anti-Plagiarism tool and Technical writing and Publishing. Library orientation was given to newly joined members, Summer School Program Students, and Research Scholars. Library also provided internship training programme to 02 LIS students from Gujarat University, Ahmedabad during the year 2018-19.

Library actively participated and contributed to other Institutional activities, such as FEC-2018, Swacchata Abhiyan, Hindi Seminars/Meetings, Safety Week, National Science Day, International Yoga Day, etc.

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E. PUBLICATION AND PRESENTATIONS

E.1 Articles Publications

E.1.1 Journal Articles

Design and Analysis of Manifolds for Indian HCCB Blanket Module
DEEPAK SHARMA, PARITOSH CHAUDHURI
Fusion Engineering and Design, 129, 40, 2018

ACTYS-ASG, Tool for Coupling ACTYS-1-GO with ATTILA
PRITI KANTH, P.V. SUBHASH
Fusion Engineering and Design, 129, 196, 2018

Spiral Waves in Driven Dusty Plasma Medium: Generalized Hydrodynamic Fluid Description
SANDEEP KUMAR, BHAVESH PATEL, AMITA DAS
Physics of Plasmas, 25, 043701, 2018

Interplay of Single Particle and Collective Response in Molecular Dynamics Simulation of Dusty Plasma System
SRIMANTA MAITY, AMITA DAS, SANDEEP KUMAR, SANAT KUMAR TIWARI
Physics of Plasmas, 25, 043705, 2018

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PURUSHOTHAMA CHIPPAR, SWARAJ D. LEWIS, SUDHIR RAI, AMIT SIRCAR
International Journal of Hydrogen Energy, 43, 8007, 2018

Activation Characteristics of Candidate Structural Materials for a Near-Term Indian Fusion Reactor and the Impact of Their Impurities on Design Considerations
H.L. SWAMI, C. DANANI and A.K. SHAW
Plasma Science Technology, 20, 065602, 2018

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HARISH CHARAN, RAJARAMAN GANESH
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Review of Scientific Instruments, 89, 043510, 2018

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LAVITA SARMA, TRINAYAN SARMAH, N AOMOA, S SARMA, U DESHPANDE, HEMAN BHUYAN, SUNITA OJHA, U BORA and M KAKATI
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The European Physical Journal D, 72, 74, 2018

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V. GAYATHRI DEVI, AMIT SIRCAR, DEEPAK YADAV, JAYRAJ PARMAR
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Theoretical and Computational Fluid Dynamics, 32, 165, 2018

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EXCITATION OF KdV ALFVEN SOLITONS BY A PULSED CO2 LASER IN PLASMA IN THE PRESENCE OF AN EXTERNAL MAGNETIC FIELD
ATUL KUMAR, CHANDRASEKAR SHUKLA, DEEPA VERMA, AMITA DAS and PREDHIMAN KAW
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D. BORAH, A. K. CHATTOPADHYAY, M. BANDYOPADHYAY and A. J. DEKA
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A. SATYAPRASAD, N. I. JAMNAPARA, R. RANE, S. BELSARE, G. RAVI, P. KIKANI, S. KHIRWADKAR and S. MUKHERJEE
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P. PANDIT(NÉE MEHTA), A. SARMA, J. GHOSH, VARA PRASAD K., N. RAMAIYA, R. MANCHANDA, SANTOSH PANDYA, M. B. CHOWDHURI and P. I. JOHN
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H. L. SWAMI, M. ABHANGI, SANCHIT SHARMA, S. TIWARI, A. N. MISTRY, V. VASAVA, V. MEHTA, S. VALA, C. DANANI, V. CHAUDHARI and P. CHAUDHURI
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L. T. LACHHVANI, T. MACWAN, J. GHOSH, P. K. CHATTOPADHYAY, N. CHAKRABARTI and R. PAL
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K. A. JADEJA, J. GHOSH, KIRAN PATEL, K. M. PATEL, B. G. ARAMBHADIYA, R. L. TANNA, K. S. ACHARYA, S. B. BHATT, M. B. CHOWDHURI, R. MANCHANDA, MINSHA SHAH, S. GHOSH, VARA PRASAD KELLA, TANMAY MACWAN, ROHIT KUMAR, SUMAN AICH, DEVILAL KUMAWAT, M. B. KALAL, RACHANA RAJPAL, C. N. GUPTA, P. K. CHATTOPADHYAY and ADITYA-U TEAM
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S. RANJITHKUMAR, B. K. YADAV, ABHISHEK SARASWAT, PARITOSH CHAUDHURI, E. RAJENDRA KUMAR, ANDRE KUNZE and B. E. GHIDERSA
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JOINING OF HEAT SINK WITH STRUCTURAL MATERIAL FOR ITER LIKE DIVERTOR APPLICATION
K. P SINGH, ALPESH PATEL, KEDAR BHOPE, MAYUR MEHTA, NIKUNJ PATEL and S. S. KHIRWADKAR
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ASHA ADHIYA, RAJWINDER KAUR and PRABAL CHATTOPADHYAY
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MAULIK PANCHAL, A. SARASWAT, S. VERMA, PARITOSH CHAUDHURI
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K. P. SINGH, PRIYANKA PATEL, KAUSHALKUMAR DARJI, ALPESH PATEL, KEDAR BHOPE, PRAKASH MOKARIA, SUNIL BELARE AND SAMIR S KHIRWADKAR
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R. GANGRADEY, R. JHA, J. MISHRA, S. MUKHERJEE, P. NAYAK and P. PANCHAL
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EFFECT OF INHOMOGENEOUS MAGNETIC FIELD ON PLASMA GENERATION IN A LOW MAGNETIC FIELD HELICON DISCHARGE
SONU YADAV, KSHITISH K. BARADA, SOUMEN GHOSH, JOYDEEP GHOSH and PRABAL K.CHATTOPADHYAY
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S. AICH, R. KUMAR, T. M. MACWAN, D. KUMAVAT, S. JHA, R. L. TANNA, SATHYANARAYANA K., J. GHOSH, K. A. JADEJA, K. PATEL, SHARVIL PATEL, VAIBHAV RANJAN, MADANLAL KALAL, DINESH VARIA, D. SADHARKIYA, D. RAJU, P. K. CHATTOPADHYAY, C. N. GUPTA, Y. C. SAXENA and ADITYA-U TEAM
IPR/RR-1069/2019 MARCH 2019

BROADBAND CHARACTERIZATION OF HIGH TEMPERATURE BLACK BODY SOURCE WITH FOURIER TRANSFORM MICHELSON INTERFEROMETER FOR ECE MEASUREMENTS
ABHISHEK SINHA, S. K. PATHAK, STEFAN SCHMUCK and JOHN FESSEY
IPR/RR-1070/2019 MARCH 2019

UNDERSTANDING LANGMUIR PROBE CHARACTERISTICS IN A MAGNETIZED PLASMA WITH TWO-TEMPERATURE ELECTRON POPULATION
M. P. BHUVA, S. K. KARKARI and SUNIL KUMAR
IPR/RR-1071/2019 MARCH 2019

D-T NEUTRON GENERATOR AT INSTITUTE FOR PLASMA RESEARCH (IPR)
SUDHIRSINH VALA, M. ABHANGI, RATENSH KUMAR, S. TIWARI, R. KUMAR and M. BANDYOPADHYAY
IPR/RR-1072/2019 MARCH 2019

DESIGN OPTIMIZATION OF HELIUM COOLING SYSTEMS FOR INDIAN LLCB TBM
B. K. YADAV, A. GANDHI, K. T. SANDEEP, A. SARASWAT, D. SHARMA and P. CHAUDHURI
IPR/RR-1073/2019 MARCH 2019

ESTIMATION OF RADIAL PROFILE OF PARTICLE CONFINEMENT TIME FROM H alpha EMISSIVITY PROFILE IN ADITYA TOKAMAK AND INFERENCE OF ITS PARTICLE TRANSPORT
RITU DEY, M. B. CHOWDHURI, J. GHOSH, R. MANCHANDA, N. YADAVA, R. L. TANNA and ADITYA TEAM
IPR/RR-1074/2019 MARCH 2019

ELECTRIC FIELD FILAMENTATION AND HIGHER HARMONIC GENERATION IN A VERY HIGH FREQUENCY CAPACITIVE DISCHARGES
SARVESHWAR SHARMA, N. SIRSE, A. SEN, J. S. WU and M. M. TURNER
IPR/RR-1075/2019 MARCH 2019

OCCUPATIONAL RADIATION EXPOSURE ANALYSIS of 14 MeV NEUTRON GENERATOR FACILITY: A NEUTRONIC ASSESSMENT FOR THE BIOLOGICAL AND LOCAL SHIELD DESIGN
H.L. SWAMI, S. VALA, M. ABHANGI, RATNESH KUMAR, C. DANANI, R. KUMAR and R. SRINIVASAN
IPR/RR-1076/2019 MARCH 2019

ELECTRON TEMPERATURE CONTROL IN A DOUBLE PLASMA DEVICE BY SELECTIVE BIASING OF CONTROL GRID
PRINCE ALEX, A.K. SANYASI, PRABHAKAR SRIVASTAV, P. K. SRIVASTAVA, R. SUGANDHI and L. M. AWASTHI
IPR/RR-1077/2019 MARCH 2019

DESIGN AND DEVELOPMENT OF A 2.45 GHz ECR ION SOURCE FOR AN ACCELERATOR BASED FUSION NEUTRON SOURCE
SUDHIRSINH VALA, RATNESH KUMAR, MITUL ABHANGI, CHINMOY MALLICK, R. KUMAR and M. BANDYOPADHYAY
IPR/RR-1078/2019 MARCH 2019

E 2. 2 Technical Reports

Adaptation of Fast Responding Power Supply for Radial Position Control in SST-1
DINESH KUMAR SHARMA, AKHILESH KUMAR SINGH, AMIT OJHA, MURTUZA M. VORA, KIRIT KUMAR B. PATEL and JASRAJ DHONGDE
IPR/TR-474/2018 (APRIL, 2018)

Current Status of Far-Infrared Interfero/Polarimeter for SST-1
ASHA ADHIYA and RAJWINDER KAUR
IPR/TR-475/2018 (APRIL, 2018)

Standard Operation Procedures of Regulated High Voltage Power Supply (RHVPS) for LHCD and ECRH
C. B. SUMOD and NBI POWER SUPPLY & DATA ACQUISITION DIVISION
IPR/TR-476/2018 (APRIL, 2018)

Standard Operation Procedure for SST-1 Magnet System by Magnet System Division, IPR
UPENDRA PRASAD, BHADRESH R PARGHI, PANKAJ VARMORA, AZAD MAKWANA, MONI BANAUDHA and CHIRAG DODIYA
IPR/TR-477/2018 (APRIL, 2018)

Conditioning, Installation, Testing and Commissioning of PF Converter Transformer
AKHILESH KUMAR SINGH, AMIT OJHA, DINESH KUMAR SHARMA, MURTZA M. VORA, CHIRAG B. BHAVSAR and SUPRIYA A. NAIR
IPR/TR-478/2018 (APRIL, 2018)

Development of Substation Monitoring System (SMS) for 132 KV Sub-station at IPR
AMIT OJHA, MURTUZA M. VORA, DINESH KUMAR SHARMA and AKHILESH KUMAR SINGH
IPR/TR-479/2018 (MAY, 2018)

Power Supply Quench Protection System of Toroidal Field Superconducting Coil for SST-1
MURTUZA VORA, AKHILESH SINGH, DINESH SHARMA, AMIT OJHA, PRAKASH PARMAR, CHIRAG BHAVSAR and A. VARADHARAJULU
IPR/TR-480/2018 (MAY, 2018)

Testing of PF2 Power Supply
DINESH KUMAR SHARMA, MURTUZA M. VORA, AKHILESH KUMAR SINGH, AMIT OJHA and SUPRIYA A. NAIR
IPR/TR-481/2018 (MAY, 2018)

SOP for SST-1 APC Power Supply
DINESH KUMAR SHARMA, AKHILESH KUMAR SINGH, AMIT OJHA, JASRAJ DHONGDE, MURTUZA M. VORA and SUPRIYA A. NAIR
IPR/TR-482/2018 (MAY, 2018)

SOP for SST-1 TF Power Supply
DINESH KUMAR SHARMA, MURTUZA M. VORA, AKHILESH KUMAR SINGH, AMIT OJHA AND SUPRIYA A. NAIR
IPR/TR-483/2018 (MAY, 2018)

Pipe stress analysis report of Helium Cooling Systems (FWHCS and LLHCS)
ADITYA KUMAR VERMA, B. YADAV, A. GANDHI and E. RAJENDRA KUMAR
IPR/TR-484/2018 (MAY, 2018)

Development of Precise electronic system for cryogenic two phase flow void fraction measurement
G. PURWAR, G. K. SINGH, R. PATEL, H. D. NIMAVAT and V. L. TANNA
IPR/TR-485/2018 (MAY, 2018)

Modular, High Current, Fast Response IGBT Based Inverter Power Supply of SST-1 Tokamak
DINESH KUMAR SHARMA, AKHILESH KUMAR SINGH, AMIT OJHA and MURTUZA M. VORA
IPR/TR-486/2018 (MAY, 2018)

Design, Testing, Installation and Commissioning of LT Circuit Breaker Panels for Auxiliary Building
PRAKASH PARMAR, SUPRIYA NAIR, CHIRAG BHAVSAR and C. K. GUPTA
IPR/TR-487/2018 (MAY, 2018)

PLC Based Ladder Logic for Control, Monitoring, Interlocks and its Signal Conditioning of 100kW, 45.6 MHz ICRH System
H. M. JADAV, RAMESH JOSHI, BHAVESH KADIA, KIRIT PARMAR, SRINIVAS Y.S.S., SUNIL KUMAR, S. V. KULKARNI AND ICRH RF GROUP
IPR/TR-488/2018 (MAY, 2018)

Erection, Testing and Commissioning of 31.5MVA, 132/11.2kV Power Transformer at 132kV IPR Substation
CHANDRA KISHOR GUPTA, SUPRIYA NAIR, PRAKASH PARMAR and CHIRAG BHAVSAR
IPR/TR-489/2018 (MAY, 2018)

Installation, Testing and Commissioning of Control and Relay panel (CRP-6) for 31.5 MVA, 132/22 kV Power Transformer at IPR Substation
CHIRAG B. BHAVSAR, PRAKASH PARMAR, C.K. GUPTA and SUPRIYA NAIR
IPR/TR-490/2018 (MAY, 2018)

Development and optimization of the antenna assembly for the ADITYA-U Reflectometry diagnostic systems
VARSHA GOYAL, JJU BUCH, and S. K. PATHAK
IPR/TR-491/2018 (MAY, 2018)

Conceptual Design of Cryo-Sorption Cryopump for Application in SST-1 Tokamak
RANJANA GANGRADEY, SAMIRAN SHANTI MUKHERJEE, JYOTISHANKAR MISHRA, PARESH PANCHAL, PRATIK NAYAK, VISHAL GUPTA and SUBHADIP DAS
IPR/TR-492/2018 (MAY, 2018)

Design, Fabrication and Testing of 7kV, 6A Series Connected IGBTs Switch for Triode Based 20 kW Stage ICRF Amplifier
BHAVESH R. KADIA, KIRIT PARMAR, Y. S. S. SRINIVAS, S. V. KULKARNI and ICRH GROUP
IPR/TR-493/2018 (JUNE, 2018)

Measurement of Ultrasonic Velocity in Plasma Facing Materials at Elevated Temperatures
KEDAR BHOPE, MAYUR MEHTA, SAMIR KHIRWADKAR, TUSHAR PATEL and NIKUNJ PATEL
IPR/TR-494/2018 (JUNE, 2018)

SST-1 Vacuum System Operations Manual Handbook (Ver. 1.0)
ZIAUDDIN KHAN, DILIP C. RAVAL, KALPESHKUMAR R. DHANANI, PRATIBHA SEMWAL, GATTU RAMESH, FIROZKHAN PATHAN, SIJU GEORGE, PARAVASTU YUVAKIRAN, PRASHANT THANKEY and ARUN PRAKASH A.
IPR/TR-495/2018 (JUNE, 2018)

VME System Based Technique for IGBT Switching and Current Control
DINESH KUMAR SHARMA, AKHILESH KUMAR SINGH and SUBRATA PRADHAN
IPR/TR-496/2018 (JULY, 2018)

Generic Power Supply Feedback Controller for Control of Plasma Parameters in SST-1
DINESH KUMAR SHARMA, AKHILESH KUMAR SINGH and SUBRATA PRADHAN
IPR/TR-497/2018 (JULY, 2018)

Development of Liquid Nitrogen Based Cryo-Sorption Cryopump
RANJANA GANGRADEY, SAMIRAN SHANTI MUKHERJEE, JYOTI SHANKAR MISHRA, PARESH PANCHAL, PRATIK NAYAK, VISHAL GUPTA and SUBHADIP DAS
IPR/TR-498/2018 (JULY, 2018)

Characterization of Black Body Target Materials for Calibration of Michelson Interferometer Diagnostics
ABDUL SHABIR, ABHISHEK SINHA and S. K. PATHAK
IPR/TR-499/2018 (JULY, 2018)

Numerical Study of Argon Diffusion in Ambient Air from Jet in the Absence of Plasma
AKSHAY VAID, G. RAVI and SUBROTO MUKHERJEE
IPR/TR-500/2018 (JULY, 2018)

Survey of Tritium Facilities for Fusion Research
DEEPTI DUBEY and SHISHIR P. DESHPANDE
IPR/TR-501/2018 (JULY, 2018)

SST-1 TR3 (B) Deformation Analysis & Remedial Action for Support design, Fabrication & Integration
PROSENJIT SANTRA, PRABAL BISWAS, SNEHAL JAYSWAL, PRADEEP CHAUHAN, HITESH PATEL, AZADSINH MAKWANA, BHARAT DOSHI and UPENDRA PRASAD
IPR/TR-502/2018 (AUGUST, 2018)

Installation, Testing and Commissioning of Current Transformer for Tariff metering at 132kV IPR Substation
CHANDRA KISHOR GUPTA, SUPRIYA NAIR, PRAKASH PARMAR and CHIRAG BHAVSAR
IPR/TR-503/2018 (AUGUST, 2018)

Conceptual Design of Instrumentation and Control System for IN-LLCB TBS
T. SRINIVAS RAO, A. SARASWAT, D. MOHANTA and E. RAJENDRA KUMAR
IPR/TR-504/2018 (AUGUST, 2018)

A Study of Factors Affecting Temperature Diagnostic on Copper Block at the High Heat Flux Test Facility in IPR
VINAY MENON, MOHIT SHARMA, SAMIR KHIRWADKAR, KEDAR BHOPE, SUNIL BELSARE, SUDHIR TRIPATHI, NIKUNJ PATEL, MAYUR MEHTA, PRAKASH MOKARIA, TUSHAR PATEL, RAJAMANNAR SWAMY and KALPESH GALODIYA
IPR/TR-505/2018 (AUGUST, 2018)

Modelling and Piping Flexibility Analysis Report of

Experimental Helium Cooling Loop (EHCL)
ADITYA KUMAR VERMA, BRIJESH YADAV, ANKIT GANDHI, ABHISHEK SARASWAT, SHRIKANT VERMA, UNNATI PATEL and E. RAJENDRA KUMAR
IPR/TR-506/2018 (AUGUST, 2018)

