ANNUAL REPORT
2017-2018

प्लाज़्मा अनुसंधान संस्थान

Institute for **Plasma Research**

Bhat, Gandhinagar 382428

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EXECUTIVE SUMMARY

Results from several experiments from basic research setups in diverse areas, e.g., plasma transport and turbulence, microwave, non-neutral plasma, surface interactions, negative ion generation, dusty plasma, electrostatic confinement fusion, etc., reported good outcome and resulted in good number of publications in peer reviewed journals.

Aditya tokamak was routinely operated at about 80mS/ 90kA plasma current operation after upgrading with installation of graphite limiters. Experiments with several new equipments, e.g., molecular beam injection, fast feedback system, etc., are initiated towards better plasma performance in the machine. In SST-1, several changes were made and success was achieved in simultaneous cooling of both TF coils and a set of PF coils to superconducting temperature. Further changes are being implemented in preparation for enhanced plasma operation.

On technology development front; new magnets using High Temperature Superconducting materials have been developed and full characterization of indigenously built liquid nitrogen based Cryopumping panels were completed. In several other development areas, viz., diverter, large cryo-plant, fusion blanket technologies, remote handling and negative neutral beam systems, expansion of facilities by addition of new equipments or better diagnostics have been done.

Emphasis was put on projects bearing direct societal benefits in short time frame. Several new areas of interdisciplinary research have been initiated in collaboration with organizations relevant to the intended applications. Few among them are; use of plasma torch in treatment of brain tumours, Surface Enhanced Raman Scattering (SERS) studies of blood glucose and cancerous cells, hydrophobic coating on glass surface, nanoparticle manufacturing, nitriding of equipments for space applications, seed sterilization, etc. Several new projects in food preservation, textiles, etc. were also initiated.

Studies in theoretical and computational fields continued in diverse topics like design of future tokamaks and concepts of plasma-thrusters, etc.

ITER-India reported considerable progress during the year. Manufacture of Cryostat base and lower cylinder made visible progress at site. The In-Wall Shields for 3 sectors were completed. Major deliveries including 2000 pipe spools and several heavy equipments for cooling water system were dispatched to ITER site. So is the case of delivery of Cryo-lines by Indian and European manufacturers. Cryo-distribution system was manufactured and reached test phase in

factory. One 100kV power supply was supplied and installed at Padova, Italy as a part of ITER deliverable. In house R&D activities in 35-65MHz, high power range Radio Frequency system, Diagnostic Neutral Beams, Diagnostics and Power Supplies too have reported several experimental results as well as progress in deliveries.

The institute had 16 Doctoral Theses submissions and 187 Journal publications during the report period apart from a large number of conference presentations. Other details of importance like facility additions, building construction, administrative reports, etc. are covered at appropriate places in the Annual Report.

DIRECTOR,
IPR.

ANNUAL REPORT

APRIL 2017 TO MARCH 2018

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 Fundamental Plasma Physics

The fourth state of matter, Plasma, after solid, liquid and gas is being studied in various conditions so as to explore its applications for the humankind. Here it is being studied in very small scale laboratory experiments as well as in moderately bigger size in tokamak configurations.

A.1.1 Basic Experiments

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. External investigations on particle confinement using hot cathode discharge has been conducted for various values of toroidal and vertical field strengths. A new Microwave plasma source with the frequency of 2.45 GHz using electron cyclotron resonance (ECR) was developed and preliminary experiments suggests interesting plasma features. A comparative study of particle confinement and equilibrium plasma profiles has been performed using hot cathode source and ECR source for the same experimental conditions. A detailed experimental study has been performed to determine the role of toroidal field topology in ECR produced plasma with variation in the external vertical magnetic field. For the first time, existence of Geodesic Acoustic Modes in a simple toroidal magnetized plasma was demonstrated experimentally.

Large Volume Plasma Device (LVPD)

This is a large laboratory experimental plasma device involved in investigations, primarily on physical phenomenon's involving turbulence and plasma transport, relevant to magnetosphere and fusion plasmas. Significant results are obtained from the physics studies on fluctuation induced plasma transport and loss mechanism for the energetic electrons, mimicking situations of earth's atmosphere.

Investigations on turbulent plasma transport due to ETG turbulence: Turbulent transport due to electron temperature gradient driven turbulence in fusion devices is considered as a major cause for plasma loss. Its direct measurement is extremely difficult in fusion devices due to extremely small scale lengths. In LVPD, direct measurement of it is made possible by the introduction of a large Electron Energy Filter (EEF). Equilibrium plasma density and temperature profiles exhibits centrally peaked nature. This can happen only if an inward particle transport exists i.e., particle pinch. This phenomenon is demonstrated and validated against theory.

Investigation of Loss Mechanism for energetic electrons: Introduction of large (2m diameter) Electron Energy Filter (EEF) in LVPD has divided LVPD plasma into three regions of Source, EEF and Target plasmas. The source plasma region is the region between the filaments and the first layer of EEF, the EEF region is the volume of plasma between its two layers and the Target plasma is the diffused plasma region be-

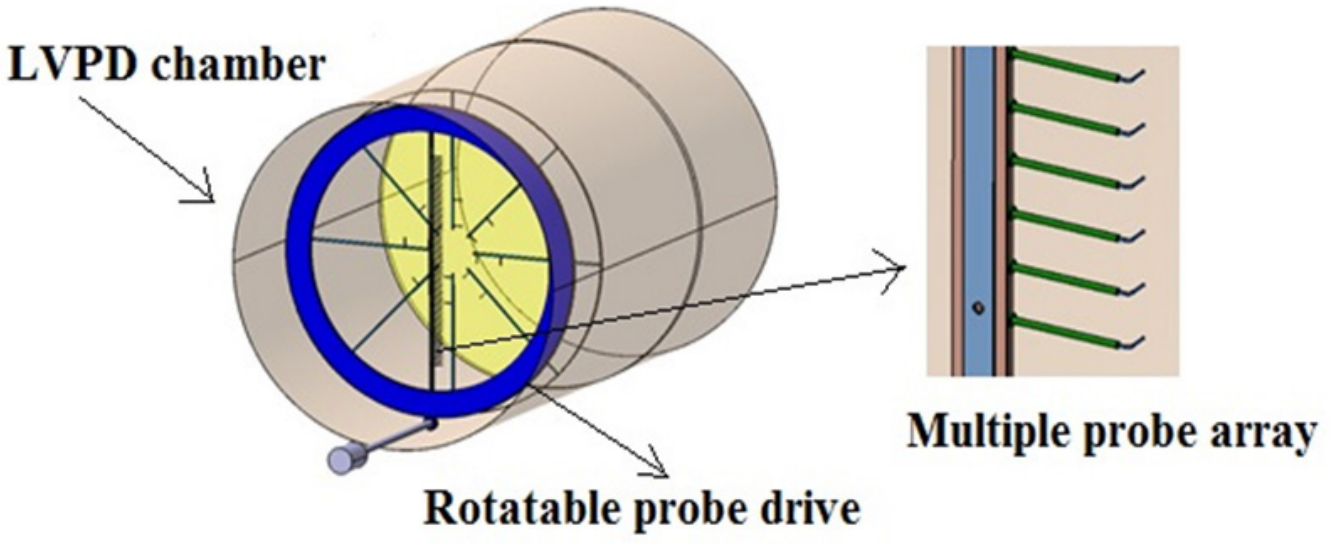

Figure A.1.1.1 Schematic of rotatable probe drive with probe array accommodating multiple probes

tween the end plate and the second layer of EEF. The energetic electrons are generated in the source region and propagate toward EEF and dissipate energy. This phenomenon mimics the situation of earth's magnetosphere where plasma travelling from solar space along with inter-planetary magnetic field line reconnect to the earth's magnetic field and result in the injection of the energetic particles. Further their precipitation results in the formation of auroras. Such a plasma scenario is developed in the source region of LVPD plasma.

Investigation of Non-linear structures in ETG background: To understand non-linear structures such as streamers, zonal flow etc. in the ETG plasma, engineering design and fabrication of circular shaped, gear based mechanical assembly has been completed. This assembly will be equipped with plasma diagnostics probe for exploitation of plasma cross section with least perturbation. A 100 channels vacuum interface has been developed for taking signals to DAC in the laboratory. The electrical system to control the mechanical assembly is based on stepper motor, drive and encoder.

Large uniform area, high density plasma source: The design of high density (ne ~ 10^{12} cm^{-3}) and large cross-section (~ 1.6 m) plasma source (Figure A.1.1.3) has been successfully carried out and its fabrication work is underway. The source will be used for obtaining uniform plasma density for active and passive investigations on ETG and Whistlers. Investigations will be carried out to understand effect of plasma beta scaling on ETG and whistler turbulence. This source will replace existing rectangular shaped plasma source and will enhance plasma beta values exceeding unity.

Automated Linear Probe Positioning System: The positioning of plasma diagnostics probes is crucial for spatial accuracy of measurements. An electro-mechanical system (Figure A.1.1.4) for linear movement of probes in the horizontal plane of cylindrical shaped vacuum vessel has been developed. The integration and performance benchmarking of 12 installed electro-mechanical assemblies has been car-

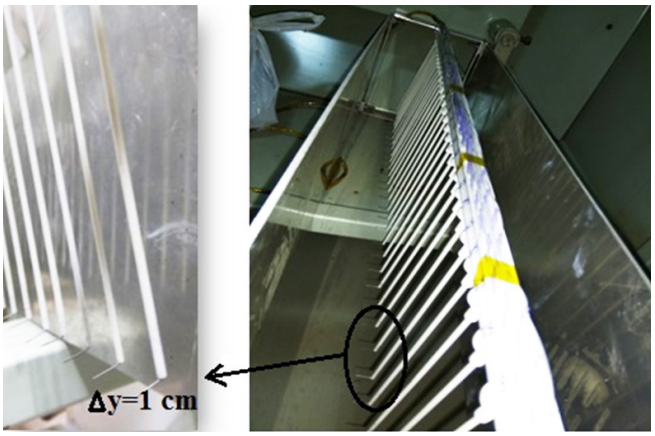

Figure A.1.1.2 Developed probe array with assembled 100 Langmuir probes. This probe array forms the chord of rotatable probe drive

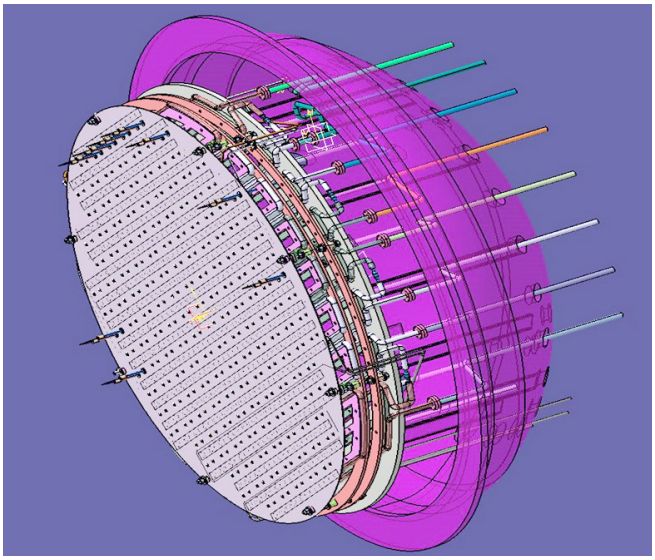

Figure A.1.1.3 3D schematic of the large area uniform emission filamentary plasma source with 155 filaments

ried out for simultaneous operation using in-house developed software in LabVIEW. The accuracy in movement using software control is achieved within 3mm for full travel length of 1000 mm. Three set of electrical hardware has been procured for further enhancement of the system.

SYstem for Microwave PLasma Experiments (SYMPLE)

Generation of Plasma Suitable for Microwave Interaction Study: The major tasks during the report period have been the following (i) to enhance the plasma density to the required value ~ $1x10^{18}$ m^{-3} in the experimental volume where interaction experiments are intended and (ii) to bring down the working pressure, by adjusting the differential pumping and by throttling of various valves to low enough range so that the condition $\nu_{e\text{-}n} << f_p$ can be maintained. Suitable system / operational parametric combinations have been identified and a detailed characterization of the plasma has been carried out using Langmuir probes by measuring density and electron temperature at various axial and radial locations.

Experiments: On the experimental front following developments have been made. A circular wave guide terminator has been developed of inner diameter of 71.42 mm. This load has been done to test circular waveguide components. The measured bandwidth range of this load is 2.85 – 2.97 GHz for 18 dB return loss. A mode converter using mono-stair from TM01 to TE11 has also been developed (figure A.1.1.5 and A.1.1.6). A wave guide mode visualization matrix array has

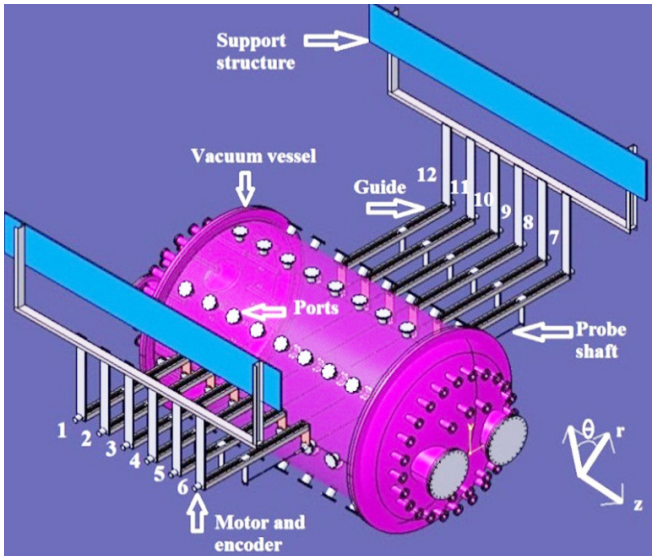

Figure A.1.1.4 Schematic of the installed probe positioning system (top view)

also been developed using neon bulb setup to estimate the wave guide mode and modes are visualized using that array matrix as shown above. One microwave extraction setup has also been developed which extracts one KW of microwave power from the magnetron used in commercial microwave oven One KW power is achieved as shown in the figure A.1.1.7. A variable short of half wave length is used for impedance matching.

Non-Neutral Plasma Experiments

The Non-neutral plasma experimental system (SMARTEX-C) is a C – shaped trap for electrons in a fat toroidal vessel. Studies on electron-plasma confinement, its progress and underlying physics, have been carried out in a systematic manner, eliminating factors that degrade the confinement. Brief description of up gradation activities are as following: (i) Vacuum vessel is electro polished and all ports are metal sealed making vessel capable of achieving SMARTEX-C less than 10-9 mbar; (ii) Toroidal Field coil has been upgraded and vessel bore-diameter increased to make SMARTEX-C operate at B = 1000 Gauss with droop as low as 5% for 2 second of operation; (iii) Trap components are redesigned for better toroidal symmetry, better spatial resolution in probing plasma, making space resolved charge collector diagnostics possible; (iv) Floating potential measurement using high-impedance Langmuir probe, designed and installed. All of the above up-gradation has made electron plasma experiment to operate with minimal down-time of experiments and successfully taking >400 shots in two months of operation. Relay

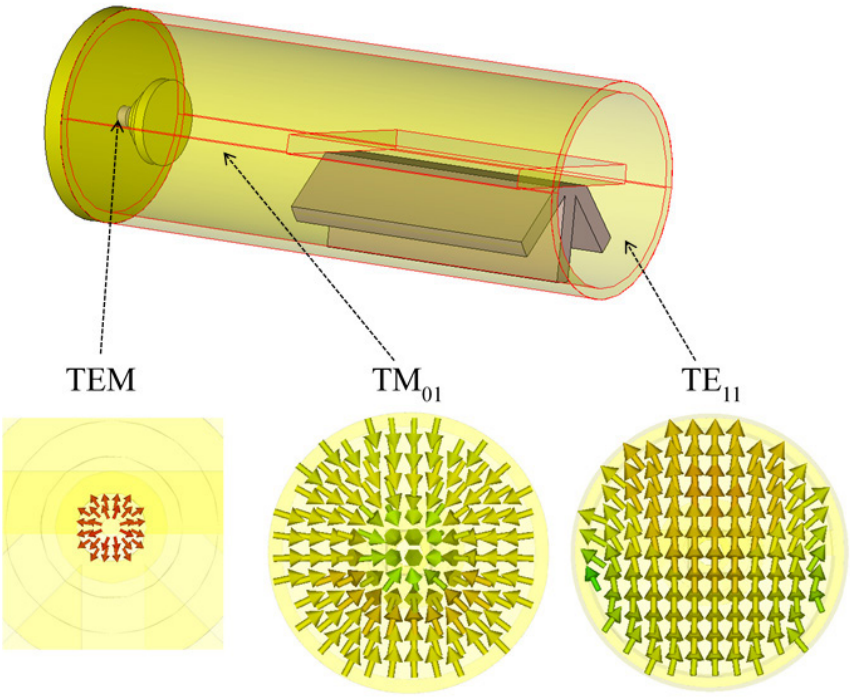

Figure A.1.1.5 Schematic of the mode convertor with the mode structures

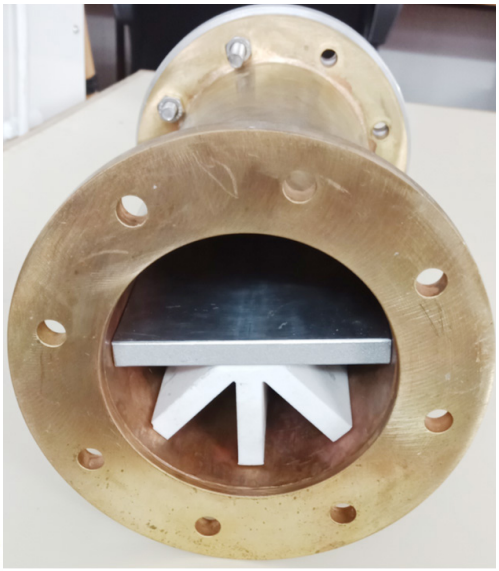

Figure A.1.1.6 Photograph of the fabricated Mode Converter TM01 to TE11

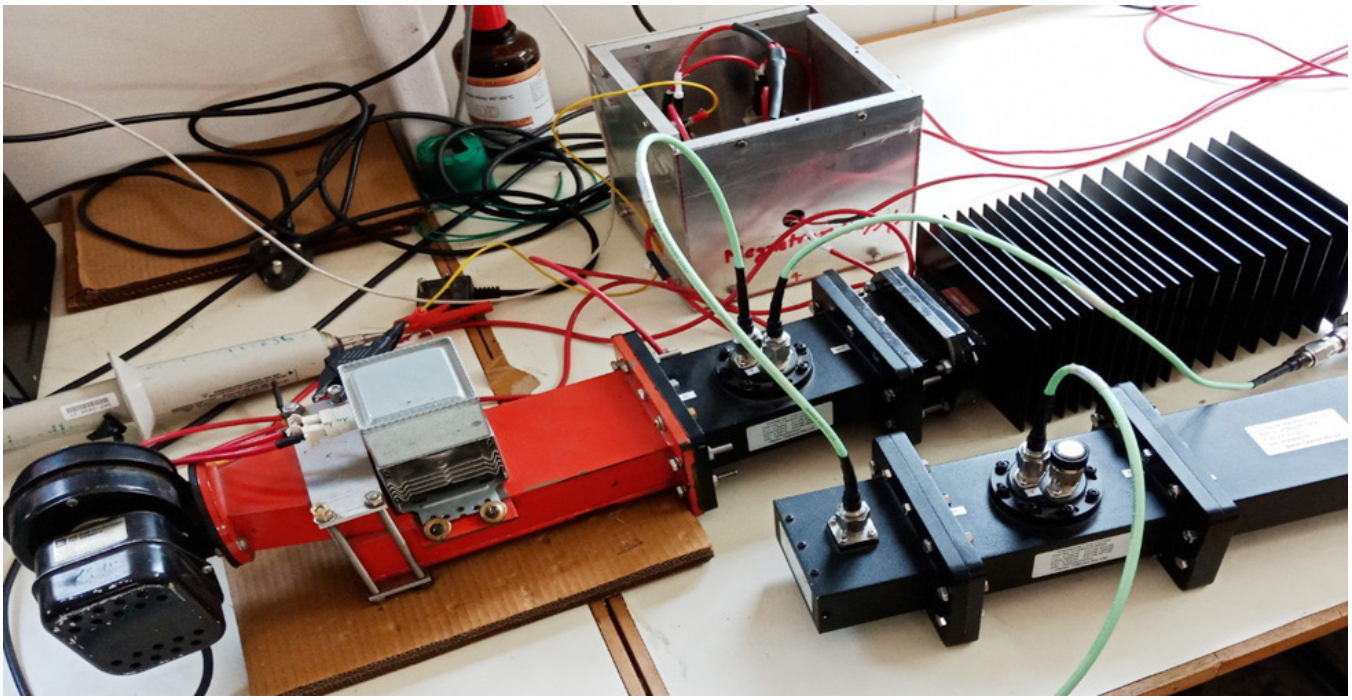

Figure A.1.1.7 Set up to Extract 1.0 KW Microwave Power from Commercial Oven Magnetron

based controlled baking system has been developed and integrated with a LabVIEW® application. Conceptual and Engineering Design of a trap with a larger aspect ratio (LAR) with the help of EDAS has been completed and is ready for prefabrication review. Components of the test setup for imaging diagnostics has been designed and forwarded for fabrication. Three uninterrupted power supplies each of rating 5kVA have been integrated with the vacuum pumping and monitoring system in order to have smooth pumping of the vessel during unforeseen power failures as well as declared power outages

Interaction of Low Energy Ion and Neutral Beams with Surfaces

Here there is an experimental setup which produces high density (~ $10^{13}cm^{-3}$) plasma and neutral beams (energy ≤ 100 eV) of importance to plasma processing. In the same setup neutral beams are produced as a consequence of surface neutralization of Auger electrons of a biased reflector plate and the impinging ions. The bias voltage on the reflector plate determines the energy of the neutral beam. Unlike plasma beams, however, neutral beams diverge outward in the forward hemisphere, hence its intensity falls as inverse of the square of the distance from the neutralizer / reflector plate. To detect neutral beams a micro channel plate (MCP) cum phosphor screen has been placed 900 to the direction of the plasma beam and about 70 cm from the centre of the reflector (SS 304) plate. Here first confirmed observation of low energy (≤ 50 eV) neutral beam of nitrogen atoms is being reported. Apart from its obvious application in providing information for better understanding of processing plasmas, its major impact may be felt in nanotechnology for atomic layer processing of semiconductor materials. Unlike ions / ion beams which cause charging of semiconductor / insulating materials and hence cause problems for anisotropic etching as semiconductor device dimensions shrink below 5 nm. Etching with neutral beams is increasingly being thought of solving this problem. This achievement can lead to semiconductor device fabrication for the coming decade.

Experiments with Dusty Plasmas

Experimental observation of precursor solitons in a flowing complex plasma: Imagine sitting on the seashore and being able to predict the arrival and speed of an oncoming ship by observing a train of waves hitting the coast. Such a phenomenon has been known and observed in hydrodynamics since the early seventies as precursor solitonic waves emitted by the brow of a ship moving at a speed faster than the phase velocity of surface waves. The excitations are also observed when water is made to flow over a submerged object at such

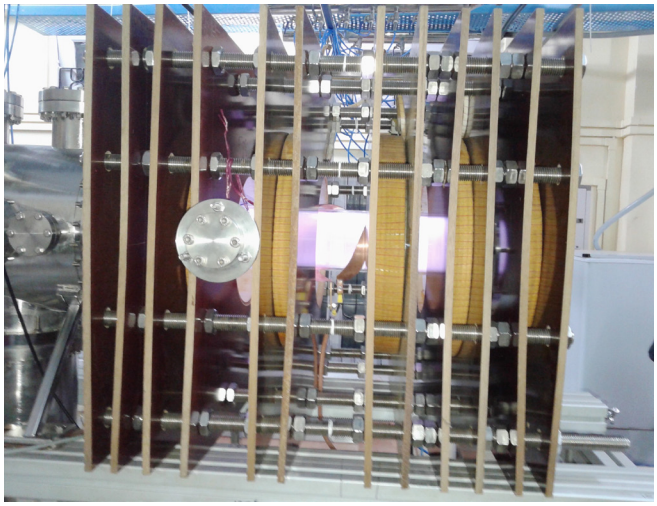

Figure A.1.1.8 Argon plasma produced in the HeliPS system

a transcritical speed. Surprisingly precursor solitons have not received any attention in plasma physics although solitons and other nonlinear waves have been widely studied for over half a century. This work reports on the first experimental observation of precursor solitons in a plasma medium that is caused by a supersonic flow of the plasma over a charged obstacle. Transcritical (supersonic) flows of plasmas can occur in many natural situations such as in astrophysical jets, plasmas created by laser blow-off of targets, solar winds etc. The encounter of such flows with a stationary charged object can recreate the situation discussed in our experiment. Likewise, the occurrence of charged objects moving at supersonic speeds in a plasma can be commonly found in situations like satellites (which naturally acquire surface charges) orbiting the earth in the ionospheric region, high energy ion beams impinging on targets in inertial fusion schemes etc. The excitation of precursor solitons in such situations can have significant practical implications. At a fundamental level the existence of such excitations would be of interest to a large community of researchers engaged in studies of collective excitations in charged media including plasmas, colloids and other soft condensates. This experimental investigations can motivate the study of such precursor soliton excitations in these media and thereby open up new areas of experimental and theoretical research in the field.

Dusty Plasma Coulomb Crystal: Experimental model for Soft condensed matter, Thermodynamics and Statistical Mechanics: Solid state physics is an important branch of physics, which deals with the structural and physical characterization of crystal state. Moreover, two-dimensional crystals

are of more interest due to its special behaviors. Invention of Graphene (a two dimensional hexagonal carbon crystal) and its nano-tubes revolutionized the science and technology in the 20th century. However, it is very difficult to investigate the underline features of this kind of crystals in atomic scale. A model system is very badly required to explore the physics in individual particle information. Dusty plasma offers such an excellent model to investigate crystal properties both in two and three dimensions. Observation of Coulomb crystal in 1993 opened up a new era in dusty plasma physics. Two-dimensional hexagonal Coulomb crystals are quite common in RF discharges. Here the dusty plasma crystals have been produced for the first time in a DC glow discharge plasma in Dusty Plasma Experimental (DPEx) Device. An argon plasma is created in between the disk shaped anode and a long grounded cathode. The dusty plasma is then made by introducing mono-dispersive micron sized Melamine Formaldehyde particles into the plasma. At appropriate discharge parameters, a mono layered dusty plasma crystal is observed in the cathode sheath. Structural details of the crystal are studied using pair correlation function and Voronoi diagram analysis. The crystalline structures are found to be melted into a fluid phase when the discharge parameters are varied.

Multi-Cusp Plasma Device

The fluctuations observed at various radial locations along the central vertical plane show very interesting results. It is found that the fluctuation are mostly there only in the low beta regions (where the magnetic field pressure is more than the plasma pressure) while the central region is found to be free from any observable fluctuations. It is to be noted that the central region has very small or negligible magnetic field due to the multi-line cusp magnetic field configuration. This proves that the fluctuations in the low beta edge regions are not being carried to the high beta central region because of the favorable curvature of the magnetic field. Hence this central region will be ideal for studying wave excitation experiments and non-linear energy couplings. Also because of the variable nature of the magnetic field configurations, this device also holds the capability to study many earth ionosphere related phenomena like magnetic reconnections.

Inertial Electrostatic Confinement Fusion (IECF) Device

At present, continuous operation of the cylindrical IECF device at 80 kV input voltage for a 5 minutes has been successfully realized and the neutron counts up to 106 neutrons per second has been recorded. Recently the fast DD neutrons are detected using solid state nuclear track detector (CR-39) which directly detects recoil particles, in particular recoil protons resulting from elastic neutron-proton (np) scattering. Meanwhile another IECF device (spherical geometry) has been installed at CPP-IPR and by making use of by cold cathode discharges the deuterium plasma is being produced in it. The purpose of having spherical IECF device is that to obtain isotropic DD neutron emission from it. Further characterization is in progress.

Studies on Negative Ion Source

In a hot cathode discharge or arc discharge, plasma, produced by electrons emitted from hot filaments, can be confined by multi-cusp magnetic fields. A magnetic field can reduce the flow of energetic primary electrons from the region where plasma is produced to the region where plasma diffuses. This magnetic field partition or magnetic filter can produce a region having electrons of energy in the range of 60 – 100 electron volts (eV) and a region having electrons of 1 eV or less. Negative ions generated in plasmas in such a configuration have traditionally been called “volume production sources”. In the volume of these sources, negative ions are generated in molecular gases due to dissociative attachment of low energy electrons to rotationally and vibrationally excited molecules. The project investigates the physical phenomena arising out of the use of magnetic filter field for production of negative ions.

<u>*Measurement of negative ion density using laser photo-detachment method:*</u> Experiments were performed in the Double plasma device to measure the negative ion density using

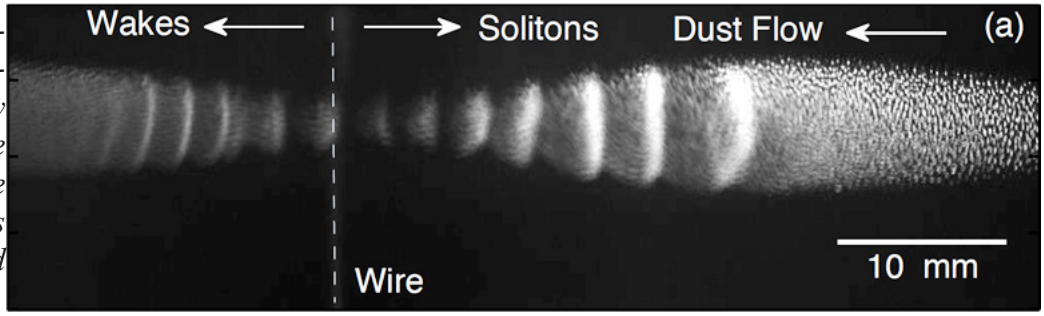

Figure A.1.1.9 An experimental image of the excited solitons. The dusty plasma is flowing to the left and flows over the object whose location is indicated by the dashed line

the laser photo-detachment technique by varying experimental parameters. The experimental setup has length of 110 cm and diameter 30 cm. The device contains two multi-dipole magnetic cages (length 30 cm, diameter 27 cm). The source and target region is separated by transverse magnetic field and the field strength at the center is nearly 26 G. The chamber pressure is first reduced to ~10^{-5} mbar using a rotary and oil diffusion pump and working pressure fixed at 4×10^{-4} mbar. In the source region, filaments of different materials having diameter 0.3 mm, and length of 4 cm are used. Nd-YAG laser of 1064 nm wavelength, 4 mm aperture and frequency 1 Hz was used for laser photo-detachment in the target region. It was found that the tungsten filament produced the maximum density. The negative ion densities in presence of different confining magnetic field strengths were also measured.

Ion-Ion Plasma Experiments in a Helicon Source

With electronegative gases, the Helicon Plasma source can produce efficiently an exotic plasma called ion-ion plasma where positive ions and negative ions co-exist. Considering the importance of ion-ion plasma and advantages of the helicon plasma, a system has been designed and developed which will be used for production and experiment of ion-ion plasma using electronegative gases. In the system the plasma density variation has been studied with magnetic field along the axis at the centre of glass chamber and found that the density peaks between 400-500 Watts of RF power for a field of 300 G. A B-dot probe has been designed and fabricated to measure the fluctuations in the magnetic field.

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

The CPP-IPR High Heat Flux (HHF) device can regenerate ITER like controlled heat flux (10 MW/m^2) with an argon jet, generated through a segmented plasma torch. CIMPLE-PSI is a tokamak divertor simulator device, indigenously developed and has been commissioned. For 0.4 Tesla axial field and 300 A plasma current (31.5 kW), the helium ion density at the center of the first window, 80 mm away from the torch anode, was estimated from Stark Broadening as 3×10^{20} m^{-3} (temperature 2.2 eV). Taking advantage of the very high resolution of a 1.33 meter McPherson spectrometer, the velocity of the plasma beam was measured from the Doppler line shift of a Helium emission line as 6.8 km/s. From these values, the corresponding ion and heat flux at the first window were estimated as 2.04×10^{24} $m^{-2}s^{-1}$ and 10.3 MW/m^2 respectively, which confirms that ITER divertor like parameter regimes were comfortably achieved in the device under operation with fusion like gases, with just 31.5 kW input plasma power. Tungsten targets with negative bias and controlled surface temperature (930 K), was irradiated under helium plasma in CIMPLE-PSI, which led to formation of nanosized tendril like structures on the exposed parts of the target. This exotic nanomaterial is known as W-fuzz, which has been observed before in both tokamak divertor simulators as well as actual tokamaks.

A.1.2 Aditya Tokamak

Ohmically heated circular limiter tokamak, Aditya has been upgraded to a tokamak named Aditya Upgrade (Aditya-U) having open divertor configuration with diverter plates. After successful commissioning (R0 = 75 cm, a=25 cm), the Phase-I operation was successfully completed after about ~ 17 weeks of operation.

Analysis of Phase-I operation Experimental Results: This analysis study has been carried out in detail. Density enhancement with Hydrogen gas puff and runaway suppression in high density plasma has been studied. In this, a single broad hydrogen gas puff is introduced at plasma current flattop 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 pulse width timing and voltage level, time (T) for the gas puff to start has been pre-programmed with programmable pulse generator. Fast visible imaging video camera for 2D tangential viewing, has been installed. This has captured a wide angle panoramic view of the tokamak from the radial port. The entire poloidal cross section including the limiter is within the field of view of the camera. Data was acquired at 14 kHz, and the consecutive frames are 71 μs apart. Excellent images of plasma evolution at high spatial and temporal resolution are obtained during start-up/burn-through, gas-puff at flattop and during disruption phase is shown in figure A.1.2.1. Apart from the density enhancement, the runaway suppression has also been studied by enhancing the line average electron density of the discharges. The runaway electrons are detected by measuring the limiter generated hard X-rays using a NAI (Tl) Scintillation detector placed in front of limiter to measure the hard X-rays emission from the limiter. Intensive bursts of hard X-rays emission with energies reaching up to ~ 5 MeV have been observed in the plasma current flat-top region in discharges with densities $\leq 1.2\times10^{19}$ m^{-3}. However, in the high density discharges, where the density is maintained $\geq 1.5\times10^{19}$ m^{-3} in the plasma current flat-top mainly by using the multiple periodic gas-puffs, the runaway generation ceases. Furthermore, Magneto hydrodynamic (MHD) experiments

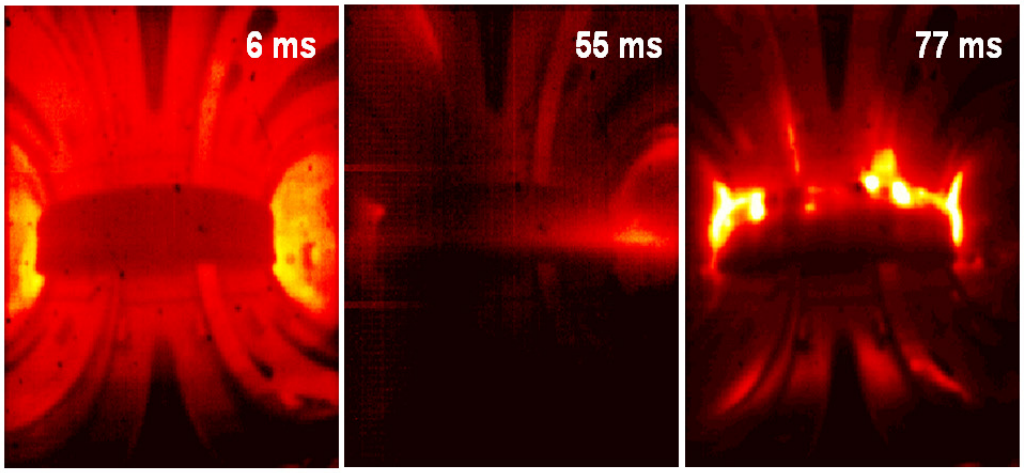

Figure A.1.2.1 Images of plasma evolution at high spatial and temporal resolution are obtained during start-up/burn-through, gas-puff at flattop and during disruption phase

and studies have been carried out. It has been possible to modulate the MHD mode frequencies by using gas puff. An interesting correlation between Runaway electrons and MHD amplitude has also been found and studied as well.

Machine preparation for Phase-II Operation: As a part of the Phase-II operation preparation, calibration of magnetic diagnostics have been completed followed by commissioning of major diagnostics and installation of control baking systems.

Mirnov coils calibration: The 16 magnetic probes (Mirnov coils) garland placed at two different toroidal locations have been successfully calibrated. Mirnov coils are used to detect the magnetic fluctuations and plasma position measurements. For the purpose of calibration of the above probes, we have installed a hollow copper conductor inside the vacuum vessel. It is placed toroidally inside the vessel. A changing current is passed through the conductor in order to simulate the plasma current. Conductors with varying diameter were prepared and used for simulating the plasma position. The schematic of such a calibration setup is shown in figure A.1.2.2.

Rogowski calibration for Plasma Current measurement: Two internal and one external Rogowski coils for plasma current measurement has been calibrated. A new long pulse hardware integrator circuit is used during the calibration. The output voltage signal (raw signal) of the Rogowski coil has been integrated with hardware integrator as well as software integrator and then compared with standard calibrated DC Current Transformer.(CT) signal.

Vacuum Vessel Baking: The vacuum vessel has been successfully baked up to ~ 130°C in subsequent baking cycles for the purpose of achieving lower base vacuum. The base pressure of the order of ~ 9 x 10^{-9} mTorr has been achieved after solving all leaks.

Phase-II Plasma Discharge Operation: After all the relevant preparations, the Phase –II plasma operation have been resumed in Aditya-U in February 2018 in a Graphite limiter (toroidal belt limiter) configuration and continued to achieve plasma parameters close to design parameters. Repeatable plasma discharges with plasma current of ~ 80 kA – 90 kA with plasma duration of 75 – 80 ms with BΦ (max.) ~ 1T and chord-averaged electron density ~ 2.0×10^{19} m^{-3} has been achieved within ~ 10 days of operation. Several experiments, including the estimation of plasma position with different techniques such as magnetic probe, Sine –Cosine position coil and optical In-Out position measurement during actual

Figure A.1.2.2 Setup for Magnetic diagnostics coils in-situ calibration

plasma discharges operation as well as real time control of plasma position using Fast Feed Back Power Supply (FFPS) is undergoing. In addition to that other experiments such as fuelling with Supersonic Molecular Beam Injection (SMBI), Hydrogen gas puffing for density enhancement and runaway control during current flat-top and disruptions, 42 GHz Electron Cyclotron Resonance (ECR) assisted heating experiment, Neon gas puff assisted radiative improved confinement and the experiments related to plasma shaping will be carried out in near future.

Diagnostics on Aditya-U Tokamak

Microwave Reflectometry: The reflectometry diagnostics to measure the edge density profile in Aditya-U machine for coupling studies of lower hybrid waves is under development. The reflectometry system is designed to operate in the frequency range from 26 GHz to 36 GHz and would cover a density range from SOL to 5x1018 m-3 with a toroidal magnetic field between 1 T and 1.5 Tesla. The total frequency band is swept in 100 microsecond to improve density profile reconstruction. The Aditya-U reflectometer is built to operate in frequency modulation continuous mode or at a fix frequency mode for density fluctuation study. FPGA based data acquisition system with 12 bit resolution with maximum sampling frequency of 125 MSPS and E-plane sectorial horn antenna for transmitting and receiving microwave signal has been developed and is being tested for its performance.

Heating and Current Drive Systems

Electron Cyclotron Resonance Heating (ECRH) System: The 42GHz ECRH system has been successfully installed on tokamak Aditya-U. The system has been tested for its high power performance. Some experiments related to ECR heating in Aditya-U plasma has been carried out which confirms the successful coupling of ECRH power.

Gyrotron Operation with PXI DAC system: The PXI based DAC system procured to operate the Gyrotron has been commissioned with real field signal. Later it was integrated with Gyrotron with new fibre-optic based front-end electronics. Now this system is operated with real Gyrotron and first campaign of Aditya-U has been carried out with PXI based DAC system

Lower Hybrid Current Drive (LHCD) System: Design and development of passive-active-multijunction (PAM) antenna or launcher for Aditya upgrade machine has been completed. The schematic of PAM launcher is shown in figure-A.1.2.3a and it is in advanced stage of fabrication. Fabrication of intermediate component is in progress which includes mode converter, power divider section, vacuum enclosure, support structure, etc. and the same would be assembled soon. The picture of some of the components during fabrication is shown in figure-A.1.2.3 (b & c). Pill Box vacuum windows would be used to isolate the pressurized transmission line and the vacuum of the PAM launcher. The activity related to development of vacuum widow for PAM antenna is initiated. Ceramic discs of alumina and aluminium nitride, OFHC copper material for circular waveguide and circular to rectangular waveguide converters are procured. For prototype window fabrication, an aluminium circular waveguide and circular to rectangular waveguide transitions are made in the workshop. The activity related to the prototype development of high power circulator is initiated. The Coupler and Phase shifter assembly document and drawings are made and the components are indented. The Coupler and Phase shifter are

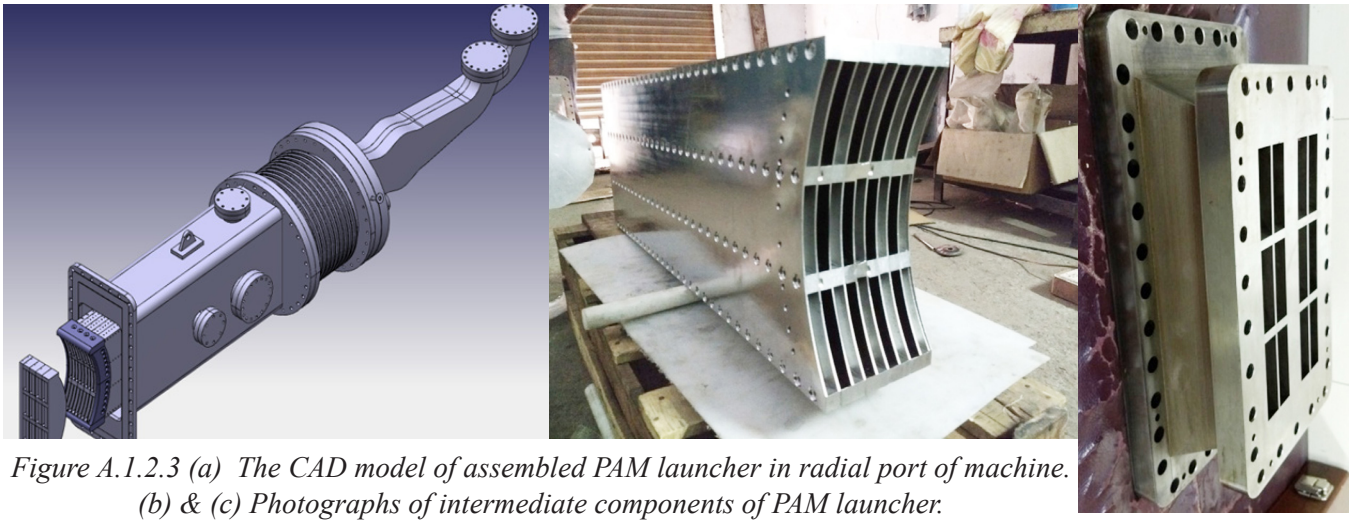

Figure A.1.2.3 (a) The CAD model of assembled PAM launcher in radial port of machine. (b) & (c) Photographs of intermediate components of PAM launcher.

to be fabricated from OFHC Copper Grade 1 or 2 material. Coupler and Phase shifter assemblies would be provided with cooling arrangement.

A.1.3 Superconducting Steady-state Tokamak(SST-1)

To achieve better performance of cool down of superconducting magnets, two dedicated experimental campaigns were carried out in this year. Some of the main highlights from the experiments are:

Simultaneous cool down of TF and PF coils to superconducting temperatures: After a series of upgrades and refurbishments, the simultaneous cool down of Toroidal Field (TF) and Poloidal Field (PF) coils have been carried out to ~ 9 K for the first time while the TF Case was hydraulically bypassed. All TF and PF coils except PF-5 (L) coil, showed superconducting transition through resistance measurement.

Cool down of PF coils to superconducting temperatures: During the 20th campaign of SST-1, for the first time, successful cool down of all nine PF magnets to ~ 6 K under two phase helium flow conditions has been demonstrated. This is well below the superconducting transition temperatures for NbTi superconductor based PF magnets (NbTi has critical temperature of 9.4 K at zero magnetic field)

TF Coils charged up-to 2.5 T magnetic field at R=1.1m: During the 21st campaign of SST-1, the TF coils were charged for the first time up to 7.9 kA (which corresponds to 2.5 T at R=1.1 m) for 300 seconds of flattop. During the same campaign long pulse operation of TF coils at1.5 T was carried out with a flattop of 23,280 seconds.

Performance Evaluation of SST-1 Helium Refrigerator/ Liquefier (HRL):We have evaluated cold capacity of HRL in all 3 possible modes of operation viz. pure liquefier (L-Mode), pure refrigerator (R-mode) and mixed mode (R+L mode). It has been shown that the "As on Today" measured helium plant capacity is intact and more or less similar to that of "original commissioning" of helium plant in 2004 and subsequently to the preventive maintenance activities carried out during 2009-10. The regular maintenance of HRL has been a basic protocols to enhance the reliability and availability of the plant system.

Helium screw Compressors Overhauling: The helium screw compressors overhauling activities have been carried out in collaboration with M/s. Axima Engie, France after an operation of 20,000 hours. During overhauling activities of helium screw compressors, all essential and mandatory spare parts including gaskets, seals, O-rings, balance piston sets, thrust bearing sets, oil seals, mechanical shaft seals, sleeve bearing sets, etc has been replaced. Alignment of Motor with compressors skid in horizontal / vertical was achieved within 50 m ± 10 m. Compressor assembled on Skid, Levelling of Motor done within 10 m. Compressors Run Test at Full Load of 70 g/s at 14 bar (a) discharge Pressures, Test shows motor current 415 A (in acceptable limit), Vibration reduced to 2.3 mm/s were obtained.

Heating and Current Drive Systems

Electron Cyclotron Resonance Heating (ECRH) System Similar to previous campaigns, the 42GHz ECRH system has shown its performance on SST-1. The successful ECRH assisted plasma start-up has been carried out in SST-1. Approximately 150kW to 200kW ECRH power is launched in SST-1 for 70ms to 150ms duration and several experiments have been carried out at 1.5T operation.

Procurement of 42GHz Gyrotron Tube: The existing 42GHz ECRH system has been extensively used in SST-1 and Aditya-U. In the ECRH system, the Gyrotron has limited life, hence the procurement of 42GHz Gyrotron tube has been initiated to renew the existing ECRH. The indent has been raised and it has been cleared by the committees.

Regulated High Voltage Power Supply (RHVPS) for Gyrotron: In order to operate the megawatt level Gyrotron, a 55kV-110A power supply is under development. The modules of regulated high voltage power supply have been tested at factory and now being delivered to IPR. This system integration will be started soon at IPR.

Solid state crowbar development for Gyrotron: The development of solid state crowbar is as per the schedule. Earlier 20kV solid state crowbar developed and integrated with the power supply. This system has been further upgraded to 35kV and system has been tested up 30kV. The 50kV solid state crowbar is under design stage.

Lower Hybrid Current Drive (LHCD) System:
The LHCD system is made available for experiments on SST-1 during campaign-XX and campaign-XXI. Prior to campaigns, the LHCD grill antenna and vacuum window are actively cooled throughout the baking cycle, during which SST-1 machine and its PFC's inside the machine is baked up

to 250°C. Later, the standard procedure for high voltage and rf conditioning is followed to bring up LHCD high power sources for the said campaigns. The klystrons are operated, in parallel mode, with regulated high voltage power supply (RHVPS). The LHCD power has been successfully launched in to the SST-1 machine during these campaigns. The breakdown capability of lower hybrid waves has been successfully demonstrated in helium plasma with LH power ~50kW. Initially low density plasma (ne ~10^{11} cm^{-3}) is formed which improves by an order (ne ~10^{12} cm^{-3}) with the second pulse. The breakdown of plasma could be achieved over a wide range of toroidal magnetic field (from 1.2 T to 1.5T) and pressure ($1 – 5 \times 10^{-4}$ mbar). A new 4-turn spiral antenna (having cross section of 3.7×5mm and gap of 3.7mm), having inner radius of 1.85mm and outer radius of 70.3mm, has been designed and fabricated using water jet cutting method to form plasma using helicon waves. Plasma was produced using it in the basic toroidal device (R~30cm, a~10cm) with a 13.56 MHz RF source. Plasma could be formed over wide pressure range ($2 – 10 \times 10^{-3}$ mbar) in the absence of toroidal magnetic field and also in the presence of toroidal magnetic field (800G max.). After successful operation of spiral antenna in basic toroidal device, the spiral antenna was used in SST1 machine in campaign-XX, to form the plasma using helicon waves launched by spiral antenna (Forward power ~200W). It was mounted on radial port without breaking the SST-1 machine vacuum. Plasma could be formed up to a toroidal magnetic field of 1.5 T and over a pressure range of $2 – 10 \times 10^{-3}$mbar. However the plasma formation was highly localised near the radial port#12 extension.

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A.2 Technology Developments

Under the purview of continuous progress in Plasma Science and Technology, many technologies are being developed. A brief about the technologies developed under various heads are given here.

A.2.1 Magnet Technologies

This programme caters to the development of different magnets which will be used for confining plasma in various configurations. SST-1 superconducting Toroidal Field (TF) Magnets successfully cooled up to 5 K with the available SST-1 helium refrigeration and liquefaction system. TF magnets charged up to 7.9 kA, which is equivalent to the magnetic field of 2.5 T at major radius of 1.1 m of SST-1. This system also operated continuously for more than six hours at 1.5 T for plasma experiments. Poloidal field (PF) magnets were cooled exclusively below the superconducting (SC) transition temperature. The simultaneous cooling down of TF and PF magnets were also achieved after hydraulic modifications. The heat treatment of Nb3Sn superconducting strands and sub-cables carried out at 650°C. The metallurgical characterization of heat treated strands for Nb3Sn phase formation and its superconducting transition temperature measurements also carried out. The development of high voltage compatible insulation system for SST-1 SC magnets current leads is in progress. The laboratory scale high temperature superconductor based D-shaped magnet fabricated and tested for its cooling characteristics up to 77 K, current charging and magnetic field measurement.

A.2.2 High Temperature Technologies

This project deals with the research and development of the materials & technologies relevant to Plasma Facing Components (PFCs) viz. Divertors and Firstwall Components, for fusion grade tokamak devices. Major activities are as follows: Development of diagnostic techniques and high heat flux tetsing of plasma facing components and materials, engineering analysis of plasma facing components and high heat flux tests carried out using HHFTF, studies on development and/or testing of tungsten based materials, functionally graded tungsten-copper materials and joining of similar and dissimilar materials. The brief of the work done during the report period is following:

(i) Technique for ultrasonic inspection of tungsten-copper interface in a full-scale ITER-like tungsten monoblock divertor target element with curved copper-alloy tube having inner diameter of 12mm and radius of curvature of 500mm has been developed and demonstrated on a dummy tube with defects of known sizes. Developed technique uses a side-looking focussed ultrasonic probe mounted on a flexible shaft for accurate rotational and linear movement while maintaining precisely water-gap between probe and inner surface of tube.

(ii) Spatial Resolution of Infra-Red images to monitor temperature distribution on targets under high heat flux testing condition in HHFTF has been improved by 4 times to surface area of 0.5 × 0.5mm on target placed at a typical distance of 1.0-1.5m from IR-Camera.

(iii) Strain and strain-rate measurements on solid bulk

material samples mounted for tensile testing on Universal Testing Machine (UTM) are performed simultaneously using Two Dimensional Digital Image Correlation (2D-DIC) technique. Strain rates observed by DIC technique are found to be in close agreement with data obtained from UTM.

(iv) High Heat Flux Testing of tungsten coated Faraday Screen for WEST Tokamak has been successfully performed using HHFTF. Complexities in depositing desired cyclic heat loads for given time on predefined multiple areas of the job are successfully handled due to excellent flexibility in programming the electron beam at various power levels and using various beam patterns. Tests for quasi-steady state heat flux up to 4MW/m^2 as well as ELM-like transient heat flux of 100-250MW/m^2 for 0.4ms ON & 100ms OFF duration are successfully completed as per requirements.

(v) Studies performed for joining Inconel-625 materials using diffusion bonding and brazing process. Obtained joints are characterized for their micro-structural and mechanical properties. Brazing studies are conducted for Copper-to-Copper alloy and Steel-to-Copper alloy joints.

(vi) Development and characterization of tungsten-copper Functionally Graded Materials (FGM) are continued for reduction of thermal stresses in macro-brush type divertor components. Seven layered 1D-FGM of Tungsten and Copper materials is produced with linear gradient. 2D-FGM is under development;

(vii) Developmental studies are conducted for magnetron sputterred coating of various substrates (graphite/ steel/ copper) with of Titanium and Tungsten materials;

(viii) Engineering Finite Element Analyses (Thermal-Hydraulic, Thermal, CFD) are carried out for various experiments conducted using High Heat Flux Test Facility. Nukiyama curve for Critical Heat Flux (CHF) is developed for ITER-like coolant water parameters (Pressure=40bar; Temperature= 70°C). A new test mock-up using 500mm long copper test mock-up is developed to study two-phase flow and onset of Critical Heat Flux using HHFTF;

(ix) A low-priced wireless digital data transmission module has been developed and tested for transmitting low-frequency (< 30Hz) signals of thermocouples mounted inside vacuum chamber of high heat flux test facility (Pressure ~ 10-5 mbar) to data acquisition system outside the vacuum chamber.

(x) Development of ultrasonic technique to estimate damage to tungsten mono-block due to thermal fatigue is in progress. Ultrasonic velocity measurements performed on various tungsten mono-block test mock-ups indicates possibility of detecting signature that can be helpful for such estimation.

(xi) Development of acoustic technique to detect onset of Critical Heat Flux phenomena in water-cooled divertor targets during high heat flux testing is in progress. For benchmarking studies, separate experimental set-up is developed using fast optical imaging camera and ultrasonic sensor to detect air-bubbles injected in water flowing at constant speed;

(xii) High heat flux testing of mechanically mounted assembly of 20mm thick graphite tiles on 25mm thick copper-alloy module of Outboard Passive Stabilizer of SST-1 tokamak is performed using HHFTF. Tests are conducted for heat flux of 0.25, 0.6 and 1.0 MW/m^2, with and without flow of water though OPS copper backplate.

(xiii) Dome fabricated using tungsten macro-brush vacuum brazing technique is successfully tested for thermal cyclic load at quasi-steady state incident heat flux up to 7MW/m^2 using High Heat Flux Test Facility.

(xiv) High heat flux testing on three different samples

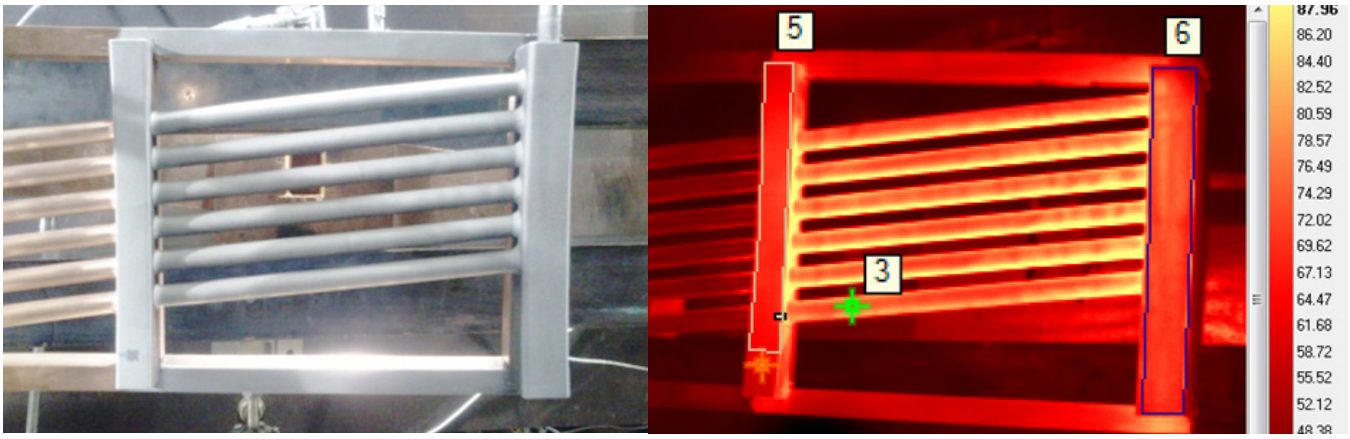


Figure 2.2.1 (a) Faraday Screen of WEST tokamak installed in High Heat Flux Testing Facility (b) Infra-Red Image during High Heat Flux testing

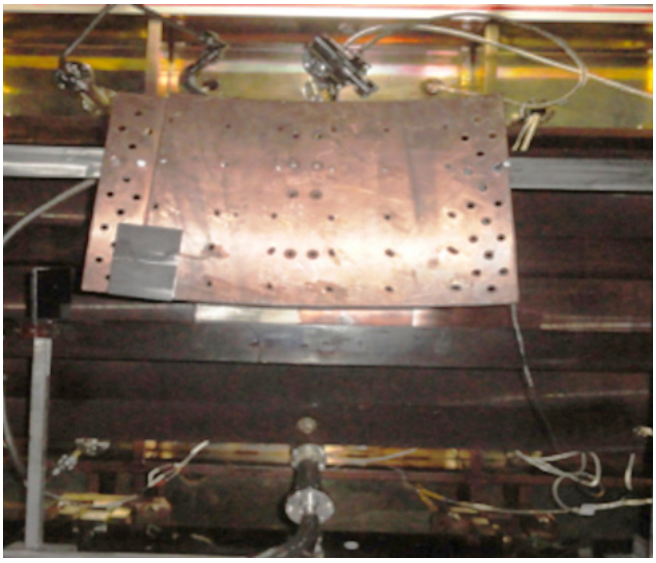


Figure 2.2.2 High Heat Flux testing of Outboard Passive Stabilizer (OPS) Module of SST-1

of Heat Transfer Element (HTE) made of copper-alloy for ITER-India is performed to study the effect of shape of cross-section of coolant channel on its heat transfer characteristics.

(xv) Tungsten coating technology development work for first wall application under MoU with ARCI (Hyderabad) has been completed. Tungsten coated test mock-ups with Cu-CrZr, SS316LN and IN-RAFM Steel are tested for material properties of the coating as well as heat removal during high heat flux tests using HHFTF.

(xvi) Batch production of about 100 nos. of tungsten-copper electrodes for thermal plasma spray coating units is successfully achieved using vacuum brazing furnace at IPR. Electrodes are checked using ultrasonic flaw detector. Operational performance of the electrodes is found to be satisfactory.