SST-1 Central Control System (CCS) Operation Handbook
HITESH GULATI, KIRTI MAHAJAN, HARISH MASAND, AVEG KUMAR, KIRIT PATEL, MANISHA BHANDARKAR, HITESH CHUDASMA, JASRAJ DHONGDE and D. RAJU
IPR/TR-507/2018 (AUGUST, 2018)

Development of Digital Control System in LabVIEW for Stepper Motor Drives
R. SINGH, R. SUGANDHI, G. KAUR, D. TRIVEDI, P. SRIVASTAV and L. M. AWASTHI
IPR/TR-508/2018 (AUGUST, 2018)

Operation of High Heat Flux Test Facility
SUNIL BELSARE, SAMIR KHIRWADKAR, RAJAMANNAR SWAMY, KEDAR BHOPE, TUSHAR PATEL, PRAKASH MOKARIA, SUDHIR TRIPATHI, KALPESH GALODIYA, NIKUNJ PATEL, PRIYANKA PATEL and MAYUR MEHTA
IPR/TR-509/2018 (SEPTEMBER 2018)

3D Thermo-fluid Magneto Hydrodynamic Analysis for Pb-Li flow inside the LLCB TBM
A. PATEL, S. RANJITHKUMAR, R. BHATTACHARYAY, D. SHARMA, P. CHAUDHURI, P. SATYAMURTHY, H. L. SWAMI and C. DANANI
IPR/TR-510/2018 (SEPTEMBER 2018)

Power Load Estimation on ROBIN Source and Accelerator Grids using Water Calorimetry
KAUSHAL PANDYA, MAHENDRAJIT SINGH, AGRAJIT GAHLAUT, RATNAKAR YADAV, MANAS BHUYAN, HIMANSHU TYAGI, MAHESH VUPPUGALLA, KARTIK PATEL, BHAVESH PRAJAPATI, JIGNESH BHAGORA, HIREN MISTRI, RAVI PANDEY, MAINAK BANDYOPADHYAY and ARUN CHAKRABORTY
IPR/TR-511/2018 (SEPTEMBER 2018)

Investigation of LabVIEW and Syslog Interface using In-house Developed Generic Logging Software
G. KAUR, R. SUGANDHI, S. TRIVEDI, P. SRIVASTAV and L. M. AWASTHI
IPR/TR-512/2018 (SEPTEMBER 2018)

The Negative Ion Source; ROBIN Performance in Terms of Negative Ion Current Density and Electron to Ion Ratio and Impurities Impact on Surface Production of Negative Ions
KAUSHAL PANDYA, AGRAJIT GAHLAUT, RATNAKAR YADAV, MANAS BHUYAN, MAINAK BANDYOPADHYAY, V. MAHESH, HIMANSHU TYAGI, K. G. PARMAR, BHAVESH PRAJAPATI, KARTIK PATEL, JIGNESH BHAGORA, HIREN MISTRI, RAVI PANDEY, M. J. SINGH and ARUN CHAKRABORTY
IPR/TR-513/2018 (OCTOBER 2018)

Discrete Element Simulation to Study Mechanical Behaviors of Lithium Ceramic Breeder Pebble Beds
MAULIK PANCHAL, PARITOSH CHAUDHURI, CHUNBO ZHANG and ALICE YING
IPR/TR-514/2018 (OCTOBER 2018)

Microcontroller based High Voltage, High Speed, Trigger Control Circuit for SMARTEX-C
MINSHA SHAH, HITESH MANDALIYA, LAVKESH LACHHVANI, MANU BAJPAI and RACHANA RAJPAL
IPR/TR-515/2018 (OCTOBER 2018)

Engineering Analysis of ITER Divertor
VINAY MENON, DEEPU KRISHNAN, SHOBHIT TRAPASYA and S. S. KHIRWADKAR
IPR/TR-516/2018 (NOVEMBER 2018)

Integration of additional 128 channels for RF power measurement in LHCD DAC with MDSplus data archival system
RAMESH JOSHI, CHETAN VIRANI, KIRAN AMBULKAR and P. K. SHARMA
IPR/TR-517/2018 (NOVEMBER 2018)

Design & Characterization of the IF Receiver System (1-20 GHz) for D-Band Radiometer System (130-170 GHz)
ABHISHEK SINHA and SURYA K. PATHAK
IPR/TR-518/2018 (NOVEMBER 2018)

Estimation of Optical Constants of a Metal Substrate using Principal Angle of Incidence Method
ASHA ADHIYA and RAJWINDER KAUR
IPR/TR-519/2018 (NOVEMBER 2018)

Remote Control of the NBI Cryogenics Utility
VISHNU PATEL
IPR/TR-520/2018 (NOVEMBER 2018)

Characteristics of Arbitrary Ramp Generator: A tuning voltage setup for the FMCW Reflectometer
GIBIN CHACKO GEORGE, BITTU N., JJU BUCH, A. AMALIN PRINCE, NEENA GOVEAS and SURYA K. PATHAK
IPR/TR-521/2018 (NOVEMBER 2018)

Monitoring and Control PLC via Web Access using EPICS IOC for ICRH DAC
RAMESH JOSHI, H. M. JADAV, SUNIL KUMAR and HIGH POWER ICRH SYSTEMS DIVISION
IPR/TR-522/2018 (NOVEMBER 2018)

Design of a Mechanical Heat Switch for Low Temperature Application
PARTH SATHAVARA, J. MISHRA, P. M. PANCHAL, S. MUKHERJEE, P. NAYAK, V. GUPTA, A. R. PATEL and R. GANGRADEY
IPR/TR-523/2018 (DECEMBER 2018)

Development of Rapid Thermal Processing (RTP) Vacuum Furnace
SAGAR AGRAWAL
IPR/TR-524/2018 (DECEMBER 2018)

Dimensional Inspection of Tungsten Monoblock Divertor Assembly using Articulated co-ordinate Measuring Machine
KEDAR BHOPE, MAYUR MEHTA, SAMIR KHIRWADKAR, SUDHIR TRIPATHI and NIKUNJ PATEL
IPR/TR-525/2018 (DECEMBER 2018)

Access MODBUS supported devices using EPICS environment for ICRH DAC
RAMESH JOSHI, H. M. JADAV, SUNIL KUMAR and HIGH POWER ICRH SYSTEMS DIVISION
IPR/TR-526/2019 (JANUARY 2019)

Gas Fuelling Control System of ADITYA Upgrade Tokamak
N. C. PATEL, C. CHAVDA, K. A. JADEJA, K. M. PATEL, S. B. BHATT, J. GHOSH, R. L. TANNA and THE ADITYA -U TEAM
IPR/TR-527/2019 (JANUARY 2019)

Study on Joining of Dissimilar Materials using Electro Magnetic Pulse Welding technique and weld joint characterization
BHARATKUMAR DOSHI, PARITOSH CHAUDHURI and RAJESH KUMAR
IPR/TR-528/2019 (JANUARY 2019)

Thermo-Structural Analysis of SST-1 Cryopump
VISHAL GUPTA, VIPUL L. TANNA, RANJANA GANGRADEY, SAMIRAN SHANTI MUKHERJEE, JYOTI SHANKAR MISHRA, PARESH PANCHAL and PRATIK A. NAYAK
IPR/TR-529/2019 (JANUARY 2019)

The Operation, Control, Data Acquisition System of ASDEX Pressure Gauge for Neutral Pressure
KIRAN PATEL, K. A. JADEJA, H. C. JOSHI and J. GHOSH
IPR/TR-530/2019 (JANUARY 2019)

IoT based Online Fault Notifier Device
FIROZKHAN S. PATHAN, D. C. RAVAL and ZIAUDDIN KHAN
IPR/TR-531/2019 (FEBRUARY 2019)

Design, Simulation, Testing & Installation of Wave Collection and Transport System for Michelson Interferometer Diagnostic at SST-1 Tokamak
ABHISHEK SINHA, SONAM SHARMA and S. K. PATHAK
IPR/TR-532/2019 (FEBRUARY 2019)

Standard Operation Procedures (SOP) of Signal Conditioning Electronics for Steady State Superconducting Tokamak-1 (SST-1) Plasma Diagnostics
MINSHA SHAH, PRAVEENLAL EDAPPALA, PRAMILA and PRAVEENA KUMARI
IPR/TR-533/2019 (FEBRUARY 2019)

SST-1 Data Acquisition System Operation Handbook
IMRAN MANSURI, ATISH SHARMA, TUSHAR RAVAL and MANIKA SHARMA
IPR/TR-534/2019 (FEBRUARY 2019)

Multiphysics Analysis of the Passive Active Multijunction (PAM) Launcher for LHCD System of ADITYA-Upgrade Tokamak
YOGESH M. JAIN, P. K. SHARMA and HARISH V. DIXIT
IPR/TR-535/2019 (FEBRUARY 2019)

Aditya UpGradation- Equilibrium Study
DEEPTI SHARMA, R. SRINIVASAN, JOYDEEP GHOSH, P. CHATTOPADHYAY AND ADITYA TEAM
IPR/TR-536/2019 (FEBRUARY 2019)

Conceptual Design of Neutron Activation System for in LLCB TBM

S. TIWARI, ARVIND KUMAR, DEEPAK SHARMA, VILAS CHAUDHARI, ATIK MISTRY, H. L. SWAMI, C. DANANI and E. RAJENDRA KUMAR
IPR/TR-537/2019 (FEBRUARY 2019)

Development of Online Annual Performance Appraisal Report (APAR) System for IPR
HEMANT JOSHI, SHARAD JASH and R. GANESH
IPR/TR-538/2019 (FEBRUARY 2019)

Machine Control System for Large Volume Plasma Device: Current Status and Future Directions
R. SUGANDHI, P. K. SRIVASTAVA, P. SRIVASTAV, A. K. SANYASI and L.M. AWASTHI
IPR/TR-539/2019 (MARCH 2019)

Design of Feedback controlled Steerable ECRH Launcher
HARDIK MISTRY, HARSHIDA PATEL, JATIN PATEL, DHARMESH PUROHIT, K.G. PARMAR, M. KUSHWAH and B. K. SHUKLA
IPR/TR-540/2019 (MARCH 2019)

E.3 CONFERENCE PRESENTATIONS

22nd Topical Conference on High-Temperature Plasma Diagnostics (HTPD 2018), San Diego, USA, 16-19 April 2018

ECE System for ITER
Austin, M.E., Basile, A., Beno, J.H., Bryant, A., Danani, S., Feder, R., Houshmandyar, S., Hubbard, A.E., Johnson, D.W., Khodak, A., Kumar, R., Kumar , S. , Ouroua , A. , Padasalagi , S.B. , Pandya, H.K.B. , Phillips , P.E. , Rowan , W.L. , Stillerman , J.A. , Taylor , G. , Thomas , S. , Udintsev, V.S. , Vayakis , G. , Walsh , M.J. , Weeks , D. et al.

NFP-PFRC Vision Meeting (NPVM-2018), Nirma University, Ahmedabad, 26-28 April 2018

Electronics, Instrumentation and Software technological projects and vision for future development
Dave Haresh J.

Development of Barium Zinc Tantalate (BZT) Ceramics for Microwave Window Application in Fusion System
Swathi Manivannan, Dibakar Das, Surya Chandra, Andrews Joseph, K C James Raju, P K Sharma

Efforts in indigenous design and development of high power microwave devices
Sandeep Sainkar, Snehal D., Harish Dixit, Alice Cheeran, P K Sharma, Manjunatha Reddy

Development of ferrite material for microwave application of high power CW circulator at 3.7 GHz/5 GHz
S K S Parashar, Ashwani Tyagi and P K Sharma

Design and development of GUI and a prototype hardware interfacing module for data acquisition for phase and power measurement of LHCD channels
Prarthan Mehta, Rizwan Alad, K K Ambulkar, J. Kumar and P K Sharma

FPGA based Implementation of Adaptive Filter Algorithm for External Noise Cancellation
Priyank Prajapati, Aksh Patel, A.D. Darji, Kiran Patel, Ajai Kumar

FPGA implementation of Fuzzy logic Controller for Laser beam pointing Stability Correction
Gibin George, Kiran Patel, Amalin Prince, Ajai Kumar

Studies and Current Status of W/W-Y-Cr Based Double Layer Structure Development
Shubhra Bajpai, P. A. Rayjada, A.R. Pati, M. Debata, S.K. Pradhan

Microwave Hydrothermal Synthesized $LaNbO_4$ Nanocrystalline as Electrolyte for Electrochemical Hydrogen Pump
S. Balasundari, S. Jayasubramaniyan, P. M. Raole, Pratipalsinh A. Rayjada, N. Satyanarayana and P. Muralidharan

Classification and Prediction of Disruptions of Disruptions in tokamak using Deep Learning Techniques
Priyanka Sharma, Swati Jain, Vaibhav Jain, Sutapa Ranjan, R. Manchanda, D. Raju, J. Ghosh and R.L. Tanna

Design and development of reflectometry diagnostics system for Aditya-U tokamak
K. Mahant, P. K. Sharma, A. Patel, B. Shah, J. Kumar, K. K. Ambulkar

Characterization and Comparison of Copper Coatings Developed by Low Pressure Cold Spraying and Laser Cladding Techniques
Surinder Singh, Harpreet Singh, Ramesh Kumar Buddu

Laser Shock Peening of 316LN Stainless Steel and Structured

Metal Surfaces
Pardhu Yella, Venkateswarlu Pinnoju, Ramesh Kumar Buddu, Koteswararao V. Rajulapati, P. Prem Kiran, and K.Bhanu Sankararao

Distortion Validation of Laser Beam Welded SS316 Steel Plates
Suresh Akella, Harinadh Vemanaboina, Ramesh Kumar Buddu, G.Edison

5th IAEA DEMO Programme Workshop (DPW-5), National Fusion Research Institute, Daejeon, Republic of Korea, 7-10 May 2018

Fusion relevant superconductor and magnet development activities at IPR.
Upendra Prasad, P. Raj, M. Ghate., S. Roy, A Makwana, D. Kanabar, Y. Singh, P. Varmora, B. Parghi, M. Banaudha, A Panchal, D Bhavsar, A Bano, N Kumar and R Srinivasan

20th Joint Workshop on Electron Cyclotron Emission (ECE) and Electron Cyclotron Resonance Heating (ECRH), Alfried Krupp Wissenschaftskolleg, Greifswald, Germany, 14-17 May 2018

Developments towards 1MW Gyrotron test facility at ITER-India
Vipal Rathod, E. Sharan Dilip, Ronak Shah, Deepak Mandge, Amit Yadav, Anjali Sharma, Rajvi Parmar, N.P. Singh and S.L. Rao

Comparative studies of various types of transmission lines in the frequency range 70 GHz 1 THz for ITER ECE diagnostic
Ravinder Kumar

19th International Congress on Plasma Physics Conference, Vanouver, Canada, 4-8 June 2018

Role of poloidal flows on the particle confinement in a simple magnetized toroidal plasma
Umesh Kumar, R. Ganesh, K. Sathyanarayana and Y. C. Saxena, S G Thaipamula, D Raju

28th Symposium on Plasma Physics and Technology, Czech Technical University in Prague, Czech Republic, 17-22 June 2018

Electron Temperature Gradient (ETG) turbulence induced particle transport due to finite electromagnetic fluctuations
Prabhakar Srivastav, Rameswar Singh, L.M. Awasthi, A.K. Sanyasi, PK Srivastava, R Sugandhi, and R Singh

7th International Conference on Plasma Medicine, Drexel University, Philadelphia, USA, 17- 22 June 2018

Estimation of plasma density along the plume length in low-temperature atmospheric pressure plasma jet
G. Veda Prakash, Kiran Patel, Narayan Behera, and Ajai Kumar

45th International Conference on Plasma Science (ICOPS-2018), Denver, Colorado, USA, 24-28 June 2018

Role of electric field on power coupling mechanisms during evolution of plasma in an off-resonance microwave discharge
Chinmoy Mallick, Mainak Bandyopadhyay, Rajesh Kumar

Irradiation effects in graphite induced by helium ions: surface, structural, and chemical analyses
S.R. Mohanty, N.J. Dutta, N. Buzarbaruah, M. Ranjan, R.S. Rawat

15th Spacecraft Charging Technology Conference, Kobe, Japan, 25-29 June 2018

An Overview of Spacecraft Charging Research in India: Spacecraft Plasma Interaction Experiments - SPIX–III
Suryakant B Gupta

45th European Physical Society Conference on Plasma Physics (EPS-2018), Prague, Czech Republic, 2-6 July 2018

Demonstration of Loss Cone Induced Quasi-Longitudinal (QL) Whistlers in large laboratory Plasma of LVPD
A K Sanyasi, L M Awasthi, Prabhakar Srivastav, P. K. Srivastava, R. Sugandhi, S K Mattoo, D Sharma, R Singh, R Paikaray and P K Kaw

Impedance Characteristics of a magnetized 13.56 MHz capacitive discharge
J.K. Joshi, S.K. Karkari and Sunil Kumar

Using biased hairpin probe for determining negative oxygen ions in a double plasma device
A K Pandey, and S K Karkari

Characterization of laterally colliding plasma plumes formed by the multi-species target Alamgir Mondal, Bhupesh Kumar, R. K. Singh, H. C. Joshi, and Ajai Kumar

Workshop on Pulsed Power Technology for EM Launcher and other applications, Armament Research & Development Establishment (ARDE) - DRDO, Pune, 4-5 July 2018

Pulse Power and other technologies available at IPR suitable for rail-guns and other applications
Y.S.S. Srinivas

71st IIW Annual Assembly & International Conference, Bali, Indonesia, 15-20 July 2018

Effect of Activating Fluxes on Microstructure and Hardness Properties of A-TIG welded Aluminized Coated 9Cr-1Mo Steels
Arunsinh B Zala, Nirav I Jamnapara, Vishvesh J Badheka, C. S. Sasmal, Shiju Sam, Mukesh Ranjan

International Conference on Plant Genetics & Genomics Next Gen Crops for Sustainable Agriculture, Chandigarh, 19-20 July 2018

Study of Radio-Frequency (RF) Air Plasma Treatment Effect on Pulses (Brown Chickpeas and Mung) Seeds for Improvement of Water Uptake and Germination
C. Jariwala, Kalyanrao Patil, N. Chandwani and Ajai Kumar

Siegman Summer School on Lasers, Island of Hven Backafallsbyn, Sweden, 28 July-4 August 2018

Origin and Evolution of the Diamagnetic Cavity in Expanding Laser-Produced Plasma Plume
Narayan Behera, R. K. Singh and Ajai Kumar

6th PSSI Plasma Scholar's Colloquium (PSSI-PSC 2018), Sikkim Manipal Institute of Technology (SMIT), Sikkim, 24-26 August 2018

Effect of Medium on the Size Properties of Metallic Nanoparticles Produced by Laser Ablation in Liquid
Kaushik Choudhury, Rajesh Kumar Singh, Atul Srivastava, Ajai Kumar

Study of Excitation of Electrostatic Modes in 1D Vlasov - Poisson Plasma
Sanjeev Kumar Pandey, P. Trivedi, R. Ganesh

Merger of Two Symmetric High Density Electron Vortices
Swapnali Khamaru, Meghraj Sengupta, Rajaraman Ganesh

Investigation of Kelvin Helmholtz instability in 2D self-driven Yukawa Particles or Active Yukawa particles using MD Simulation
Soumen De Karmarkar, R Ganesh

Kinetic Eulerian simulations of Driven Electrostatic Phase Space Vortices in a 1D Vlasov-Yukawa System
Pallavi Trivedi and Rajaraman Ganesh

Studies on ion dynamics of an inertial electrostatic confinement fusion device
D. Bhattacharjee, N. Buzarbaruah, S. Kalita and S.R. Mohanty

Effect of atomic mass on dynamics of laser induced colliding plasma plume and interaction zone
Alamgir Mondal, Bhupesh Kumar, R. K. Singh, H. C. Joshi, and Ajai Kumar

27th International Cryogenic Engineering Conference - International Cryogenic Materials Conference 2018 (ICEC27-ICMC2018), Oxford, England, 3-7 September 2018

Cryogenic process optimization for simultaneous cool down of the TF and PF superconducting coils of SST-1 Tokamak
P Panchal, R Panchal, R Patel, G Mahesuriya, D Sonara, L N Srikanth G, A Garg, D Christian, N Bairagi, R Sharma, K Patel, P Shah, H Nimavat, G Purwar, J Patel, V Tanna, U Prasad, A Sahu, C Chakrapani, R Srinivasan and D Raju

13th Carolus Magnus Summer School on Plasma and Fusion Energy Physics (CMSS-2018), Netherlands, 3-14 September 2018

Generation and Transport of Runaway electrons in ADITYA tokamak
Harshita Raj, J. Ghosh, R.L. Tanna, P.K. Chattopadhyay, D. Raju, S.K. Jha, J. Raval, S. Joisa, S. Purohit and R. Pal

International workshop on ECR ion sources (ECRIS-2018), Catania, Italy, 9-14 September 2018

Development of test bench of 2.45GHz ECR ion source for RFQ
Sudhirsinh Vala, Ratnesh Kumar, Mitul Abhangi, Rajesh Kumar, Mainak Bandyopadhyay

30th Symposium on Fusion Technology (SOFT-2018), Sicily, Italy, 16-21 September 2018

Investigation of Alumina Films formed over Aluminized RAFM steels by Plasma assisted Heart Treatments
Arunsinh B Zala, Nirav I Jamnapara, C. Sasmal, Paritosh Chaudhari, Mukesh Ranjan

Development of medium size dome & reflector plate for ITER like Tokamak application
K. Premjit Singh, S.S Khirwadkar, Nikunj Patel, Prakash Mokaria, Kedar Bhope, Sunil Belsare, Vinay Menon, Deepu Krishnan, Mayur Mehta, Sudhir Tripathi, Alpesh Patel, Rajamannar Swamy, Tushar Patel, Kalpesh Galodiya

Material optimization technique to minimize radiological responses in fusion reactors
Priti Kanth, T.S. Chaitanya, P.V. Subhash

Automation of upgraded NBI Cooling Water System
Karishma Qureshi, Paresh Patel, M. R. Jana, Laxmi Narayan Gupta, Dipal Thakkar, C B Sumod, Vijay Vadher and Ujjwal Baruah

Development of Experimental Helium Cooling Loop (EHCL) for testing nuclear fusion blanket components
B. K. Yadav, A. Gandhi, A. Saraswat, S. Verma, T. S. Rao, A.K. Verma, D. Mohanta, Unnati Patel, P. Chaudhuri, E.R. Kumar, Amit Sircar, Sujay Bhattacharya

Profile tolerances influence on cryostat base section
Sarbjeet S. Sandhu, T. K. Sharma, S. B. Padasalagi, K. S. Bhatt, M. Patel, G.K. Gupta, M.K. Pandey, Amit Palaliya

Manufacturing experience and commissioning of Large Size UHV Class Vacuum Vessel for Indian Test Facility (INTF) for Neutral Beams
Dhananjaykumar Singh

42 GHz ECRH system on Aditya Upgrade
B.K.Shukla, J. Patel, M. Kushwah, H. Patel, D. Purohit, K.G. Parmar, H. Mistry

16th International Conference on Plasma Surface Engineering (PSE-2018), Garmisch-Partenkirchen, Germany, 17-21 September 2018

Investigation of mechanical, structural and corrosion resistance properties of low carbon steel after plasma carburizing and carbonitriding process
Alphonsa Joseph

OSI-International Symposium on Optics (OSI-ISO 2018), Indian Institute of Technology, Kanpur, 19-22 September 2018

Quasi distributed strain and temp. Sensing using four in-line multiplexed FBGS
K Dey, Sourabh Roy, BR Kumar, M. Sai Shankar

79th JSAP Autumn Meeting (JSAP-OSA-2018), Nagoya, Japan, 21-25 September 2018

Analysis of FBG Interrogation using SMS and OTDR for simultaneous measurement of temperature and strain
K Dey, Sourabh Roy, BR Kumar, M. Sai Shankar

Conference on Virtual Reality, Augmented and Mixed Reality, PHD House, August Kranti Marg, New Delhi, 22 September 2018

AR VR Technologies for Education & Skill Development
Naveen Rastogi (Panelist in roundtable discussion)

National Conference on advances in Spectroscopy: Molecules to Materials (NCASMM-2018), Institute of Infrastructure Technology Research and Management, Ahmedabad, India, 4-6 October 2018

Surface Modification of Non-woven Polypropylene Fabric by atmospheric pressure air plasma for improved functionality
Nisha Chandwani and Sudhir Nema

Student Conference on Optics and Photonics (SCOP-2018), Physical Research Laboratory, Ahmedabad, 4-6 October 2018

Study of ambient pressures effect on the LIBS spectra
Pravin Kumar Tiwari, R. K. Singh, Ajai Kumar and A K Rai

National Seminar on Advances in Electronics and Allied Science & Technology (NaSAEAST- 2018), Gauhati University, Assam, India, 5-6 October 2018

Helium ion characterization of plasma focus device
N. J. Dutta and S.R. Mohanty

International Conference on Ion Beams in Materials Engineering and Characterizations (IBMEC 2018), Inter-University Accelerator Centre (IUAC), New Delhi, 9-12 October 2018

Wettability Studies of Nanostructured Gallium Antimonide Surface Prepared by Low Energy Ar+ Ion Beam
Vivek Pachchigar, Mukesh Ranjan, Sooraj K P

27th IAEA Fusion Energy Conference (FEC 2018) hosted by the Department of Atomic Energy, Government of India and the Institute for Plasma Research at the Mahatma Mandir, Gandhinagar (Ahmedabad) Gujarat, India, 22-27 October, 2018

India's Quest for Fusion Energy & Road to ITER
S. P. Deshpande

Progress of ITER-India Activities for ITER Deliverables: Challenges and Mitigation Measures
A. K. Chakraborty, U. K. Baruah, A. Mukherjee, S. L. Rao, V. Kumar, A. Kumar, G. Gupta, H. Vaghela, H. A. Pathak, H. B. Pandya, I. Bandyopadhyay, and S. P. Deshpande

Overview of Operation and Experiments in the ADITYA-U Tokamak
R. L. Tanna, J. Ghosh, H. Raj, R. Kumar, S. Aich, T. Macwan, D. Kumawat, K. A. Jadeja, K. M. Patel, M. B. Kalal, D. S. Varia, D. H. Sadharakiya, S. B. Bhatt, K. Sathyanarayana, B. K. Shukla, P. K. Chattopadhyay, M. N. Makwana, K. S. Shah, S. Gupta, V. Ranjan, V. Balakrishnan, C. N. Gupta, V. K. Panchal, E. V. Praveenlal, B. Arambhadiya, M. Shah, V. D. Raulji, M. B. Chowdhuri, S. Banerjee, R. Manchanda, D. Raju, P. K. Atrey, S. K. Pathak, U. C. Nagora, J. V. Raval, Y. S. Joisa, M. Kumar, K. Tahiliani, S. K. Jha, M. V. Gopalakrishna, J. Thomas, A. Kumar, and S. N. Pandya

Design, Development and Recent Experiments at the CIMPLE-PSI Device
M. Kakati, T. Sarmah, N. Aomoa, J. Ghosh, and G. De Temmerman

Activity of Indian High Heat Flux Test Facility
S. M. Belsare, S. S. Khirwadkar, R. Swamy, K. S. Bhope, S. Tripathi, T. Patel, P. K. Mokaria, N. Patel, M. Mehta, and K. Galodiya

Origin of Harmonics of Drift Tearing Mode in ADITYA Tokamak
H. Raj, J. Ghosh, A. Sen, R. L. Tanna, K. A. Jadeja, D. Raju, P. K. Chattopadhyay, and R. Pal

Leak Width in a Multicusp Field Configuration: A Revisit with a Versatile Experimental Device
M. Sharma, A. D. Patel, N. Subramanian, R. Ganesh, and P. K. Chattopadhyay

Effect of the Controlled Density Gradient on Equilibrium and Confinement in a Simple Toroidal Device with Two Plasma Sources
U. Kumar, R. Ganesh, K. Sathyanarayana, Y. C. Saxena, S. G. Thatipamula, and D. Raju

Imaging of SST-1 Plasma with LHCD Power
M. Kumar, P. K. Sharma, and V. Chaudhary

Characterization of Particle Growth and Enhancement of Sputtering Yields in a Cogenerated Dusty Plasma
J. Pramanik, P. Patra, and P. Bandyopadhyay

A Transmission Electron Microscopy Investigation of Defects Induced in Tungsten Foils by Au and B Ion Irradiation
P. Sharma, S. Akkireddy, P. N. Maya, A. Attri, P. M. Raole, A. K. Tyagi, P. K. Kulriya, P. K. Bajpai, S. Mishra, T. A. Trivedi, K. B. Khan, and S. P. Deshpande

Modelling Studies of X-Divertor Configuration on SST-1 Tokamak using SOLPS5.1
M. Himabindu, A. K. Tyagi, Deepti Sharma, Devendra Sharma, R. Srinivasan, Z. P. Chen, and S. M. Mahajan

Effect of Cathode Geometry on Magnetically Coupled Hollow Cathode Plasma Source
M. P. Bhuva, S. K. Karkari, and S. Kumar

Observations of Plasma Stimulated Electrostatic Sideband Emission and Harmonic Distortion: Evidence of Overdense Plasma Generation inside a Microwave Discharge Ion Source
C. Mallick, M. Bandyopadhyay, and R. Kumar

Radial Characteristics of a Magnetized Plasma Column
S. Das, S. K. Karkari

Investigations on Temperature Fluctuations and Energy Transport in ETG Dominated Large Laboratory Plasma
P. Srivastav, R. Singh, L. M. Awasthi, A. K. Sanyasi, P. K. Srivastava, R. Sugandhi, and R. Singh

Preliminary Results of Wall Conditioning Experiments using High Power ICRH System on SST-1 at Different Toroidal Magnetic Fields
D. Rathi, S.V. Kulkarni, K. Mishra, A. Varia, Sunil Kumar, Gayatri A., H.M. Jadav, Y.S.S. Srinivas, R. Joshi, Bhavesh

Kadia, K.M. Parmar, D. Raval, D. Raju, M.K. Gupta, R. Manchanda

Fully Noninductive 2nd Harmonic Electron Cyclotron Current Ramp-Up with Focussed Polarized Beams in the QUEST Spherical Tokamak
H. Idei, T. Onchi, T. Kariya, T. I. Tsujimura, S. Kubo, S. Kobayashi, M. Fukuyama, M. Yunoki, S. Kojima, M. Hasegawa, K. Nakamura, A. Ejiri, N. Matsumoto, K. K. Mishra, T. Imai, O. Watanabe, K. Kuroda, K. Hanada, Y. Nagashima, A. Higashijima, K. Nagata, R. Yoneda, G. Taylor, N. Bertelli, M. Ono, Y. Takase, A. Fukuyama, and S. Murakami

Broadband Characterization of High Temperature Blackbody Source with Fourier Transform Michelson Interferometer for ECE Measurements
A. Sinha, S. K. Pathak, S. Schmuck, and J. Fessey

Design and Development of 140 GHz D-Band Phase-Locked Heterodyne Interferometer System for Real-Time Density Measurement
U. C. Nagora, A. Sinha, S. K. Pathak, and P. Ivanov

Study of Iron Impurity Behaviour Using VUV Spectroscopy in ADITYA and ADITYA-U Tokamak
S. Patel, M. B. Chowdhuri, A. K. Srivastava, R. Manchanda, A. Bhattacharya, and J. Ghosh

Runaway Electron (RE) Mitigation Using Supersonic Molecular Beam Injection in the ADITYA-U Tokamak
S. Banerjee, H. Raj, J. Ghosh, N. K. Bisai, A. K. Singh, S. George, R. Manchanda, M. B. Chowdhuri, R. L. Tanna, J. V. Raval, Y. Paravastu, D. Chandra, and
A. Sen

Neon Gas Seeded Radiative Improved Mode in ADITYA-U Tokamak
M. B. Chowdhuri, J. Ghosh, R. L. Tanna, K. A. Jadeja, K. M. Patel, R. Manchanda, N. Yadav, P. Pandit, S. Patel, G. Shukla, K. Shah, H. Raj, L. T. Lachhvani,
S. N. Pandya, S. B. Bhatt, N. C. Patel, S. Banerjee, U. C. Nagora, S. K. Pathak, P. K. Atrey, J. V. Raval, Y. S. Joisa, M. V. Gopalakrishna, K. Tahiliani, C. N. Gupta, and P. K. Chattopadhyay

Impurity Screening in High Density ADITYA Tokamak Plasmas
R. Manchanda, M. B. Chowdhuri, N. Yadava, J. Ghosh, P. Pandit, S. Patel, G. Shukla, K. Shah, S. Banerjee, N. Nimavat, K. Tahiliani, M. V. Gopalakrishna, U. C. Nagora, P. K. Atrey, J. V. Raval, Y. S. Joisa, K. A. Jadeja, and R. L. Tanna

Radiation Power Loss Study during Gas Puff Induced Disruptions in ADITYA-U Tokamak
K. Tahiliani, M. B. Chowdhuri, M. V. Gopalakrishna, K. A. Jadeja, K. M. Patel, P. Kumari, U. C. Nagora, J. V. Raval, H. Raj, L. T. Lachhvani, S. N. Pandya , R. Manchanda, P. K. Atrey, S. K. Pathak, R. L. Tanna, J. Ghosh, and A. Kumar

Observations of Intrinsic Toroidal Rotation Using X-Ray Crystal Spectrometer in ADITYA-U Tokamak
K. Shah, G. Shukla, M. B. Chowdhuri, H. Raj, R. Manchanda, R. L. Tanna, K. M. Jadeja, K. Patel, K. B. K. Mayya, and J. Ghosh

Controlling Plasma Rotation Using Periodic Gas-Puff in ADITYA-U Tokamak
G. Shukla, K. Shah, M. B. Chowdhuri, H. Raj, R. Manchanda, R. L. Tanna, K. M. Jadeja, K. Patel, K. B. K. Mayya, and J. Ghosh

Effect of Externally Applied Radial Electric Field (Biased-Electrode) on Geodesic Acoustic Modes in SINP Tokamak
L. T. Lachhvani, J. Ghosh, T. Macwan, P. K. Chattopadhyay, N. Chakrabarty, and R. Pal

Application of TEM to Study the Changes in Subsurface Defects in Tungsten Samples as a Function of Annealing Temperature
S. Akkireddy, P. Sharma, P. N. Maya, P. K. Mokaria, S. Mishra, K. B. Khan, P. M. Raole, S. S. Mukherjee, and S. P. Deshpande

Effect of Multiple Periodic Gas Puff on Neutral Temperature in ADITYA-U Tokamak
N. Yadav, H. Raj, R. Dey, J. Ghosh, M. B. Chowdhuri, R. Manchanda, S. Banerjee, N. Nimavat, R. L. Tanna, K. A. Jadeja, K. Pate, and D. Tripathi

Design of a NIR Spectrometer for ADITYA-U Tokamak and Initial Results
P. Pandit, R. Manchanda, R. Dey, J. Ghosh, M. B. Chowdhuri, and S. Banerjee

Mass Dependent Impurity Transport Study in ADITYA Tokamak
S. Mishra, A. K. Singh, M. B. Chowdhuri, R. Manchanda, S.

Banerjee, K. A. Jadeja, K. M. Patel, R. L. Tanna, S. Varshney, and J. Ghosh

Plasma Potential Measurements in the Edge Region of ADITYA-U Tokamak Using Reciprocating Laser Heated Emissive Probes
A. Kanik, J. Ghosh, P. Pandit, and A. Sarma

Edge Current Density Profile Measurement Using an Array of Miniature Magnetic Probes in ADITYA-U Tokamak
T. Macwan, H. Raj, R. Kumar, D. Kumawat, S. Aich, K. A. Jadeja, K. M. Patel, R. L. Tanna, and J. Ghosh

Development of Multipurpose Soft X-Ray Tomography System for ADITYA-U
J. V. Raval, A. K. Chattopadhyay, Y. S. Joisa, S. Purohit, and P. K. Shukla

Ka-Band Reflectometer System for Measuring Radial Electron Density Profile at IPR
J. J. U. Buch, S. K. Pathak

Experimental Investigation of Power Coupling by RF Antenna into Plasmas in Presence of Magnetized Ions
J. K. Joshi, S. K. Karkari, and S. Kumar

A Diagnostic Approach for the Detection of Spatially Distributed Low Energy Confined Runaway Electrons in the ADITYA-U Tokamak by Means of Synchrotron Emission Imaging in the Sub-Millimetre Wavelength Band
S. P. Pandya, S. N. Pandya, A. E. Shevelev, V. V. Rozhdestvensky, and S. I. Lashkul

Design and Testing of X-Mode Reflectometry System for Coupling Studies of Lower Hybrid Waves in ADITYA-U Tokamak
J. Kumar, P. K. Sharma, K. Mahant, A. V. Patel, Y. Jain, K. K. Ambulkar, and C. G. Virani

Design and Development of Passive Charge Exchange Neutral Particle Analyser for ADITYA-U Tokamak
S. Aggarwal, P. Santosh, and K. Ajay

Excitation of Electron Temperature Gradient (ETG) Turbulence and Effect on Plasma Transport in LVPD
L. M. Awasthi, P. Srivastav, R. Singh, A. K. Sanyasi, P. K. Srivastava, R. Sugandhi, S. K. Singh , S. K. Mattoo, R. Singh, and P. K. Kaw

ADITYA Experimental Results of Core Ion Temperature Measurements on ADITYA Tokamak Using Four Channel Neutral Particle Analyser
K. Ajay, S. Aggarwal, and S. P. Pandya

Chord Average Density Measurement Using Microwave Interferometry in LVPD
P. K. Srivastava, P. Srivastav, A. K. Sanyasi, R. Sugandhi, P. K. Atrey, and L. M. Awasthi

Investigations on Growth of Quasi-Longitudinal (QL) Whistlers with Energy Scaling of Energetic Electrons in LVPD
A. K. Sanyasi, L. M. Awasthi, P. Srivastav, P. K. Srivastava, R. Sugandhi, and D. Sharma