A.2.3 Cryo-Pump Technologies

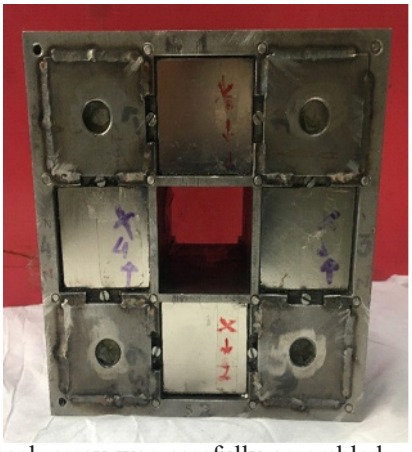
Cryo-pumping refers to the use of cryogenic temperatures to produce vacuum in enclosed spaces. It has a number of advantages, including very high pumping speed, the ability to create large and complicated shapes for the pumping surfaces and the creation of clean vacuum spaces without the possibility of contamination by hydrocarbons as in mechanical pumps. Cryo-adsorption cryo-pump technology offering pumping speed of 2 and 5 litre/sec/cm^2 for Helium and Hydrogen gases, respectively had been successfully developed. Similarly in space research large volume cryo-vac chambers are used where satellite and its components undergo climatic test. Under an MOU arrangement with Space Applications Center, Ahmedabad, development of LN_2 cooled Sorption Cryo pumps for small and medium sized thermovac chambers has been started.

Liquid Nitrogen Based Cryo-Sorption Cryopump: For space applications, development of 300 mm opening cryo adsorption pump as a product for target pumping of water vapour and air (mainly nitrogen) has been started. All works from concept , design, assembly integration , test set up, experimental studies related to performance and its repeatability were carried out. The work also included a) Selection of suitable adsorbents, b) Selection and qualification of cryogenic adhesive, c) In house coating and characterization of cryo-panels. At liquid nitrogen temperature, helium and hydrogen will not be pumped through cryo adsorption, hence a turbo molecular pump with minimum required pumping speed used for the residual gas pumping in order to maintain the vacuum level below ~10^{-7} mbar in the cryo-pumping chamber. To get the sufficient pumping capacity conical cryo-pumping panel were selected which will have adequate cryo-pumping surface area or sorption capacity. The developed pump was operated for 54hours continuous operation with constant gas dosing of 2 × 10^{-2} mbar/l-s. Initial pumping speed was greater than 7000 l/s and after 54 hours of operation it was ~4000l/s.

Cryopumping study for ISAC Bengaluru Cryopanels using Cryocooler: Saturated cryopanel obtained from the ISAC, Bengaluru has been refurbished with coconut shell charcoal and tested for its pumping performance for different gasses (N_2, Ar, H_2, He and Xenon). Pumping speed is measured by American Vacuum Society (AVS) standard throughput method. A known quantity of gas dose is introduced into the test dome, and pumping speed is measured using the throughput and the pressure rise data. Continuous pumping experiment is carried out for a gas dosing duration of > 30 hours. Total gas dosing in this period is > 9 bar.l/s. The ISAC cryopanel has been successfully tested for more than 15 thermal cycles.

A.2.4 Fusion Blanket Technologies

Liquid Metal Technology: Various in-house R&D activities are under progress for the development of Pb-Li technology with the prime objective of using it as a coolant as well as tritium breeder in future liquid breeder fusion blanket. In this regard, two D-type magnetic core flow meters were fabricated and successfully calibrated in high temperature (350^{o}C) Pb-Li loops. Another highly sensitive flow meter has been designed and fabricated (Figure A.2.4.1(a)) using a dipole



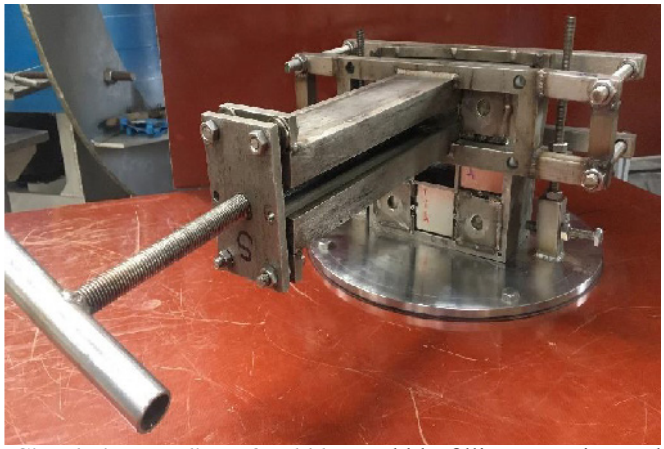


Figure 2.4.1 (a) The Halbach array magnet producing 0.78 T of magnetic field in the central air cavity and (b) mechanical system used for its assembly

Halbach array. The Halbach array was carefully assembled from its constituent eight permanent magnets with the help of a mechanical system. The integration and assembly of Pb-Li MHD (Magneto Hydro Dynamic) experimental facility is under progress. A test section, with more than 200 potential pins welded on the surface (Figure A.2.4.2), has been fabricated at IPR to study various MHD phenomena under 1.4 T magnetic field. The Pb-Li corrosion loop has been operated for ~5000 hrs to generate corrosion database for IN-RAFMS material. Efforts are being made to produce Pb-16Li eutectic alloy using MHD mixing technique.

Ceramic Breeder pebbles development: Lithium Titanate (Li_2TiO_3) powder and pebbles have been prepared by Solid State Reaction method followed by Extrusion and Spheronization. The pebbles of spherical shaped (~1 mm diameter) having porosity range ~10-15% for efficient tritium extraction. Alternate method of pebble preparation using "Freeze Granulation" has also been adopted for its advantage of having its purity and high spherocity values.

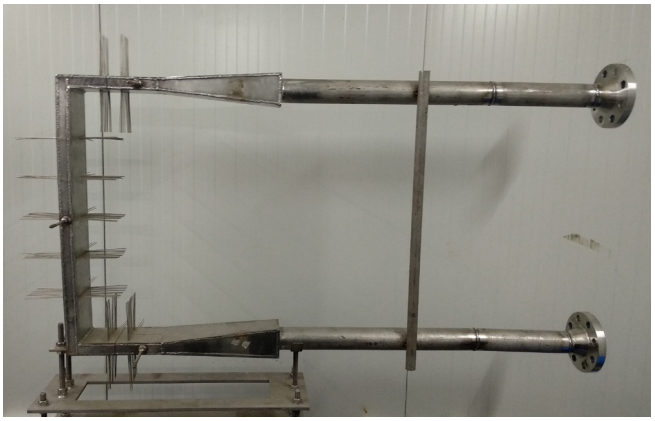


Figure 2.4.2 Test section for studying magneto-hydrodynamic (MHD) effect for Pb-Li flow

Simulation studies of pebbles: Pebble filling experimental set up has been developed to examine the filling mechanism in the canister (Figure A.2.4.3). The effect of bulk region and at near wall regions have also been characterized numerically for the different pebble filling cases by using Discrete Element Method (DEM). The open source code 'LIGGGHTS' has been implemented for pouring and compression simulation of pebble beds. Trial experiments for measurements of gas pressure drop across pebble bed have been performed using the modified set up with differential pressure transmitter. Models of randomly close packed pebble beds have been produced using DEM for numerical estimation of gas pressure drop across pebble beds. Interface thermal conductance between Li_2TiO_3 pebble bed and stainless steel wall has been numerically estimated as a function of bed temperature using finite element simulations and results are compared with a theoretical model.

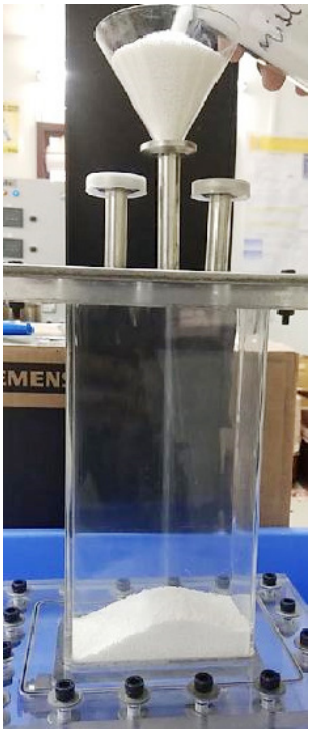


Figure A.2.4.3 Pebble filling experimental set up

Experimental Helium Cooling Loop (EHCL): This is being developed as a part of R&D activities in breeding blanket technologies. EHCL is a high pressure high temperature closed loop helium gas system. The loop is designed to operate at 8.0 MPa pressure, 300-400°C temperature and 0.2-0.4 kg/s flow rate. Most of

the loop components have been procured and the loop will be installed and commissioned shortly.

Fusion Fuel Cycle: Prepared $MnCl_2$ modified Alumina column for Gas Chromatography (GC) System, to separate and analyse very low concentration (~100 ppm) of hydrogen isotopes in carrier helium gas. We could observe two separate peaks of hydrogen isotopes (H_2 and D_2) in helium gas using this column at 77 K. The experiments were carried out for different column lengths (0.5 to 2 m). It has been observed that the retention times for H_2 varied between 2.3 and 7 minutes, whereas for that of D_2 it varied between 3 to 12 minutes.

A.2.5 Large Cryogenic Plants & Cryo-systems

It is mainly involved for the indigenous helium refrigerator/ liquefier (HRL) plant development of cooling capacity 200 kW at 4.5 K. One of the main achievements is development of a room temperature helium blower developed from air blower indigenously. This is operated to get He circulation at 80 k and at pressure up to 16 bar and flow rate 30 g/s. A data acquisition system has been also developed indigenously.

Establishing Cryogenic test facilities: Fabrication and assembly of test facility to test the indigenously manufactured components is progressing well. Mainly 3 test facilities have been planned: Heat exchanger test facility, purifier and filter test facility and turbine test facility. Out of these, Heat Exchanger test facility has been made and few heat exchangers have been tested. Also the purifier and filter test facility has also been completed.

Testing of manufactured prototype components: Pressure tests, as per ASME code, of all prototype components have been done and found successful. Pressure drop tests of all prototype components have been done and found to be as per design. In case of purifier, this pressure drop is even little less than design value. The thermal performance of 2-stream (He/LN2) and 3-stream (He/He/He) HEs are found to be as per design. Thermal performance of 2-stream (He/He) and adsorption performance of purifier are expected to be tested soon.

Instrumentations and Controls development**:** A versatile data acquisition system with SCADA and mimic diagram to find real time data and trends of different sensors simultaneously. This has been done for heat exchanger test facility and can be extended to helium plant's data acquisition system development. Using the latest electronics technology, a temperature data acquisition has been developed indigenously with good accuracy (~50 mK). Temperature sensor down to 4.5 K and LHe level meters are under consideration for development.

Activities towards fully indigenous plant: For development of helium CORS, an air compressor has been procured for conversion to helium compressor and further this will be helpful for automated helium compressor development which is required for helium HRL plant. To have faster progress in the development of cryogenic technology different other organizations have been collaborated in this project: NIT-Rourkela is for cryogenic helium turbine development; IISc-Bangalore for flexible liquid helium transfer line; PDPU-Gandhinagar for friction welding joint; BARC for review of turbine design and heat exchanger designs. A cryo-cooler for temperature sensor calibration, is also being developed by NIT-Rourkela.

A.2.6 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.

Conceptualization and prototype fabrication of Dual Arm Manipulator: Dual arm manipulator is a multi-body system, with number of joint configurations. Each manipulator arm has ~1 m length, which comprises of six degree of freedom rotary joints that provides postures during the manipulation of any components or tools inside the pre-defined viable area. Design & validation of the structural integrity of the integrated dual arm manipulator at various joint configurations for payload varying up to 5 Kg has been completed. System components such as lugs, hollow links, idler frame, shaft coupler, box support structure & motor support frames have been fabricated.

In-house development of a prototype haptic arm for telemanipulation: A 6 axis robotic system having Cartesian workspace has been designed and developed with encoders for positional feedback. This articulated master arm is capable of controlling a slave robot remotely using a TCP/IP network. The initial test results show high precision and accuracy with a low latency. Force feedback mechanism will be integrated with back-drivable actuators. Design of a 1 DOF prototype for back drivable actuator has been completed and the fabrication is presently ongoing.

Figure A.2.6.1 Prototype Master Arm for Control of Manipulators

Design & analysis of a Planetary Gearbox: Future tokamak will require heavy payload handling within constrained locations. Understanding of the kinematics of gear boxes is crucial for development customized compact gear boxes with high reduction ratio. Static & dynamic finite element analysis (2D & 3D) of integrated external & internal gearbox have been performed. Finite element results have been validated using theoretical calculation.

Selective Compliance Articulated Robot Arm (SCARA) Development: SCARA robot being developed is a 3 DOF robot, its compliance characteristics is extremely useful in assembly & inspection operations. Design of the SCARA structural components like shoulder arm, elbow arm, base column, motor support frames have been completed. The motor torque calculations have been completed and the system is under fabrication.

Safety System Development for Articulated Robotic Inspection Arm (ARIA): When working in crucial environments like inside tokamak vessel or within a hot-cell, it is extremely necessary that a robot should ensure the occupational safety of the associated system, environment and humans. For these, a number of safety systems like Safety Light Curtains, Ultrasonic Proximity Sensors have been integrated with the control system of ARIA. These systems bring the robot to a halt state in case of a possible collision with environment or human. Calibration and testing has also been performed and demonstrated

Virtual Reality (VR) based process simulator: The major objective is this task is to develop an indigenous VR based training platform for precise simulation of various processes like welding, cutting etc. This will enable the operator to train and test the operations without any risk of damages to components and injury to the trainees. In processes such as welding, there is a skill that requires not only manual dexterity, but also attention to numerous details. Weld quality depends on an operator's travel speed, angles relative to the work piece, arc position in the welding joint, and the operator's body position throughout the length of the weld. Achieving these goals using only traditional training methods can get costly—

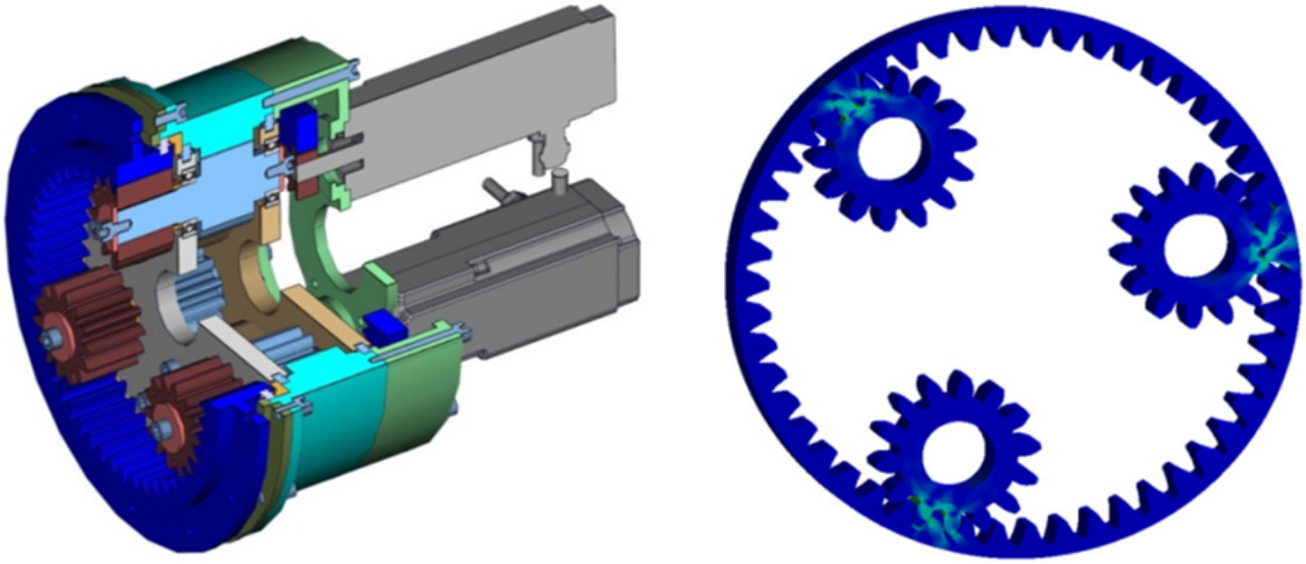


Figure A.2.6.2 (a) High reduction gearbox (b) Stress plot for high reduction gearbox

requiring more hands-on supervision and raw material. VR can help to expedite skills development and reduce training costs. Life like animations are being planned to simulate the work-cell and the processes

Development of Vacuum Compatible In-Vessel Inspection System (IVIS): Performing remote tokamak inspections without opening the vessel is one of the major requirements for existing and future systems. This ensures that the ultra-high vacuum level of the vessel is maintained thus providing a high availability of the tokamak. Presently only CEA-France has developed and tested such vacuum compatible remote inspection system in Tore-Supra and EAST tokamaks. Development of 'one-of-its-kind' high vacuum In-Vessel Inspection Arm has been started. This system will have 6 links and 5 joints actuated by vacuum compatible motors and can traverse 180^{o} inside a SST-1 like machine. The conceptual design of the system has been completed and fabrication order is being raised. A vacuum system test setup has also been developed. Various tests such as outgassing, load testing under vacuum, motion control, accuracy performance etc. are ongoing to qualify the design for use in IVIS. Development of other components like motors and cameras are being discussed with vendors.

A.2.7 Negative Ion Neutral Beam System

The objective here is to develop Radio-Frequency (RF) based negative ion sources and multi megawatt ion and neutral beams in the energy range between 20 – 100 keV and with currents ranging from 2 – 60 amperes. This is being accomplished through the parallel development activities on three test beds: (i) A single driver based RF negative ion source facility ROBIN; (ii) A two driver based RF negative ion source facility TWIN and (iii) A prototype beam line, INTF, to develop and transport beams over 21 m with ITER sized components which include a 8 driver based RF negative ion source, a neutralizer, an electrostatic residual ion dump (ERID), a calorimeter and transport duct ending with a second calorimeter. In addition to this several areas of technology and diagnostics development are also being addressed in parallel. The technology development activities aim to establish indigenous routes of manufacturing for different parts of the ion source and accelerator, welding routes, power system development and development of multichannel acquisition and control systems. An experiment towards development of HELICON based ion source has been initiated.

Single driver based RF negative ion source facility ROBIN: This facility is continuously being operated with the aim to achieve near to required, 33 mA/cm^2, negative hydrogen ion current densities with a co-extracted electron to ion ratio of <1, after cesiating (adding Ceisum) the source and enabling surface production mechanism. Several diagnostics have been employed to characterize the plasma and the extracted ion beam. Till date, the best performance with the beam is a negative hydrogen ion current density of the order of 27 mA/cm^2. Nearly ~2A of negative hydrogen ion beam @ 25 keV energy (i.e ~ 50 kW) has been achieved. The co-extracted electron to extracted negative ion ratio for such pulses is > 1. A better value of the ratio (<1) is obtained for current densities of the order of 22 mA/cm^2 for repeated experimental pulses. However, achieving an electron to ion ratio of <1 for higher current densities requires further optimization and reduced consumption of Cesium. On the diagnostics development front a cavity ring-down based spectroscopy diagnostic is under development and shall be used to detect the atomic and molecular species fraction with high sensitivity, of the order of part per billion (ppb) in volume level.

The two driver based RF negative ion source facility TWIN: TWIN source, is a two driver based RF ion source which has been developed indigenously in collaboration with the Indian industries. The source was site acceptance tested last year. This year has been dedicated to integrating the source with the vacuum vessel, setting up the desired hydraulic and gas feed systems, performing the leak tests to ensure a leak free system, fabrication, integration & operations of the starter filament, diagnostics integration, installation of the matching network and integrating with the RF generator. Experiments related to establishing the desired gas profile in the TWIN source to enable RF coupling of power are underway. Once achieved low power operation shall be initiated with the existing RF generator. Figure A.2.7.1 shows the picture of the twin source coupled to the vacuum chamber.

Prototype Beam-line: Indian Neutral-beam Test Facility (INTF): This facility is under development to produce, characterize and transport neutral beams over 21 m. When fully operational 100 keV 60 A beams shall be produced in a 3 Seconds ON - 20 Seconds OFF mode with beams modulated at 5 Hz during the 3 Seconds ON period. The database generated on the test bed shall provide important inputs towards diagnostic neutral beam operation at ITER. DNB it may be noted is one of the procurement packages to be supplied to ITER by Indian domestic agency. The various components including the ion source, the neutralizer, the calorimeter and the ERID are under manufacturing. . Detailed lay out plans have been

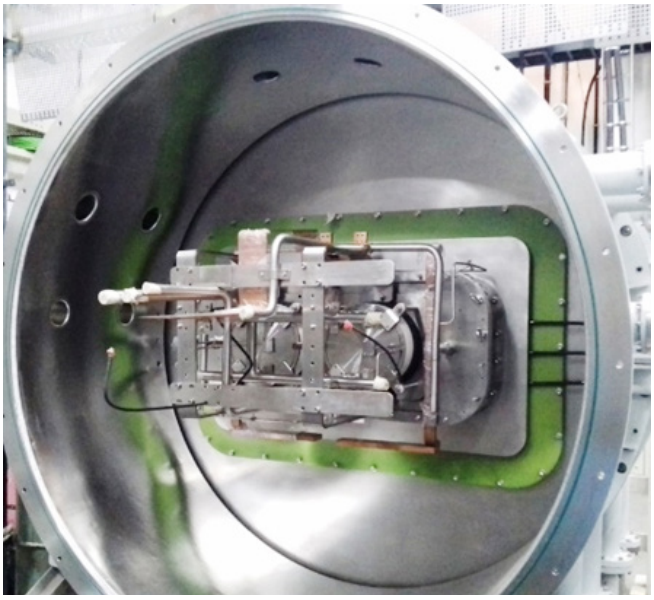


Figure A.2.7.1 TWIN source integrated with the vacuum chamber

generated and reviewed. Several prototypes are also being studied to address the difficult areas of integration. Figure A.2.7.2 shows the inside of the vacuum vessel installed on the INTF facility with the lid open. The support platforms for ion source, the components and the cryo-pump modules speak of the complexities perceived towards integration and establishing operation on the beam line.

Technology development activities:

Large diameter insulator development: This is an important step towards realizing indigenous development of high voltage bushing required on INTF to isolate the hydraulic, gas, RF and electrical feed thrus coupled to the ion source but isolated from the vacuum vessel. Two rings, made of FRP (OD ~580 mm and height: 185 mm) for the twins source and porcelain (OD ~ 800 mm and height ~500 mm) with steps at the two ends for the INTF high voltage bushing have been developed. 100 kV isolation on the FRP ring and the porcelain ring has been tested. The porcelain has been manufactured in collaboration with BHEL, Bangalore.

Power system development: A 3 phase, 415V, 200A soft starter for the 150 kVA isolation system transformer has been developed, installed and commissioned with an aim to limit the high inrush current drawn from the incoming line during the startup. This development can find its use in systems where the power levels are limited to 150 kVA. In addition all the electrical systems for the twin source facility which includes the electrical distribution system for the HV deck, LT power cables, trays, associated support structure, LT power distribution panels (3 phase, 415V, 800A two incoming feeders) have been established.

Data acquisition and control system: An 800 channel control and data acquisition system for INTF is an important inhouse development dedicated to run the INTF facility. An open source platform EPICS based CODAC Core System is used for control system and to provide the main Human Machine Interface (HMI). Labview is used for fast control system and data acquisition. The data acquisition system provides functions of real time acquisition and monitoring for 560 signals for shot duration of ~3600 sec. The sampling rate of acquisition is 10 KSps. In order to provide good data analysis support, the data acquisition system is interfaced with MySQL database, which can provide query based data to experimentalists. In addition, the design for interlock system has been completed and development work has been initiated. These systems are Safety Instrumented Systems (SIS) which will be using high reliability hardware for protection of investment and working personnel. Special analysis process such as Failure Mode Effect analysis (FMEA) and Hazard Identification Risk Analysis (HIRA) required for these systems are being initiated. The developed data acquisition and control systems has been integrated with the TWIN source for gas feed operations and upgraded integration shall take place as the source becomes operational. The system for the INTF shall be kept in an integration ready state to ensure integration prior to INTF

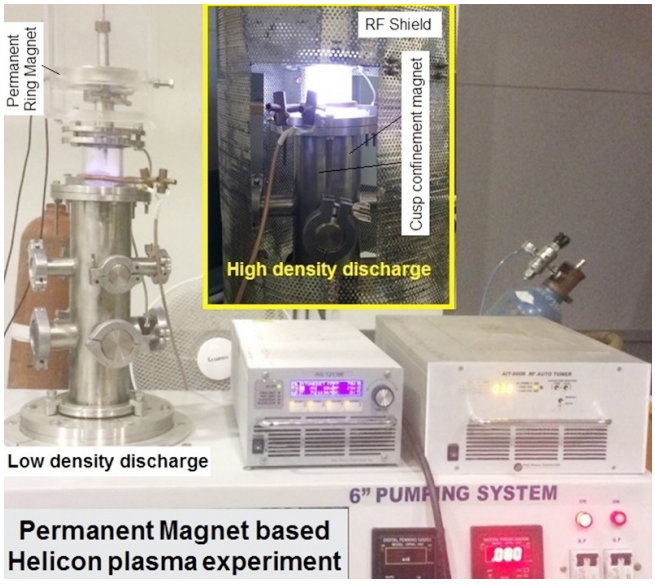


Figure A.2.7.2 HELicon Experimental set up for Negative ion source (HELEN)

operation activities in future. Several experiences made during ROBIN and TWIN source data acquisition and control system shall be incorporated with the INTF system to reduce the modification/upgradation time once INTF is operational. The signal conditioning design for INTF is now complete for HV referenced thermocouples. The design changes have been tested in ROBIN test bed and have led to improvement of signal quality in presence of high RF noise in ROBIN.

Alternate ion source development (HELicon Experiment for Negative ion source – HELEN): Helicon based plasma sources are highly efficient due to its ionization capabilities. Futuristic NBIs and deep space thrusters are considering to use such ion sources. HELEN-1 is a single driver permanent magnet based helicon plasma source being developed to study its efficiency for negative hydrogen ion production,. Density > 10^{13} cm^{-3} in Ar plasma for only ~ 200W power and ~ 10^{-2} mbar pressure is routinely obtained. Correspondingly in H_2 plasma, density > 10^{12} cm^{-3} in for > 600W power and ~ 10^{-3} mbar pressure is obtained. Negative ion (H- ion) density measurement in the plasma using in-house developed Cavity Ringdown Spectroscopy (CRDS) is under way.

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A.3 Societal Benefits of Technology

Time to time, many of the technologies developed in the institute is transferred to various vendors for commercialization. Also many technologies are developed for very special applications as and when it is required. A brief of the technologies being developed and which are under different status are given here.

In Industrial and Societal applications, IPR has initiated experiments on several innovative areas of applications: (i) Studies on brain tumor cells using plasma jet at AIIMS; (ii) Surface Enhanced Raman Scattering (SERS) studies on blood glucose level detection using metal nanoparticles in collaboration with BARC; (iii) Successfully detected breast cancer cells and oral cancer cells, drugs used in chemotherapy by SERS method; (iv) Plasma Nitriding of ball bush units were done for CDM division of BARC; (v) Developed a process for forming transparent hydrophobic coating on glass having a water contact angle of 130°; (vi) Plasma Nitriding system for surface hardening of gear components used in satellites has been installed at ISRO Inertial Systems Unit, Trivandrum; (vii) Plasma sterilization system was successfully installed and commissioned at B.V. Patel PERD Centre, Ahmedabad for effective killing of microorganisms.

Detection of glucose with lower concentration than blood glucose level using metal nanoparticles: Millions of people around the world are affected by Diabetes which requires frequent monitoring of blood glucose levels. Blood glucose levels are monitored by taking blood samples from the patient. So there is an urgent requirement for the development of non-invasive sensing techniques for glucose. Low concentration detection technologies are essential for the development of non-invasive glucose sensors. Noble metal (Gold, Silver) nanoparticles have shown the possibility to detect molecules in very low concentration using the concept of Surface Enhanced Raman Scattering (SERS) spectroscopy. This technique is based on the enhancement of electric field near metal nanoparticles due to Localized Surface Plasmon Resonance (LSPR). When the molecules come in contact with the metal nanoparticles, they experience enhanced field and their vibrational modes are intensely excited and clearly resolved in Raman spectra. Normally such modes are undetectable by Raman spectra in the absence of LSPR. So SERS spectroscopy can also be used for the detection of low concentrated glu-

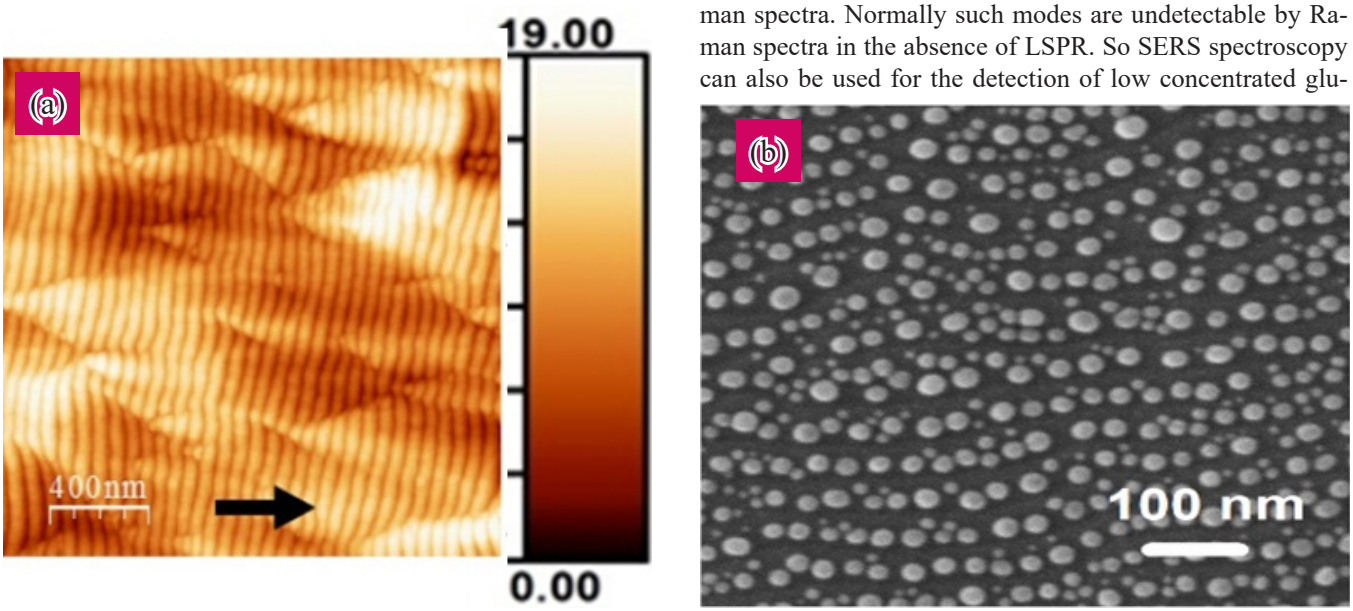

Figure A.3.1 (a) Images of ripple patterns formed on Silicon by Argon ion bombardment with 500 eV beam energy and fluence of 2×10^{18} ions/cm^2 at an incidence angle of 67°. b) Silver nanoparticles grown on ripple patterns and annealed at a temperature of 500°C.