Fast Wave Induced ICRF Plasma Expansion in ADITYA Torus
K. K. Mishra, S. V. Kulkarni, R. L. Tanna, R. Manchanda, N. Ramaiya, M. Gupta, J. Ghosh, A. Varia, M. Jadhav, R. Joshi, B. Kadia, K. Parmar, M. Parihar, Y. S. S. Srinivas, S. Kumar, D. Rathi, G. Ashok, K. A. Jadeja, and S. B. Bhat

Gas Fuelling Control System of ADITYA Tokamak
Narendra Patel, Chhaya Chavda, K. A. Jadeja, K. M. Patel, S. B. Bhatt, Joydeep Ghosh, R. L. Tanna and ADITYA Team

Integrated System Electronics and Instrumentation; Operation and Diagnostic for ADITYA-U Tokamak
R. Rajpal, C. J. Hansalia, P. Edappala, P. Kumari, P. Gautam, M. Shah, V. D. Raulji, B. Arambhadiya, A. Kumar, V. K. Panchal, and J. Ghosh

Plasma Column Position Measurements Using Magnetic Diagnostics in ADITYA-U Tokamak
S. Aich, R. Kumar, T. Macwan, D. Kumawat, R. L. Tanna, D. Raju, E. V. Praveenlal, M. Shah, K. A. Jadeja, K. M. Patel, C. N. Gupta, and J. Ghosh

A Nonlinear 2-Fluid Study of the Effect of Pellet Injection on ELM Dynamics
D. Chandra, A. Thyagaraja, and A. Sen

Burning Plasma Simulation with Particle Heating
U. Maurya, D. Banerjee, and R. Srinivasan

Analysis of Electron Cyclotron Wave Assisted Plasma Start-Up in SST-1
A. K. Singh, I. Bandyopadhyay, S. Banerjee, R. Srinivasan, and P. V. Subhash

Global PIC Simulation of RF Waves in Toroidal Geometry
A. Kuley, J. Bao, Z. Lin, S. Sharma, and A. Sen

Mode Converted Electrostatic Nonlinear Ion-Ion Hybrid Mode in Tokamak Plasma
J. K. Atul, L. Gupta, and P. K. Chattopadhyay

Numerical Relaxation of a 3D MHD Taylor–Woltjer State Subject to Abrupt Expansion
R. Mukherjee, R. Ganesh

ADITYA Up-Gradation Equilibrium Study
D. Sharma, R. Srinivasan, J. Ghosh, and P. K. Chattopadhyay

Electromagnetic Analysis of APPEL Linear Device Magnets
Y. Patil, P. Dutta, R. Srinivasan, and S. K. Karkari

Simulation of the Internal Kink Mode in Visco-Resistive Regimes
J. Mendonca, D. Chandra, A. Sen, and A. Thyagaraja

Application of the Semi-Implicit Numerical Method on the Radial Impurity Transport Equation and Determination of O4?? Emissivity with Two Separate PEC Databases
A. Bhattacharya, J. Ghosh, M. B. Chowdhuri, and P. Munshi

Dynamics of Neon Ions after Neon Gas Seeding and Puffing into Tokamak Plasma
N. K. Bisai, H. Raj, S. Banerjee, M. B. Chowdhuri, R. Dey, R. L. Tanna, R. Manchanda, K. A. Jadeja, and J. Ghosh

Study of Evolution of Trapped Particle Undamped Coherent Structures: An Important Agent in Intermittent Plasma Turbulence and Anomalous Transport
D. Mandal, D. Sharma, and H. Schamel

The Scrape-Off Layer Plasma Transport Physics Simulation Activity for Indian Tokamaks ADITYA and SST-1
D. Sharma, B. P. Sahoo, R. Srinivasan, R. Jha, J. Ghosh, A. K. Tyagi, M. Himabindu, X. Bonnin, and Y. Feng

Plasma Transport in Toroidally Discontinuous Limiter Generated 3D SOL Configurations of ADITYA Tokamak
B. P. Sahoo, D. Sharma, R. Jha, and Y. Feng

Studies of the Gas Puff Effect on Edge Plasma of ADITYA Tokamak Using Coupled DEGAS2-UEDGE Code
R. Dey, H. Raj, M. B. Chowdhuri, J. Ghosh, K. A. Jadeja, K. M. Patel, N. C. Patel, R. L. Tanna, R. Manchanda, S. Banerjee, R. Srinivasan, D. Sharma, U. C. Nagora, P. K. Atrey, J. V. Raval, Y. S. Joisa, P. K. Chattopadhyay, D. P. Stotler, and T. D. Rognlien

Outcome of R&D Programme for ITER ICRF Power Source System
R. G. Trivedi, A. Mukherjee, R. Singh, K. Rajnish, D. G. Soni, S. Verma, G. Suthar, A. Jha, A. P. Subbarao, M. Patel, R. Anand, R. Agarwal, K. Mohan, J. V. S. Harikrishna, H. Machchhar, P. Vasava, H. Patel, H. Dalicha, U. K. Baruah, A. Patel, N. P. Singh, N. S. Goswami, K. R. Mehta, D. V. Upadhyay, H. Dhola, A. E. White, D. Francois, J. Sainz, and K. Kozard

Technologies for Realization of Large Size RF Sources for -ve Neutral Beam Systems for ITER: Challenges, Experience and Path Ahead
J. Joshi, A. K. Chakraborty, H. Patel, M. Singh, M. Bandyopadhyay, E. Pfaff, J. Schäfer, C. Eckardt, A. Metz, and M. Gelfert

Progress in the ITER Neutral Beam Test Facility
V. Toigo, D. Boilson, T. Bonicelli, A. K. Chakraborty, M. Kashiwagi, C. Rotti, and P. Sonato

Preliminary Pipe Stress Analysis of High Pressure, High Temperature Experimental Helium Cooling System
A. K. Verma, B. K. Yadav, A. Gandhi, and E. Rajendra Kumar

Experimental Measurements of Cryogenic Heat Loads on SST-1 Helium Cryogenic Plant
N. Bairagi, V. L. Tanna, P. N. Panchal, R. N. Panchal, D. Sonara, R. Patel, G. Mahesuria, G. L. N. Srikanth, A. Garg, D. Christian, R. Sharma, K. Patel, H. Nimavat, P. Shah, G. Purwar, J. C. Patel, G. K. Singh, U. Prasad, A. K. Sahu, R. Srinivasan, and D. Raju

Thermo-Mechanical Experiments on Lithium Titanate Pebble Bed
R. Bright, P. Chaudhuri, M. N. Makwana, S. Gupta, M. Panchal, A. Shrivastava, E. Rajendra Kumar, C. Zhang, and A. Ying

The Operation, Control, Data Acquisition System of ASDEX Pressure Gauge for Neutral Pressure
K. Patel, K. A. Jadeja, A. Kumar, and J. Ghosh

Progress on Lithium Ceramic Breeder Materials Development, Characterization and R&D Activities in IPR

P. Chaudhuri, M. Panchal, A. Shrivastava, M. N. Makwana, and S. Kanjiya

Machine Control System for Large Volume Plasma Device: Current Status and Future Directions
R. Sugandhi, P. K. Srivastava, P. Srivastav, A. K. Sanyasi, and L. M. Awasthi

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VME system based technique for IGBT switching and current control
Dinesh Kumar Sharma, Akhilesh Kumar Singh and Subrata Pradhan

Light, Energy and the Environment Congress, Sentosa Island, Singapore, 5-8 November 2018

A Novel Rapid Scanning Fourier Transform Spectrometer for the Measurement of Electron Cyclotron Emission in a Plasma Fusion Reactor
David Naylor, Brad Gom, Sudhakar Gunuganti, Trevor Fulton, Hitesh Pandya, Vinay Kumar

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Experimental investigation of plasma torch dynamics using magnetic diagnostics
Ganesh Ravi, Vidhi Goyal and Subroto Mukherjee

Magnetic Field Induced Anode Sheath Transition in Modified Hollow Cathode Discharge
Ramkrishna Rane, Kushagra Nigam, P. Bharathi, Alphonsa Joseph, Subroto Mukherjee

Study the excitation of high frequency waves and its effect on plasma properties in weakly magnetized capacitive discharge.
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Magnetization effect on secondary electron emission in a hollow cathode plasma source
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Exploring Role of Reynolds and Maxwell Stress towards shear layer formation in ETG turbulence dominated Large Laboratory Plasma
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A New Unified Understanding of Electron and Ion Normal Modes in a 1D Electrostatic Vlasov-Poisson Plasma
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Temperature Fluctuation Measurement in Electron Temperature Gradient (ETG) turbulent plasma of Large Volume Plasma Device (LVPD)
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Control of Magnetohydodynamic modes by periodic gas-puffing in ADITYA and ADITYA-Upgrade Tokamak
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Sequential steady state co-rotating dust vortices in sheared streaming plasma
M. Laishram, D. Sharma, and Ping Zhu

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Estimation of effective thermal conductivity for lithium meta-titanate (Li_2TiO_3) pebble beds using steady state and axial heat flow methods
Maulik Panchal, Abhishek Saraswat, Shrikant Verma, Paritosh Chaudhuri

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Plasma processing of textile components for enhanced service life
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Thermal Simulations of Microwave Mirror for ECRH Launcher
Hardik Mistry and B K Shukla

Experimental Technique and Precautions for Measurement of Standing Wave Patterns inside the Rectangular Waveguide
Jitendra Kumar, Amol Deshpande, Raj Singh and Anitha V. P.

Implementation of Line Type High Voltage Nanosecond Impulse Generator
Amol Deshpande, G Veda Prakash, Raj Singh and Anitha V. P.

Brazing and mechanical testing of Cu-Alumina for the development of vacuum window for LHCD system of Aditya-U tokamak
Y. M. Jain, P. K. Sharma

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Hitesh B. Pandya, Ravinder Kumar, S. Danani, P. Vaghashiya, Vinay Kumar

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Interplay Between Kinetic and Magnetic Energies in Three Dimensional Magnetohydrodynamic Plasma
Rupak Mukherjee, Rajaraman Ganesh and Abhijit Sen

Effective Secondary Electron Emission Coefficient in Glow Discharge Plasmas
Saravanan A, Prince Alex, Suraj K S,

Breaking of Nonlinear Plasma Oscillations against an Ion-pulse/Cavity: A Particle-inCell Simulation Study
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Wave Breaking of Nonlinear Relativistic Electron Plasma Wave in Inhomogeneous Plasma
Mithun Karmakar, Nikhil Chakrabarti, Sudip Sengupta

Conceptual Design and Prototyping of 2-D Probe Positioning System for Large Volume Plasma Device
P. Chauhan, R. Sugandhi, A. K. Sanyasi, P. Srivastav, P. K. Srivastava, M. K. Gupta, B. R. Doshi and L. M. Awasthi

Synchronization dynamics between three inductively coupled DC glow discharge plasma Sources
Neeraj Chaubey, S. Mukherjee and A. Sen,

Design and Analysis of Plasma Diagnostic Supports Structure and Mechanisms for Aditya-U Tokamak
Gupta Manoj Kumar, Doshi Bharatkumar, Jayswal Snehal,Biswas Prabal,Gupta Pratibha, Buch Janmejay, Pathak Surya Kumar, Tahiliani Kumudni, Meduri Gopala Krishna

Validation of Smartex-C Vacuum Vessel Heating Results with Fem Analysis and Prospective Conceptual Cooling Design Schemes
Ritesh Kumar Srivastava, Manoj Kumar Gupta, Bharat Doshi, Lavkesh Lachhvani, Manu Bajpai, Yogesh Yeole

Amplification of energetic electrons driven whistler mode by loss cone induced reflected particles
K. Sanyasi, Prabhakar Srivastav, P.K. Srivastava, R. Sugandhi and L.M. Awasthi

Finite Beta Effect on Turbulent Particle Transport in ETG Plasma
Prabhakar Srivastav, Rameswar Singh, L. M. Awasth, A. K. Sanyasi, P. K. Srivastava, R. Sugandhi, and R. Singh

Electron Temperature Control using Multi- Grid Biasing System in Prototype Double Plasma Device
Prince Alex, A. K. Sanyasi, Prabhakar Srivastav, P. K. Srivastava, R. Sugandhi, and L. M. Awasthi

Injection of Electrons in SMARTEX – C
Manu Bajpai, Yogesh G. Yeole and Lavkesh T. Lachhvani

Global Particle Balance in a 13.56 MHz Magnetized Parallel Plate Capacitive Discharge
S. Binwa, a, Y.Patil, S. K. Karkari, b and L. Nair

Envisaging Space Propulsion Experiment in a Helicon Plasma Source
P. K. Saha, M. Chakraborty, N. Sharma, N.K. Neog, M. Bandyopadhyay

Axial characterization of a segmented cylindrical capacitively coupled plasma source by triple Langmuir probe
J.K. Joshi, S. Binwa, S.K. Karkari and Sunil Kumar

Biased Hairpin Probe in Magnetized Plasma Column
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Particle-In-Cell Simulation of Nonlinear Plasma Oscillations in Inhomogeneous Warm Plasma
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Study of origin of Electron Acoustic Modes in a 1D Vlasov Plasma: A numerical approach Sanjeev Kr. Pandey, P. Trivedi, R. Ganesh
Plasma Containment by Magnetic field Configurations having good and bad Curvature of Magnetic field lines
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Effect of Radiation Reaction on Charged Particle Motion in a Electromagnetic Wave and a Constant Uniform Axial Magnetic Field.
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Particle-In-Cell Simulation of Bernstein-Greene-Kruskal Structures in A Cold Current Carrying Plasma
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Ion Phase Space Structures in Driven 1D Vlasov- Yukawa Systems

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Enrichment of SMARTEX-C Data Acquisition System
Vishnu Patel, Imran Mansuri, Atish Sharma, Yogesh Yeole, Lavkesh Lachhvani, Manu Bajpai, Kirti Mahajan and DAC Division

Optical Emission Spectroscopy of Atmospheric Pressure Micro Plasmas under the Influence of Strong Magnetic Field
Kalyani Barman, Mohit Mudgal, Sudeep Bhattacharjee, S. K. Nema and Ramkrishna Rane

Study of Nonlinear Plasma Oscillations in Quantum Plasmas
Ratan Kumar Bera, Amita Das, and Sudip Sengupta

Transport of Test Particle in Magnetohydrodynamics
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Identification of Low frequency Zonal Flow like mode in IMPED
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Highlights and Achievements of Cryogenic System for SST-1
V. L. Tanna and SST-1 Cryo Team

Two Fluid Simulations of Internal Kink (M=1) Modes
Jervis Ritesh Mendonca, Debasis Chandra, Abhijit Sen, Anantanarayanan Thyagaraja

Erection, Testing and Commissioning of 31.5MVA, 132/11.2kV Power Transformer at 132kV IPR Substation
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Operational Experiences of 42 GHz gyrotron system with PXIe based Data Acquisition and Control system
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Interface of Arduino Based PWM Pulse Generation Using Labview for ICRH-DAC Software
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Commissioning of 12kV Light Triggered Thyristor based Solid State Crowbar System Kirit M Parmar, Bhavesh R Kadia, Y S S Srinivas, S V Kulkarni, Sunil Kumar and High Power ICRH Systems Division

Mdsplus Integration with LHCD DAC Software
Ramesh Joshi, ChetanVirani, P K Sharma & LHCD group

Packed Bed Column Performance and Mass Transfer Characteristics for Hydrogen Isotope Separation Process
Sudhir Rai and Amit Sircar

Optics of Aperture Offset for Focusing of High Power Ion Beamlets
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Development of Software Analyzers on Modbus for Integration and Commissioning of an Experimental System: An Investigation in Large Volume Plasma Device
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Design of Gravity Compensated Remote Handling Arm
M. Manoah Stephen, N. Ramasubramanian

Mechanical engineering design, analysis, manufacturing, inspection and testing support for the In-house R&D projects and opportunity to extend the support to other R&D Institutions in India
Bharat Doshi and MESD team

Development of a Fast Response Controller for Ionization Gauge Working in UHV Range M. M.S. Khan, Abhijeet kumar, Kumarpalsingh Jadeja, Sanjay Parmar, Ziauddin Khan

Applications of Magnetic Pulse Welding Technology in Tokamak Fusion Machines Bharatkumar Doshi

FPGA based programmable delay circuit for Synchronization studies in the dc-glow discharge plasma system.
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Experimental Setup to Prepare Ppm Level of Hydrogen in Helium Gas Mixture
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Conceptual Design and Development of Upgraded Electronics for Bolometer Diagnostic Praveena kumari, Kumudni Tahiliani, Rachana Rajpal

Tungsten Deposition on Graphite Substrates Using a Cylindrical Magnetron and High Heat Flux Studies
A. Satyaprasad, R. Rane, Nirav I Jamnapara, S. Belsare, G. Ravi, P. Kikani, S. Khirwadkar, S. Mukherjee,

Thermo-Structural Analysis of Radiation Shield of SST-1 Cryopump
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Effect of Contact Angle on Stress-Strain Characteristics of Nb_3Sn-Nb_3Sn and Nb_3Sn Copper strands in superconducting cable using FEA
M. Ghate, S. Chauhan, P. Raj, U. Prasad, R. Srinivasan

Ion Dynamics Study in an Inertial Electrostatic Confinement Fusion Device and its Application in Explosive Detection
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Rise in Input Density Effect on Diffusive Plasma Transport Properties in the Scrape off Layer of Tokamak Aditya
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DAQ Development for Prototype MgB_2 current lead test facility
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Supriya Nair, Chandra Kishor Gupta, Prakash Parmar, Chirag Bhavsar

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Performance of Up-graded VME Based Data Acquisition System for Superconducting Magnets Sensors of SST-1
Pankaj Varmora, Bhadresh Parghi, Moni Banaudha, Magnet System Division, Upendra Prasad and R. Srinivasan

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Architecture of Neutral Beam Injectors

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Anees Bano, Upendra Prasad, R Srinivasan, Magnet System Division

Conceptual Design Study of a Laboratory Scale HTS Solenoid
Swati Roy, Piyush Raj, Deven Kanabar, Mahesh Ghate, Arun Panchal, D.Bhavsar, Upendra Prasad and R. Srinivasan

Development of Quench Detection System for PF#3 Coils of SST-1
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Preliminary Engineering Design Study of Compact HTS based TF Coil
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Simulation Tool for Designing Safety Relief Circuit of Cryogenic Volume in Fusion Devices
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Initial Results from a Low Cost Electrostatic Confinement Fusion Device at IPR
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Upendra Prasad, Magnet System Division and R. Srinivasan

Pumping Speed Effect on Glow Discharge Wall Conditioning in Aditya Upgrade Tokamak Vacuum Vessel
K. A. Jadeja, K. M. Patel, J. Ghosh, B. G. Arambhadiya, Kiran Patel, R.L. Tanna, Tanmay Macwan, Minsha Shah, M. B. Chowdhuri, R. Manchanda, Rohit Kumar, Suman Aich, Rachana Rajpal, C. N. Gupta, D. C. Raval, Ziauddin Khan, P. K. Chattopadhyay and AdityaU Team

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Optical Emission Spectroscopy of Laterally Colliding Carbon Plasmas
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Measurement of Electron Temperature and Negative Ion Concentration Using Biased Hairpin Resonator Probe
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Density Measurement Techniques for Negative Hydrogen Ion Source
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Reinstallation of ADITYA Thomson Scattering System with Modified Calibration Facility P. K. Mishra, Neha Singh,