Figure A.3.2 Plasma system for Sterilization experiments.

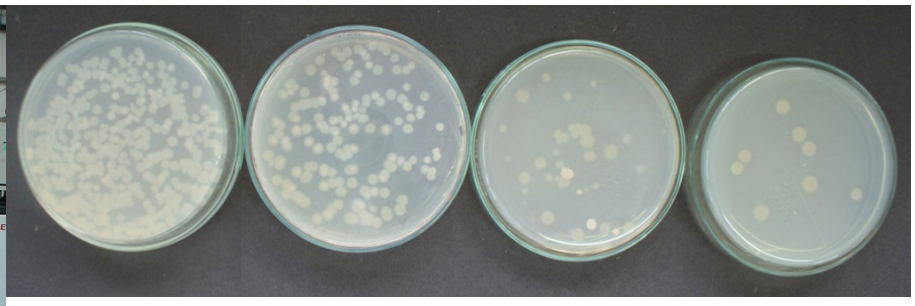

Figure A.3.3 Effect of 'plasma sterilization exposure duration' on Bacillus subtilis

cose. In the work carried out, SERS based detection of glucose deposited on ion beam produced ripple patterned substrate (Figure A.3.1.a) with silver nanoparticle arrays (Figure A.3.1. b) is reported for concentrations 5×10^{-2} g/ml, 5×10^{-3} g/ml, 5×10^{-4} g/ml and 5×10^{-5} g/ml without using any binder molecule.These concentrations are relevant to blood glucose level. A comparative study of detection of glucose deposited on plane Si substrate, Plane Si substrate with silver nanoparticles, and patterned Si substrate with Silver nanoparticles is reported. Due to larger enhancement of nanoparticle chain, we could detect glucose even without the binder molecule for much lower concentrations. Finally Raman spectra on actual blood sample was also captured and successfully detected the Glucose peaks in the spectrum.

Plasma Sterilization: There is a growing demand for a technique which can sterilize temperature sensitive devices such as endoscope, instruments that are used in operation theatres etc., without producing any toxic residue and harmful emissions. Plasma sterilizer is an emerging low temperature and eco-friendly technique which can fulfil above requirements. Institute for plasma research has developed a plasma sterilization system which has been successfully commissioned at B V Patel Pharmaceutical Education Research Development (PERD) centre, Ahmedabad, to carry out sterilization experiments. Photograph of the system is shown in figure A.3.2. At PERD, experiments are in progress to inactivate different micro-organisms using air, oxygen and ozone plasmas. It has been observed that oxygen and ozone plasmas are more effective in sterilization process. The detailed study is underway.

Space quality plasma nitriding system installed & commissioned at ISRO Inertial Systems Unit, Trivandrum: In order to provide wear resistant coating for intended operation of spacecraft components without degradation, plasma nitriding process was established by FCIPT-IPR for the SADA gears. This process has been qualified and life tested at subsystem level and rendered excellent performance on board in all the ISRO spacecraft geo-missions since 1998. A UHV plasma nitriding system of 500 mm diameter and 500 mm height was installed & commissioned at IISU Trivandrum and this will henceforth be used for nitriding all spacecraft components for enhanced service life.

Development of plasma nitriding process as an alternative to DLC Coating: A project was taken up from BARC to assess the suitability of using plasma nitriding (along with TiN coating), as an alternative to Diamond Like Carbon (DLC) coating, on Ball & Socket Hinge joints for Actuators of Hexapod. Plasma nitriding and duplex coating of TiN was done on ball and disc samples made of 17-4 PH stainless steel supplied by BARC for tribological studies. The plasma nitrided 17-4 PH samples showed a case depth of 150 microns and the TiN coating thickness was about 4.5 microns. The experiments are in progress. If the process is found suitable for application, it will be considered to develop and install a plasma Nitriding system at Center for Design and Manufacturing (CDM), BARC.

Development of Bio-medical implants with enhanced reliability: Development of prototype biomedical implant specimens, mainly of HIP joint head, based on plasma nitriding of SS 316L & Ti-6Al-4V alloy along with nanostructured Ti/TiN multilayer coatings was undertaken through a DST funded project. Prototype samples of actual size and conducive to surgical utility, were deposited with a topcoat of nanostructured Ti/TiN multilayer along with plasma Nitriding.

Figure A.3.4 Plasma Nitrided 17-4 PH samples for Tribology studies

The HIP simulation test was carried out at CGCRI, Kolkata; on these prototype specimen which were plasma nitrided followed by Ti/TiN coating. The HIP simulation test was successfully carried out for 10,00,000 cycles for two weeks in a simulated body fluid (SBF) against polymer cup. When compared with these results, the bare TA HIP joint could resist only up to 2,00,000 cycles, indicating the suitability of plasma based duplex process, mentioned above, for HIP implants. All other results including mechanical and biocompatibility studies also suggest that plasma nitrided and multilayer Ti-TiN coated Ti alloy is much better bio implant than bare Ti alloy.

Experiments for scaling up of plasma pyrolysis system: The experiments have been performed which will help in scaling up of plasma pyrolysis system from 50 kg/hr to 200 kg/hr. The existing graphite electrode assemblies for electrode dimension of 42 mm diameter have been replaced with electrodes dimensions of 75mm and 100 mm diameter. With this electrode dimensions the net power coupling in plasma torch is increased up to 80 kW. Provision for flowing nitrogen gas through the plasma arc region is made to increase the convective heat transfer from the plasma arc region towards the centre of the primary chamber and maintain uniform temperature in primary chamber. The existing control panel was replaced with PLC and HMI based control panel by which the size of the control panel is reduced and made user friendly. Experiments were carried out in the upgraded plasma pyrolysis system and collected data on high power (80 kW) operation of the plasma torch. The temperatures were measured at various locations in the primary chamber with respect to time. The consumption of graphite electrode while operating at 80 kW was determined during the study. The data generated by performing experiments were used for benchmarking the CFD analysis of the primary chamber. Successful operation of plasma torch at 80 kW power and the data generated are the preliminary step for scaling up the plasma pyrolysis system from 50 kg/hr to 200 kg/hr. In 200 kg/hr system, three such 80 kW plasma torches will be used in a larger volume of primary chamber.

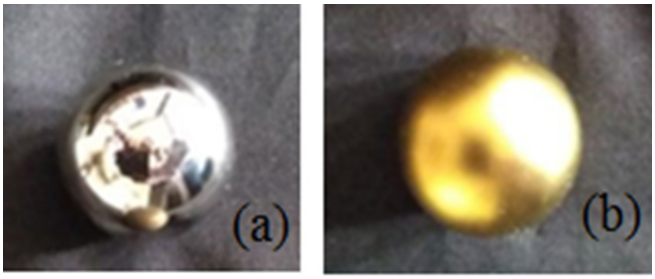

Figure A.3.5 Photographs of (a) bare, and (b) plasma nitrided Ti alloy balls (HIP joint head)

Project on solvent waste disposal using thermal plasma technology: DST has sponsored 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". The total budget of the project is Rs. 22,46,330/- and the duration is one year. Under this project experiments were initiated on disposal of solvent waste mixture in the plasma pyrolysis system installed at CSIR-CSMCRI, Bhavnagar. We have been getting combustible gases from the process, the detailed studies are underway.

Figure A.3.6 (a) Plasma torch during operation viewed through UV screen (b) Red hot graphite electrodes immediate after operation

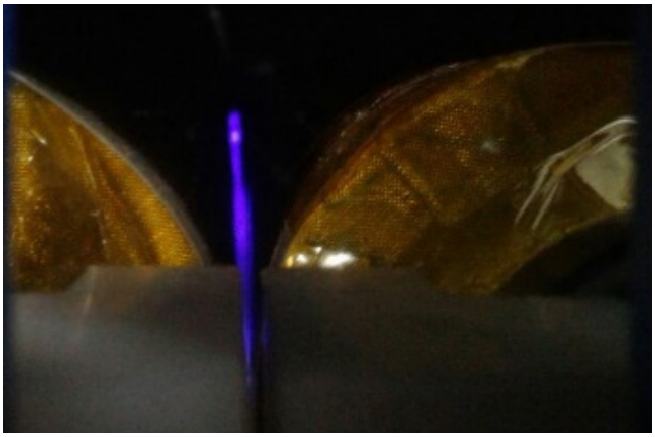

Figure A.3.7 Plasma formation between the DBD electrodes

DST project on textile treatment using DBD: The objective in this project activity is to design and develop an inline plasma treatment system for textile at moderate speed. This system is funded by Department of Science and Technology, New Delhi and Manmade Textile Research Association (MANTRA) Surat. This system will be installed and commissioned at MANTRA, Surat in this year. In this system, atmospheric pressure plasma is generated using dielectric barrier discharge (DBD) technique using a novel power supply architecture which generate uniform glow discharge plasma in air. There are 72 pairs of electrodes through which 2.5 meter wide textile material will be processed at a speed of 20 to 40 meter per minute. The plasma is generated in the air gap of each electrode pairs as shown in the image (figure A.3.7).

System to generate Plasma Activated Water (PAW): A system for generating plasma activated water was designed and developed. The plasma activated water has ph value between 2 to 3 and the oxygen reduction potential of activated water is 700mV. This property remains for at least 15 days. This water has bactericidal property which was successfully tested in GEMI (Gujarat Environment and Management Institute) lab in Gandhinagar. The system was installed and commissioned at BARC, Mumbai for further research on application of activated water, after giving training to scientific officers for operation of the PAW system in January 2018.

Figure A.3.8 Inline plasma treatment system for textile

Nano powder production system: A second transfer of technology to Vishal Engineers and Galvanizers Pvt. Ltd., Ahmedabad was done for production of ZnO nanoparticles. The nanoparticle production system being fabricated by technology partner is a completely PLC controlled system with a provision for large feed-material input possibility. Once completed this will be the first indigenously designed and PLC controlled plasma based nanopowder production system.

Isotopic nanotracer synthesis by plasma: An MoU was signed with IIT-Gandhinagar for fund transfer and execution of a research project related to isotopic nanotracer synthesis by plasma process. This project has been funded by Ministry of Human Resource & Development (MHRD) and Government of Gujarat (GoG) for 3 years. In this project Inst. for Plasma Research will be working in collaboration with IIT-Gandhinagar, Inst. of Life Science and Indian Institute of Toxicology Research. Preliminary experiments have already begun with non-isotopic encapsulated nanoparticles. Outcome of the project will lead to development of nanotracer based bio implants.

Project on industrial applications of ZnO and TiO2 nanoparticles: A series of studies have been initiated targeting the industrial applications (especially those related to environment and agriculture) of ZnO and TiO2 nanoparticles. A small project to supply ZnO nanoparticles to Vishal Engineers and Galvanizers Pvt. Ltd. was done successfully.

Atmospheric plasma system for food grain processing: Atmospheric pressure plasma (APP) technology involving the use of non-thermal plasmas is emerging rapidly to enhance germination and to improve food preservation. APP generates reactive oxygen species (ROS) and reactive nitrogen species (RNS) which interact with the seed and does etching of its surface. Hence, the plasma treatment enhances soaking of moisture thus improves germination of seeds. Further, the atmospheric pressure plasma treatment can lead to inactivation of bacteria, bacterial spores, and fungi if present on the surface of food grains. The plasma treatment system has been developed and it has been commissioned at Anand Agricultural University Anand for detailed study.

Fly-ash project: This project is funded by an Indian industry and revolves around feasibility studies on converting fly-ash into useful refractory material using the thermal plasma technique. Fly-ash is a by-product of various industrial systems and its composition can have a wide range of products. However, the typical composition contains silicon dioxide, aluminium oxide and various other elements. The project involves feasibility studies for converting fly-ash into a material called silicon alumino oxy-nitride abbreviated as SiAlON. This material has excellent electrical and thermal properties and is not commercially available in India. Therefore, there exists great potential for developing indigenous plasma technology resulting in cost-cutting and generation of new Intellectual Property. The project has been taken up with a view to use knowledge and experience gained on plasma torches for deployable industrial technologies and indigenization. In this project, a novel technique to introduce powder into the torch was developed, ensuring residence time of powder is maximized and it reacts with plasma. The powder is mixed with shroud gas and introduced in the form of a dust-laden gas. A novel powder feeder mechanism for introducing fly-ash with very fine particles (nano to micro millimeters) was also developed by the team. The system was set up and several experiments were conducted. A photograph of the system is shown in the figure A.3.9

Figure A.3.9 Fly-ash system developed by IPR

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A.4. 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.4.1 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.4.2 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 lin-

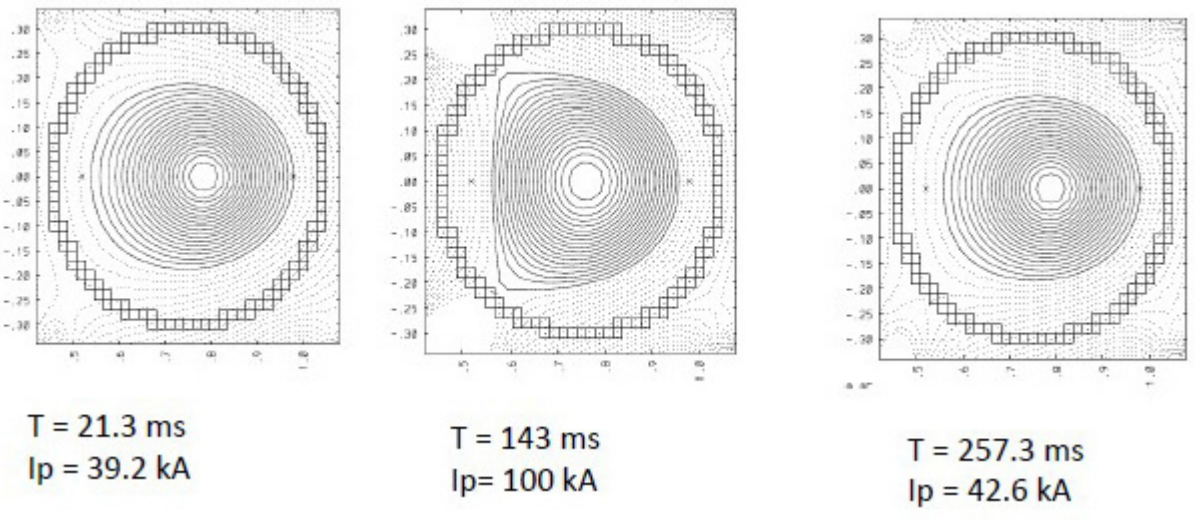

Figure A.4.4.1 It shows the evolution of plasma equilibrium in Aditya Upgrade

ear 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 neu-

trals 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.4.3. 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 sta-

tistical 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. The manufacturing of IWS blocks is in progress at Avasarala Technologies Ltd. Bangalore. Rigorous Factory Acceptance Tests (FAT) of (i) IWS blocks, (ii) SR+LB welded and machined assemblies, (iii) Platforms and (iv) Studs, to check actual assembly issues were carried out. CMM and digital gauges were mainly used for all dimension inspection. Assembly of IWS blocks with different shapes and high accuracy and vacuum packing for high cleanliness during transportation and storage were carried out. At every stage of production lots of risks were involved and many technical challenges were tackled and overcome by the IWS team. Large numbers of blocks and components have been successfully manufactured, Assembled, Inspected, Packed and Shipped to Europe and Korea. India has achieved the major milestones of completion of IWS for Vessel Sector 1 and manufacturing of Studs and Platforms for all 9 Vessel Sectors. Fabrication and factory acceptance tests of rest of components for remaining 6 Vessel Sectors and Field Joints are in progress. Contracts for procurement of IWS Materials and (ii) with L&T for manufacturing of IWS Blocks of Special Vessel Sector. Tender has been floated for manufacturing of IWS Blocks of remaining 4 vessel sectors and Field Joints.

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. Factory fabrication of Lower Cylinder of Cryostat, Factory Acceptance test and packing for 3 blocks of outer shielding and Factory acceptance test & packing of 18 Female lugs has been completed. Factory fabrication of Upper Cylinder Tier-1 is completed and that

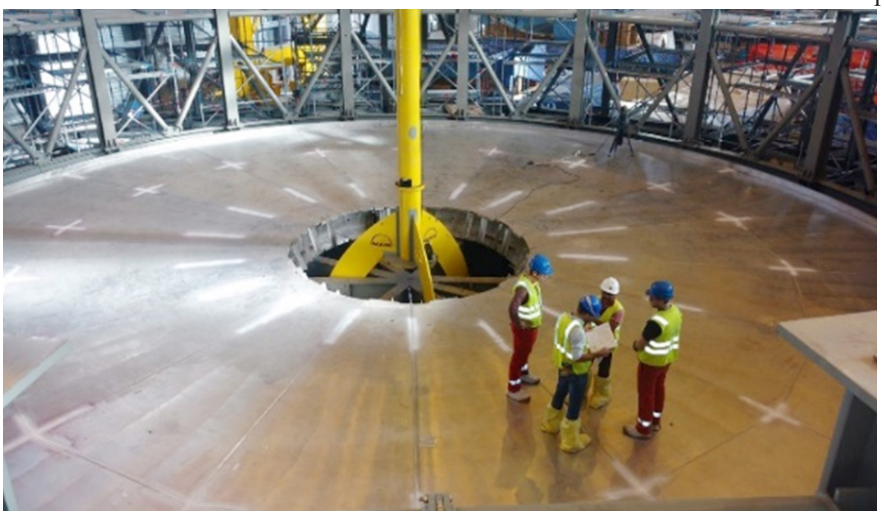
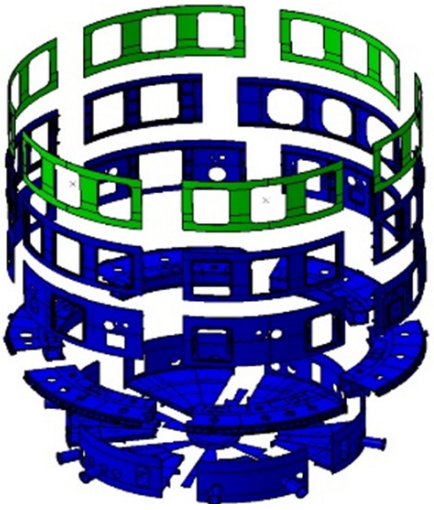


Figure B.2 Cryostat Base Section Tier-1 welding and testing at ITER site workshop



(b) ***Fabrication Completed*** *and* ***Ongoing upper cylinder fabrication***

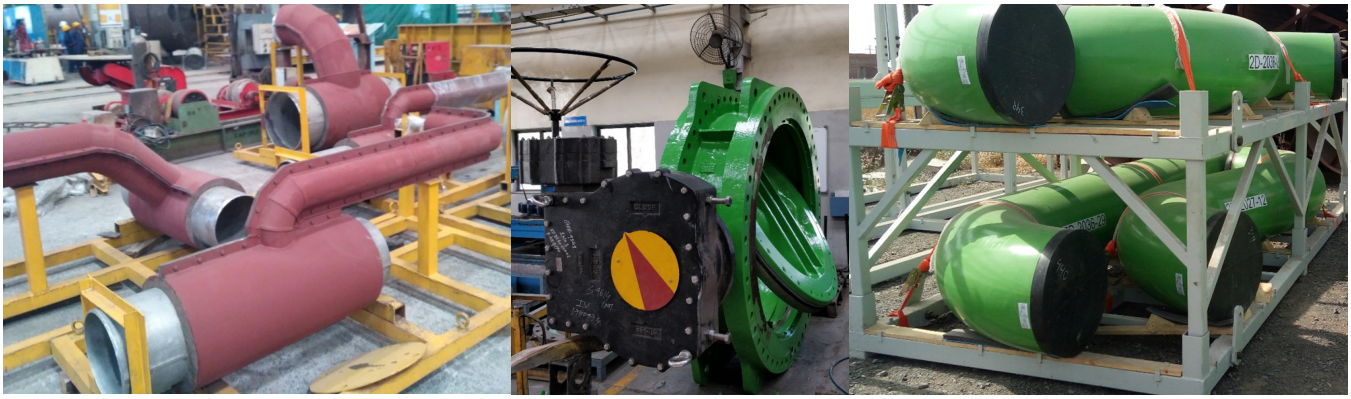


Figure B.2 Parts of water cooling system (a) Pipe Spools (b) valve and (c) Pipe spools

of Upper Cylinder Tier-2 is in progress. 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

Certain ITER systems/components will be working on specific temperature during the operation, this temperature is needed to be kept in the required margins. 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. 2000 pipe spools were delivered to ITER site. The Ozonator System was delivered to ITER site. Manufacturing Readiness Reviews were conducted for several equipment like Strainers, LV MCCs & DBs, Variable Frequency Drives, Manual Valves, Electrical Valves and Pumps. Post Successful Factory Acceptance Tests were conducted for 6 Plate Heat Exchangers and 8 Chillers along with soft starters and 6 Horizontal Pumps were shipped to ITER. Further, several items like Pipe Supports, Valves, Instrumentation & Control components and Electrical components were shipped to ITER.

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 and installation phase.

Cryolines and warm lines: Detail design of the group-Y cryolines required for the ITER cryoplant has been completed and are currently under manufacturing stage at M/s INOX India Ltd. The first shipment of group-Y cryolines was flagged of in May 2017 from India. The cryolines (lot X3) for the ITER cryopump cooling has been passed through the several design reviews and manufactured at M/s. Air Liquide Advanced Technologies under strict quality control and has been dispatched to ITER site. Preliminary design review (PDR); final design review (FDR) for several lots of Cryolines, Oil Separator and manufacturing readiness review (MRR) for several lots of cryolines, have been successfully completed. The site activities of group-Y cryolines has been initiated last year. The workshop for performing fabrication activities for Group Y lines on site has been constructed and the installation activities for Group Y cryolines and warmlines began in cryoplant area of ITER site.

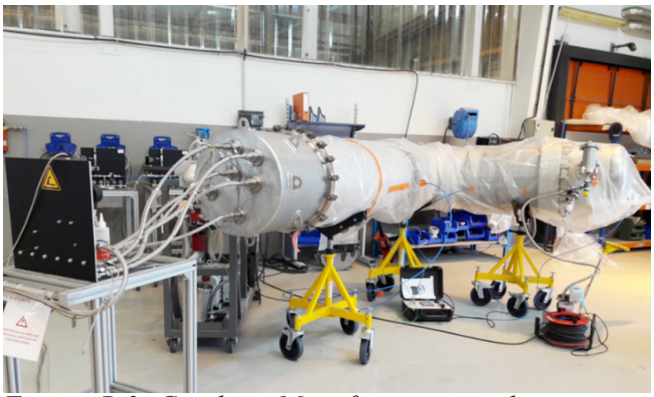


Figure B.3 Cryoline Manufacturing and testing at ALAT France

Figure B.4 CTCB at factory for mechanical factory acceptance test (FAT)

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). Mechanical factory acceptance test (FAT) of CTCB has been successfully completed after the complete manufacturing at M/s Linde Kryotechnik. Hardware FAT of electrical cubicles and instrumentation cubicles of CTCB has been successfully completed. 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 final design of cold circulators has been completed and manufacturing has been started.

B.5. Ion Cyclotron Heating & Current Drive Sources

The Ion Cyclotron Heating and Current Drive (IC H&CD) system is expected to play an important role for heating & driving plasma current for ITER machine. The same system will also be used for wall conditioning at low power level. The IC H&CD power source is design to couple 20 MW RF power into the plasma utilizing eight identical RF sources. India is responsible to deliver nine numbers of RF Sources, each having 2.5 MW/CW RF power handling capability with load VSWR 2:1 in the frequency range 35-65 MHz, with 25% duty cycle. Since no high power vacuum tube exists as per ITER requirement, each RF source is a combination of two amplifier chains capable to deliver 1.5MW RF power. An R&D program, using Diacrode (TH628) & Tetrode (4CM2500KG) technologies was launched for the qualification of final stage tube and associated critical components for the ITER application. In this R &D program, single chain experimentation at 1.5MW/CW/35-65 MHz/ VSWR 2:1 is considered. A chain of high power amplifiers using Tetrode technology is being developed for the R&D program, which consists of three cascaded amplifiers i.e. pre-driver, driver and final stage amplifiers, auxiliary power supplies, transmission line components and dedicated control system. ITER-India has developed a complete test facility with all the required infrastructure and associated auxiliary systems to conduct comprehensive testing of such amplifiers. 1.5 MW at 60 MHz for 2000s duration is tested successfully at ITER-India test facility using Tetrode technology. To simulate mismatch load condition, MMTL system comprising of single stub and phase shifter, made out of 10 nos. of bellow sealed flexible transmission line sections are used. Experiment performed succesfully at 36 MHz/ 1200 s with VSWR 2:1 at 1 MW power level. Expertise developed in high power RF switch design and fabrication methodology. To optimize the space and efficiency for auxiliary power supplies (especially for Screen Grid and Control Grid power supplies), a dedicated test bench-top model, based on Zero Voltage Switching (ZVS) resonant converter developed and tested successfully. Further optimization and testing is underway. Further, lab module is developed with response time corresponding to 200 kHz frequency for fast analog optical Tx/Rx, which will be used in between field signal and control system. Initial testing of amplitude control loop to control

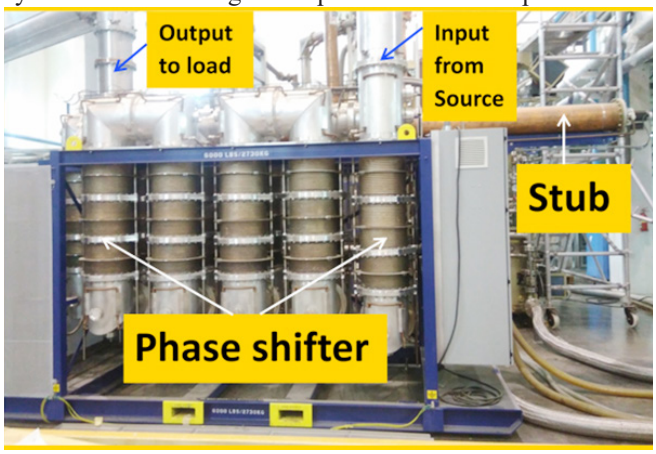


Figure B.5. Mis-match Transmission Line (MMTL) system comprising of Stub and bellow sealed transmission line sections as part of Phase Shifter

output of RF amplifier in real time using 10kW solid state power amplifier is completed successfully.

B.6. Electron Cyclotron Heating (ECH) system

The ITER 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 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. Procurement process for a Test Gyrotron and waveguide component set for the ITER-India Gyrotron test facility is in advanced stage. Towards the auxiliary systems for the IIGTF various developmental and procurement activities have been carried out. A large volume cooling distribution system has been successfully installed and commissioned at the Gyrotron test facility. Towards establishing high voltage power supplies for the Test facility, a cost effective and modular solution using high voltage solid-state switches is under development to meet the high frequency modulation requirement for the Gyrotron Body Power Supply (35kV/100mA/5 kHz). Full parameter testing has been conducted up to 1 kHz @ 35kV on equivalent RC load and satisfactory results achieved. Also in parallel, a fast responding (1ms) 35 kV @ 100 mA power supply for Gyrotron DC operation is also under procurement. For development of Control system for the Gyrotron test facility, few design and development activities have been carried out. The full scale production of in-house developed Centralized Interlock Module and Signal Conditioning modules is currently ongoing. A field simulator for Gyrotron control system has also been established with representative hardware. The testing of control system logic and its user interface application is currently ongoing. 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 of major components [electron gun (MIG), cavity, collector etc.] has been done and a conceptual design review is currently being planned.