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Radial Plasma Column Movement Measurements Using Soft X-Ray Diagnostics in Aditya-U
Jayesh Raval, Sameer Kumar, Tanmay Macwan, Manoj Kumar, Shantanu Banerjee, Kumudni Asudani and Aditya Team

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Upgrade Design of Detection Sub-system for SST-1 Thomson Scattering Diagnostic
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Power Balance Studies in the Aditya – Upgrade Tokamak
M.V. Gopala Krishna, Kumudni Tahiliani, Sameer Kumar, Praveena Kumari, K.A. Jadeja, K. Devi Lal, S.K. Pathak

Image Analysis of Magnetized dc Plasma Using Singular Value Decomposition
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Global Particle Balance and Wall Recycling Study for Aditya – U Tokamak
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Conceptual Design of a Tomographic System for Helicon Plasma Device
Dipshikha Borah, A. Pandey, H. Tyagi, D. Mukhopadhyay, A.K. Chattopadhyay, M. Bandyopadhyay

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G Shukla, K Shah, M.B. Chowdhuri, R. Manchanda, K. B. K. Mayya, K.A. Jadeja, R.L. Tanna, J Ghosh and ADITYA-U Team

Observation of Argon Impurity Lines in ADITYA-U Tokamak using Spectroscopic Diagnostic
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Uniform Software for Data Acquisition Systems of all SST-1 Diagnostics
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Finite Temperature and Magnetic Shear Induced Stabilization of Multiple Instabilities in Convective Fluid Plasma Transport Scenario.
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Coil Optimization to Maximize Projectile Velocity for a Simple Capacitor Bank Parameters
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Plasma Stream Parameter Measurement in Pulsed Plasma Accelerator Using Optical Emission Spectroscopy
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2D Transient Magnetic Field Analyses of Linear Induction Motor
Ananya Kundu, Pedada Prasada Rao, Y.S.S. Srinivas, Vilas C. Chaudhari, Arvind Kumar, Ankur Jaiswal, Anita Patel, E.Rajendra Kumar

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Characterization of Carbon Dust Formation and Enhancement

of its Growth in a DC Sputtering Discharges
J. Pramanik, P. Patra, P. Bandyopadhyay

Staggering transverse shear waves in strongly coupled dust fluid
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Synchronization of Weakly Nonlinear Dust Acoustic Waves
Ajaz A. Mir, Sanat K. Tiwari, Abhijit Sen, Gurudas Ganguli, Chris Crabtree, Bin Liu, and John Goree

Characterization of Carbon Dust Formation and Enhancement of its Growth in a DC Sputtering Discharges
J. Pramanik, P. Patra, P. Bandyopadhyay

Study of Non-equilibrium Steady State in Rayleigh-Benard Convection of Yukawa liquids using Molecular Dynamics
Pawandeep Kaur, Harish Charan, R.Ganesh

Effect of Two-temperature Electrons on Plasma Sheath in a Collisional Magnetized Plasma
G. Sharma, S. Adhikari, R. Moulick, S. S. Kausik, B. K. Saikia

Magnetized Plasma Sheath in Presence of Negative Ions
R. Paul, S. Adhikari, R. Moulick, S. S. Kausik, B. K. Saikia

Effect of Ion Temperature on Plasma Sheath in Presence of Oblique Magnetic Field
K. Deka, S. Adhikari, R. Moulick, S. S. Kausik, B. K. Saikia

A Dust Particle Based Technique to Measure the Potential Profile in a Plasma
Garima Arora, P. Bandyopadhyay, M. G. Hariprasad, and A. Sen

Formation of Finite Coulomb Clusters through Controlled Particle Additions
M. G. Hariprasad, P. Bandyopadhyay, Garima Arora and A. Sen

Study of Melting Dynamics Triggered By Localized Perturbation in Crystalized Dusty Plasma Layers
Srimanta Maity, Sandeep Kumar, and Amita Das
In-situ Ion Heating via a New Absorption Mechanism with pulsed CO2 Laser in Presence of an External Magnetic Field
Atul Kumar, Chandrasekhar Shukla, Deepa Verma, Amita Das, and Predhiman Kaw

Diamagnetism in Expanding Plasma Plume
Narayan Behera, R. K. Singh and Ajai Kumar

Numerical Study of Laser Induced Blow-off Shock Wave from 10 μm Al Foil in Glass Confinement and Its Comparison with Experiments
S Sai Shiva, Nagaraju Guthikonda, D. P. S. L. Kameshwari, C. D. Sijoy, V. R. Ikkurthi, S. Chaturvedi, P. Prem Kiran

Study of Laser Pulse Width Dependence on Ablation of Thin Film and Plasma Plume Propagation
Jinto Thomas, Hem Chandra Joshi, Ajai Kumar and Reji Philip

Optical Emission Spectroscopic Studies of Ultrashort Laser Produced Graphene Oxide Plasma
Parvathy N, Anju K Nair, Jemy James, Pranitha Sankar, Rahul M T, Sivakumaran Valluvadasan, Ravi A V Kumar, Reji Philip, Sabu Thomas, Nandakumar Kalarikkal

2D Simulation of Electron Transport in Magnetized DC Glow Discharge Using COMSOL Multiphysics
Y. Patil, S. Karkari

Quasi-steady States of Toroidal Pure Electron Plasmas: A Numerical Approach
S. Khamaru, M. Sengupta, R. Ganesh

Numerical Simulation of Plasma Transferred Arc Characteristics Using Fourier Transforms
Satya Prakash Reddy Kandada, and C. Balasubramanian

Burning Plasma Simulation with Alpha-Particle Heating
Udaya Maurya, Debabrata Banerjee, R. Srinivasan

Simulation Study of High Current Density Miniaturized Pseudospark Based Sheet Electron Beam Source
N. Gurjar, Afaque M. Hossain, V. P. Anitha, R. Singh and N Kumar

Impurity Modelling for the Study of Start-Up and Burn-Through Phases in Tokamaks with the 0d Code
Amit K. Singh, Kshitij Sharma, Santanu Banerjee, I. Bandyopadhyay, R. Srinivasan, and P.V. Subhash,
Investigation of Machine Learning Algorithms on Estimation

of Neutral Beam
Properties
Arnab Jyoti Deka, Mainak Bandyopadhyay, Bharathi P

2D PIC-MCC Simulations Based Study of Evolution of Electron Energy Distribution Function for Understanding Plasma Transport across Magnetic Filter
Miral Shah, Bhaskar Chaudhury, Mainak Bandyopadhyay, Arun Chakraborty

Formulation and Computation of ICRH antenna-plasma coupling using Brussels Antenna Coupling Code (BRACC) for the Tokomak Plasma
A. K. Shaw, D. Sharma, A. Mukharjee and S. Chaturvedi

Anode Fireball for Making Super-Hydrophobic Nanodot Surfaces
M. Ranjan, S. Chauhan

Investigation of Mechanical, Structural and Corrosion Resistance Properties of AISI Low Alloy Steel after Incorporating Nitrogen and Carbon in Subsurface by Plasma Assisted Difussion Processes
J. Alphonsa, G. Jhala, A. Vaid, S.B. Gupta, K. Kalaria, N. Vaghela, S. Mukherjee

Pulsed Laser Deposition-A Versatile Technique for Depositing Thin Films of ComplexOxides
Snehlata Aggarwal, S. Nawaz and V. R. Palkar

Preliminary Design of Primary Chamber of Large Scale Plasma Waste Disposal System
A.N. Mistry, A. Sanghariyat, P.V. Murugan, S.K. Nema

Development of Rotatable Magnetron
Sagar Agrawal

Plasma Nitriding of Maraging Steel C300 for Improvement of Wear Resistance and Tensile Properties
Nand Kumar, B. Ganguli, S. Sharma, B. Roy, B. Deb

Influence of Atmospheric Pressure Air Plasma on the Surface Properties of Raw Knitted Cotton Fabric
Nisha Chandwani, Vishal Jain, Kushagra Nigam, Adam Sanghariyat and S.K.Nema

Design and Development of a Power Source for a Novel Electrical Model of Underwater DBD Air Plasma Jet for Generating Plasma Activated Water
Vishal Jain, Adam Sanghariyat, Sudhir Kumar Nema,

Development of Plasma Sterilisation system for medical components
Akshay Vaid, S.K.Gupta, Anshu Srivastava, Bharathi.P, Naresh Vaghela, Kamala K. Vasu, K. Kalaria, Manish Nivsarkar, S.K.Nema

The Anode Glow Formation and Its Effect on Thin Film Deposition in a Hollow Cathode Cylindrical Magnetron (HCCM) Discharge
R. Rane, A. Joseph and S. Mukherjee

Comparison of Conventional Plasma Nitriding and Radical Nitriding Processes on 16mncr5 at Different Process Parameters.
Ghanshyam Jhala, Alphonsa Joseph, Saisikha Naidu, Bharati Mahesh

A Study of RF (13. 56 MHz) Air Plasma Treatment Effect on Carbon Fiber to Improve Interface Layer Coating Properties for Carbon Fiber Based Composites Applications
C. Jariwala, Sonam H. Suthar, N. Chandwani and N. Chauhan

Development of Non Thermal Plasma Torch (NTPP) for enhancing surface energy of HDPE
Adam Sanghariyat, Chirayu Patil, Nisha Chandwani, Vishal Jain, Royal Christian, Sudhir Nema

Development and Characterization of Non-Thermal Atmospheric Pressure Plasma Jet Array for Application of Large Area Treatment
Chirayu Patil, Akshay Vaid, Adam Sanghariyat, Ramkrishna Rane

Safe Disposal of Solvent Waste Using Thermal Plasma Technology
P. Vadivel Murugan, A.Sanghariyat, C.Patil, F.Bhabhor, S.K.Nema

Development of High Voltage DC Source for Corona Formation Using Half Wave Cockcroft-Walton Voltage Multiplier Circuit
Anand Visani

Testing and Development of Cost Effective Microwave Source (1KW, 2.45GHz) Based on Magnetron for Plasma Interaction Experiments
Jitendra Kumar, G. Veda Prakash, Raj Singh and Anitha V. P.

Design of 14.5 Ghz Multi-Charge ECR Ion Source
Ratnesh Kumar and Sudhirsinh Vala

First Principle Studies of Multiferroic Pbfe0.5Ti0.5O3
Snehlata Aggarwal

Fabrication of Tungsten Coated Graphite Tiles for Aditya Upgrade Tokamak
Sachin S. Chauhan, Uttam Sharma, Jayshree Sharma, A.K. Sanyasi, J. Ghosh, Nandini Yadava, K K Choudhary, S. K. Ghosh

Impact of Pre-Sowing Treatment of Seeds with Plasma on Germination and Growth of Soybean and Maize
Sachin S. Chouhan, Uttam Sharma, KN Guruprasad, Jayshree Sharma, Ramkrishna Rane, J. Ghosh

Simulation of Plasma Based Chemical Processes
H. L. Swami, R. Srinivasan, Shashank Chaturvedi

Numerical Modeling of A Circularly Interdigitated Piezoelectric Micro-Actuator Using Comsol Multiphysics
Snehlata Aggarwal

Oxygen Diffusion Barrier Properties of Plasma Deposited SiOx Films on Low Density Polyethylene
Purvi Dave, Nisha Chandwani and S. K. Nema

Excitation and dynamics of spiral structures (wave) in strongly coupled dusty plasmas Sandeep Kumar, Amita Das, and Bhavesh G. Patel

High Frequency, Global Geodesic Acoustic-like Mode in a Simple Magnetized Toroidal Plasma: An Experimental Study
Umesh Kumar, R. Ganesh, K. Sathyanarayana and Y. C. Saxena

Study of Plasma Transport due to Electron Temperature Gradient Induced Turbulence in Laboratory Plasma
Prabhakar Srivastav, L. M. Awasthi, Rameswar Singh, A. K. Sanyasi, P. K. Srivastava, R. Sugandhi, and R. Singh

FEA Investigation for Support Structure towards Installation of Prototype Magnet Test Cryostat
Hemang Agravat, Mahesh Ghate, Arvindkumar Tomar, Upendra Prasad, R. Srinivasan

Characterization and Tribological Evaluation of TiAlN Thin Films Deposited by Reactive Magnetron Sputtering
Parth D. Tilavat, B.M. Patel, B. Ganguli, G. Avasthi

Software Simulation of Field Devices using Python for ITER-India Gyrotron Test Facility
Deepak Mandge, Vipal Rathod, Ronak Shah, Rajvi Parmar, Sharan Dilip, Amit Yadav, Anjali Sharma, and S. L. Rao

Design of Sectorial E Plane Horn Antenna and Vacuum Window for X-mode Reflectometry System for ADITYA-U tokamak
Jagabandhu Kumar, Keyur Mahant, A V Patel, Kiran K Ambulkar and P.K. Sharma

International Conference on Renewable and Alternate Energy (ICRAE-2018), Assam Science and Technology University, Guwahati, 4-6 December 2018

Plasma material interaction studies of Tungsten under ITER relevant plasmas
Trinayan Sarmah and M. Kakati

Fusion Energy: A sustainable source for future generation
Pubali Dihingia, Trinayan Sarmah, Monmoyuri Baruah and M. Kakati

Inertial electrostatic fusion: A source for societal applications
N. Buzarbaruah, D. Jigdung, D. Bhattacharjee, and S. R. Mohanty

7th International and 45th National Fluid Mechanics and Fluid Power Conference (FMFP) 2018, IIT Bombay, Mumbai, 10-12 December 2018

Numerical Study of the Effect of Fuel Distribution on Single Shot Thrust in Pulse Detonation Engine Operating with Octane Air Propellant
Sunil Bassi, Manika Sharma, Shashank Chaturvedi

DAE-International Symposium on Nuclear Physics, BARC, Mumbai, 10-14 December 2018

Measurement of $^{93}Nb(n,2n)^{92}Nb$ cross-section at different neutron energies
Mayur Mehta, N. L. Singh, P. V. Subhash, Rajnikant Makwana, Rakesh Chauhan, Ratankumar Singh, H. Naik, S. Mukherjee, S.V. Suryanarayana, Mitul Abhangi, Sudhirsingh Vala, Naveen Agrawal, Nidhi Shetty, R. Acharya

14th International Conference on Fiber Optics and

Photonics (Photonics-2018), Indian Institute of Technology Delhi, New Delhi, India, 12-15 December 2018

FBG Interrogation using SMS and OTDR for simultaneous measurement of temperature and strain
K Dey, Sourabh Roy, BR Kumar, M. Sai Shankar

National Welding Seminar & Young Welding Professional's Conference, Kochi, 13-15 December 2018

Welding Distortion Assessment for Hydraulic Connections of Neutral Beam Accelerator Grid
A Yadav

Characterization of dissimilar weld joints of copper to SS using Inconel Transition by Orbital TIG technique
A Yadav

25th IEEE International Conference on High-Performance Computing, Data, and Analytics, Bengaluru, India, 17-20 December 2018

Parallel & Distributed Computing (PDC) Using Low Cost, Compact and Portable Raspberry Pi Mini Cluster
Deepak Aggarwal, Prashant Kumar, Harish Charan, and Hemant Joshi

Conference & exhibition on non-destructive evaluation (NDE 2018), CIDCO Exhibition & Convention Centre, Mumbai, 19-21 December 2018

Simulation Studies on Inspection Possibilities of Curved Cu-W Monoblock Assembly using Ultrasonic Circular Phased Array
Kedar Bhope, Mayur Mehta and Samir Khirwadkar

IEEE International Conference on Circuit and Systems in Digital Enterprise Technology, Kottayam, Kerala, 21-22 December 2018

Development of digital control system in LabVIEW for stepper motor drives
Ravinder Singh, Ritesh Sugandhi, Gurpreet Kaur Khalsa, Dharmik Trivedi, Prabhakar Srivastava and Lalit Mohan Awasthi

Intelligent Computing Techniques for Smart Energy Systems (ICTSES 2018), Manipal University Jaipur, Jaipur, India, 22-23 December 2018

Real Time High Speed Novel Data Acquisition system based on ZYNQ
Himanshu Tyagi, Nagendra Gajjar, Mainak Bandyopadhyay, Arun Chakraborty

Lectures at DST-SERB school on Ultrahigh Intensity Laser Produced Plasmas: Physics and Applications, RRCAT Indore, 7-25 January 2019

Intense Ultra-relativistic electron beam driven wake field in a cold plasma
S. Sengupta

27th National Symposium on Cryogenics and Superconductivity (NSCS-27), IIT Bombay, Mumbai, 16-18 January 2019

Development of Lab Scale Subcooled Liquid Nitrogen Facility for HTS Applications
Nitin Bairagi, H. Nimavat, D. Sonara and V. L. Tanna

80 K Helium Test Facility and Upgradation to Sub-cooled Liquid Nitrogen Temperature Level
Hitensinh Vaghela, Ketan Choukekar, Pratik Patel, Vinit Shukla, Anuj Garg, Srinivasa Muralidhara, Vikas Gaur, Shk Madeenavalli and Bikash Dash

Thermo-structural analysis of Radiation shield of SST-1 Cryopump
Vishal Gupta, Vipul L. Tanna, Ranjana Gangradey, Samiran Mukherjee

High Field Operational Performances of Superconducting TF coils of SST-1
Upendra Prasad, P. Varmora, B. Parghi, M.Banaudha, A. R. Makwana, C. Dhodiya, P. Raj, S. Roy ,D. Kanawar, A Panchal, D. Bhawsar, N. Kumar, A.Bano. M.Ghate, Y.Singh, D. Raju, R. Srinivasan and SST-1
Team

Quench Dynamics Study in 2nd generation HTS Tapes
Upendra Prasad, A. Bano, Moni Banaudha and R. Srinivasan

Numerical and Experimental Investigation of 80K Thermal Shield assembly of 1st Pre-Series Cryoline (PTCL) of ITER cryolines
Uday Kumar, K. Choukekar, M. Jadon, H. Vaghela, H. Kapoor, A. Garg, S. Muralidhara, B. Dash, V. Gaur, S. Madeenavalli, P. Patel, V. Shukla, Y. Sarvaiya, N. Shah, B. Sarkar, B. Joshi, R. Panjwani
Efforts to mitigate direct heat in-leaks in SST-1

Hiren Nimavat, Dasarath Sonara, Ketan Patel, Pankil Shah and Vipul Tanna

Test Results of Indigenous Prototype 3-Stream (He/He/He) Plate-Fin Heat Exchanger of He Plant
Mishra V, Sahu A K, Sharma P , Shah B , Mahapatra O, Dave H, Kavad H, Bhatasana R, Chandratre O, Kumar N and Brahmbhatt P

Present Status and Future Plan of Indigenous IPR Helium Refrigerator/Liquefier
Sahu A K and LCPC Division

Test Set-up and Results of Indigenous Prototype 80 K Helium purifier of He Plant
Sahu A K, Boda N, Pandya D, Brahmbhatt P, Bohra D, Behera A, Prajapati D, Arya B, Kavad H, Dave H, Bhattasana R, Chandratre O and Kumar N

Conceptual Design of 1 kA Conduction Cooled Current Leads for HTS Coils
Atul Garg and V.L. Tanna

In The Quest of High Tc Multiferroic material
Snehlata Aggarwal, M. Aggarwal

LIGO-India Session, Conference on Multi-messenger Astronomy in the Era of LIGO-India, Dukes Retreat, Khandala, 17 January 2019

Data Acquisition and Control System
Amit Kumar Srivastava, Hitesh Kumar Gulati, Arnab Das Gupta and S. Mukherjee

International Conference on Advances in Nanomaterials and Devices for Energy and Environment (ICAN-2019), Gwalior, 27-29 January 2019

Synthesis, Optimization and Characterization of ZnO nanoparticles prepared by sol-gel technique
Mudit Singh, Dipali Vadher, Vishwa Dixit and C. Jariwala

International conference on High voltage engineering and technology, Begumpet, Hyderabad, 7-9 February 2019

High voltage behaviour of large size air insulated Coaxial Transmission Line
Bhavin Raval, Vikrant Gupta, Dishang Upadhya, Niranjan Goswami, Kush Mehta, N.P.Singh, Rasesh Dave, Sandip Gajjar, Amit patel,Hitesh dhola, Aruna Thakar, Ujjwal Baruah

International Conference on Recent Trends in Nanomaterials for Clean Energy (ICRTNCE-2019), S. V. National Institute of Technology, Surat, 16-17 February 2019

Effects of varying pH in Synthesis of ZnO Nanoparticles using Sol-Gel technique
Mudit Singh, Dipali Vadher, Vishwa Dixit and C. Jariwala

35th Tocklai Conference on Sustainability: Challenges and the way forward from today, Jorhat, Assam, 22-23 February 2019

Scope of emerging plasma technology in Tea Industry
Suryakant B. Gupta, Alphonsa Joseph, G. Jhala, Keena R. Kalaria, and Naresh P. Vaghela

2nd International conference on Power and Advanced Computing, Vellore Institute of Technology, Vellore, Tamil Nadu, 22-23 March 2019

Investigation of LabVIEW and Syslog interface and in-house development of generic logger software
G. Kaur, R. Sugandhi, Prabhakar Srivastav and L. M. Awasthi

Trends in Modern Physics 2019 at Assam Don Bosco University, Tepesia, Sonapur, Assam, 22-23 February 2019

Plasma Parameter Variation with Experimental Parameters in a Hot Cathode Multicusp Discharge
J. Sangma and M. Chakraborty

High Speed Pulsed Plasma Stream and its Characteristics
Azmirah Ahmed, N. Talukdar, N. K. Neog, T. K. Borthakur and J. Ghosh

International Conference on Advanced Functional Materials and Devices (ICAFMD–2019), NIT (REC), Warangal, 26-28 February 2019

Characteristic study on chemically etched optical fibres for enhanced sensitivity
K Dey, Sourabh Roy, BR Kumar, M. Sai Shankar

Applications of Nuclear Energy in Food & Agriculture, Water, Industry and Sewage Treatment, PDPU, Gandhinagar, 25-26 March 2019
Industrial application of plasma- Technology demonstrators

Alphonsa Joseph

22nd National Conference on Atomic and Molecular Physics (22nd NCAMP), IIT Kanpur, Kanpur, India, 25-28 March 2019

Structural behaviour of diamagnetic cavity in laser-produced plasma
Narayan Behera, R. K. Singh and Ajai Kumar

Topical Meeting on Advances in Photonics (TMAP), NISER Bhubaneswar, India, 29-30 March 2019

Two directional time-resolved fast imaging of the laser-produced plasma in a magnetic field
Narayan Behera, R. K. Singh and Ajai Kumar

PATENT APPLIED

Splitted Plasma Anode Fire-ball Based Ion Source for both Nanopatterning and thin film deposition
MUKESH RANJAN, TAPAN BURMAN, SAMIRSINH CHAUHAN, AKSHAY VAID, SUBRATO MUKHERJEE
Indian Patent App. No. 201821021321, June 2018

A novel method for increasing the service life as well as retention of sharpness-of cutting tools
ALPHONSA JOSEPH, GANSHYAM JHALA, AKSHAY VAID, S. MUKHERJEE
Indian Patent Application number 201821022517, June 2018.

AWARDS and ACHIEVEMENTS

Study of Propagation of Ion Acoustic Soliton in Multi-cusp Plasma Device
Meenakshee Sharma, A. D. Patel, and N. Ramasubramanian received **Best Poster Award** at 45th European Physical Society Conference on Plasma Physics, Prague, Czech Republic, 2-6 July 2018

A Kinetic simulation of the expanding plasma in axially nonuniform magnetic field for scape propulsion thruster
Sneha Gupta and Devendra Sharma received **Best Poster Award** at International Conference on Mathematical Modelling and Scientific Computing (ICMMSC-2018), IIT Indore, India, 19-21 July 2018

Investigation of C_2 production in the stagnation layer of colliding plasmas
Arvind Kumar Saxena, R.K.Singh, H.C.Joshi and Ajai Kumar received **first prize** for oral presentation at Plasma Scholar Colloquium (PSC), Department of Physics, Sikkim Manipal Institute of Technlogy (SMIT), Majitar, Rangpo, Sikkim, 24-26 August 2018

Prof. Amita Das selected for the prestigious J.C. Bose fellowship for her foundational contributions in the field of laser plasma interactions emphasising the role of self-generated magnetic fields (August 2018)

Prof. Amita Das, Institute for Plasma Research, Gandhinagar, elected fellow 2018 of Indian National Science Academy (INSA), Delhi, for her foundational contributions in the field of laser plasma interactions emphasising the role of self-generated magnetic fields (October 2018)

The IPR staff club is pleased to inform that Dr. Madhuchandra Laishram, who finished his Ph.D in January 2018 working as student with Basic Theory and Simulation Division of IPR, is among the winners of this Year's Under 30 Scientist and Student Award of Association of Asia Pacific Physical Societies - Division of Plasma Physics (AAPPS-DPP). Thesis work carried out by Dr. Laishram has been awarded as outstanding theoretical and numerical works on vortex characteristics of steady state multiple vortices observed in dusty plasma experiments and relevant driven-dissipative natural flows. The winners of Year 2018 S. Chandrasekhar Prize and all U40, U30 awards will receive the honor in the opening Session of 2nd Asia-Pacific Conference (Nov. 12-17, 2018) at Kanazawa, Japan. Staff club congratulates Dr. Madhuchandra Laishram and the Basic Theory and Simulation group for the award.

Evidence of Virtual Anode and Cathode in an Inertial Electrostatic Confinement Fusion Device
D. Jigdung, D. Bhattacharjee, N. Buzarbaruah, S. Kalita and S.R. Mohanty received **first prize** for oral presentation at 11th Biennial National Conference of Physics Academy of North East (PANE), Department of Physics, Assam University Diphu Campus, Assam, 21-23 November 2018

Power Supplies for Electron Cyclotron Resonance Heating (ECRH) System on Tokamaks SST1 & Aditya-U
Mahesh Kushwah and ECRH Group received **best paper presentation award** at National Symposium on Vacuum Electronic Devices and Applications (VEDA)-2018, IIT Guwahati, 22-24 November 2018
Inertial electrostatic fusion: A source for societal applications

N. Buzarbaruah, D. Jigdung, D. Bhattacharjee and S.R. Mohanty received **1st best poster award** at International Conference on Renewable & Alternate Energy (ICRAE-2018), Assam Science and Technology University (ASTU), Guwahati, Assam, 4-6 December 2018

Amplification of Energetic Electrons Driven Whistler Mode by Loss Cone Induced Reflected Particles.
A. K. Sanyasi, Prabhakar Srivastav, P. K. Srivastava, R. Sugandhi and L. M. Awasthi received **Z. H. Sholapurwala Award** at 33rd National Symposium on Plasma Science & Technology (PLASMA-2018), University of Delhi, Delhi, 4-7 December 2018

DAQ Development for Prototype MgB2 Current Lead Test Facility
Rakesh Patel, Gaurang Mahesuria, Rohit Panchal, Dashrath Sonara, Pradip Panchal, Dikens Christian, Hiren Nimavat and Vipul Tanna received **PSSI poster award** at 33rd National Symposium on Plasma Science & Technology (PLASMA-2018), University of Delhi, Delhi, 4-7 December 2018

Dynamics of Runaway Electrons in Presence of MHD Modes in ADITYA-U Tokamak
Harshita Raj, J. Ghosh, R.L. Tanna, Tanmay Macwan, Rohit Kumar, Suman Aich, K.A. Jadeja, K.M. Patel, J. Raval, D. Raju, S.K. Jha, P.K. Chattopadhyay, and the ADITYA Upgrade Team received **PSSI oral award** at 33rd National Symposium on Plasma Science & Technology (PLASMA-2018), University of Delhi, Delhi, 4-7 December 2018

Electrical Model of ADITYA-U Tokamak
Devilal Kumawat, Rohit Kumar, Joydeep Ghosh, Rakesh Tanna received **2nd Best Paper Presentation award** at International Conference on ‘’Energy Systems, Drives and Automation’’ (ESDA 2018), Seminar Hall, Science City, Kolkata, West Bengal, India, 29-30 December 2018

IPR has been presented **Official Language Shield** (Jointly) and **Best Official Language Magazine Award** in Aided Institute Category of DAE for the year 2017-18. Shri. Raj Singh, SO-G & Vice Chairman, OLIC has been awarded **Rajbhasha Bhushan Puraskar** for the year 2017-18 with a memento, cash prize of Rs. 11000 and a shawl by the Department of Atomic Energy for his excellent and creative contribution in the propagation of Hindi. These awards were presented at the DAE 19th All India Official Language Conference held at NISER, Bhubaneswar on 2 February 2019

Design of Experimental Setup for Visualization Studies of Two Phase Liquid Nitrogen
Gaurav Kr. Singh, R. Patel, R. Panchal, H. Nimawat, S. Pradhan and V. L. Tanna received **Best Paper award** in Multi Phase Flow and Heat Transfer at 12th International Conference on Thermal Engineering: Theory and Applications (ICTEA-2019), Pandit Deendayal Petroleum University (PDPU), Gandhinagar, 23-26 February 2019

Prof Subroto Mukherjee, Senior Professor-H, IPR was Elected **Fellow of Indian National Academy of Engineering - FNAE** in 2018. The induction program was done at Research Centre Imarat, RCI-DRDO, Hyderabad during 13-15 December 2018.

Mr. Amitkumar V Patel from ITER-India has been selected to be the recipient of the “**INAE Young Engineer Award 2018**“, instituted by the Indian National Academy of Engineering. The award was presented to during the INAE Annual Convention, Hyderabad during 14-15 December 2018.

E.4 INVITED TALKS DELIVERED BY IPR STAFF

PARITOSH CHAUDHURI

Gave an Invited talk on “Materials for blanket applications” at NFP-PFRC Vision Meeting (NPVM-2018), Nirma University, Ahmedabad, 26-28 April 2018

P K SHARMA

Gave an Invited talk on “High Power RF Technologies” at BRFST-BRNS Vision Meet – 2018, Nirma University, Ahmedabad, 27 April 2018

Gave an Invited talk on “Vacuum RF antennas for high power LHCD system in Aditya tokamak” at
National Symposium on Vacuum Electronic Devices & Applications (VEDA-2018) Conference, Indian Institute of Technology, Guwahati, 22-24 November 2018

SARVESHWAR SHARMA
Gave an Invited talk on “Plasma: Key Tool for Energy Needs and Industrial Applications” at ITPL Inventor building,

International Technology Park, Applied Materials India Private Limited, Whitefield, Bangalore, Karnataka, 23 May 2018

Gave an Invited talk on "Development of Plasma Fluid Modeling Code with Immersed Boundary Method" (Co-authors: Kuan-Lin Chen, Meng-Fan Tseng, Jong-Shinn Wu, Gary Cheng, Richard Branam) at 2018 Plasmadynamics and Lasers Conference, 2018 AIAA Aviation and Aeronautics Forum and Exposition, Atlanta, Georgia, USA, 25-29 June 2018

Gave an Invited talk on "An overview of capacitive discharges: A key tool for plasma processing"
at Photonics, Metamaterials & Plasmonics" (PMP-2019), Jaypee Institute of Information Technology (JIIT), Noida, India, 14-16 February 2019

P. A. RAYJADA

Gave an Invited talk on "Energy Thirst and Nuclear Fusion: Challenges from Materials" at Short Term Training Program (STTP, 11-16 June, 2018) on Recent Trends in Power Electronics and Power Systems, G.H. Patel College of Engineering & Technology (GCET), Vallabh Vidyanagar, Gujarat, 16 June 2018

Gave an Invited talk on "Materials Characterization and Study: Roles of X-ray Diffraction and Photoelectron Spectroscopy" at National Workshop Advanced Characterization Techniques for Materials Analysis (ACTMA – 2019), Department of Materials Science, Sardar Patel University, Vallabh Vidyanagar, Gujarat, 8-9 March 2019

MUKESH RANJAN

Gave an Invited talk on "Dense Nanoparticles Arrays for SERS Based Glucose Sensor and Plasmonic Solar Cells" (Co-author: Sooraj K P) at Advance Photonics Congress -2018, Zurich, Switzerland, 2-5 July 2018

Gave an Invited talk on "Surface Wettability tuning using ion beams" at 1st International Conference, Future Learning Aspects in Mechanical Engineering, Amity University, Noida, 1-5 October 2018

Gave an Invited talk on "Dense Metal Nanoparticles Arrays for SERS Sensors and Plasmonic Solar Cells" at Student Conference on Optics and Photonics (SCOP-18), PRL, Ahmedabad, 4-6 October 2018

Gave an Invited talk on "Low energy ions for fabricating ordered plasmonic structures for Plasmonic Solar Cell and Second Harmonic Generation Applications" at Ion Beam in Material Engineering and Characterization (IBMEC-2018), IUAC, New Delhi, 9-12 October 2018

Gave an Invited talk on "Magnetically constricted anode fireball for making super-hydrophobic nanodot surfaces and role of plasma flux" at 2nd Asia-Pacific Conference on Plasma Physics, Kanazawa, Japan, 12-17 November 2018

Gave an Invited talk on "Plasma and Plasmonics for Nanosensing" at National Conference on Recent Innovations in Science (NCRIS-2019), School of Science, RK University, Rajkot, Gujarat, 18-19 January 2019

Gave an Invited talk on "Plasmonic Dense Nanoparticles Arrays for Sensor and Solar Cells" at Photonics, Metamaterial and Plasmonics (PMP-2019), JIIT, Noida, 14-16 February 2019

Gave an Invited talk on "Glucose Sensing based on Nanoparticles Arrays" at International Conference on Resent Trends in Nanomaterials for Clean Energy, SVNIT, Surat, 16-17 February 2019

Gave an Invited talk on "Self organised structure formation on graphite and Tungsten surfaces with low energy plasma ion irradiation" at Indo-French Seminar on Radiation Damage in Nuclear Material, Amity University, Noida, 18-20 February 2019

AMITA DAS

Gave an Invited talk on "Novel Mechanism of Magnetic field generation in finite beam plasma system" (Other collaborators: Atul Kumar, Chandrasekhar Shukla, Ratan Kumar Bera, Deepa Verma, Devshree Mandal, Ayushi Vashishta, Bhavesh Patel, Predhiman Kaw, Y. Hayashi, K. A. Tanaka, G. Ravindra Kumar) at the 45th European Physical Society Conference on Plasma Physics (EPS-2018), Prague, Czech Republic, 6 July 2018

Gave a Popular talk on "Sun on Earth" at Inspire Science Camp-2018, St. Xavier's College, Rajkot, Gujarat, 13 July 2018
Gave an Invited talk on "Electron beam transport in plasmas"

at Physics Department Colloquium, Indian Institute of Technology, Kanpur, 7 September 2018

Gave a Guest Lecture on "The enigma of Magnetic Fields" at the Foundation day of Udaipur Solar Observatory, Udaipur Solar Observatory, Rajasthan, 20th September 2018

C. BALASUBRAMANIAN

Gave an Invited talk on "One dimensional nanostructures of SiC - large scale synthesis by thermal arc plasma" (Co-authors: Jigar Patel, A. Satyaprasad, C. Sasmal) at 12th International Conference on Ceramic Materials and Components for Energy and Environmental Applications (CMCEE 2018), Singapore, 22-27 July 2018

N. I. JAMNAPARA

Gave an Invited talk on "Plasma grown alumina coatings for high temperature applications" at 12th International Conference on Ceramic materials & Components for Energy & Environmental Applications (CMCEE 2018), Singapore, 22-27 July 2018

SAROJ DAS

Gave an Invited talk on "Leadership Basics: What Library Professionals necessities?" at 6th Refresher Course in Library and Information Science on Academic Librarianship in New Millennium, Gujarat University, 16 August 2018

Chaired a Session "Trends in Scholarly Communication: Open Science, Open Access & Open Data" at International Conference on Changing Landscape of Science & Technology Libraries (CLSTL-2019), IIT Gandhinagar, 28 Feb - 02 Mar 2019

Gave an Invited talk on "Rethinking Role of Librarians in the Present Day" at ADINET Quarterly Seminar 2019, Central University of Gujarat (CUG), Gandhinagar, 9 March 2019

MAYUR KAKATI

Gave an Invited talk on "Plasma-Assisted, Bulk Synthesis of Nanomateials for Water Treatment and Studies on their Absorption Properties" (Co-author: Gopikishan Sabavath) at International Conference on Environmental Nanotechnology for Socio-Economic Development of India (ENTSED-2018), DIT University, Dehradun, 28-30 September 2018

Gave an Invited talk on "Glimpses of some experimental plasma physics research at CPP-IPR" at Workshop on Basic Plasma Physics, Assam Don Bosco University, Sonapur, Assam, 29-30 January 2019

Gave an Invited talk on "ITER relevant plasma surface interaction studies in CPP-IPR CIMPLE-PSI and HHF devices" at Symposium on Trends in Modern Physics, Department of Physics, Assam Don Bosco University, Sonapur, Assam, 22-23 February, 2019

Gave an Invited talk on "ITER relevant plasma surface interaction studies in CPP-IPR CIMPLE-PSI Laboratory" at CPP-IPR One-day Symposium on Recent Trends in Basic Plasma Research, 8 March, 2019

S. SUNIL

Gave an Invited talk on "Discovering Applications: Interaction between Optical and Mechanical Modes" at National Conference on Advances in Spectroscopy: Molecules to Materials, Institute of Infrastructure Technology Research and Management (IITRAM), Ahmedabad, 4th October 2018

S MUKHERJEE

Gave a Keynote address on "Plasma based surface engineering; from subsurface modification to surface nanopatterning" at National Metallurgist's Day - Annual Technical Meeting 2018 (NMD-ATM 2018), JW Mariott Hotel, Kolkata, 14-16 November 2018

B K SHUKLA

Gave an Invited talk on "Application of High Power Microwave for Disinfection and Sterilization of Stored Food Grains" at National Symposium on Vacuum Electronic Devices & Applications (VEDA-2018) Conference, Indian Institute of Technology, Guwahati, 22-24 November 2018

B. J. SAIKIA

Gave an Invited talk on "Theoretical Plasma Physics Research" at Workshop on Basic Plasma Physics (for B. Sc. and M. Sc. students), Department of Physics, Assam Don Bosco University, Sonapur, Assam, 29-30 January 2019

RAJENDRA BHATTACHARYA

Gave an Invited talk on "Plasma and Fusion Research at IPR" at Viswajyoti College of Engineering and Technology, Vazhakulam, Muavattupuzha, Kerala, 13 February 2019