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.
For Beam Line components (BLCs), manufacturing is in advance stage of manufacturing. Manufacturing drawings & manufacturing and inspection plans (MIPs) have been finalized for almost all major sub-components of all BLCs. The trials for establishing the critical manufacturing process like EB welding of BLC panels with water connector has been successfully completed and subsequently Welding Procedure Qualification (WPQR) for various material combination i.e CuCrZr to CuCrZr , CuCrZr to Ni , Ni to SS, OFCU to OFCU, OFCU to Ni have been undertaken. Heat transfer elements for calorimeter have been manufactured. Also, the Neutralizer panel & RID panel have been deep drilled with required accuracy. BLC Support structure like support frames & side plates of Neutralizer & Residual Ion Dump have been manufactured & inspected. These components are now heading towards its assembly with other sub-components. Below is the glimpse of ongoing manufacturing activities of BLCs. In collaboration with CDM, BARC, prototype grid segment (of size ~1/3rd size of real grid segment) have been manufactured for the first time on domestic front. The main specifications targeted were: aperture positioning of 50 microns, flatness of 20 microns and angle of +/-0.002°. This has provided an excellent demonstration of meeting the tight tolerances. Additionally, experience has been generated for developing machining parameters, sequence of machining, fixture development need, tool selection and measurement methodology. Successful application of laser based lip seal welding and its demonstration for the large scale rectangular shape with corner radius (size: 1.5m x 3m)- corresponding to 1/3rd size of DNB Vessel (size: 9m x 4.5m) and elliptical shape (size: 1m length, 1.2m dia.)-corresponding to 1:1 size of High voltage flange has been achieved. A clamping tool for the correction of manufacturing inaccuracies in terms of air gap, has been developed and integrated with robotic welding head. The development is now being taken to the next step with the added feature of remote control for automatic weld path control system, integrated laser cutting and re-welding of lip seal, which is essential for nuclear environment. A special device, named ‘Internal Bore Welding Torch’ has been developed, put into application and tested for the production quality. In DNB Beam Source Manufacturing, The crucial stage of electron beam welding for the angled grid segments

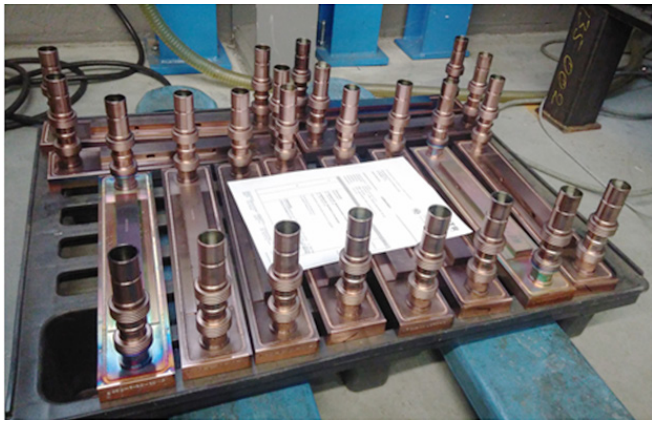


Figure B.6. (a) Heat transfer element for calorimeter to be utilized in Diagnostic Neutral Beam

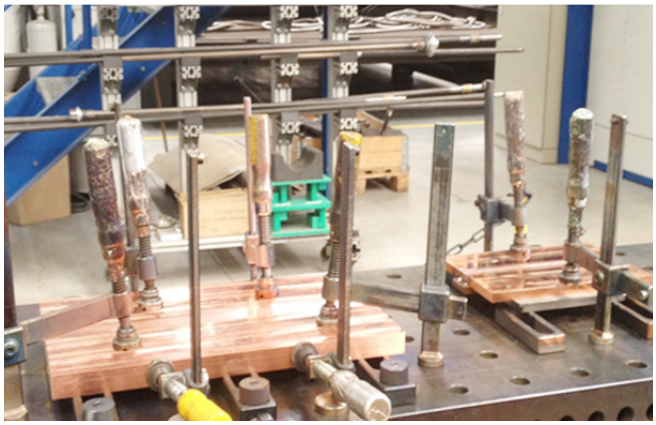


Figure B.6 (b) WPQR setup for Cu-OF Cu & CuCrZr to CuCrZr weld joint

have been completed successfully for Plasma grid, Extractor grid and Bias plate. 3 segments of plasma grid segments have been manufactured and are in final stage of dimensional inspection. Large mounting flanges, support frames, rear driver plates which involves high precision machining of stainless steel, have been completed. Ion source components like faraday shield lateral walls, back plates, plasma driver back plates, which involves intense electrodeposition, have been manufactured and they are undergoing the component level inspections.

B.8. Power Supplies

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. 7MW, 100kV SIDER Acceleration Grid power supply, installed at NBTF site, Padua, Italy is ready for site acceptance test. 40kW high frequency (1MHz) solid state power source developed with domestic industry, this power source shall be utilized for plasma formation; besides it has potential application for AM radio transmission as well. Multipurpose, multichannel optical signal simulator cum repeater is developed in-house and being used for field tests of various power supply controllers. 140kV DC HV transmission line successfully developed with domestic industry and installed at lab; capacitated industry for ITER deliverable. Development program for MHVPS is in advanced stage to cater for Gyrotron test facilities at Iter-India lab and IPR, to be utilized on time sharing basis.

B.9. Diagnostics

The preliminary design development activities were carried out like thermal and fire analysis of the Survey sight-tube,

SPIDER AGPS installed at RFX

plant I&C systems detailing, interfaces with ITER PBS and integration with the respective port-plugs. Technical details of Pilatus detector and its integration with plant, power requirements, and understating for development of I&C deliverables has progressed. Calculations were done for estimating Gamma field and dose on detector due to activated machine water passing around the port-cell. Rework of CAD design ITER Survey spectrometer was done following new maintenance scheme. The CAD model of R&D survey spectrometer was worked out and draft of technical specifications for tendering was prepared. A CAD study was completed for finding impacting factors and amount of misalignment in the survey spectrometer sight-line. Measurements and computation of Tungsten filament emission current was made on Fixed-Anode X-ray source after its successful assembly and integration testing. The transport of carbon impurity was study after successfully installing latest version of impurity transport code. The ITER ECE diagnostic system, preliminary design and prototype work are progressing very well; The site acceptance test of fast scanning Fourier Transform Spectrometer (FTS) is completed successfully at ITER-India lab, IPR. Prototype transmission line comprising of 5 waveguide sections each of 2 m length, and 3 mitre bends has been assembled, installed and integrated with FTS. Transmission line measurements are ongoing. Measurements of TL in air and vacuum have been done using Infrared blackbody source and liquid Nitrogen source. Design of Support structure for TL in ISS and PCSS is completed. Support structures are designed to accommodate the misalignments caused by machine movements keeping in view the ISS constraints and meeting the ITER measurement requirements. Detailed analysis is done and the stresses and deformations are within the operating limits of the system. From above results, loss for 43m length of ITER ECE TL with 6 miter bends in air is estimated as ~10dB for 100GHz-400GHz and ~ 15dB for 400-1000GHz, which is well within the ITER requirement.

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

The QA Program Manual of ITER-India was updated as per the new requirements. QA team witnessed special process like welder's qualifications, Non-Destructive Examination Qualification. Internal Audit and ITER Organization audit related preparatory work was carried out. Extensive QC inspection of Piping and equipment were done. 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. Participation in Risk Management activities 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. Regular schedule updates were made and reported at ITER International organization. The Risk Register was periodically updated. Participation was made in Configuration Management related working groups. Facilitation for Intellectual Property identification and filing was done.

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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

Eleven (11) new students with Physics (3) and with different Engineering background (8) including Nuclear engineering have joined this programme during this year and are going through the course work. After successful completion of this course work, they will be enrolled for their Ph.D, in HBNI. Overall there are seventy four (74) PhD students in total have been enrolled at present in HBNI including some IPR employees.

Ph.D. Thesis Submitted (during April 2017 - March 2018)

Experimental Studies on Collective Phenomena in Dusty Plasmas
Mangilal Choudhary
Homi Bhabha National Institute, 2017

Synchronization Studies between Two Coupled Glow Discharge Plasma Sources
Neeraj Chaubey
Homi Bhabha National Institute, 2017

Studies on Magnetically Constricted Anode Plasma Source
Samirsinh Ganpatsinh Chauhan
Homi Bhabha National Institute, 2017

Particle-In-Cell Simulations of Fast Electron Time Scale Phenomena
Chandrasekhar Shukla
Homi Bhabha National Institute, 2017

The Study of Localised Solution in Laser Plasma System
Deepa Verma
Homi Bhabha National Institute, 2017

Studies in Non-Neutral Plasmas Using Particle-In-Cell Simulations
Meghraj Sengupta
Homi Bhabha National Institute, 2017

Yukawa Liquids under External Forcing: A Molecular Dynamics Study
Harish Charan
Homi Bhabha National Institute, 2017

Shear Flows in 2D Strongly Coupled Fluids - A Theoretical and Computational Study
Akanksha Gupta
Homi Bhabha National Institute, 2017

Ion-Flow Driven Instabilities in Sheath-Presheath Region of Low Temperature Plasma
Vara Prasad Kella
Homi Bhabha National Institute, 2017

3D Simulations and Analysis of Plasma Transport in the Scrape-Off Layer of Tokamak Aditya
Bibhu Prasad Sahoo
Homi Bhabha National Institute, 2017

A Study of the Dynamics of Delay Coupled Nonlinear Oscillators and Some Model Applications
Bhumika Thakur
Homi Bhabha National Institute, 2017

Studies on Driven Dust Vortex Flow Dynamics in Dusty Plasma
Laishram Modhuchandra Singh
Homi Bhabha National Institute, 2017

Collective Plasma Structures with Kinetic Nonlinearity: Their Coherence, Interaction and Stability
Debraj Mandal
Homi Bhabha National Institute, 2017

Bubble-Induced Vibration in Liquid Nitrogen Cryopump
Manoj Kumar Gupta
Nirma University, Ahmedabad, 2017

Study on Plasma Shaping and Control in Steady State Superconducting Tokomak (SST-1)
Subrata Jana
Homi Bhabha National Institute, 2017

Investigation of Particle Swarm Optimization Technique for Multi Disciplinary Problems
Ritesh Sugandhi
Homi Bhabha National Institute, 2018

C.2 SUMMER SCHOOL PROGRAMME (SSP)

The Summer School Programme (SSP)-2017 at IPR commenced on 29th May 2017 and ended on 7th July 2017. This year a total of 50 students joined the programme, of which

30 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-2017 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-2017 participants was also arranged as evaluation of their performance.

C.3 ACADEMIC PROJECTS FOR EXTERNAL STUDENTS

Around 75 students of BE/B. Tech/M.Sc/ME/M.Tech are engaged to do various academic projects under their course curriculum in different fields of science and technology from various college/universities/Institute in IPR

D. TECHNICAL SERVICES

D.1 Library Services

Institute for Plasma Research (IPR) Library continues to provide specialized services using modern tools to the user community involved in the Research and Development activities of Plasma Physics and Fusion Science and Technology.

2017-18 was an eventful year for the Library as the library management system was migrated to KOHA, an open source software and the newly designed OPAC is made available to the users. All e-resources, both subscribed and internal, are made available through the library website (http://www.ipr.res.in/library/) and the website is continuously updated with latest information. Library continues to provide current awareness services by delivering current content, widely to plasma physicists at national level. Total 245 News items were displayed and archived as an Alerting Service. Library started a new email based REcent Articles to Discover (READ) service.

During reporting period total of Rs. 23353943.00 budget was utilized. About 465 books and back volumes, 96 internal research reports, 46 technical reports, 17 research reports received from other research institutes, 80 reprints and 273 IPR Publications, 49 pamphlets and 20 software were added to the library collection. Library is maintaining focused user-driven collection and subscribed to 110 periodicals. This year a total of 13 journal titles were migrated to only online and 1 new online journal title was added to the e-collection. Apart from this, the library also added Measurement Science & Technology archive to its collection and continues to subscribe to major databases such as SCOPUS, Online Archives of core journals, and library has access to SCIENCEDIRECT as part of the DAE Consortium. Library also continued to provide Publication Management services to manage internal publications.

Library continued to collaborate with DAE units and other National and International libraries to provide Article Delivery Services through Inter Library Loan (ILL). 84.80% 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. Total 18188 photocopies supplied to users. 1262 scanned copies were provided to the users.

Library is actively carrying out Information Literacy and Training programmes for its users. IEEE Users Awareness Programme, SCOPUS and Mendeley Training Sessions were organized. Library orientation was given to newly joined members, Summer School Program Students, and Research Scholars.

Library actively participated in other Institutional activities, such as Swacchata Abhiyan, Hindi Seminars/Meetings, Safety Week, National Science Day, International Yoga Day, etc. Library provided internship training programme to 02 BLISc and 02 MLISc students from Gujarat University, Ahmedabad during the year 2017-18.

D.2. Mechanical Engineering Services

The MESD division has four sections namely Engineering Design & Analysis Section (EDAS), Drafting Section, Workshop Section and Inspection & Quality section (IQS). The activities undertaken by the division is conforming to full product cycle which includes concept to commissioning. The major tasks are design and analysis of the various experimental systems of various projects in IPR, preparation of the engineering drawings, fabrication/manufacturing, inspection, testing and commissioning of various systems. The division comprises of team of experienced mechanical engineers, physicist, draftsman and tradesman.

The EDAS of MESD has been actively executing various tasks related to design, analysis, and technical specifications preparation for fabrication/manufacturing of various systems. During the last year, section has satisfactorily com-

pleted more than 20 tasks and report is submitted for different experimental systems of various divisions. These tasks are design and analysis of various diagnostic systems (Reflectometer, Bolometer and Optical imaging) of Aditya-Upgrade tokamak, The design and layout of TF and PF magnets current feeding bus bar connections with current leads for SST-1 tokamak, large aspect ratio system for basic experiments, Radio Frequency Quadruple system, large area cathode plasma source for LVPD, ionizer system for multi-cusp plasma device, SST-1 TR coils damage analysis and repair, Aditya VV thermo-structural analysis, RFQ,LVPD,FCIPT etc. The division is also working on thermo-structural and CFD analysis of the Plasma pyrolysis system using ANSYS and COMSOL software. The special task related to RF antenna design parameters optimization using CST software has been also undertaken. The different kind of analysis such as structural, thermal, electro-magnetic and coupled field is being carried out routinely using ANSYS and COMSOL software.

The Drafting section of MESD is equipped with 6 licences of CATIA-V5 R13 installed on work stations for 3D modelling and 2D drawing preparation and HP inkjet T2300 plotter. Section has been supporting the users for designing and preparation of engineering drawings for various systems of Aditya-Upgrade and SST-1 Tokamaks, LVPD system and other experimental projects being executed at IPR, FCIPT and CPP. During last year, section has executed more than 150 job cards for 3D modelling, 2D engineering drawing preparations, poster plotting etc.

3-axis abrasive water-jet machine

3-axis CNC machine with multi-tool holder

The Workshop section of MESD is equipped with modern versatile machineries including machining and fabrication (shearing, rolling, TIG welding etc.) facilities catering for needs of IPR, FCIPT, ITER-India and CPP for the fabrication of a system/product required by users. Apart from conventional machines, Workshop has 3-axis abrasive water-jet machining facility as shown in picture, useful for machining the intricate shapes of different materials at room temperature. It has also CNC machining centre with better than 10 micron accuracy. Workshop has manufactured the UHV/HV components on CNC machine and delivered to stores (which are otherwise stores stock items procured from outside). During last year, workshop has executed more than 1300 job cards (including 165 job cards of abrasive water jet machining) and fabricated systems/product of different materials (Stainless steel, Aluminium, Copper, Brass, Ceramics, Teflon, Hylum, PEEK etc.) weighing more than 6000kgs.

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E. PUBLICATION AND PRESENTATIONS

E.1 Articles Publications

E.1.1 Journal Articles

Design of a Helicon Plasma Source for Ion-Ion Plasma Production
N. SHARMA, M. CHAKRABORTY, N.K. NEOG, M. BANDYOPADHYAY
Fusion Engineering and Design, 117, 30, 2017

Search for Continuous Gravitational Waves from Neutron Stars in Globular Cluster NGC 6544
B.P. ABBOTT, A. DASGUPTA, G. GAUR, M. K. GUPTA, Z. KHAN, R. KUMAR, A. K. SRIVASTAVA, S. SUNIL, et al. (LIGO Scientific Collaboration and Virgo Collaboration)
Physical Review D, 95, 082005, 2017

First Search for Gravitational Waves from Known Pulsars with Advanced LIGO
B. P. ABBOTT, A. DASGUPTA, M. K. GUPTA, Z. KHAN, R. KUMAR, A. K. SRIVASTAVA, S. SUNIL (LIGO Scientific Collaboration and Virgo Collaboration)
Astrophysical Journal, 839, 1, April 2017 [Erratum]

Nonlinear Dynamics of Turbulence Driven Magnetic Islands. I. Theoretical Aspects
O. AGULLO, M. MURAGLIA, S. BENKADDA, A. POYE, N. DUBUIT, X. GARBET, and A. SEN
Physics of Plasmas, 24, 42308, 2017

Nonlinear Dynamics of Turbulence Driven Magnetic Islands. II. Numerical Simulations
O. AGULLO, M. MURAGLIA, S. BENKADDA, A. POYE, N. DUBUIT, X. GARBET, and A. SEN
Physics of Plasmas, 24, 42309, 2017

Effects of Waveform Model Systematics on the Interpretation of GW150914
B.P. ABBOTT, A. DASGUPTA, M.K. GUPTA, Z. KHAN, R. KUMAR, A.K. SRIVASTAVA, S. SUNIL et al. (LIGO Scientific Collaboration, Virgo Collaboration)
Classical and Quantum Gravity, 34, 104002, 2017

Effect of Cold Plasma Treatment on Physiological Quality of Okra Seed
RAVINDER SEHRAWAT, ASHOK K. THAKUR, AMIT VIKRAM, A. VAID, R. RANE
Journal of Hill Agriculture, 8, 66, 2017

Plasma Wakefield Excitation in a Cold Magnetized Plasma for Particle Acceleration
MITHUN KARMAKAR, NIKHIL CHAKRABARTI and SUDIP SENGUPTA
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Correlation of Structural and Optical Properties of PVD Grown Amorphous Carbon Thin Films
INFANT SOLOMON, MUKUL BHATNAGAR, KRISHNANAND SHUKLA, BORNALI SARMA, MUKESH RANJAN, ARUN SARMA
Diamond & Related Materials, 75, 69, 2017

Virtual Reality Applications in Remote Handling Development for Tokamaks in India
PRAMIT DUTTA, NAVEEN RASTOGI, KRISHAN KUMAR GOTEWAL
Fusion Engineering and Design, 118, 73, 2017

Nonlinear Simulation of ELM Dynamics in the Presence of Resonant Magnetic Perturbations
D. CHANDRA, A. THYAGARAJA, A. SEN and P. KAW
Nuclear Fusion, 57, 076001, 2017(IPR/RR-846/2016)

Energy Exchange Dynamics Across L-H Transitions in NSTX
A. DIALLO, S. BANERJEE, S.J. ZWEBEN and T. STOLTZFUS-DUECK
Nuclear Fusion, 57, 066050, 2017

Studies on Radial and Poloidal Particle Transport at the Edge of SST-1 Tokamak
B. KAKATI, S. PRADHAN, J. DHONGDE, P. SEMWAL and SST-1 TEAM
Physics of Plasmas, 24, 052306, 2017

Amplification of a Turbulence Driven Seed Magnetic Island by Bootstrap Current
M. MURAGLIA, O. AGULLO, A. POYE, S. BENKADDA, N. DUBUIT, X. GARBET and A. SEN
Nuclear Fusion, 57, 072010, 2017

Time-Resolved Whole Field Investigation of Plasma Plume-Induced Shock Wave in Liquid Media of Different Densities

KAUSHIK CHOUDHURY, R. K. SINGH, SURYA NARAYAN, ATUL SRIVASTAVA and AJAI KUMAR
Applied Physics B: Lasers and Optics, 123, 163, 2017

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M. ZUBAIRUDDIN, S.K. ALBERT, M. VASUDEVAN, S. MAHADEVAN, V. CHAUDHARI and V.K. SURI
Journal of Manufacturing Processes, 27, 87, 2017 (IPR/RR-755/2015)

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Surface Engineering, 34, 620, 2017

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Design of the 3.7 Ghz, 500 Kw CW Circulator for the LHCD System of the SST-1 Tokamak
HARISH V. DIXIT, AVIRAJ R. JADHAV, YOGESH M. JAIN, ALICE N. CHEERAN, VIKAS GUPTA and P.K. SHARMA
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R. GANGRADEY, J. MISHRA, S. MUKHERJEE, P. PANCHAL, P. NAYAK, J. AGARWAL
and Y.C. SAXENA
Review of Scientific Instruments, 88, 063503, 2017

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B.P. ABBOTT, A. DASGUPTA, M.K. GUPTA, Z. KHAN, R. KUMAR, A.K. SRIVASTAVA, S. SUNIL, et al (LIGO Scientific Collaboration, Virgo Collaboration)
Physical Review D, 95, 122003, 2017

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LUIS O. SILVA, AMITA DAS and G. RAVINDRA KUMAR
Nature Communications, 8, 15970, 2017

Nonlinear Laser–Plasma Interactions (Chandrasekhar Lecture)
P.K. KAW
Reviews of Modern Plasma Physics, 1, 1, 2017

Investigation of Neutral Particle Dynamics in Aditya Tokamak Plasma with DEGAS2 Code
RITU DEY, JOYDEEP GHOSH, M.B. CHOWDHURI, R. MANCHANDA, S. BANERJEE, N. RAMAIYA, DEEPTI SHARMA, R. SRINIVASAN, D.P. STOTLER and ADITYA TEAM
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S. CHAUHAN, T. BARMAN, M. BHATNAGAR, M. RANJAN and S. MUKHERJEE

Review of Scientific Instruments, 88, 063507, 2017 (IPR/RR-877/2017)

Development of Data Acquisition and Control System for Long Pulse Operations of Indian Test Facility of ITER DNB
HIMANSHU TYAGI, RATNAKAR YADAV, KARTIK PATEL, MAINAK BANDYOPADHYAY, CHANDRAMOULI ROTTI, DASS SUDHIR, AGRAJIT GAHLAUT, KAUSHAL PANDYA, ARUN CHAKRABORTY and TEJ TRIVEDI
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KIRAN PATEL, VISHAL PILLAI, NEHA SINGH, JINTO THOMAS and AJAI KUMAR
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Nuclear Fusion, 57, 102001, 2017

Helical Type EM Induction Pump with Permanently Magnetized Rotor for High Pressure Heads
I. BUCENIEKS, E. PLATACIS, O. MIKANOVSKIS, A. ZIK and V. MEHTA
Magnetohydrodynamics, 53, 423, 2017

The ITER Neutral Beam Test Facility towards SPIDER Operation
V. TOIGO, A. CHAKRABORTY, U. BARUAH, C. ROTTI, H. PATEL, M.V. NAGARAJU, N.P. SINGH, A. PATEL, H. DHOLA, B. RAVAL et al.
Nuclear Fusion, 57, 086027, 2017

Search for Intermediate Mass Black Hole Binaries in the First Observing Run of Advanced LIGO
B.P. ABBOTT, A. DASGUPTA, M.K. GUPTA, Z. KHAN, R. KUMAR, A.K. SRIVASTAVA, S. SUNIL, et al (LIGO Scientific Collaboration, Virgo Collaboration)
Physical Review D, 96, 022001, 2017

A Parametric Model for Contribution of Superthermal Electrons to Oblique Measurement Electron Cyclotron Spectra under ITER-Like Conditions
P.V. SUBHASH, AMIT KUMAR SINGH, HITESH PANDYA, V.S. DIVYA, M.P. APARNA and T.K. BASITHA THANSEEM
Fusion Science and Technology, 72, 49, 2017

Time-Resolved Raman Spectroscopy of Polystyrene under Laser Driven Shock Compression
VINAY RASTOGI, S. CHAURASIA, USHA RAO, C.D. SIJOY, V. MISHRA, MANMOHAN
KUMAR, S. CHATURVEDI and M.N. DEO
Journal of Raman Spectroscopy, 48, 1007, 2017

Magnetic Flux Surfaces and Radial Shafranov Shifts (ΔR) in SST-1 Tokamak Plasma
SUBRATA JANA, SUBRATA PRADHAN, JASRAJ DHONGDE, HARISH MASAND, MANOJ KUMAR, SAMEER KUMAR, PRAVEENLAL EDAPPALA, HITESH PATEL and DEBASHIS GHOSH
Fusion Engineering and Design, 120, 39, 2017

200 kJ Pulsed Power System for Pulsed Plasma Device
SURAMONI BORTHAKUR, NAYAN TALUKDAR, NIROD KUMAR NEOG, TRIDIP KUMAR BORTHAKUR, RAJESH KUMAR, RISHI VERMA, and ANURAG SHYAM
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Search for High-Energy Neutrinos from Gravitational Wave Event GW151226 and Candidate LVT151012 with ANTARES and IceCube
A. ALBERT, A. DASGUPTA, M.K. GUPTA, Z. KHAN, R. KUMAR, A.K. SRIVASTAVA, S. SUNIL, et al (ANTARES Collaboration, IceCube Collaboration, LIGO Scientific Collaboration, Virgo Collaboration)
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Measurements of the Cross Sections of the $^{186}W(n,\gamma)^{187}W$, $^{182}W(n,P)^{182}Ta$, $^{154}Gd(n,2n)^{153}Gd$, and $^{160}Gd(n,2n)$ ^{159}Gd Reactions at Neutron Energies of 5 to 17 MeV
RAJNIKANT MAKWANA, S. MUKHERJEE, P. MISHRA, H. NAIK, N.L. SINGH, M. MEHTA, K. KATOVSKY, S.V. SURYANARAYANA, V. VANSOLA, Y. SANTHI SHEELA, M. KARKERA, R. ACHARYA, and S. KHIRWADKAR
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Study of Surface Properties of Plasma Nitrided Ferritic Stainless Steel 430L
D. GAUTAM, B. GANGULI, and S. SHARMA
Material Performance and Characterization, 6, 581, 2017

Effect of Cold Plasma Treatment and Priming in Bell Pepper (Capsicum annuum L.)
CHERRY NALWA, ASHOK K. THAKUR, AMIT VIKRAM, R. RANE and A. VAID
International Journal of Bio-resource and Stress Management, 8, 535, 2017

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RAVINDER KUMAR, ASHOK K. THAKUR, AMIT VIKRAM, A.VAID, R. RANE
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S. SAI SHIVA, CH. LEELA, P. PREM KIRAN, C.D. SIJOY, V.R. IKKURTHI and S. CHATURVEDI
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Influence of DC Arc Current on the Formation of Cobalt-Based Nanostructures
P.B. ORPE, C. BALASUBRAMANIAN and S. MUKHERJEE
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P.B. ORPE, E. PARIS, C. BALASUBRAMANIAN, B. JOSEPH, S. MUKHERJEE, D. DI GIOACCHINO, A. MARCELLI and N.L. SAINI
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TARUN SOURADEEP, SENDHIL RAJA, ZIAUDDIN KHAN, C.S. UNNIKRISHNAN and BALA IYER
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Aligned Multi-Walled Carbon Nanotubes (MWCNT) and Vapor Grown Carbon Fibers (VGCF) Reinforced Epoxy Adhesive for Thermal Conductivity Applications
AMIT KUMAR SINGH, ASHUTOS PARHI, BISHNU PRASAD PANDA, SMITA MOHANTY, SANJAY KUMAR NAYAK and MANOJ KUMAR GUPTA
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Performance of Epitaxial and HPSI 4H-SiC Detectors for Plasma X-Ray Imaging Systems
P.V. RAJA, J. AKHTAR, S. VALA, M. ABHANGI and N.V.L.N. MURTY
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The PRIMA Test Facility: SPIDER and MITICA Test-Beds for ITER Neutral Beam Injectors
V TOIGO, A CHAKRABORTY, U BARUAH, C ROTTI, H PATEL, M.V. NAGARAJU, N.P SINGH, A PATEL, H DHOLA, B RAVAL, ET. AL.
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RAVI PANDEY, M. BANDYOPADHYAY, R. YADAV, D. PARMAR, H. TYAGI, H. SHISHANGIYA, S. SHAH, DASS SUDHIR KUMAR, A. GAHLAUT, M. VUPPUGALLA, J. SONI, J. BHAGORA, G. BANSAL, K. PANDYA, and A. CHAKRABORTY

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SHARAD K YADAV, BHAVESH G PATEL, R.K SINGH, AMITA DAS, PREDHIMAN K KAW and AJAI KUMAR
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SAI CHAITANYA TADEPALLI, PRITI KANTH, GUNJAN INDAULIYA, ISHWITA SAIKIA, SHISHIR P. DESHPANDE, P.V. SUBHASH
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MALAY DALUI, M. KUNDU, SHEROY TATA, AMIT D. LAD, J. JHA, KRISHANU RAY, and M. KRISHNAMURTHY
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P. VIGNESHWARA RAJA, JAMIL AKHTAR, C.V.S. RAO, SUDHIRSINH VALA, MITUL ABHANGI and N.V.L. NARASIMHA MURTY
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E.1.3 Book Chapters

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E.2. INTERNAL RESEARCH AND TECHNICAL REPORTS

E.2. 1 Research Reports

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A FEASIBILITY STUDY: MULTI-LAYERED JOINING OF W/Cu-CuCrZr-SS316L-SS316L COUPON USING VACUUM BRAZING ROUTE
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B. RISCOB, CHUNBO ZHANG, ALICE YING, MAYANK MAKWANA, PARITOSH CHAUDHURI and E. RAJENDRA KUMAR
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AN ASSESSMENT OF TENSILE FLOW BEHAVIOUR OF INDIA-SPECIFIC REDUCED ACTIVATION FERRITIC MARTENSITIC STEEL (IN-RAFMS)
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AN EXPERIMENTAL STUDY ON PNEUMATIC CAPSULE TRANSPORT FOR NEUTRON ACTIVATION SYSTEM (NAS) FOR IN-LLCB TBM
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K. P SINGH, S. S. KHIRWADKAR, NIKUNJ PATEL, PRAKASH MOKARIA, KEDAR BHOPE, SUNIL BELSARE, VINAY MENON, DEEPU K, MAYUR MEHTA, SUDHIR TRIPATHI, ALPESH PATEL, RAJAMANAR SWAMY, TUSHAR PATEL and KALPESH PATEL
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R. L. TANNA, J. GHOSH, HARSHITA RAJ, ROHIT KUMAR, SUMAN AICH, VAIBHAV RANJAN, K. A. JADEJA, K. M. PATEL, S. B. BHATT, K. SATHYANARAYANA, P. K. CHATTOPADHYAY, M. N. MAKWANA, K. S. SHAH, C. N. GUPTA, V. K. PANCHAL, PRAVEENLAL E. V., BHARAT ARAMBHADIYA, MINSHA SHAH, VISMAY RAULJI, M. B. CHOWDHURI, S. BANERJEE, R. MANCHANDA, D. RAJU, P. K. ATREY, UMESH NAGORA, J. RAVAL, Y. S. JOISA, K. TAHILIANI, S. K. JHA and M. V. GOPALKRISHANA
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OF MIRROR REFLECTIVITY IN CAVITY RING DOWN SPECTROSCOPIC DIAGNOSTIC
D. MUKHOPADHYAY, B. K. DAS, M. BANDYOPADHYAY, DASS SUDHIR and A. CHAKRABORTY
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ARUNSINH B. ZALA, NIRAV I. JAMNAPARA, VISHVESH J. BADHEKA, SHIJU SAM and MUKESH RANJAN
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DESIGN OF 106 kVA, 20 kHz POWER SUPPLY FOR FEEDING COCKCROFT-WALTON VOLTAGE MULTIPLIER TO GENERATE 500 kV
ARITRA CHAKRABORTY, ASHOK MANKANI, PAUL CHRISTIAN, URMIL THAKKER, AMAL S. and KUMAR SAURABH
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R. RANE, A. JOSHI, A. SATYAPRASAD and S. MUKHERJEE
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DESIGN, DEVELOPMENT AND TESTING OF PROTOTYPE COLD TRAP FOR Pb-Li PURIFICATION
A. DEOGHAR, A. JAISWAL, P. PRASAD RAO, S. VERMA, C. SASMAL, S. GUPTA, A. SARASWAT, A. PRAJAPATI, S. SAHU and R. BHATTACHARYAY
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ROLE OF ION MAGNETIZATION IN THE FORMATION OF RADIAL DENSITY PROFILE IN MAGNETICALLY EXPANDING HELICON PLASMA
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2-D FLUID SIMULATION OF A RIGID RELATIVISTIC ELECTRON BEAM DRIVEN WAKEFIELD IN A COLD PLASMA
RATAN KUMAR BERA, AMITA DAS and SUDIP SENGUPTA
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INFLUENCE OF DRIVING FREQUENCY ON THE METASTABLE ATOMS AND ELECTRON ENERGY DISTRIBUTION FUNCTION IN A CAPACITIVELY COUPLED ARGON DISCHARGE
S. SHARMA, N. SIRSE, M. M. TURNER and A. R. ELLINGBOE
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E.2. 2 Technical Reports

Adsorption Test Facility for Characterizing Adsorbents at a Cryogenic Temperature Down to 4.5 k
J. MISHRA, J. AGARWAL, P. NAYAK, P. PANCHAL, S. MUKHERJEE, S. KASTHURIRENGAN and R. GANGRADEY
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Report on Demonstration of Different EPICS extension for control and Monitoring of Power Supply
ARNAB DAS GUPTA, HITESH K. GULATI, AMIT K. SRIVASTAVA, S. SUNIL and Z. KHAN
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Implementation of an OROCOS based Real-Time Equipment Controller for Remote Maintenance of Tokamaks
NAVEEN RASTOGI, PRAMIT DUTTA and KRISHAN KUMAR GOTEWAL
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Development of Pneumatic Punch and Cutter for Extruder Type Pellet Injector Application
PARESH PANCHAL, SAMIRAN MUKHERJEE and RANJANA GANGRADEY
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A Theoretical and Experimental Hydrodynamic Analysis of Molten PbLi for Round Liquid Jet
ARVIND KUMAR, V. C. CHAUDHARI, GAUTAM PULUGUNDLA, and SERGEY SMOLENTSEV
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Design and Assessment of Horizontal Access Module (Ham) for Laser Interferometer Gravitational-Wave Observatory (Ligo)-India Project
RAKESH KUMAR, MANOJ KUMAR GUPTA AND ZIAUDDIN KHAN
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ABHISHEK SINHA, S. K. PATHAK, STEFAN SCHMUCK AND JOHN FESSEY
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Comparison of ANISN and ATTILA Codes Neutronics Results for a Simplified Model of US DCLL Blanket
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Stokes Parameters of Beam Reflected from Optically Absorbing Medium
ASHA ADHIYA, RAJWINDER KAUR and PRAMILA
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Design and Development of 140 GHz D-Band Phase Locked Heterodyne Interferometer System for Real Time Density Measurement
UMESH NAGORA, ABHISHEK SINHA, S. K. PATHAK, PHILIP IVANOV, R. L. TANNA, K. A. JADEJA, K. M. PATEL and J. GOSH
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Technical Report on Automation in calorimetric pulse power measurement of ECRH Gyrotron system
HARSHIDA PATEL, GUNJAN PATEL, SHAH MOKSHA and B. K. SHUKLA
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Thermo-Mechnical Analysis for Basic Symmetric Chamber (BSC)
MANOJ KUMAR GUPTA, RAKESH KUMAR and ZIAUDDIN KHAN
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Numerical Modelling for the Effective Thermal Properties of Lithium Meta-Titanate Pebble Beds
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USB Web Camera Based Feedback Control Technique of Aligning a Laser Beam
S. SUNIL, AMIT K SRIVASTAVA and ZIAUDDIN KHAN
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Frequency Sweep Linearisation of Ka Band Microwave Source for the FMCW Reflectometer Diagnostic
JJ.U. BUCH, E. V. PRAVEENLAL and S. K. PATHAK
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Indigenous MgB_2 Strands Development Activities at IPR
SUBRAT KUMAR DAS, ANEES BANO, ANANYA KUNDU, MONI BANAUDHA and SUBRATA PRADHAN
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Data-Acquisition & Interlock System Design for Corrosion Experiments of Indian RAFMS with Flowing Pb-Li
A. SARASWAT, S. VERMA, S. GUPTA, A. SARADA SREE and E. RAJENDRA KUMAR
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Design and Analysis of Circular Waveguide Termination for SYMPLE
JITENDRA KUMAR, ZEESHAN, RAHUL JAISWAL, ARPIT BARANWAL, RAJ SINGH and ANITHA V. P.
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3D Magneto-hydrodynamic numerical analysis for Pb-Li flow in a test mock up with electrically coupled flow channels and complex manifold
ANITA PATEL, R. BHATTACHARYAY, P. SATYAMURTHY, P. K. SWAIN and S. RANJITHKUMAR
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Transient Thermal Analysis of Cathode for High Density Multi-Filamentary Plasma Source of LVPD
PROSENJIT SANTRA, AMULYA K. SANYASI, VIVEK

PATEL, NISARG RAVAL, AKASH PATEL, PINAKIN PATEL, PRAMIT DUTTA, PRABHAKAR SRIVASTAV, P. K. SRIVASTAVA, R. SUGANDHI, MANOJ K. GUPTA, BHARATI DOSHI and L. M. AWASHTI
IPR/TR-449/2017 (OCTOBER, 2017)

Jitter Minimization in Triggering Multiple Solid State Devices using Fiber Optical Cables
BHAVESH KADIA, V. S. KIRAN MEDURI, Y. S. S. SRINIVAS and S. V. KULKARNI
IPR/TR-450/2017 (NOVEMBER, 2017)

Design Aspects of Two Stub Matching Network for the Up-gradation of Aditya ICRH System for Fast Wave and Ion Bernstein Wave Heating Experiments
SUNIL KUMAR, S. V. KULKARNI and HIGH POWER ICRH SYSTEMS DIVISION
IPR/TR-451/2017 (DECEMBER, 2017)

Proposed RFID (Radio Frequency Identification) based Inventory/Asset Management Solution for IPR
MANISHA BHANDARKAR, PANKAJ SRIVASTAVA, L. M. AWASTHI, B. R. DOSHI, SANJAY PANDYA, YOGESH DADEECH, MUKESH C. JHA, R. RATHOD, KIRAN AMBULKAR, BRIJ K. SHUKLA, KUMUDINI TAHILIANI, AGRAJIT G. GAHALAUT, CHHAYA CHAVDA, DILIP C. RAVAL, VINAY KUMAR, V. PRAHLAD, FALGUNI SHAH, BKBS RAO and H. S. CHAMUNDE
IPR/TR-452/2017 (DECEMBER, 2017)

Real-time Control of Gas feed Pulses to Reduce Wall Loading of Fuel Gas in ADITYA Upgrade Tokamak
PRAVEENLAL EDAPPALA, MINSHA SHAH, RACHANA RAJPAL, K. A. JADEJA, R. L. TANNA and J. GHOSH
IPR/TR-453/2017 (DECEMBER, 2017)

Trigger and Timing Control System using FPGA and MicroBlaze Soft Processor for Plasma Operations of ADITYA-U Tokamak
MINSHA SHAH, PRAVEENLAL EDAPPALA, VISMAY RAULJI, RACHANA RAJPAL, R. L. TANNA, C. N. GUPTA and J. GHOSH
IPR/TR-454/2017 (DECEMBER, 2017)

Design and Development of TM Mode Launcher for Circular Waveguide for SYMPLE
ARPIT BARANWAL, RAHUL JAISWAL, SHREEKANT PATEL, JITENDRA KUMAR, RAJ SINGH and ANITHA V. P.
IPR/TR-455/2018 (JANUARY, 2018)

Application of 2D Digital Image Correlation (DIC) Technique for Strain measurement during tensile test
KEDAR BHOPE, MAYUR MEHTA, JIGNESH CHAUHAN, HARDIK TAILOR and SAMIR KHIRWADKAR
IPR/TR-456/2018 (JANUARY, 2018)

Assembly and Characterization of Fourier Transform Michelson Interferometer Diagnostic
ABHISHEK SINHA, S. K. PATHAK, JOHN FESSEY and STEFAN SCHMUCK
IPR/TR-457/2018 (JANUARY, 2018)

Design and Development of Millimeter Wave Interferometer Circuit for Real-Time Measurement of Plasma Density
PRAVEEN KUMAR ATREY, DHAVAL PUJARA, SUBROTO MUKHERJEE, UMESH NAGORA, PRAVEENLAL EDAPPALA, PRAVEENA KUMARI and RACHANA RAJPAL
IPR/TR-458/2018 (JANUARY, 2018)

Study on Interactions of Inter-Winding Capacitances of Multi-Secondary Transformer and their Effect on the Performance of PSM Based High Voltage Power Supply
L. N. GUPTA, S. V. KULKARNI, N. P. SINGH, PARESH. J. PATEL, DIPAL THAKKAR, SUMOD C. B. and U. K. BARUAH
IPR/TR-459/2018 (JANUARY, 2018)

Thermo-Mechanical Analysis of Horizontal Access Module (HAM) Chamber
MANOJ KUMAR GUPTA, RAKESH KUMAR and ZIAUDDIN KHAN
IPR/TR-460/2018 (JANUARY, 2018)

Wireless and Wired Data Communication for High Heat Flux Test Facility (HHFTF)
KALPESH GALODIYA, SUNIL BELSARE, SAMIR KHIRWADKAR, TUSHAR PATEL and PRAKASH MOKARIA
IPR/TR-461/2018 (JANUARY, 2018)

Determination of Mueller Matrix of a Hollow Rooftop Reflector
ASHA ADHIYA and RAJWINDER KAUR
IPR/TR-462/2018 (JANUARY, 2018)

Design Basis of First Wall Helium Cooling System for LLCB

TBM
B. K. YADAV, A. GANDHI, S. RAO, P. CHAUDHURI and E. R. KUMAR
IPR/TR-463/2018 (FEBRUARY, 2018)

Development of Pump Performance Test Loop for Feasibility Study of Operation Similar to LLCS loop for IN-LLCB TBM
MRITUNJAY KUMAR, ANKUR JAISWAL, ABHISHEK SARASWAT and R. BHATTACHARYAY
IPR/TR-464/2018 (FEBRUARY, 2018)

Experimental plan for testing TBM FW mock-up of IPR in Helium Loop Karlsruhe (HELOKA), at KIT, Germany
B. K. YADAV, S. RANJITH KUMAR, A. SARASWAT, S. RAO, S. GUPTA, A. N. MISTRY, P. CHAUDHURI and E. R. KUMAR
IPR/TR-465/2018 (FEBRUARY, 2018)

NDOT-1D (v1.2): A MATLAB code for preparation & execution of MCNP input files for 1-D radial model of fusion reactors
P. J. BHUYAN, B. J. SAIKIA and C. DANANI
IPR/TR-466/2018 (FEBRUARY, 2018)

Development of Machine Vision Acquisition System for Tokamak in Visible Spectrum
VISHNU CHAUDHARI, MANOJ KUMAR and AJAI KUMAR
IPR/TR-467/2018 (FEBRUARY, 2018)

A Code for Magnetic Field Due to Arbitrary Electromagnets (CAE v1.0)
DIVYANG R. PRAJAPATI and GATTU RAMESH BABU
IPR/TR-468/2018 (FEBRUARY, 2018)

Implementation of PLC Based Quench Fault Monitoring and Control Mechanism for TFPS
AKHILESH KUMAR SINGH, DINESH KUMAR SHARMA, MURTUZA M. VORA, AMIT OJHA and SUPRIYA A. NAIR
IPR/TR-469/2018 (MARCH, 2018)

Heat treatment and Metallurgical Characterization of Nb_3Sn/Cu KODA Strands
YOGENDRA SINGH, PIYUSH RAJ, ARUN PANCHAL, CHIRAG DODIYA, SUBRAT KUMAR DAS, NITISH KUMAR, ANEES BANO, ANANYA KUNDU, BHADRESH PARGHI, DHAVAL BHAVSAR, DEVEN KANABAR, AZAD MAKWANA, MAHESH GHATE and UPENDRA PRASAD
IPR/TR-470/2018 (MARCH, 2018)

E.3. CONFERENCE PRESENTATIONS

IEEE International Conference on Circuit, Power and Computing Technologies (ICCPCT-2017), Baselios Mathew II College of Engineering, Kollam, Kerala, 20-21 April 2017

Spectral statistical analysis of low frequency coefficients from diagnostic signals depicting MHD disruptions
T. T. M. Delsy, N. M. Nandhitha, R. L. Tanna and J. Ghosh

11th IAEA Technical Meeting on Control, Data Acquisition and Remote Participation for Fusion Research, Greifswald, Germany, 8-12 May 2017

Design maturity of Plant Instrumentation and Control for ITER XRCS-Survey
Sanjeev Varshney, Shivakant Jha, Stefan Simrock, Prabhakant Patil, Vincent Martin, Robin Barnsley, Philippe Bernascolle, Sapna Mishra, Shiddharth Kumar, Vinay Kumar

32nd meeting of the ITPA Topical group on diagnostics, SWIP, Chengdu, China, 9-12 May 2017

Report of Passive spectroscopy Specialist Working Group
Sanjeev Varshney, Changrae Seon, Robin Barnsley

Progress on ITER XRCS-Survey and XRCS-Edge Spectrometer Systems
Sanjeev Varshney, Siddharth Kumar, Sapna Mishra, Shivakant Jha, Subhash Puthenveetil, Chirag Khairnar, Ravi Patel, Dharmesh Bhatia, Sejal Kamaliya, Vinay Kumar, Robin Barnsley, Philippe Bernascolle, Julio Guiro, Vincent martin, Stefan Simrock, Vincent Martin, Jean-Marc Drevon, Richard O' Conner and Michael Walsh

IN-DA Progress on Upper Port #09
Siddharth Kumar, Sanjeev Varshney, Shrishail Padasalagi, Shrichand Jhakar, Mitul Abhangi, Shivakant Jha, Vinay Kumar, Richard O' Connor, Julio Guiro, Victor Udintsev

14th Cryogenics 2017 IIR International Conference, Dresden Germany, 15-19 May 2017

A Hydrostatic Pressurization Test of High Pressure Helium Gas Storage Vessels at IPR

Sharma Rajiv, Tanna Vipul, Patel J .C, Panchal Rohit, Nimavat Hiren, Srikanth GLN, Patel Ketan, Shah Pankil, Panchal Pradip, Christian Dikens, Sonara Dasarath, Garg Atul, Bairagi Nitin, Patel Rakesh, Mahesuria Gaurang, Gaurav Purwar, Pradhan Subrata

8th International Conference on the Physics of Dusty Plasmas, Prague, Czech Republic, 19-26 May 2017

Compressible Kolmogorov flow in strongly coupled dusty plasma: A study using Molecular dynamics and Computational fluid dynamics
Akanksha Gupta, Rajaraman Ganesh and Ashwin Joy

Emergence and propagation of elastic wave from a vortex source in strongly correlated dusty plasma using molecular dynamics
Akanksha Gupta, Rajaraman Ganesh and Ashwin Joy

44th International Conference on Plasma Sciences (ICOPS 2017), Atlantic City, New Jersey, USA, 21-25 May 2017

Liquid Dielectric Breakdown Study under Sub Microsecond Pulse Conditions using Tesla Based Pulse Generator
G. Veda Prakash, R. Kumar, V.P. Anitha and A. Shyam

Technical visit to KIT (Cryogenic Division), Karlsruhe Institute of Technology, Karlsruhe, Germany, 22 May 2017

SST-1 Cryogenics System and Related Facilities
Rajiv Sharma and Cryogenic division

38th Progress in Electromagnetics Research Symposium (PIERS-2017), St. Petersburg, Russia, 22-25 May 2017

Multiphysics analysis of high power CW ferrite phase shifter designs for application in circulators
Harish V. Dixit, Aviraj R. Jadhav, Yogesh M. Jain, Alice N. Cheeran, Vikas N. Gupta, P. K. Sharma

27th IEEE Symposium on Fusion Engineering, Shanghai, China, 4 - 8 June 2017

Design, Construction and Installation of Limiter & Divertor of Aditya Upgrade Tokamak
K. M. Patel, J Ghosh, S. B. Bhatt, K. A. Jadeja, M. B. Kalal, Deepti Sharma, R. Shrinivasan, Y. C. Saxena, R. L. Tanna and Aditya Upgrade Team

6th Gleeble User Workshop India (GUWI-2017), IIT Bombay, Mumbai, 15-17 June 2017

Studies on the joining techniques for ITER like Divertor target application using Gleeble system
K.P Singh, Alpesh Patel, Samir S Khirwadkar, Kedar Bhope

Tensile Testing of Materials at Elevated Temperatures using Small Size Specimens
A.Patel, D.Makvana, S.Khirwadkar

44th European Plasma Physics Conference on Plasma Physics (EPS-2017), Belfast, Northern Ireland, 26-30 June, 2017

Growth of Electron hole in subcritical regime of Ion Acoustic instability: Extends the Parameter Regime of the Conventional Plasma Turbulence
Debraj Mandal and Devendra Sharma

Breaking of Large Amplitude Relativistically Intense Waves in a Warm Plasma
Arghya Mukherjee and Sudip Sengupta

Electro-magnet for plasma confined in cusp magnetic field
Amitkumar D. Patel, Meenakshee Sharma, N. Ramasubramanian, P. K. Chattopadhyay

34th DAE Safety & Occupational Health Professionals Meet, Kudankulam Nuclear Power Project, Tamilnadu, 28-30 June 2017

Safety Considerations in Remote Handling and Robotic Work-Cells
Naveen Rastogi, Pramit Dutta, Parag Lalwani, Ravi Ranjan Tiwari, Krishan Kumar Gotewal

International conference on Sophisticated Instrument in Modern Research, Indian Institute of Technology, Guwahati, Assam, 30 June 2017

A supersonic plasma beam assisted experimental reactor configuration for controlled synthesis of super-paramagnetic nanomaterials for biomedical applications
Lavita Sarma, N. Aomoa, Trinayan Sarmah, Sunita Ojha, U. Bora, S.Sarma, and M. Kakati.

3rd International Conference on Advances in Robotics, IIT Delhi, Delhi, 28 June - 2 July 2017

A Hyper-Redundant Robot Development for Tokamak Inspection
Pramit Dutta, K.K. Gotewal, Naveen Rastogi, Ravi Ranjan Tiwari, Manoah Stephen M.

Implementation of an OROCOS based Real-Time Equipment

Controller for Remote Maintenance of Tokamaks
Naveen Rastogi, Pramit Dutta, Vamshi Krishna, K.K. Gotewal

International Conference on Sophisticated Instruments in Modern Research, CIF, IIT Guwahati. 30 June - 1 July 2017

Surface and structural analyses of fusion materials
N.J. Dutta, N. Buzarbaruah and S.R. Mohanty

International Conference on Phenomena in Ionized Gases (ICPIG-2017), Estoril/Lisbon, Portugal, 9-14 July 2017

Optical Emission Spectroscopy Investigations in a Non-Transferred DC Plasma Torch
Vidhi Goyal, P. Bharathi and G. Ravi

Study of Turbulent Particle Transport in ETG Dominated Plasma of LVPD
Prabhakar Srivastav, Rameshwar Singh, L. M. Awasthi, A.K. Sanyasi,, P. K. Srivastava, R. Sugandhi, R. Singh, and P K Kaw

International Conference on Electron Microscopy and Allied Techniques (EMSI 17), Mahabalipuram, Tamilnadu, 17-19 July 2017

Investigation of Tungsten deposition using Magnetron Sputtering & its Characterization
A. Satyaprasad, Nirav I Jamnapara, R. Rane, Purvi Kikani, G. Ravi, S. Mukherjee

4th International Conference on Nanoscience and Nanotechnology (ICONN-2017). SRM University, Chennai, 9-11 August 2017

Investigations on structural and dielectric properties of Co – doped ZnO synthesized by Co-precipitation Method
Chirag Savaliya, Savan Katba, Sadaf Jethva, A.U. Vyas, P. Kikani, M. Ranjan, D.G. Kuberkar

8th International Conference on Photonics, Devices and Systems, Prague, Czech Republic, 28-30 August 2017

A novel method for fabrication of size-controlled metallic nanoparticles by laser ablation
Kaushik Choudhury, R. K. Singh, Mukesh Ranjan, Ajai Kumar, and Atul Srivastava

16th Rapidly Quenched and Metastable Materials, Leoben, Austria, 27 August 2017 - 01 September 2017

Powder metallurgy of W-Cu material synthesized by hot consolidation process
A.Chaubey, R.Gupta, B.Bhoi, S.Kanpara, S.Khirwadkar

1st Asia-Pacific Conference on Plasma Physics (AAPPS-DPP2017), Chengdu, China, 18-23 September 2017

Trigger and Timing Control System Using FPGA and MicroBlaze Soft Processor for Plasma Operations of ADITYA-U Tokamak
Minsha Shah, Praveenlal Edappala, Vismay Raulji, Rachana Rajpal, R.L. Tanna, C N Gupta, J. Ghosh and ADITYA-U Team

Plasma Production and Preliminary Results from the ADITYA Upgrade Tokamak
R.L. Tanna, J. Ghosh, Harshita Raj, Rohit Kumar, Suman Aich, Vaibhav Ranjan, K.A. Jadeja, K.M. Patel, S.B. Bhatt, K. Sathyanarayana, P.K. Chattopadhyay, M.N. Makwana, K.S. Shah, C.N. Gupta, V.K. Panchal, Praveenlal E.V, Bharat Arambhadiya, Minsha Shah, Vismay Raulji, M.B. Chowdhuri, S. Banerjee, R. Manchanda, D. Raju, P.K. Atrey, Umesh Nagora, J. Raval, Y.S. Joisa, K. Tahiliani, S.K. Jha, M.V. Gopalkrishana and the ADITYA-U Team

Experimental Results from ADITYA and ADITYA Upgrade Tokamak
R. L. Tanna, J. Ghosh, P. K. Chattopadhyay, Harshita Raj, Rohit Kumar, Suman Aich, Vaibhav Ranjan, Sharvil Patel, K. A. Jadeja, K. M. Patel, Kulav Rathod, K.S. Acharya, S. B. Bhatt, K.S. Shah, M.N. Makawana, C.N. Gupta, M. B. Kalal, D. S. Varia, D.H. Sadharakiya, V. K. Panchal, N. C. Patel, C. Chavda, Pravesh Dhyani, K. Sathyanarayana, S. K. Jha, D. Raju, M.V. Gopalkrishna, K. Tahiliani, R. Jha, S. Purohit, J. V. Raval, Y. S. Joisa, Umesh Nagora, P. K. Atrey, S.K. Pathak, N. Ramaiya, S. Banerjee, M. B. Chowdhuri, R. Manchanda, Kiran Patel, J. Thomas, Ajai Kumar, S. Gupta, Kumar Ajay, S. Pandya, M. Gupta, Praveenlal E.V, Minsha Shah, Praveena Kumari, Bharat Arambhadiya, Vismay Raulji, R. Rajpal, S. V. Kulkarni & ICRH Group, B. K. Shukla & ECRH Group, P.K. Sharma & LHCD Group, R. Goswami, R. Srinivasan, I Bandopadhyay, A. Das, Y. C. Saxena, A. Sen and P. K. Kaw

Estimation of Mutual Inductances and Measurement of Reflected Voltage for Designing a Power Supply for Shaped Plasma Operation in ADITYA - U tokamak
Vaibhav Ranjan, Rohit Kumar, Suman Aich, R.L. Tanna, J. Ghosh, M.B. Kalal, Harshita Raj, K. Sathyanarayana, P.K. Chattopadhyay and the ADITYA-U Team

Real-time Control of Gas-Feed Pulses to Reduce Wall Loading of Fuel Gas in Aditya-Upgrade Tokamak
Praveenlal Edappala, Minsha Shah, Rachana Rajpal, K.A. Jadeja, R. L. Tanna and J. Ghosh

19th International Workshop Ceramic Breeder Blanket

Interactions (CBBI-19), Kyoto, Japan, 21-23 September 2017

Experimental and numerical measurement of thermal properties of Li_2TiO_3 pebble bed & DEM simulation for mechanical characterization of pebble bed
Maulik Panchal, A. Shrivastava, R. Bright, S. Gupta, M. Makwana, P. Chaudhuri, E. Rajendrakumar

13th International Symposium on Fusion Nuclear Technology (ISFNT-13), Kyoto, Japan, 25-29 September 2017

Design and development of an experimental set-up for the measurement of the effective thermal conductivity of Li_2TiO_3 pebble bed by steady state and axial heat flow methods
Maulik Panchal, A. Saraswat, S. Verma, M. Makwana, P. Chaudhuri, E. Rajendrakumar

Conceptual Design of Tritium Extraction System and Coolant Purification System for Indian LLCB TBM
R. Patel, V.G. Devi, S. Rai, D. Yadav, A. Verma, D. Mohanta, S. Rao, A. Sircar, E. Rajendra Kumar, S. Mohan, K. Bhanja, K.C. Sandeep, R. Bhattacharyya and V. Kandalam

Fabrication Feasibility Studies for First Wall of Indian LLCB TBM
Shiju Sam , S. Bhattacharya , A.N. Mistry, Narender Singh, Surinder Kumar, Santosh Kumar, G. K. Dey, E. Rajendra Kumar

International Conference on High Energy Radiation and Applications, M. S. University, Vadodara, 10-13 October 2017

Investigation of structural and electrical behavior of Al2O3 ceramic material under high energy neutron irradiation
Sunil Kumar, Sejal Shah, Sudhir Vala, Mitul Abhangi, Ratnesh Kumar, Purvi Kakani, Satya Prasad, N. Jamnapara, M. Bandyopadhyay, A. Chakraborty

International Conference on Nano Structuring by Ion Beam (ICNIB 2017), Devi Ahilya University, Indore (M.P), 11-13 October 2017

Molecular sensing using nanoparticle arrays on ion beam patterned substrates
Sooraj K P, Mukesh Ranjan, Subroto Mukherjee

17th International Conference on Ion Sources (ICIS), CERN-CICG, Geneva, Switzerland, 15-20 October 2017

Spectral Modelling of Neutral Beam for Doppler Shift Spectroscopy Diagnostics of INTF
Arnab J. Deka, Bharathi P, D. Sudhir, M. Bandyopadhay, A. K. Chakraborty

33rd Meeting of the ITPA Topical group on diagnostics, ITER Organization, Cadarache, France, 16-19 October 2017

Report of Passive spectroscopy Specialist Working Group
Sanjeev Varshney, Changrae Seon, Robin Barnsley

Progress on ITER XRCS-Survey and XRCS-Edge Spectrometer Systems
Sanjeev Varshney, Siddharth Kumar, Sapna Mishra, Namita Yadav, Shivakant Jha, P V Subhash, Vinay Kumar, Robin Barnsley, Philippe Bernascolle, Julio Guiro, Vincent martin, Stefan Simrock, Vincent Martin, Jean-Marc Drevon, Richard O' Conner and Michael Walsh

IN-DA Progress on Upper Port #09
Siddharth Kumar, Shrishail Padasalagi, Sanjeev Varshney, Shrichand Jhakar, Mitul Abhangi, Shivakant Jha, Vinay Kumar, Victor Udintsev, Thibaud Giocomin, Richard O' Connor