S. R. MOHANTY

Gave an Invited talk on "Basics and Applications of Inertial Electrostatic Confinement Fusion" at
Recent trends in Basic Plasma Research, CPP-IPR, Assam, 8 March 2019

R. SUGANDHI

Gave an Invited talk on "Machine control system for experimental plasma devices: An Overview" at 2nd International conference on Power and Advanced Computing, Vellore Institute of Technology, Vellore, Tamil Nadu, 22-23 March 2019

B. GANGULI

Gave an Invited talk on "Surface Modification by Low Temperature Plasma" at Indus University, Ahmedabad, 23 March 2019

Invited talks given at 33rd National Symposium on Plasma Science & Technology (PLASMA-2018), University of Delhi, Delhi, 4-7 December 2018

PALLAVI TRIVEDI, SANJEEV K PANDEY, R GANESH gave an Invited talk on "Novel aspects of 1D Collision-less plasma using a general Vlasov-Poisson Model"

R.L. TANNA and the ADITYA Upgrade Team gave an Invited talk on "Overview on ADITYA Upgrade Tokamak Experimental Progress"

DEBJYOTI BASU, MASARU NAKAJIMA, A.V. MELNIKOV, DAVID MCCOLL, AKBAR ROHOLLAHI, SAYF ELGRIW, CHIJIN XIAO AND AKIRA HIROSE gave an Invited talk on "Experimental studies of geodesic acoustic mode (GAM) like oscillations in STOR-M tokamak"

VISHAL JAIN gave an Invited talk on "Novel approaches in Generating Atmospheric Pressure Non-thermal Air Plasmas for Textile Processing and Bactericidal Applications"

P. BANDYOPADHYAY, G. ARORA, M. G. HARIPRASAD, S. JAISWAL AND A. SEN gave an Invited talk on "Experiments in flowing dusty plasma"

MUKTI RANJAN JANA gave an Invited talk on "High Power Ion Acceleration System for Tokamak Plasma Heating: The Physics and Technology"

E.5 TALKS DELIVERED BY DISTINGUISHED VISITORS AT IPR

Dr. S. Sangeetha, Bharathiar University, Coimbatore, gave a talk on "A Study on Teletherapy Dosimetry using Monte Carlo Code" on 27th April 2018

Mr. Sunil Kumar, Bhabha Atomic Research Centre, Mumbai, gave a talk on "Experimental and computational study to Suppress thermal stratification in a water pool with shrouds" on 4th June 2018

Mr. Rudrashish Panda, Kalinga Institute of Industrial Technology, Bhubaneswar, gave a talk on "Efficient second harmonic generation with 1D ZnO nanostructures and their application for realization of ultrafast laser diagnostic system" on 11th June 2018

Dr. Mayur Shukla, CSIR-Central Glass and Ceramic Research Institute, Kolkata, gave a talk on "Joining of ceramic materials by microwave-assisted brazing" on 22nd June 2018

Dr. Mithun Karmakar, Saha Institute of Nuclear Physics, Kolkata, gave a talk on "Excitation and Breaking of Nonlinear Plasma Wave" on 06th July 2018

Dr. Madhusudan Raghunathan, Swiss Plasma Center, EPFL, Lausanne, Switzerland, gave a talk on "Exploring 3D Ideal Geometric Effects on Bootstrap Current and Impurity Accumulation" on 20th July 2018

Dr. Arka Bokshi, Culham Centre for Fusion Energy, UK, gave a talk on " Towards a new (toroidal drift mode) theory of small-ELMs" on 27th July 2018

Dr. Raj Kumar, CSIR-Central Scientific Instruments Organization, Chandigarh, gave a talk on "Applications of holographic optics" on 13th August 2018

Dr. Tapasi Ghosh, Federal University of Goias, Brazil, gave a talk on "Simulation, Track Reconstruction and Data Analysis Techniques for High Energy Physics Experiments" on 23rd August 2018

Prof. Lekha Nair, Jamia Millia Islamia, New Delhi, gave a talk on "Knowledge from Damage: Ion Beam Interactions with Surfaces and Molecules" on 28th August 2018

Dr. Vanarajsinh Jashavantsinh Solanki, Indian Institute of Science, Bengaluru, gave a talk on "Porous Metal Oxides:

Synthesis and Applications" on 30th August 2018

Dr. Aniruddha Samanta, School of Material Science and Nanotechnology, Jadavpur University, Kolkata, gave a talk on "Development of Smart Bio-Materials" on 7th September 2018

Dr. Umesh Gaur, National Institute of Technology, Jalandhar, gave a talk on "Magnetic nanostructures: nano scale properties and recent applications" on 14th September 2018

Dr. Somesh Tewari, Technion Israel Institute of Technology, Israel, gave a talk on "Underwater Electrical Wire Explosion" on 20th September 2018

Dr. Venkatraman, Bharathiar University, Coimbatore, Tamilnadu, gave a talk on "Fabrication and Characterization of a 3D Positive Ion Detector and its Application" on 27th September 2018

Dr. Saakshi Dhanekar, Indian Institute of Technology, New Delhi, gave a talk on "Nano-materials based sensors for the society" on 3rd October, 2018

Dr. Uttam Goswamy, Central Electronics Engineering Research Institute (CEERI), Pilani, gave a talk on "Study of Beam Collector for a High Power and High Efficiency Gyrotron for Fusion Application" on 5th October, 2018

Dr. A. Saravanan, Pondicherry University, Puducherry, India, gave a talk on "Role of Effective Secondary Electron Emission Coefficient in Glow Discharge Plasmas" on 12th October 2018

Shri Mervin Alexander, Joint Secretary (Admin) and CVO, DAE, Mumbai, gave a talk in connection with the Observance of Vigilance Awareness Week on 30th October 2018

Dr. Shashi Kant Verma, Malla Reddy Engineering College, Secunderabad, gave a talk on "Experimental and Numerical Investigation of Spacer Effect on Turbulent Mixing Phenomena of AHWR Rod Bundle" on 16th November 2018

Dr. Jalaj Jain, Comision Chilena de Energía Nuclear, Casilla 188-D, Santiago, Chile, and Center for Research and Applications in Plasma Physics and Pulsed Power, gave a talk on "Basic studies on a hundred joules plasma focus device and its applications in biological sciences" on 26th November 2018

Dr. Kirit Makwana, DESY Zeuthen, 15738 Zeuthen, Germany, gave a talk on "Nature of plasma turbulence and magnetic reconnection going from fluid to kinetic scales" on 14th December 2018

Dr. Sayantan Nath, Indian Institute of Information Technology, Allahabad, gave a talk on "Fire Protection in Coal Mine through Image Processing" on 28th January 2019

Dr. Satyajit Chowdhury, Saha Institute of Nuclear Physics, Kolkata, gave a talk on "Experimental observation of Electron -Acoustic Wave Propagation In laboratory plasma" on 31st January 2019

Dr. Sharad Kumar Yadav, Columbia University, New York, gave a talk on "Hydrodynamics simulation of plasma plume for the study of the lateral interaction of two plasma plumes" on 7th February 2019

Dr. Raj Kumar Saini, IIT Mumbai, gave a talk on "CFD Based Analysis of Flow Phenomena in Disc and Doughnut Pulsed Column and Stirred Tank Photobioreactor" on 12th February 2019

Dr. Sabbir Ahmed, Amrita Centre for Research and Development, Coimbatore, gave a talk on "Characteristics of Adhesive Joining of PEEK to Titanium for Aerospace Application" on 1st March 2019

Dr. Jayarao Gorinta, National Institute of Technology, Rourkela, gave a talk on "Development of Li_4SiO_4-based Ceramics for Solid breeder and CO2 Absorption Applications" on 27th March 2019

E.6 COLLOQUIA PRESENTED AT IPR

Dr. Sudhir Ranjan Jain, Bhabha Atomic Research Centre, Mumbai, gave a talk on "Making the Sound Visible" on 13th April 2018 (Colloquium # 287)

Prof. Deshdeep Sahadev, IIT Kanpur, gave a talk on "A Practical Approach to Strengthening Our Scientific Ecosystem" on 31st July 2018 (Colloquium # 288)

Prof. Rahul Pandit, Division of Physical and Mathematical Sciences, Indian Institute of Science, Bangalore, gave a talk on "Two-dimensional turbulence in fluids with particles, conducting fluids, fluids with polymer additives, binary-fluid mixtures, and superfluids" on 09th August 2018 (Colloquium # 289)

Prof. B. V. R. Tata, University of Hyderabad, gave a talk on "

Like Likes Like: Experiments on Charged Colloids to Dusty Plasmas" on 17th August 2018 (Colloquium # 290)

Prof. Spenta R. Wadia, International Centre for Theoretical Sciences (ICTS-TIFR), Tata Institute of Fundamental Research, Bangalore, gave a talk on "Holography, Black Holes and the Sachdev-Ye-Kitaev Model" on 12th October 2018 (Colloquium #291)

Prof. Raghvendra Singh, National Fusion Research Institute (NFRI), Daejeon, Republic of Korea, gave a talk on "Generation of the Micro-scale and Meso-scale Structures at the Marginally BM Stable Pedestal: A Scenario for ELM Crash and I-mode" on 30th October 2018 (Colloquium # 292)

Prof. Ramaprosad Mukhopadhyay, Raja Ramanna Fellow, DAE, Govt. of India, Ex-Head, Solid State Physics Division, BARC, gave a talk on "Structural and Dynamical Transition in Functional Materials" on 2nd November 2018 (Colloquium # 293)

Prof. A. Ganguli, IIT Delhi, gave a talk on "Exploring possibility of using a Compact ECR Plasma Source for plasma thruster applications" on 18th January 2019 (Colloquium # 294)

E.7 SCIENTIFIC MEETINGS HOSTED BY IPR

NFP-PFRC Vision Meeting (NPVM-2018)

The first NFP-PFRC Vision Meeting was jointly organized by the Institute for Plasma Research, Gandhinagar and Nirma University, Ahmedabad during 26-28 April 2018. Over 150 participants, mainly consisting of PI's, PC's, experts and prospective PI's attended this meeting. The meeting was also attended by the current and past PFRC committee members.

This meeting was conceptualized by the PFRC Committee to take stock of the work carried out under the aegis of erstwhile BRFST earlier and since 2014, under the Plasma and Fusion Research Committee of the BRNS during the last 10 years. This meeting also had detailed deliberations to charter the plans for future areas of R&D in the coming decade.

Prof. P I John, Chairman PFRC in his keynote address entitled "The National Fusion Programme: Retrospect, Prospect", gave a brief account of the 10 years of NFP, BRFST and formation of PFRC. He described how PFRC has been able to bring together faculty from various institutions in India who had no prior experience in R&D related to plasma or fusion to successfully work on a fusion related topic. There were two plenary talks on "Tokamak Research in India and Its Future" by Dr. R. Srinivasan and "Societal Benefits of Plasma Technologies – Alignment of Future R&D towards DAE 11-Point Vision" by Dr. S Mukherji respectively. This was followed by 16 invited talks by PC's who consolidated the various projects in a specific area as well as gave their views on possible new areas of R&D possible in those areas. The Scientific Secretary of BRNS, Prof Sangita gave a talk on BRNS, its activities and funding procedures for the benefit of the participants and prospective PI's. PI's also presented over 75 posters based on the work carried out under various BRFST and PFRC funded projects. A book of abstracts was also released during the meeting. It is proposed that selected papers presented during the meeting would be peer reviewed and published as a special issue in a journal.

Two panel discussions were organized to discuss various issues related to carrying out R&D projects and also to discuss future areas of work. It was proposed to initiate NFP-PFRC working groups under 12 different areas where most of the R&D under PFRC were focused on.

27th IAEA Fusion Energy Conference (FEC-2018)

IPR hosted the 27th IAEA Fusion Energy Conference (FEC-2018) at Mahatma Mandir during 22-27 October, 2018. The meeting was inaugurated by lighting the traditional lamp by Dr. Meera Venkatesh, Director of Division of Physical and Chemical Sciences in the Department of Nuclear Applications, at IAEA, Dr. R Chidambaram, former Chairman, AEC and Secretary, DAE, Dr. R. B. Grover, Member AEC, Dr. Shashank Chaturvedi, Director, IPR, Dr. S Deshpande, Project Director, ITERIndia, Dr. P. A. Child, EURATOM, Prof. N. K. Prinja, AMEC Clean Energy, UK, representatives from IAEA Ms. Sehila M. Gonzales de Vicente, Dr. Danas Ridikas and the conference convener, Dr. Raju Daniel.

A total of 718 participants from 39 member countries of IAEA and 4 international organizations participated in this conference which has both oral (131) and poster presentations (641). Indian participants were 225 in number.

There were 167 papers presented from IPR including 7 oral presentations. An exhibition for vendors and institutes to showcase their wares and achievements. There were stalls in

Fusion Energy Conference (FEC-2018) hosted by DAE-India. ***Left -*** *Dr. Meera Venkatesh lighting the lamp during inauguration while Dr. R.Chidambaram and Dr. R.Grover are nearby.* ***Right -*** *a part of the audience in the conference*

the exhibition from IPR, FCIPT, CPP-IPR as well as BARC along with exhibits from private agencies.

During the opening session, Dr. Venkatesh welcomed the gathering and mentioned the importance of the role of IAEA in fusion related activities. Dr. Chidambaram talked about the current energy crisis as well as India's contribution to fusion research. Dr. Grover emphasized upon India's power requirements and the need for a balance between currently available energy sources and appropriate options for the future. Dr. Deshpande gave a brief history of IPR and its fusion related activities as well as India's contribution to the ITER project. Dr. Child put forth the plans of EURATOM in fusion related activities for the next five years and finally, Dr. Prinja described the 4th industrial revolution of digitalization of industry and how it can be applied to fusion activities around the world. The Nuclear Fusion awards by IAEA were also presented to the winners during the inaugural session.

Dr. R.Chidambaram is addressing during the inaugural function of FEC-2018

A welcome dinner was organized by the LOC for the participants at Mahatma Mandir on 22nd October and the Conference Banquet was held at the Sabarmati Riverfront Park in the evening of 24th October. The participants enjoyed traditional Indian dance forms as well as participated in "Garba" wearing traditional Guajarati attire that was provided to them at the venue.

Satellite scientific meetings of various international fusion R&D groups were also held in the sidelines of the conference. During the last session, the summary of all the major sessions were also presented.

International Yoga Day @ IPR

The 4th International Yoga Day was celebrated on 21 June 2018 at IPR as per the protocol set by the Ministry of Ayush, Govt of India. IPR staff, clad in khadhi kurtas, participated in the mass yoga session under the guidance of a yoga expert. Various asanas as well as meditation were practiced by IPR staff as part of the yoga session. In the afternoon, an interactive talk on "Benefits of Yoga, Disease free body and Stress free mind" and "Yoga - A Holistic Way of Life" by Dr. Mukeshchandra Patel, was arranged in the seminar hall in which, the yoga expert explained the benefits of yoga & disease free body and a stress free mind.

The international yoga day was celebrated at CPP-IPR on 21st June 2018. Dr. Manash Choudhury, CPP-IPR's Visiting Authorized Medical Officer (VAMO), who is also an expert

in Yoga, gave yoga demonstrations as well as delivered a talk on "Yoga and Meditation". Employees and students of the institute participated in the activities with great enthusiasm.

Training Programme on Plasma Science & Technology @ Guwahati

The 3rd training programme in the joint IPR-NCSTC scientific outreach series "Awareness-Cum-Training Programme on Plasma Science & Technology and Energy from Nuclear Fusion" NCSTC and IPR was conducted at Guwahati during 7-8 June, 2018. 40 Physics teachers of high/ senior school and junior colleges from the eastern states of Arunachal Pradesh, Assam, Manipur, Meghalaya, Nagaland, Orissa, Sikkim, Tripura and West Bengal attended this training programme. The meeting was held at the Regional Science Center, Khanapara, Guwahati during 7-8 June, 2018. The inauguration of the programme was done by Dr. Ranjit Barman, Senior Scientific Officer & Head I/C of the Assam Science, Technology and Environment Council (ASTEC) along with Shri. Basudev Mandal, Scientific Officer of Regional Science Center, Guwahati, Prof. Kalyal Goswami, Center Director, CPP-IPR, Sonapur and Dr. Ravi A V Kumar from IPR. The chief guest for the event was Plasma Physicist and founder director of CPP, Prof. S. Bujarbaruah.

Training Programme on Plasma Science & Technology @ Gandhinagar

The 4th training programme in the joint IPR-NCSTC scientific outreach series "Awareness-Cum-Training Programme on Plasma Science & Technology and Energy from Nuclear Fusion" NCSTC and IPR was conducted at Gandhinagar during 21-22 June, 2018. 40 Physics teachers of high/senior school and junior colleges from the western states of Gujarat, Maharashtra, Rajasthan, Goa and Daman & Diu attended this training programme. The meeting was held at the Science City, Ahmedabad. The training programme was inaugurated by Shri Ravinder Gaur, DST and was presided over by Dr, Natottam Sahoo Member Secretary, GUJCOST, Shri S. D. Vora, Executive Director, Gujarat council of Science City, Shri. P. K. Atrey and Dr. Ravi A V Kumar from IPR. Apart from hands-on experiments, several models on plasma applications were also exhibited for the benefit of the participants.

IITRAA-Ahmedabad Meeting @ FCIPT/IPR

IIT-Roorkee Alumni Association (IITRAA), Ahmedabad Chapter meeting was organised at FCIPT/IPR on 19 August 2018. Delegates from various government agencies (ISRO, ONGC, Indian Railways, IIT-Gandhinagar, GSPL, Custom, Income Tax etc.) and private industries (Selan Exploration Tech., ESSR etc.) participated in the event. A talk on "Harnessing Plasmas for a Better Tomorrow" was delivered by Dr. Mukesh Ranjan also an Alumni of IIT-Roorkee. Some of the IPR technologies were also demonstrated to the participants.

6th PFRC Review Meeting

The 6th meeting of the Plasma & Fusion Research Committee (PFRC) of the Board of Research in Nuclear Sciences (BRNS) was held at IPR during 6-7 September, 2018. The following members attended the meeting Prof P I John (Chairman), Prof. Prabal Chattopadhyay, Shri. D. K. Dalal (Project Officer, BRNS), Shri. P. K. Atrey, Prof Amit Roy, Prof. G Amarendra, Dr. Ravi A. V. Kumar (Member Secretary, PFRC) and Dr. N. Ramasubramanian. During this 2 day meeting, 19 new R&D projects and 46 ongoing projects were reviewed, from the new projects 17 were approved with a budget allocation of ~ Rs.4.01 Crores.

Workshop on Applications of Plasma in Textile Processing (APTP)

A workshop on "Applications of Plasma in Textile Processing (APTP)" was organized on 20th November 2018 at FCIPT. There were participants from Textile Research Associations from Ahmedabad, Surat and Mumbai, DRDO, NID, universities and textile industries. IPR also showcased various plasma systems for textile processing including plasma systems for inline textile treatment, denim fading, nano powder generation, physical vapour deposition and plasma nitriding. Speakers presented their work on plasma treatment of textile including their journey from research to product.