59th Annual Meeting of the APS Division of Plasma Physics, Milwaukee, Wisconsin Center, USA, 23-27 October 2017

2-D fluid simulation of relativistic electron beam driven wakefield in the blow-out regime
Ratan Kumar Bera, Amita Das, and Sudip Sengupta

Magnetic field generation in finite beam plasma system
Atul Kumar, Chandrasekhar Shukla, Bhavesh Patel, and Amita Das

A new regime of whistler propagation in the laboratory
Garima Joshi and G. Ravi

Recent Developments in Control, Automation and Power Engineering (RDCAPE-2017), Amity University, Noida, 26-27 October 2017

A Control Algorithm for Co-operatively Aerial Survey by using Multiple UAVs
Shivam Kumar Gupta, Pramit Dutta, Naveen Rastogi, Shashank Chaturvedi

AIChE (American Institute of Chemical Engineers) Annual Meeting, Minneapolis, USA, 29 October – 3 November 2017

Understanding the surface chemistry, surface roughness and wettability of Argon plasma treated cornstarch powder.
Deepa Dixit, Shreya Bunk, Ramkrishna Rane, Chinmay Ghoroi

Collisionless Boltzmann (Vlasov) Equations and Modeling of Self-Gravitating Systems and Plasmas, CIRM, Marseille, France, 30 October - 3 November 2017

Vlasov Simulations of Driven Electrostatic Phase Space Vortices in a 1-D Electron-Ion Plasma
Pallavi Trivedi, R. Ganesh

International Conference on Nanotechnology: Ideas, Innovations & Initiatives (ICN: 3I-2017), IIT-Roorkee, Roorkee, 6-7 November 2017

Hydrophobization of magnetic Iron-nanoparticles with single-step surface modification
Krupali Mehta, Sandip Bhatt, Bhavesh Bharatiya, Mukesh Ranjan and Atindra Shukla

9th National Conference on Thermophysical Properties (NCTP), IGCAR Kalpakum, 6-8, November 2017

Ultrasonication effect on thermal conductivity of Al_2O_3nanofluids
Janki Shah, Sanjeev K. Gupta, Mukesh Ranjan, Yogesh Sonvane

32nd National Symposium on Plasma Science & Technology (PLASMA-2017), Institute for Plasma Research, Gandhinagar, 07-10 November 2017

Dynamo Effect in 3D Driven Magnetohydrodynamic Turbulent Plasmas
Rupak Mukherjee, Rajaraman Ganesh

Sheet Model of Upper-Hybrid Oscillations
Nidhi, Someswar Dutta, R. Srinivasan, Sudip Sengupta

Relativistic Motion of a Charged Particle in an Electromagnetic Wave in the Presence of Radiation Reaction
Shivam Kumar Mishra and Sudip Sengupta

Development of a Helicon Source and Preliminary Experiments
N. Sharma, M. Chakraborty, N.K. Neog, M. Bandyopadhyay

Estimation of Plasma Frequency in Cold Plasma Using Power Balance Equation and its Validation Using Microwave Absorption
Hiral B. Joshi, N. Rajanbabu, Anitha V P, Agrajit Gahlaut, Shashank Chaturvedi

Proton-Driven Plasma Wakefield Acceleration: Effect of an External Magnetic Field
Mithun Karmakar, Nikhil Chakrabarti, and Sudip Sengupta

Nature of Kinetic Processes in the Presence of Nonlinear Phase Space Vortices
S.K Pandey, P. Trivedi, R. Ganesh

Intrinsic Parallel Current Generation from ETG Turbulence in a Cylindrical Plasma
Rameswar Singh, P K Kaw, Ozgur D Gurcan and R Singh

Onset of 2D Rayleigh-Benard Convection in Strongly Correlated Liquids: A Comparative Study
Pawandeep Kaur, Harish Charan, Akanksha Gupta, R. Ganesh

Trapped Particle Nonlinearity Generated Coherent Structures and their Stability
Debraj Mndal and Devendra Sharma
Spatial Distribution of Cesium Atom Density in a Vacuum Chamber
M.R. Karim, S.S. Kausik and B.K. Saikia

Parametric Study of a Magnetized Hollow Cathode Plasma Discharge
M.P. Bhuva, Sunil Kumar and S.K. Karkari

Sheath in Electronegative Plasma
A.K. Pandey and S.K. Karkari

Effect of External Forcing on the Periodic Oscillations of a DC Glow Discharge Plasma Source
Neeraj Chaubey, S. Mukherjee and A.Sen

Characteristics of Floating Potential of an Electrode in Magnetized Plasma
Satadal Das and S.K. Karkari

Measurement of Electron Energy Distribution in Presence and Absence of Current Free Double Layer in Helicon Plasma
Sonu Yadav, Bhoomi Khodiyar, Prabal K Chattopadhyay, J Ghosh

On The Radial Expansion Velocity of Plasma Produced by Washer Stacked Plasma Gun with and without External Nonuniform Magnetic Field
R K Barad, R Paikaray, P Das, B K Sethy, S Samantaray, G Sahoo, J Ghosh

Spectroscopic Study of Two Interacting Plasmas in a Compact

Plasma System
P Das, R Paikaray, R K Barad, B K Sethy S Samantaray, G Sahoo, J Ghosh

Helicon Wave Field Measurements Using a B-Dot Probe
Arun Pandey, Mainak Bandyopadhyay, Dass Sudhir, Arun Chakraborty

Probe Positioning System for Large Volume Plasma Device
A. K. Sanyasi, R. Sugandhi, P. K. Srivastava, Prabhakar Srivastav, and L. M. Awasthi

Data Handling System for Large Volume Plasma Device
R. Sugandhi, P. K. Srivastava, Prabhakar Srivastav, A. K. Sanyasi, and L. M. Awasthi

Identification of Kelvin-Helmholtz Instability in Imped Plasma
Neeraj Wakde, Sayak Bose, P K Chattopadhyay, J Ghosh

Experimental Results from Up-Graded Small Aspect Ratio Toroidal Electron Plasma Experiment in C-Shape
Lavkesh T. Lachhvani, Manu Bajpai,Yogesh Yeole, Sambaran Pahari, Prabal Chattopadhyay

Design and Development of a Circular Waveguide Terminator for Microwave Plasma Interaction Experiments
Jitendra Kumar, Zeeshan, Rahul Jaiswal, Arpit Baranwal, Raj Singh and Anitha V. P.

Design and Analysis of Tuneable Waveguide Directional Coupler for Microwave Plasma Interaction Experiments
Jitendra Kumar, G. Sandhya Rani, Arpit Baranwal, Raj Singh and Anitha V. P.

Observation of Electron Drift Dominated Instability in the Near Electron Energy Filter (EEF) Region of Target Plasma in LVPD
A. K. Sanyasi, L. M. Awasthi, P. K. Srivastava, Prabhakar Srivastav and R. Sugandhi

Preparation and Study of Plasma in Borosilicate and Quartz Glass Tube
Nisha, Rajesh Kumar, Unnati Patel

Excitation of Reflected Electron Driven Quasilongitudinal (QL) Whistlers in Large Volume Plasma Device
A. K. Sanyasi, L. M. Awasthi, P. K. Srivastava, S. K. Mattoo, D. Sharma, R. Singh, R. Paikaray and P. K. Kaw

Two-Stream Instabilities in the Sheath-Presheath Region of AR+HE Two-Ion-Species Plasma
Vara Prasad Kella, J. Ghosh, P. K. Chattopadhyay, D. Sharma and Y. C. Saxena

Analysis and Applications of Software Define Radio in Plasma Diagnostics
Unnati Patel, Rajesh Kumar, Nisha Panghal

Revisit of Cusp Leak Width for Argon Plasma in a Multi Cusp Plasma Device with Variable Field Values
A. D. Patela, M. Sharma, N. Ramasubramanian, R. Ganesh, P. K. Chattopadhyay

Study of Effect of Multi-Line Cusp Magnetic Field on Plasma Parameters
Meenakshee Sharma, A. D. Patel, and N. Ramasubramanian

Experimental Measurement of Ion Concentration Ratio in Ar+He Two-Ion-Species Plasma
Pradeep Bairagi, Vara Prasad Kella, Joydeep Ghosh

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Analysis of Multiple Magnetohydodynamic Modes in Aditya-Upgrade Tokamak
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Solenoid Valve Based Gas Feed System for Variable Pressure in Alternate Arrangement of Mass Flow Controller
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Process Design of Cryogenic Distillation Column for Hydrogen Isotope Separation System
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Conceptual Design of Tritium Accountancy System for LLCB TBM
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Conceptual Design of Aditya-Upgrade Baking Control System
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3D Eddy Current Analysis in SST-1 Start-Up Using Finite Element Method
A. Amardas, B. D. Raju and SST-1 Team

Up Gradation of VME Based Data Acquisition for SST-1 Superconducting Magnets
Pankaj Varmora, Bhadresh Parghi, Moni Banaudha and Upendra Prasad and SST-1 Magnet Team

Upgradation and Testing of Signal Conditioning Electronics for SST-1 Magnets
Bhadresh R Parghi, Pankaj Varmora, Moni Banaudha, Upendra Prasad & SST- 1 Magnet
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Development of Field Simulator to Test & Qualify the Gyrotron Local Control Unit for ITER-India Gyrotron Test Facility
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Test Setup for Pressure Drop and Flow Measurement for Cable in Conduit Conductor
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Experimental and Simulation Study on Filling Mechanism of LI_2TIO_3 Pebble for LLCB TBM
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Yogesh M. Jain, P. K. Sharma, P. R. Parmar, K. K. Ambulkar

Adsorption Characteristic of Different Types of Charcoals at Cryogenic Temperature
J. Mishra, J.Agarwal, S. Mukherjee, P. Nayak, P. Panchal, and R. Gangradey

Development of Cobalt Ferrite for High Frequency Microwave Circulators
Ashwani Tyagi P. K Sharma, S.K.S Parashar, Kajal Parashar

Modification in Potential Well of an Inertial Electrostatic Confinement Device
N. Buzarbaruah, D. Borgohain and S.R. Mohanty

Ethernet Based Parameter Setting and Control for Soft X-Ray Electronics
Praveena Kumari, Chandresh Hanasalia and Rachana Rajpal

Application of Function Parametrization for Radial Plasma Position Calibration in Aditya-U
Sameer Kumar and Raju Daniel

Software Development Environment for Control and Data Acquisition Systems
Hitesh Kumar Gulati, Amit Srivastava, Arnab Dasgupta, S. Sunil and Ziauddin Khan

Development, Implementation and Remote Operation of Twin Source Vacuum System through TS-DACS
Ratnakar Kumar Yadav, Tyagi, Himanshu, Bhagora, Jignesh, Mistri, Hiren, Patel, Kartik, Bandyopadhyay, Mainak, Pandey, Ravi, Parmar, Deepak, Chakraborty, Arun, and Shishangiya, Hardik

Design of a 3.7 GHZ Oscillator for the Solid State Drive of the LHCD System
Sandeep Sainkar, Harish V. Dixit, Alice N. Cheeran, and P. K. Sharma

Design of Test Jig for Centralized Interlock & Protection Module of ITER-India Gyrotron Test Facility
Vipal Rathod, Praveenlal Edappala, Rachana Rajpal and S.L Rao

Data Acquisition System for Cooling Water System of ITER-India Gyrotron Test Facility
Deepak Mandge, Amit Yadav, Ronak Shah, Vipal Rathod, Rajvi Parmar, Sharan Dilip, Anjali Sharma and S.L Rao

In-Situ Monitoring of Dynamic Work Function in Conditions Relevant to Negative Hydrogen Ion Sources
Pranjal Singh, M. Bandyopadhyay, K. Pandya, H. Tyagi, R.K. Yadav, A. Gahlaut, M. Vuppugalla, H. Mistri, K. Patel, M.Bhuyan, S. Shah, A. Chakraborty

Development of Pickling and Passivation Process for XM-19(UNS S20910) Fasteners for IWS Block Assembly
Sunil Dani, Haresh A. Pathak

Heat Transfer Analysis of ZnO-Water Nanofluid for Nuclear Application
Bikash Pattanayak, Abhishek Mund, Jayakumar JS, P.Chaudhuri, Kajal Parashar, SKS
Parashar

Overview of High Pressure, High Temperature Helium Cooling System−An Attractive Coolant for Fusion Blankets
B. K. Yadav, A. Gandhi, A. K. Verma, T.S. Rao, A. Saraswat, S. Y. Verma, E. R. Kumar

Development and Simulation of Visual Servo Controller for Remote Handling Systems
Pramit Dutta, Amit Kumar Srivastava, Naveen Rastogi, K. K. Gotewal

Identification and Simulation of Spectral Molecular Bands of Nitrogen Present in RF Plasmas
Nandini Yadava, Sachin Singh Chouhan, Uttam Sharma, Jayashree Sharma, A. Sanyasi, M. B. Chowdhuri, J. Ghosh

Algorithm Development for Tomographic Study of Helicon Plasma
Dipshikha Borah, A.K. Chattopadhyay, M. Bandyopadhyay

Estimation of Emissivity of FE14+ and FE15+ VUV Spectral Lines Relevant To Aditya-U Tokamak Plasma
Sharvil Patel, Malay Bikas Chowdhuri, Anand Kumar Srivastava, Ranjana Manchanda and Joydeep Ghosh

Design of an X Mode Reflectometry System to Measure Edge Plasma Density during Lower Hybrid Wave Coupling in Aditya -U Tokamak
Jagabandhu Kumar, P. K. Sharma, K. Mahant, A. V Patel, Yogesh M. Jain, K.K.Ambulkar, C.G.Virani

Upgradation of Tangential Far-Infrared Interferometer for Polarimetry Measurement in SST-1
Asha Adhiya and Rajwinder Kaur

Power Division and Mixing in Multichannel Far-Infrared Interferometer for SST-1
Asha Adhiya and Rajwinder Kaur

Re-Vamping of PLC Control System for NBI Cryogenics Sub-Systems Signals
Karishma Qureshi, Paresh J. Patel, L. K. Bansal, Dipal Thakkar, C. B. Sumod, L. N. Gupta, Vijay Vadher and U. K. Baruah

A Non-Invasive Method of Estimating Collision Frequency in 13.56 MHZ Capacitive Coupled Argon Discharge
S. Binwal, J. K. Joshi, S. K. Karkari, P. K. Kaw and L. Nair

Electric Probe Analysis of Low Temperature Helium Plasma
Y. Patila, S. Binwala,b, M. Bhuvaa, J. Joshia, A. Pandeya, S. Dasa, S. K. Karkaria

RF Power Measurement by Phase Calibration Technique for a Magnetized CCP Discharge
Jay Joshi, S. Binwal, S.K. Karkari and Sunil Kumar

Characterization of the Prototype Michelson Interferometer for the ITER ECE Diagnostic System
Hitesh Kumar B. Pandya, Suman Danani, Ravinder Kumar, Pratik Patel, Vinay Kumar

A Novel Rogowski Coil for the Detection of Pulsed Currents Associated with High Frequency Electromagnetic Waves in Plasma
Garima Joshi, G. Ravi, Krishnan Namboodiri and Monali Borthakur

Estimation of Plasma Column Position in Aditya-U Tokamak Using Mirnovcoils
Suman Aich, Rohit Kumar, Sameer Jha, Tanmay M Macwan, Devilal Kumawat, Vaibhav Ranjan, Rakesh L Tanna, D. Raju, Joydeep Ghosh and ADITYA-U Team

Study of Impurity Radiated Power during Neon Gas Puff
M.V. Gopala Krishna, Sameer Kumar, KumudniTahiliani, D. Raju, R. Jha, P.K. Atrey, Umesh Nagora, S.B. Bhatt, Jadeja Kumarpalsinh. A. Praveena, J. Ghosh, M.B Chowdhuri, S. Benarjee, R.L Tanna, Sankar Joisa, J. Raval, R. Manchanda, Shwetang N Pandya, Kumar Ajay, Ajai Kumar

Time Resolved Density and Temperature Measurement in Pulsed DC Anodic Glow Plasma
M. Kiruthika, S.K. Karkari, G. Shanmugavelayutham

On Analysis of Charge Exchange Neutral Particle Analyzer Measurements in the Aditya Tokamak
Kumar Ajay, Santosh P. Pandya, Snehlata Aggarwal and the ADITYA team

Calibration of Sine and Cosine Rogowski Coils
Tanmay Macwan, Devilal Kumawat, Rohit Kumar, Suman Aich, RakeshTanna, Vaibhav Ranjan, Madanlal Kalal, Dinesh Varia, D. H. Sadharakiya, Praveenlal E V, Minsha Shah, Vismaysinh Raulji, Vipul Panchal, Sameer Kumar, Gopalakrishna M V, Joydeep Ghosh and ADITYA-U Team

Modelingof an Optical Cavity Using Finesse
S. Sunil, Amit. K. Srivastava and Ziauddin Khan

Development of Vacuum Equipment Interface Using Python for Monitoring and Control
S. Sunil, Amit. K. Srivastava, Hitesh Kumar Gulati and Ziauddin Khan

Fabrication and Characterization of Transmission Line for ITER ECE Diagnostics
Ravinder Kumar, Suman Danani, Pratik Vaghashiya, Hitesh B. Pandya, Vinay Kumar

Design and Development of ICRH Diagnostics on Aditya-U Tokamak
Gayatri Ashok, Atul varia, S.V. Kulkarni and ICRH group

ITER CXRS-Pedestal Diagnostic: Performance Assessment Using SOS Code
Gheesa Lal Vyas, Ramasubramanian Narayanan, Bharathi P, Maarten De Bock, Manfred Von Hellermann, Michael Walsh and Vinay Kumar

Investigation on Metamaterial Lens Antenna Design for Fusion Plasma Diagnostics
Bajra Panjar Mishra, Sudhakar Sahu, Surya K. Pathak, S.K.S. Parashar

Conceptual Design of a NIR Spectrometer for Aditya-U Tokamak
P. Pandit, R. Manchanda, R. Dey, J. Ghosh, M. B. Chowdhuri, S. Banerjee

X-Ray Crystal Spectrometer for Aditya-U Tokamak
K. Shah, M. B. Chowdhuri, J. Ghosh, G. Shukla, R. Manchanda, K. M. Jadeja and K. B. K. Mayya

Spectroscopy Diagnostic for Measurement of Plasma Rotation on Aditya-U Tokamak
G Shukla, M.B. Chowdhuri, J Ghosh, K Shah, R. Manchanda, and K. B. K. Mayya

Calibration of Michelson Interferometer Diagnostics and Measurements with Monochromatic Source
Abhishek Sinha, S K Pathak, Stefan Schmuck and John Fessey

1-Channel Wireless Acquisition System for Magnetic Diagnostics of Aditya-U Tokamak
Suvendu Kumar Dash, Daniel Raju, Sakuntala Mahapatra, Shaik Mohammad Ali

Magnetic Diagnosis of Plasma in a DC Non-Transferred ARC Plasma Torch
Vidhi Goyal and G. Ravi

Concepual Design of Langmuir Probes for the Diagnosis of Plasma Edge of Aditya-U
Lavkesh T. Lachhvani, Shwetang N. Pandya, Harshita Raj, Ramakrishnan B. Iyer, Akash Barot, Kaushal M. Patel, Kumarpalsinh Jadeja, Pramila Gautam, Nishita H. Joshi and Joydeep Ghosh

Boost-Buck Bias Floating High Voltage Power Supply for Double/ Triple Probe Diagnostics in LVPD
Prabhakar Srivastav, P. K. Srivastava, A. K. Sanyasi, Pushpendra Srivastava, R. Sugandhi and L. M. Awasthi

Influence of the Magnetic Field on Near Anode Plasma Properties of Reflex Plasma Source
R. Rane, K. Nigam, A. Vaid, S. Mukherjee

Feasibility Study to Upgrade the Space Resolve VUV Spectroscopy System to Measure Ion Temperature in Aditya-U Tokamak
R. Manchanda, Nisha, Malay Bikas Chowdhuri, and J. Ghosh

Parametric Variation of Radiated Power in Aditya Tokamak
Kumudni Tahiliani, M.B. Chowdhuri, R. Manchanda, M.V. Gopalakrishna, J. Raval, U.C. Nagora, Praveena, K.A. Jadeja, Y.S. Joisa, P.K.Atrey, D. Raju, R.L. Tanna, J. Ghosh, Ajai Kumar and ADITYA Team

Passive Charge Exchange Neutral Particle Analyzer for Adiya-U Tokamak
Snehlata Aggarwal and Kumar Ajay

Impurity Behavior in the High Density Aditya Tokamak Plasmas
R. Manchanda, M. B. Chowdhuri, Nandini Yadava, J. Ghosh, S. Banerjee, Jinto Thomas, K. Tahiliani, M. V. Gopalakrishna, U. C. Nagora, P. K. Atrey, J. Raval, Y. S. Joisa, K. A. Jadeja, R. L. Tanna, and Aditya team

ITER-India Progress on the Design of the ITER ECE Diagnostic System
Suman Danani, Ravinder Kumar, Sajal Thomas, Shivakant Jha, Mahesh Patel, Pratik Patel, Shrishail Padasalagi, Rachana Rajpal, Hitesh Kumar B. Pandya, Vinay Kumar, Gary Taylor, Victor S. Udintsev, and Michael J. Walsh

Arming the Non-Neutral Plasma System with Imaging Diagnostics – A Scheme
Manu Bajpai, Lavkesh Lachhvani, Swadesh Patnaik, Sambaran Pahari, Prabal K. Chattopadhyay

Designing and Fabrication of Laser Heated Emissive Probe for Aditya – U Tokamak
Kanik, Abha, Sharma, Arun, Ghosh, Joydeep, and Pandit, Payal

Recent Development and Primary Results of 2.45 GHZ Microwave Discharge ECR Ion Source Along With High Power Beam Diagnostics Facility
Mallick, Chinmoy and Kumar, Rajesh

Studies of Oxygen Impurity Behavior in Aditya Tokamak Plasma
Nandini Yadava, M.B. Chowdhuri, J. Ghosh,R. Manchanda, J. V. Raval, Y. S. Joisa, U. C. Nagora, P. K. Atrey, K. A. Jadeja, R. L. Tanna, and Aditya team

Chord Average Zeff Calculation for SST-1 and Aditya Tokamak Using Modified Anomaly Factor A
Jayesh Raval, Y Shankar Joisa, S. Purohit, Ranjana Manchanda, Kumudni Asudani, M.V. Gopalakrishna

Magnetic Field Generation in Finite Beam Plasma System
Atul Kumar, Chandrasekhar Shukla, Bhavesh Patel, Amita Das, and Predhiman Kaw

2-D Fluid Simulation of Relativistic Electron Beam Driven Wakefield in a Cold Plasma
Ratan Kumar Bera, Amita Das, and Sudip Sengupta

The Stability of 1-D Soliton in Transverse Direction
Deepa Verma, Ratan Kumar Bera, Amita Das, and Predhiman Kaw

Role of Temperature in the Evolution of 1-D Localized Laser Plasma
Devshree Mandal, Ayushi Vashistha, Deepa Verma and Amita Das

Localised 1-D Laser Pulse Solutions in Strongly Coupled Plasma
Ayushi Vashistha, Devshree Mandal, Deepa Verma, Amita Das

Effect of Laser Wavelength on Resonance Absorption of Ultrashort Laser Pulses in Atomic Clusters
Sagar Sekhar Mahalik and Mrityunjay Kundu

Impact of Laser Induced Plasma on the In-Situ Decoration of Graphene Oxide with Silver Nanoparticles in Liquid Media
Parvathy N, Anju K Nair, Jemy James,Sivakumaran Valluvadasan, Ravi A V Kumar,Sabu Thomas, Nandakumar Kalarikkal

Merging of Current Filaments in Weibel Separated Relativistic Electron Beam Propagation through Over Dense Plasmas
Chandrasekhar Shukla, Atul Kumar, Amita Das and Bhavesh Patel

Plume Dynamics in Magnetic Field
Narayan Behera, R. K. Singh and Ajai Kumar

Effect of Ablation Geometry on Laser Induced Plasma of Thin Film
Mr. Mondal, Alamgir, Dr. Singh, Rajesh and Prof. Kumar, Ajai

Influence of Plasma Nitriding on Wear and Corrosion Properties of Nitronic 50 Stainless Steel
S. Dixit, B. Ganguli, S. Sharma

Plasmonic Response of AG Nanoparticle Arrays and AG Nanodots
Mukul Bhatnagar, Mukesh Ranjan and Subroto Mukherjee

Development of RF Based Capacitively Coupled Plasma System for Deposition of Tungsten on Graphite for Aditya Upgrade Tokomak
Sachin S. Chauhan, Uttam Sharma, Jayshree Sharma, A. K. Sanyasi, J. Ghosh, Nandini Yadav, K. K. Choudhary, S. K. Ghosh

Inquisition of Charged Particle Interaction with SXR System in SST-1
Nikita Dhankhar, Jayesh Raval, Y. Shankar Joisa, R. Rane, N. Chauhan, Mitul Abhangi

Plasma Stream Velocity Measurement in Pulsed Plasma

Accelerator
N. Talukdar, S. Borthakur, N. K. Neog and T. K. Borthakur

Fiber Optic Based Field Simulator for HVPS
Kush Mehta, Hitesh Dhola, Niranjanpuri Goswami , Amit Patel, Rasesh Dave, Dishang Upadhaya, Bhavin Raval, Sandip Gajjar, Aruna Thakar, Vikrant Gupta, N P Singh, Ujjwal Baruah

Short Circuit Switch for Joule Energy Test of HVPS
Niranjanpuri Goswami, Amit Patel, Kush Mehta, Dishang Upadhyay, Hitesh Dhola, Bhavin Raval, Rasesh Dave, Aruna Thakar, Sandip Gajjar, Vikrant Gupta, N. P. Sigh, Ujjwal Baruah

Studies on the Behavior of Magnetic Core Snubbers for Energy and Surge Suppression
D. Upadhyay, A. Patel, N. Goswami, K. Mehta, B. Raval, H. Dhola, S. Gajjar, R. Dave, A. Thakar, N. P. Singh, U. Baruah

Sweep Frequency Response Analysis (SFRA) Test of Power Transformer
Prakash Parmar and Electrical Power Distribution Section

Electrostatic Double Layer in a Collisionless, Unmagnetized, Multi- Component Plasma
Dharitree Dutta and K. S. Goswami

Magnetic Shear Induced Stabilization of Convective Fluid Instabilities
J.K. Atul, Rameswar Singh, S. Sarkar, O. V. Kravchenko, S. K. Singh, P. K. Chattopadhyaya, and P. K. Kaw

Breaking of Relativistically Intense Electron Plasma Waves in an Unmagnetized Homogeneous Plasma
Arghya Mukherjee, Sudip Sengupta

Turbulence at Small Reynolds Number: an Atomistic Study of Complex Plasma
Harish Charan and Rajaraman Ganesh

Generation and DE-confinement of Runaway Electrons in the ADITYA tokamak
Sundaresan Sridhar, Harshita Raj, Joydeep Ghosh, R.L. Tanna, J. Raval, S. Joisa, U. Nagora, P.K. Atrey and ADITYA Team

International Symposium on light weighting for Defence, Aerospace and Transportation NMD-ATM-2017, Goa, 11-14 November 2017

Activated sintering of self-passivating W alloy and its characterization
A.R. Pati, M Debata, S. Bajpai, P.A. Rayjada, S.K. Singh
2017 IEEE Asia Pacific Microwave Conference (APMC-2017), Kuala Lumpur, Malaysia, 13-16 November 2017

Multiphysics design of a high power CW mode convertor at 3.7 GHz for tokamak
Yogesh M. Jain, P. K. Sharma, Harish V. Dixit, Aviraj R. Jadhav and Jagabandhu Kumar

17th International Conference on Thin Films (ICTF-2017), CSIR-National Physical Laboratory, New Delhi, 13-17 November 2017

Evolution of Cubic and Monoclinic Phases in Reactive Sputter Coating of Er_2O_3
P. A. Rayjada, Amit Sircar, N. P. Vaghela, P. M. Raole

Preparation, Characterisation and Oxidation Behavior of Silicon Oxide as Inter-face Layer Coating on Carbon Fiber for Carbon Fiber Reinforced Silicon Carbide Composites
C. Jariwala, Kundan Kumar and R. Pillai

2017 Progress in Electromagnetics Research Symposium (PIERS 2017), Singapore, 19-22 November 2017

Design and multiphysics analysis of a high power continuous wave rf window for LHCD system of SST-1 tokamak
Yogesh M. Jain, P. K. Sharma, Harish V. Dixit, Aviraj R. Jadhav and P. R. Parmar

6th Nirma University International Conference on Engineering (NUiCONE-2017), Institute of Technology, Nirma University, Ahmedabad, 23-25 November 2017

Detection of Pneumonia clouds in Chest X-ray using Image processing approach
Abhishek Sharma, D. Raju, Sutapa Ranjan

26th International Toki Conference (ITC-26) and the 11th Asia Plasma and Fusion Association Conference (APFA), Toki-city, Japan, 5-8 December 2017

Development and Validation of ACTYS-1-GO: A Multipoint Nuclear Activation Code
Priti Kanth, T.S. Chaitanya, R. Srinivasan, P.V. Subhash

ASME (American Society of Mechanical Engineers), 2017

Gas Turbine India Conference, Bangalore, India, 7-8 December 2017

Characterization of Ti-6Al-4V Alloy Modified by Plasma Nitriding Process
VN Bhavsar, JS Jha, G Jhala, A Joseph, S Mishra, A Tewari

DAE-BRNS Symposium on Plasma and Allied Technologies for Better Tomorrow (PTBT-2017), Institute for Plasma Research, Gandhinagar, 7-8 December 2017

A Vision for FCIPT: Emerging Opportunities in Plasma Processing
P. I. John

Nano Patterning by Plasma to Detect Early Formation of Abnormalities
M. Ranjan

Cold Plasma Application on Skin Disease Treatment
Abhijit Majumdar, Nayan Ghosh, Sadhan Chandra Das, Subroto Mukherjee, Sumit Sen

Importance of Plasma Processing in Development of Novel Bio-Materials
Aniruddha Samanta, Manjima Bhattacharya, Himel Chakraborty, Susmit Datta, Jiten Ghosh, Sandip Bysakh, Monjoy Sreemany, Ramakrishna Rane, Alphonsa Joseph, Subroto Mukherjee, Biswanath Kundu, Mitun Das, and Anoop K. Mukhopadhyay

Plasma for Agriculture: Activities at FCIPT
R. Rane

Plasma Sterilization
Suryakant Gupta, S.K. Nema, Keena Kalaria, Akshay Vaid, Naresh Vaghela

International Conference on Advance Materials and Process (ADMAT-2017), Kovalm, Thiruvananthapuram, Kerala, 13-15 December 2017

Plasma Process Based PVD coatings, surface modifications and material sputtering yield measurements facilities
M. Ranjan, A. Vaid

Conference and exhibition on Non-Destructive Evaluation-NDE 2017, Chennai Trade Centre, Chennai, 14-16 December 2017

Ultrasonic Testing of Tungsten (W) Macro-brush Type Divertor Targets
Kedar Bhope, Mayur Mehta, K. P. Singh, S.S. Khirwadkar

Infra-Red thermal imaging of Plasma Facing Components during High Heat Flux Testing at HHFTF
Mayur Mehta, Kedar Bhope, Samir Khirwadkar, Sunil Belsare, Rajamannar Swamy, K P Singh, Shailesh Kanpara, Sudhir Tripathi, Prakash Mokaria, Tushar Patel, Nikunj Patel, Kalpesh Galodiya

25th National Conference on Internal Combustion Engine and Combustion, National Institute of Technology Karnataka, Surathkal, 15-17 December 2017

Numerical Study of Deflagration to Detonation Transitions in Pulse Detonation Engines
Sunil Bassi, Shashank Chaturvedi

8th National Power Electronics Conference - NPEC 2017, College of Engineering Pune, Shivajinagar, Pune, 18-20 December 2017

Power Supplies for Plasma Heating: PSM and Involved Challenges
Amit Patel, Suryakant Gupta, N.P. Singh, U.K. Baruah

62nd DAE-BRNS Symposium on Nuclear Physics (SNP-2017), Thapar University, Patiala, 20-24 December 2017

Visualization Technique for Nuclear Materials using ACTYS
Priti Kanth, T. S. Chaitanya, P. V. Subhash

DAE Solid State Physics Symposium (DAE SSPS-2017), BARC Mumbai, 26-30 December 2017

SERS/SEIRA Based Detection of Glucose Deposited on Glass/Silicon Substrate with Silver Nanoparticles
Sooraj K P, Mukesh Ranjan, Rekha Rao, Subroto Mukherjee

Sticking Behaviour and Plasmonic response of Silver Nanoparticle arrays
Mukesh Ranjan, Sooraj K.P.