Vigilance Awareness Week

The Vigilance Awareness Week was observed from 30th October to 4th November, 2017. The theme of the week being "My Vision-Corruption Free India". Vigilance Awareness Week was observed at IPR with staff members collectively taking the "Integrity Pledge" on 29th October 2018 at 11.00 AM. Dr. Shashank Chaturvedi, Director, Shri Niranjan

Vaishnav, CAO and Dr. Anita V.P. CVO led the pledge.
Shri Mervin Alexander, Joint Secretary to Government of India, DAE gave a talk on "Eradication of corruption in India" on 30th October, 2018 at IPR. Later he visited various labs in IPR.

Workshop on Intellectual Property Rights @ IPR

A one-day workshop on Intellectual Property Rights Sponsored by Administrative Training Institute (ATI), Dept. of Atomic Energy (DAE) was organized on 19th November 2018 at Institute for Plasma Research, Gandhinagar. The aim of this workshop was to create awareness on Intellectual property rights and procedures for protecting these rights among the researchers. The invited speaker, Ms Anuradha Maheshwari, Partner- Lexmantis, Mumbai, briefed the participants about the types of intellectual properties, procedures and limitations of protecting the same. Dr. Nutan Khalap from BARC gave a talk about the technology transfer procedures followed at BARC and Mr. Dani Rajiah from DAE discussed the procedures for filing patents for DAE Institutions. He also shared the statistics of patenting activities by DAE and those of Institute for Plasma Research in particular. Around 80 participants from IPR, CPP, FCIPT and ITER-India participated in this workshop. The workshop was appreciated by the participants. The speakers also addressed number of doubts regarding patenting amongst the participants.

ANSYS Training @IPR

A two-day training on ANSYS software was organized at IPR on 1st and 2nd November, 2018. The training focused on "SpaceClaim" which is a solid modelling tool enabling rapid editing/repairing of the geometry and meshing techniques for variety of simulations. Around 25 people from various divisions of IPR participated in the training which was conducted by the experts from the industry. The ANSYS user group is active in IPR and regular meetings are held to discuss the common technical problems among the users and also share the software based knowledge. The group activities are coordinated by Hardik Mistry, Ritesh Srivastava, Vinay Menon and Bharat Doshi.

National Science Day 2019 @ IPR

The National Science day was celebrated at IPR with immense amount of enthusiasm on 2-3 February, 2019 at the IPR main campus. The event was inaugurated by Dean Administration of IPR, Shri Ujjwal Baruah. Over 800 students and teachers from both urban and rural schools across Gujarat participated in this event. The NSD also had competitive live events like Quiz, Eloquence, Skit as well as science exhibits by schools and by IPR staff, in collaboration with the BSc Physics students of St. Xavier's College, Ahmedabad. Offline competitions like poster and essay writing were conducted for the school students in the month of December. In the competition organized for school teachers for innovative teaching aids, Shri Avinash K. Jayswal of Info city Science College won the first prize. This event had over 3000 visitors visiting IPR during the two days to see the exhibition and open house. The concluding session was held on 3rd February where the prizes for the various competitions were given out by Director IPR, Dr. Shashank Chaturvedi. Some of the

National Science Day Celebrations at IPR

schools that won prizes in multiple events are S.G. Dholakiya School, Rajkot, H J D Institute, Kutch, Ultra Vision School, Surendranagar, Adarshila School, Valad etc.

National Science Day Celebration @ CPP-IPR

The national science day was celebrated at CPP-IPR on 28th February, 2019, with day-long activities. The event was inaugurated by the Centre Director, Prof. B. K. Saikia. Over 300 students and teachers from 21 schools and colleges from greater Sonapur, South Guwahati city and the neighboring state of Meghalaya participated in this event. The activities included
Drawing, Quiz, Eloquence as well as Science Model competitions. Research scholars of CPP-IPR arranged an exhibition of basics of plasma science, including live demonstration of plasma production processes through glow discharge and highvoltage spark discharge to the visiting students and teachers. The concluding session was held in the afternoon where the prizes for the various competitions were given out by the Centre Director, Prof. B. K. Saikia and the chairman of the organizing committee, Dr. B. J. Saikia. Some of the schools and colleges that won prizes in multiple events are Sai Vikash Junior College, Guwahati, Saint Patrick's High School, Nazirakhat, Green View Academy, Khetri, Saint Agnes School, Khetri, etc.

National Safety Week @ IPR

The 48th National Safety Week was celebrated at IPR from 4-10 March 2019. The institute organized various competitions during this week to create safety awareness among its employees. Competitions were organized on Slogan in Gujarati, Hindi & English, Cartoon Making, Quiz and Essay Writing in Gujarati, Hindi & English based on decided topics for the employees of IPR, FCIPT & ITER-India. Encouraging response was received from the employees for various competitions. During the concluding event on 8th March, 2019, Shri Devendra Modi gave the welcome address, which was followed by a presentation on "Safety in Mechanical Works" by Shri Bharat Doshi. The safety message was then read out by Shri P.K. Atrey, Dean (R&D). He emphasised that the best way to enhance safety across the Institute is to enhance the safety culture among us. He also administered the Safety Pledge. Dr. Vipul Tanna conducted a Safety Quiz for the audience. Director IPR delivered the keynote address on safety. He highlighted that safety is a continuous process and it does not end with National Safety Week, and that one should not learn safety through accidents. He congratulated the winners of various competitions as well as best safety co-ordinators of IPR. Prizes were also distributed to them. Shri Sunil Kumar, Chairman-Safety Committee presented the vote of thanks.

E.8 MoU SIGNED

E.8.1 NATIONAL MoU SIGNED

1) Collaboration with Vikram Sarabhai Space Centre (VSSC), ISRO for development of electromagnetic module

A Memorandum of Understanding (MoU) was signed by and between IPR and VSSC-ISRO on 2nd August 2018 for collaboration on development of an electromagnetic module. VSSC has developed a software package 'STR-Tools' which is used for deisgn and simulation prupose, but does not have a code for validating electromagnetic effects. IPR has developed a code on electromagnetic module and would be useful for STR-Tools of VSSC. A collaborative MoU is thus executed between IPR & VSSC. This will enhance the application base of STR tools software which is indegenously developed.

2) Collaboration with Saurashtra University for development and demonstration of experimental plasma systems

A scientific collaborative agreement on development and demonstration of experimental plasma systems was executed by and between IPR and Saurashtra Univeristy on 30th July 2018. Under this agreement IPR was responsible for

Technology Transferred to M/s Rubamin Ltd., Vadodara

developing and demonstrating experimental plasma systems for Department of Nanoscience and Advanced Materials, Saurashtra University, Rajkot. The purpose was for experimental training of the students at Saurashtra University as well as to help them pursue research in the field of plasma science and technology. A system was delivered under above referred agreement as an externally funded project by IPR.

E.9 TECHNOLOGY TRANSFERS

Technology Knowhow & License agreement between IPR & M/s Rubamin Ltd.

IPR has developed and patented (patent applied for) a novel metal oxide nano powder production technology using thermal plasma. This technique is unique since it produces precisely controlled distribution of metal oxide nano powders ranging from 10-80 nm size in a single step. Oxides such as zinc oxide, iron oxide, cobalt oxide, titaniaum oxide etc. can be synthesized using this technique.

Rubamin Ltd., Baroda is a company having global presence and is into the business of zinc and zinc derivatives, including zinc oxide powders. Rubamin was interested in entering the nano powder market of zinc oxide and hence approached IPR for the lincensing of the technology. Subsequently, on 05th March 2019, a technology knowhow and license agreement was signed by and between IPR & Rubamin Ltd. at IPR, Bhat, Gandhinagar. On this occasion, the technology documents were handed over to M/s Rubamin for absorption of the technology. The company also showcased their plans of commercializing the licensed technology. Zinc oxide nano powders have immense applications in the field of pharmaceuticals, paints & chemicals, fertilizer & agri-nutrients, animal health etc. Since this technology will foster production of zinc oxide nano powders in India, this agreement contributes directly to the ‘Make-in-India’ programme of Government of India.

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F. OTHER ACTIVITES

F.1 Outreach

Pravasi Bhartiya Divas

IPR participated in the exhibition organized as part of the 15th Pravasi Bhartiya Divas at Varanasi during 21-23 January, 2019 along with other DAE institutions. The exhibition was inaugurated by Hon. Prime Minister as well as the Minister of State, External Affairs, the Chief Minister of Uttar Pradesh as well as several other high ranking officers of the state and central government. Over 1,000 visitors visited the exhibition during the two day event. IPR exhibited models related to industrial and medical applications of plasma, robotic arm and AI based software for x-ray and sputum analysis.

IPR stall at Pravasi Bhartiya Divas at Varanasi

ParamanuTech 2019

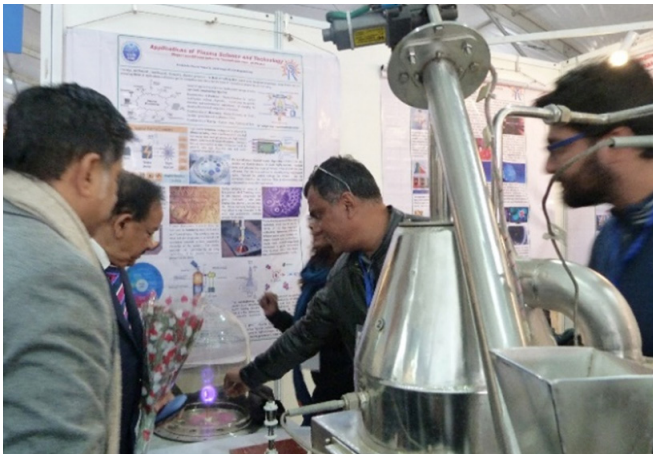
Department of Atomic Energy, in consultation with MEA organized a conference "ParmanuTech 2019" at New Delhi on 6-Feb-2019 for familiarizing Indian diplomats as well as foreign diplomats in India, regarding the technologies developed by DAE. The main aim of the programme is to enhance the global nuclear foot print in India and create more areas of cooperation with our foreign partners. The Conference and exhibition was held at the Pravasi Bharatiya Kendra, Chanakyapuri, New Delhi. IPR participated in the exhibition along with other DAE units. The Conference was presided over by Dr. Jitendra Singh. Hon. Minister of State for PMO, who is also in-charge of the Department of Atomic Energy. The IPR stall at the exhibition was visited by over 100 participants of the meeting, including Indian diplomats

and other senior officers from MEA, and diplomats of foreign missions in India, and had discussions with IPR team. Some of the dignitaries to visit were ; Chairman, AEC and Secretary, DAE Shri K.N. Vyas, JS (ER) DAE. Shri. Jayant Khobragade, and JS (PMO) Shri Gopal Bagle. IPR exhibited models related to industrial and medical applications of plasma, robotic arm and AI based software for x-ray and sputum analysis.

Indian Science Congress

IPR participated in the 106th Indian Science Congress that was organized at Lovely Professional University during 2-7 January, 2019. IPR stall was in the DAE Pavilion of the "Pride of India" exhibition. IPR exhibited models of Plasma Nitriding, Plasma pyrolysis and interactive exhibits of glow discharge plasma and hyper-redundant robotic arm. The exhibition was inaugurated by Dr. Harsha Vardhan, Honourable Minster of Science & Technology, Government of India. He also visited IPR's stall. Over 6,000 visitors

Dr. Harsh Vardhan, Honourable Minister of Science & Technology visiting IPR stall during Indian Science Congress



visited the exhibition during the duration of the Science Congress. The DAE pavilion won the "Most Informative Pavilion" award of the exhibition.

Training Programme for Teachers

The series of five training programme in the joint IPR-NCSTC scientific outreach series "Awareness-Cum-Training Programme On Plasma Science & Technology and Energy from Nuclear Fusion" were conducted during April-July, 2018. During this programme, 250 teachers of higher secondary and BSc were introduced to the topic of plasma and its applications. The programme also had interactive demonstrations on plasma. Of the 29 states and UTs, 250 teachers from 26 states and one UT were trained during the course of the programme. This programme was adjudged as one of the best executed programmes at the 9th National Teachers Science Congress held at Ahmedabad in December 2018.

Before the start of the training programme almost 65% of the

Participants trying on hands-on models at Teachers Training Programme

Meeting Location	Dates (2018)	Total Registration	Total Attendees	Male	Female
Chandigarh (North)	10-11 April	55	**49**	40	09
Bhopal (Central)	7-8 May	65	**49**	44	05
Guwahati (East)	7-8 June	60	**40**	26	14
Gandhinagar (West)	21-22 June	55	**39**	25	14
Bengaluru (South)	12-13 July	80	**73**	58	15
		Total Participants	**250**	193	57

participants did not know anything about plasma and only 24% of the participants has some prior knowledge about plasma. However, after the end of the programme, more than 93% of the participants reported that they had learnt sufficiently enough to introduce the topic of plasm to their colleagues and students.

Scientific Outreach in Rural Areas

As part of scientific outreach in rural areas, IPR undertook two small outreach activities in Malgad village near Deesa, Banaskatha in North Gujarat during 23-24 February, 2019 and at Dakpatthar, Dehradun Uttarakhand during 1-2 March 2019. While the Deesa program was aimed at high school children, the Uttrakhand programme was aimed at graduate and undergraduate students and teachers. Popular talks on introduction to plasma, its applications and fusion were given during these programmes.

Academic visits to IPR

During the last year, there were more than 44 academic visits by academic institutions from across India to IPR with over 1900 visitors. Visitors include high school, graduate and post graduate students of Physics and Engineering streams. The visitors were given an introductory talk on plasma and its applications and then taken to various labs at IPR depending on their areas of interest.

F.2 Official Language Implementation

The Institute has made sincere efforts for facilitating implementation of various provisions of the Official Language Act. The steps taken in this regard are listed below:

- Reports related to the implementation of Hindi are being sent regularly to DAE, Mumbai, TOLIC, Ahmedabad and DAE's Central Secretariat Office in New Delhi.

- TOLIC Meeting: 10th half yearly meeting of Town Official Language Implementation Committee (TOLIC), Gandhinagar conducted on 26th April, 2018 was attended by Director & Co-Chairman, OLIC. Institute has been honored with Consolation prize under the TOLIC, Gandhinagar Official Language Award: 2017-18 in TOLIC meeting for its performance in the implementation of official language. Dr. Sandhya Dave, Junior Hindi Translator was honoured with Consolation prize for her outstanding contribution in the implementation of Official Language.

- Hindi Seminar: Hindi Seminar on Scientific topics was conducted on 17th April, 2018. Total 8 papers on scientific topics were presented in this seminar. Hindi Quiz competition based on the papers presented in the Seminar was also conducted for the audience.

- On 11th June, 2018 a Hindi workshop was conducted by HWP, Baroda, in which Hindi Translator of IPR gave training to the employees on "Manak Hindi Vartani".

- Hindi Pakhwada Celebration 2018: The Institute celebrated Hindi Pakhwada from 31st August 2018 to 14th September, 2018. During this period total 13 competitions were conducted successfully for IPR employees. Discussion in Hindi on scientific topic by senior staff members was also a part of Hindi Pakhwara celebration. Poems of famous Hindi poets and poster made by staff members were displayed on this occasion. Prizes were distributed to the winners by our Director on the occasion of the closing ceremony.

- TOLIC Competition: Institute's staff members are encouraged to participate in TOLIC, Gandhinagar Competitions. IPR's 2 staff members bagged 1st & 3rd prizes in Hindi quiz competition conducted by Directorate of census, Gandhinagar and 2 staff members awarded 1st & 2nd prize in Essay writing Competition conducted by National Institute of Fashion Technology at TOLIC, Gandhinagar level. IPR also conducted TOLIC level "Swarachit Hasya Kavita Paath" competition in its campus for TOLIC, Gadhinagar member offices. IPR employee bagged Consolation prize in Kavita Paath.

- Implementation of incentive scheme of the DAE has encouraged the staff members to do their work in Hindi and staff members are getting benefits according to their work done for the office use.

- OLIC Meeting: Four OLIC meetings for quarter ending March, 2018, June, 2018, September 2018

and March 2019 have been convened. Minutes of the meetings has been sent to DAE Secretariat Office in New Delhi.

- Hindi Exam: The Institute puts sincere efforts towards Hindi training. Total 5 candidates have qualified the Hindi Parangath Exam and 1 candidate have qualified Hindi Praveen Exam conducted in the May 2018 session under Hindi Teaching Scheme, Ahmedabad. Total 5 employees have qualified Hindi typing exam conducted during July, 2018.

- Hindi Workshop & Computer Training: To train the employees for working in Hindi; workshops have been conducted regularly. Senior Hindi Officer from SAC, Ahmedabad has been invited to train the employees for doing work in Hindi. These workshops were conducted on the Official language policy to train the employees for working in Hindi and also to guide them for filling the Hindi Quarter Report pertaining to their section. Training was given to employees for working on computer and also to familiar them about Hindi software, voice typing, text to speech etc. Desktop to Desktop workshop also conducted and employees were trained for doing work in Hindi on computers.

- Home Magazine: Two issues of IPR's half yearly Home magazine "Plasma Jyoti" has been published during this period and distributed to all DAE Institutes and other institutes situated all over India.

- Translation: Translation of Annual Report 2017-2018 was completed in October 2018. Translation of Activity Report, Annual Review Report 2017-18, Office Orders, Covering letters, Advertisement, Tender Notice, forms and various matters of day- to-day activities have been completed.

- Hindi Inspection: Hindi Inspection of Administration-4 & Purchase Section regarding implementation of Official Language policy was done by Hindi Inspection committee and the review report was submitted to Director.

- Vishwa Hindi Diwas Celebration 2019: The Institute celebrated Vishwa Hindi Diwas on 10th January, 2019. A talk has been delivered by Ms.Purvee Joshi, Scientist, SAC, ISRO, Ahmedabad about her experience on INDIAN SCIENTIFIC EXPEDITION TO ANTARCTICA (ISEA) -'JOURNEY TO THE SOUTHERN EXTREMITY – ANTARCTICA'. A quiz completion on Hindi knowledge also conducted on this occasion.

- JHT participated in Hindi Translator's refresher training program conducted by DAE at IOP, Bhubaneswar from 8th – 12th October, 2018.

- Tally software has been made in Hindi and now tally software vouchers are generated in Hindi language. From this initiative Hindi work has been increased in Account section.

- The institute has been honored with the following awards in 19th DAE All India Official Language Meet held at NISER, Bhubaneshwar on 2nd February, 2019: 1) **Official Language Shield** (Jointly) in Aided Institute Category of DAE for the year 2017-18. 2) **Best Official Language Magazine Award** in Aided Institute Category of DAE for the year 2017-18. **3) Shri Raj Singh**, Scientific Officer - G & Vice Chairman, OLIC has been awarded DAE's topmost Rajbhasha award "**Rajbhasha Bhushan Puraskar"** for the year 2017-18 with a memento, cash prize of Rs. 11,000 and a shawl by the Department of Atomic Energy for his excellent and creative contribution in the propagation of Hindi.

The Institute is thus continuously making efforts for promoting the use of Hindi language among its staff members and in communication with other institutes/offices.

F.3 Right To Information

During the report period 18-19, a total of 80 RTI applications were received, out of which 68 were of new RTI Application, while the other 12 were of Appeal nature. All of them have been disposed off by the Public Information Officer and Appellate Authority concerned within the prescribed time-limit.

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