Surfactant-assisted synthesis and characterization of Al_2O_3 nanoparticles
Janki Shah, Mukesh Ranjan, Sanjeev K. Gupta, Yogesh Sonvane

International Conference on Recent Trends in Eng Materials and Renewable Energy, Univ College of Engineering, Villupuram, 4-5 January 2018

Proton conductivity studies on nanocrystalline $LaNbO_4$ prepared by microwave hydrothermal
S. Balasundari, S. Jayasubramaniyan, P.M. Raole, P.A. Rayjada, N Satyanarayana, P. Muralidharan

International Conference on Plasma Assisted Technologies (ICPAT-11), New York University, Abu Dhabi, 22-24 January 2018

Design and development of half bridge resonant converter based power supply for generating underwater non-thermal plasma in air
Vishal Jain, Adam Sanghariyat, Sudhir Kumar Nema, Vivek Agarwal

Fusion Power Coordination Committee (FPCC) Meeting, ITER-IO Head Quarters, Cadarache, France, 24-25 January 2018

Fusion Research Activities in India
Samir Khirwadkar

International Conference on Electrical, Electronics, Computers, Communication, Mechanical and Computing (EECCMC), Priyadarshini Engineering College, Tamil Nadu, 28-29th January 2018

Modeling of Multi-Secondary Transformer utilizing circuit simulation software
L.N.Gupta, N.P.Singh, S.V.Kulkarni, P.J.Patel, A.Patel, Dipal Thakkar, Sumod C.B and U.K.Baruah

Basic EPICS Workshop, organized by LIGO division of IPR, DAC Division, ITER India, Institute for Plasma Research, Gandhinagar, 30-31 January 2018

An Overview of LIGO Control Systems
Amit Srivastava

Introduction to Distributed control system and EPICS
Hitesh Kumar Gulati

EPICS based case study for LIGO
Hitesh Kumar Gulati

Various commonly used EPICS Clients
Kirti Mahajan

EPICS IOC, Drivers etc.
Vishnu Patel
EPICS and Control System Studio
Vishnu Patel

Integrating EPICS supervision into LabVIEW based control system
Hitesh Dhola

Installation and configuration of EPICS
Arnab Dasgupta

International Conference on Recent Advances in Metallurgy for Sustainable Development (IC-RAMSD 2018), The Maharaja Sayajirao University of Baroda, Vadodara, Gujarat, 1-3 February 2018

Preliminary Investigation into Active Screen Plasma Nitriding of Austenitic Stainless Steel 347H
S. Patel, B. Ganguli, S. Chaudhury

Asia Steel International Conference-2018, Hotel Mayfair, Bhubaneshwar, Odisha, India, 6-9 February 2018

Plasma Nitrocarburizing Process to Improve Wear Resistance along with Corrosion Resistance in Stainless Steels
Alphonsa Joseph

Frontiers of Statistical Physics, Indian Statistical Institute (ISI), and Presidency University, Kolkata, 26-28 February 2018

Statistical properties of Rayleigh-Benard Convection of Yukawa liquids using Molecular Dynamics
Pawandeep Kaur, Harish Charan, Rajaraman Ganesh

1st National Conference on Advances in Electronics and Communication Devices (AECD-2018), Suresh Gyan Vihar University, Jaipur, India, 9-10 March 2018

Simulation of TM01 to TE11 Mode Converter by using Monostair Technique
Bhushan Patil, Arpit Barnwal, Jitendra Kumar, Raj Singh, Anitha V.P.

National Conference on Recent Advances in Science

and Technology (NCRAST-2018), Assam Science and Technology University, Guwahati, Assam, 15-17 March 2018

Study of novel tungsten micro and nanostructures upon interaction of ITER relevant plasmas with tungsten targets
Trinayan Sarmah, and Mayur Kakati

7th International Conference on Material Processing and Characterization, Gokaraju Rangaraju Institute of Engineering and Technology (GRIET), Hyderabad, 16-18 March 2018

Quantitative measurement of outgassing and degassing rate for various materials used in cryogenic pumps
Samiran Shanti Mukherjee, Paresh Panchal, Jyoti Agarwal, Pratik Nayak, Jyoti Shankar Mishra, Ranjana Gangradey

The International Conference towards Extensible and Adaptable Methods in Computing, TEAMC 2018, Netaji Subhas Institute of Technology, New Delhi, 26-28 March, 2018

A Proposed Method for Disruption Classification in Tokamak using Convolutional Neural Network
Priyanka Sharma, Swati Jain, Vaibhav Jain, Sutapa Ranjan, R. Manchanda, D. Raju, J. Ghosh, R.L. Tanna

PATENTS 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 (Approved by DAE for filling Indian Patent).

A novel method for increasing the service life as well as retention of sharpness of cutting tools
ALPHONSA JOSEPH, GHANSHYAM JHALA, AKSHAY VAID, SUBRATO MUKHERJEE (Approved by DAE for filling Indian Patent).

AWARDS and ACHIEVEMENTS

Observation of the Korteweg-de Vries soliton in molecular dynamics simulations of a dusty plasma medium.
Sandeep Kumar, Amita Das, and Sanat Kumar Tiwari received **Best Student Poster Award** at 8th International Conference on the Physics of Dusty Plasmas, Prague, Czech Republic, 20-25 May 2017

Mr. S. Shravan Kumar won the consolation prize for Cartoon Competition and Dr. Sandhya Dave won a consolation prize for Hindi Safety Slogan Competition. The award was presented at 34th DAE Safety & Occupational Health Professionals Meet-2017 which was jointly held by Atomic Energy Regulatory Board (AERB) and Kudankulam Nuclear Power Project (KKNPP), NPCIL at Kudankulam, Tamilnadu from 28 to 30 June, 2017

Mr. Santosh P. Pandya was awarded a **Springer Prize** for his presentation "A synthetic diagnostic to simulate bremsstrahlung emission from the confined runaway electrons in tokamaks and application for runaway electron diagnostic design" co-authored by Laura Core, Alexander Shevelev, Joël Rosato, Robin Barnsley, Roger Reichle, Luciano Bertalot, Michael Lehnen and Michael Walsh at the Summer School of Plasma Diagnostics (PhDiaFusion 2017) was held at Podlesice, Poland from 11-15 September 2017

Ms. Priti Kanth, PhD Scholar, won the **second prize** for the poster entitled "Development of Multipoint Nuclear Activation Code for Fusion Devices" presented at the International Conference on High Energy Radiation and Applications (ICHERA-2017), which was held at the Maharaja Sayajirao University of Baroda, Vadodara, Gujarat from 10-13 October 2017

Awards won at 32nd National Symposium on Plasma Science & Technology (PLASMA-2017), Institute for Plasma Research, Gandhinagar, 07-10 November 2017

Design of a High CW Power Circulator for LHCD System of SST-1 Tokamak
P. K. Sharma, Harish V. Dixit, Yogesh M. Jain, Aviraj R. Jadhav, Alice N. Cheeran, Vikas N. Gupta ***(1st PSSI-Sholapurwala Award)***

Water Cooling System for SST Neutral Beam Injection System: From Concept to Engineering Design
M. R. Jana, Sudhir. K. Sharma, M. M. Vasani, S. Rambabu, B. Sridhar, K. A. Qureshi, S. K. Sharma, V. Prahlad, P. J. Patel, U. K. Baruah and NBI Team ***(1st PSSI-Sholapurwala Award for Fusion Research)***

Manufacturing Aspects for Long Length Superconducting Cable in Conduit Conductors
Mahesh Ghate, Piyush Raj, Arun Panchal, Dhaval Bhavsar, Upendra Prasad, R.Srinivasan ***(2nd PSSI-Sholapurwala Award)***

Role of Helium Leak Detection in SST-1 Cryogenics System
H.D. Nimavat, N. Bairagi, R. Sharma, G. Purwar, A. Garg and V. L. Tanna ***(2nd PSSI-Sholapurwala Award)***

Effects of Kinetic Ions on the Driven Phase Space Structures in a 1-D Vlasov Plasma
Pallavi Trivedi, Rajaraman Ganesh ***(Best Oral PSSI Presentation Award)***

Overview of Actys Project on Development of Indigenous State-of-the-Art Code Suites for Nuclear Activation Analysis
P.V. Subhash, Sai Chaitanya Tadepalli, Priti Kanth, R. Srinivasan and Shishir P. Deshpande ***(Oral PSSI Presentation Award - Plasma & vacuum technologies)***

Interaction of Atmospheric Pressure Plasma JET with Lung Cancer Cell Line (A549)
Akshay Vaid, Anu Ghosh, Chirayu Patil, Nishad.S, Adam Sanghariyat, Ramkrishna Rane, Subroto Mukherjee ***(PSSI Poster Award - ATOS Marketing)***

Experimental Investigation of Crystal Structures and Phase Transition in DPEx
Hari Prasad M. G., Garima Arora, P. Bandyopadhyay and Abhijit ***(PSSI Poster Award I-Design)***

Zero-Dimensional Modeling of ECRH-Assisted Plasma Start-Up in SST-1
Amit K. Singh, I. Bandyopadhyay, Santanu Banerjee, R. Srinivasan ***(PSSI Poster Award I-Design)***

Characterization of Atmospheric Pressure Plasma JET Using Optical Emission Spectroscopy
P. Bharathi, Akshay Vaid, Chirayu Patil, Adam Sanghariyat, Ramkrishna Rane and S. Mukherjee ***(PSSI Poster Award - Rittal Systems)***

Inward Turbulent Particle Flux in ETG Dominated Plasma of LVPD
Prabhakar Srivastav, Rameswar Singh, L. M. Awasthi, A. K. Sanyasi, P. K. Srivastava, R. Sugandhi, R. Singh and P.K. Kaw ***(PSSI Poster Award)***

Optical Emission Spectroscopy and Electrical Modelling of Atmospheric Pressure Micro Plasma Jets
Kalyani Barman, Pawan Pal, Sudeep Bhattacharjee, Sudhir K. Nema, and Ramakrishna Rane ***(PSSI Poster Award)***

Study of Particle Transport Due to Electromagnetic Fluctuations in ETG Suitable Plasma of LVPD
Prabhakar Srivastav, Rameswar Singh, L. M. Awasthi, A. K. Sanyasi, P. K. Srivastava, R. Sugandhi, R. Singh and P.K. Kaw ***(Best poster award in Basic plasma physics category)***

Mr. Ravi Pandey, won the **third prize** for the poster entitled "Vacuum Brazing Route for Manufacturing of Large Size Ion Source" presented at the Indian Particle Accelerator Conference (InPAC-2018), which was held at the Raja Ramanna Centre of Advance Technology (RRCAT), Indore from 09-12 January 2018.

E.4. INVITED TALKS DELIVERED BY IPR STAFF

ALPHONSA JOSEPH

Gave an Invited talk on "Radical Nitriding process for Improving the life of Cutting Tools of Agricultural Implements" at DST, Nagaland, 29-30 May 2017

Gave an Invited Talk on "Recent Trends in surface modification by Plasma processing" at
NMD-ATM-2017 Mini symposium on surface Engineering, BITS Pilani, Goa, 12-15 November 2017

Gave an Invited talk on "Plasma based Diffusion Coatings" at DAE-BRNS Symposium on Plasma and Allied Technologies for Better Tomorrow, IPR, Gandhinagar, 7-8 December 2017

M. KAKATI, NGANGOM AOMOA and TRINAYAN SARMAH

Gave an Invited talk on "CIMPLE-PSI, a magnetized tokamak divertor simulator device for ITER tokamak relevant plasma surface interaction studies" at International conference on Sophisticated Instrument in Modern Research, Indian Institute of Technology, Guwahati, Assam, India, on 30 June 2017

S.K. NEMA

Gave an Invited talk at Environment Research Meet 2017, organized by Gujarat Management Research Institute and Gujarat Pollution Control Board, Gandhi-mandir, Gandhinagar, on 5 June 2017

Gave an Invited talk on "Plasma Pyrolysis: An Eco-friendly Technology for the Disposal of Biomedical Waste" at DAE-

BRNS Symposium on Plasma and Allied Technologies for Better Tomorrow, IPR, Gandhinagar, 7-8 December 2017

Gave an Invited talk on "Thermal Plasma for Waste Disposal – Present Status & Challenges" at SERB Interaction Meeting on Recent Advances in Thermal Plasma Processing held at Coimbatore, 10-12 January 2018

NIRAV I. JAMNAPRA

Gave an Invited talk on "Coatings for Gas Turbine Applications" at Damage Mechanisms & Life Management of Gas Turbine Components, EVOLVE, Vadodara, on 1 July 2017

Gave an Invited talk on "Introduction to Microstructure & Metallography" at Training Programme on Metallography & Microsctructure, L D College of Engineering, Ahmedabad, on 16 July 2017

Gave an Invited talk on "Advances in Plasma Materials Processing" at Recent advances in Materials Joining & Processing, Pandit Deendayal Petroleum University (PDPU), Gandhinagar, on 23 August 2017

Gave an Invited talk on "Plasma Surface Engineering: Exploring novel applications" at New Vistas in Surface Engineering & Corrosion Protection Technologies, Hotel Rodas, Powai, Mumbai, on 15 September 2017

S. K. KARKARI

Gave an Invited talk on "Diagnosing electronegative plasma using electric probes" at 33rd International Conference on Phenomenon in Ionized Gases, Estoril, Lisbon, 9-14 July 2017

Gave 4 lectures on "Fundamentals of Plasma Discharges" at SERB school on Plasma Devices: Science and technology, CEERI PILANI, 4-6 December 2017

S. SUNIL

Gave an Invited talk on "Controlling three-modes interaction and parametric instability in a Laser Interferometer Gravitational wave Detector" at IUCAA, Pune, on 26 July 2017

Gave an Invited talk on "Hartmann sensor for wavefront sensing and correction" at International Topical Meeting on Applied and Adaptive Optics (INTOPMAA-2017), Indian Institute of Space Science & Technology (IIST), Thiruvananthapuram, Kerala, 11-13 August 2017

YOGESH G. YEOLE

Gave an Invited talk on "A lecture on Electronic devices" at Workshop for PGT-Physics on Enhancing Pedagogical Skills to impact Classroom Transactions, Kendriya Vidyalaya No. 1, Ahmedabad, on 21 August 2017

AMITA DAS

Gave an Invited talk on "Enigma of magnetic fields" at Physics Department, Mumbai University, on 6 September 2017

SUDIP SENGUPTA

Gave an Invited talk on "On Wave Breaking of relativistically intense longitudinal waves in plasma" at 1st Asia-Pacific Conference on Plasma Physics (AAPPS - DPP 2017), Chengdu, China, on 18 September 2017

Gave an Invited talk on "Flux corrected transport scheme for solving generalized continuity equations" at National Seminar on Advanced Numerical Methods (NSANM - 2017), PDPU, Gandhinagar, on 1 December 2017

Gave an Invited talk on "Particle-in-cell Simulation of Buneman Instability" at Conference on Plasma Simulations, Indian Institute of Science, Bangalore, 18-19 January 2018

SEJAL SHAH

Gave an Invited talk on "Neutral Beam Injectors of ITER & Impact of High Energy Neutrons on Injector Materials" at International Conference on High Energy Radiation and Applications, M.S. University, Vadodara, on 11 October 2017

MUKESH RANJAN

Gave an Invited talk on "Self-Assembly of Metal Nanoparticles on Ripple Patterned Surface and Induced Optical/Magnetic Anisotropy" at 4th International Conference on Nano Structuring by Ion Beam (ICNIB 2017), Devi Ahilya University, Indore, 11-13 October 2017

Gave an Invited talk on "Nano patterning by plasma to detect

early formation of abnormalities" at DAE-BRNS Symposium on Plasma and Allied Technologies for Better Tomorrow, IPR, Gandhinagar, 7-8 December 2017

Gave an Invited talk on "Ion Beam Produced Nanoparticles Arrays for Plasmonic Solar Cells" at International Conference on Nanomaterials for Energy Conversion and Storage Applications (NECSA-2018), PDPU, Gandhinagar, 29-31 January 2018

Gave an Invited talk on "Detection of early formation of abnormalities by nanopatterned surfaces" at 5th International Conference on Nanomaterial and Nanocomposites (ICNN-2018), Vellore Institute of Technology, Chennai, 08-10 February 2018

RAJIV SHARMA

Gave an Invited talk on "Dissimilar Materials Joining and Helium leak tightness at high pressure and cryogenic temperature" at ISRO Propulsion Complex (IPRC), Mahendragiri, Tamilnadu, at the meeting organized for the Collaborative Research/Development work with Indian Space Research Organization (ISRO) on 13 October 2017

SURYAKANT B. GUPTA

Gave an Invited talk on "Harnessing plasma technology for societal benefits and wealth creation" at Nirma University International Conference on Engineering (NUiCONE-2017), Institute of Technology, Nirma University, 23-25 November 2017

Gave an Invited talk on "Plasma Sterilization", at DAE-BRNS Symposium on Plasma and Allied Technologies for Better Tomorrow, IPR, Gandhinagar, 7-8 December 2017

Gave an Invited talk on "Role of emerging plasma technology for Environment management" at DAAD International Seminar on Water, Renewable Energies and Environmental Management in Asia, Centre for Incubation, Innovation and Entrepreneurship (CIIE), Indian Institute of Management, Ahmedabad, 12-18 March 2018

R. S. RANE

Gave an Invited talk on "Plasma for Agriculture-activities at FCIPT" at DAE-BRNS Symposium on Plasma and Allied Technologies for Better Tomorrow, IPR, Gandhinagar, 7-8 December 2017

S. S. KAUSIK, B. K. SAIKIA, D. KALITA, B. KAKATI, A. GAHLAUT, and M. BANDYOPADHYAY

Gave an Invited talk on "Cesiated Tungsten Dust in Plasma Volume: A New Source of Negative Ion" at 5th International Meeting on Frontiers of Physics, Kuala Lumpur, Malaysia, on 3-7 December 2017

P. K. SHARMA, D. RAJU, J. GHOSH, SST1 and ADITYA Team

Gave an Invited talk on "Recent Activities in ADITYA-UPGRADE and SST1 Tokamaks" at 26th International Toki Conference and 11th Asia Plasmas and Fusion Conference, Ceratopia, Toki, Gifu, Japan, 5-8 December 2017

SARVESHWAR SHARMA

Gave an Invited talk on "Plasma: Key Tools for Energy Needs and Industrial Applications" at Dept. of Physics, School of Physical Sciences, Central University of Rajasthan, Ajmer, on 12 December 2017

Gave an Invited talk on "Capacitively coupled discharges: An overview" at Conference on Plasma Simulations, CeNSE Auditorium, Indian Institute of Science, Bengaluru, 18-19 January 2018

VISHAL JAIN

Delivered a lecture on "Power Supplies and Control System in Plasma generation", at SERB School, CEERI, Pilani, 16-18 December 2017

SANTANU BANERJEE, AMIT K. SINGH, DEEPTI SHARMA, R. SRINIVASAN and D. RAJU

Gave an Invited talk on "Modeling of eddy current distribution and equilibrium reconstruction in tokamaks" at Conference on Plasma Simulations, Indian Institute of Science, Bangalore, 18-19 January 2018

VIKRANT SAXENA, ZOLTAN JUREK, BEATA ZIAJA, and ROBIN SANTRA

Gave an Invited talk on "Modeling x-ray irradiation of rare gas clusters" at Conference on Plasma Simulations, Indian Institute of Science, Bangalore, 18-19 January 2018

MANOJ KUMAR GUPTA

Gave an Invited talk on "Development of Conductive adhesive for Thermal sensor Interconnection" at International conference on Advancements in Polymeric Materials, Central Institute of Plastics Engineering & Technology (CIPET), Bhuvneshwar, 3 February 2018

PARITOSH CHAUDHURI

Gave an Invited talk on "Progress and Status on Tritium Breeder Materials for Fusion Reactor" at National Workshop on Recent Trends in Material Processing and Characterization (RTMPC 2018), Institute of Infrastructure, Technology, Research and Management (IITRAM), Ahmedabad, 12-16 March 2018

MAYUR KAKATI and TRINAYAN SARMAH

Gave an Invited talk on "CIMPLE-PSI, an advanced experimental system established at CPP-IPR for ITER relevant plasma surface interaction studies" at National Conference on Recent Advances in Science and Technology (NCRAST-2018) Venue: Assam Science and Technology University, Guwahati, Assam, 15-17 March 2018

C. BALASUBRAMANIAN

Delivered lectures as a Resource person for the UGC-Refresher course of Saurashtra University, Rajkot

Invited talks given at 32nd National Symposium on Plasma Science & Technology (PLASMA-2017), Institute for Plasma Research, Gandhinagar, 07-10 November 2017

SHANTANU KARKARI gave an Invited talk on "Experiments to Investigate Plasma Sheaths"

S.R. MOHANTY gave an Invited talk on "Compact Fusion Neutron Sources Based on Inertial Electrostatic Confinement Concept"

JOYDEEP GHOSH gave an Invited talk on "Recent Results from Aditya Upgrade"

E.5. TALKS DELIVERED BY DISTINGUISHED VISITORS AT IPR

Dr. Mike Cassidy, CEO, Apollo Fusion, Inc., gave a talk on "Towards a Sustainable Energy Future: A New Hybrid Fusion-Fission Reactor"

Prof. Praveen Chaddah, Ex-Director of the UGC-DAE Consortium, gave a talk on "New concepts in 1st order transitions"

Prof. Praveen Chaddah, Ex-Director of the UGC-DAE Consortium, gave a talk on "Studies on magnetic transitions"

Dr. Vipin K. Yadav, Vikram Sarabhai Space Centre (VSSC), ISRO, Thiruvananthapuram, gave a talk on "Plasma Instruments and Wave Detection in Space"

Dr. Girjesh Gupta, Inter-University Centre for Astronomy and Astrophysics, Pune, gave a talk on "Role of MHD waves and small-scale transients in the heating of solar corona"

Dr. Abhishek Atreya, Physical Research Laboratory, Ahmedabad, gave a talk on "The Cosmic Fluid: Chiral Instability and all that"

Dr. Sunil Rawat, Bhabha Atomic Research Centre, Mumbai, gave a talk on "Deformation and fracture of metallic single crystals"

Dr. Chandra Shekhar Pant, IIT Mumbai, gave a talk on "Large Eddy Simulation (LES) of Microphysics in Atmospheric Clouds"

Dr. Harekrishna Yadav, IIT, Mumbai, gave a talk on "Heat transfer from an impinging jet in presence of inlet oscillations"

Dr. S. M. Ahmed, Central Instruments Laboratory, University of Hyderabad, gave a talk on "Is there a Life on Mars?"

Dr. Pankaj Kumar Shaw, Saha Institute of Nuclear Physics, Kolkata, gave a talk on "Investigation on nonlinear dynamics of self-excited plasma oscillations obtained from a DC glow discharge plasma"

Dr. Sanat Kumar Tiwari, University of Iowa, gave a talk on "Reduction of Electron Heating in a Magnetized Ultracold Plasma"

Dr. Ashish Adak, Jadavpur University, Kolkata, gave a talk on "Nonlinear Coherent Structures in Pair Ion Plasmas"

Dr. Kamakshi Patel, Sardar Patel University, Gujarat, gave a talk on "Structural, optical, magnetic and biological studies of undoped and doped ZnS nanoparticles"

Dr. Rajeev Kumar, GB Pant University of Agriculture & Technology, Pantnagar, Uttarakhand, gave a talk on "Challenges of Agriculture and its possible solution by Plasma Technology"

Mr. Abhyuday Chatterjee, Laboratoire de Physique des Plasmas, PSL Research University, Palaiseau, France and Synchrotron SOLEIL, Gif Sur Yevette, France, gave a talk on "Metastable Molecules and atomic oxygen in O_2 Plasmas probed by High-Resolution Fourier Transform Absorption Spectroscopy & TALIF technique"

Dr. VikramSagar, Harbin Institute of Technology, China, gave a talk on "Dynamical Processes over Complex Networks"

Dr. Sachin Sharma, Gujarat Technological University, Ahmedabad, gave a talk on "Design and Development of Automatic Animal-Detection Algorithm using Image Processing and Machine Learning Technique"

Dr. Prince Alex, Pondicherry University, Puducherry, gave a talk on "Study of Multiple Anodic Double Layers in Glow Discharge Plasma"

Dr. Kaushik, Indian Institute of Technology Bombay, Mumbai, gave a talk on "Experimental investigation of the phenomena of laser produced plasma-induced shockwaves"

Prof. Swadesh M Mahajan, University of Texas at Austin, Texas, U.S.A., gave a talk on "Understanding "Residual" energy transport in the H-mode Pedestal Future of Nuclear fusion via Tokamaks"

Dr. Debjyoti Basu, Saha Institute of Nuclear Physics, Kolkata, gave a talk on "Experimental studies on Geodesic Acoustic Mode (GAM) and RMP effect in the STOR-M Tokamak"

Prof. Amit Agrawal, IIT-Bombay, Mumbai, gave a talk on "Search for Higher Order Continuum Transport Equations"

Mr. Moniruzzaman Shaikh, Tata Institute of Fundamental Research, Mumbai, gave a talk on "Watching relativistic electrons transit through glass"

Dr. Amol Deshpande, Sardar Patel Institute of Technology, Mumbai, gave talks on "High Voltage" and "NDT; Alphonso Mango; Image Processing"

Dr. Amit Kumar Rana, Indian Institute of Technology Indore, gave a talk on "Controlled Growth of Zinc Oxide Nanostructures for Multifunctional Applications"

Dr. Prabhakara Rao Y.P. and Dr. Vijaya Raghavan, Indian Institute of Science, Bengaluru, gave a talk on "National Nanofabrication Centre: Facilities and collaboration opportunities"

Dr. Tuong Hoang, Institute for Magnetic Fusion Research, France, gave a talk on "The Magnetic Fusion Research Program in France. Current status of the WEST Project"

Dr. Rahul Saini, Indian Institute of Technology Roorkee, gave a talk on "A novel approach for processing waste printed circuit Boards"

Dr. Amreen Ara Hussain, Indian Institute of Technology Indore, gave a talk on "Next Generation Optoelectronics through Plasma Nanotechnology"

E.6. COLLOQUIA PRESENTED AT IPR

Prof. Praveen Chaddah, Ex-Director of the UGC-DAE Consortium, on "Dissemination of Research Results: Can We fight being Plagiarised?" (Colloquium # 270)

Prof. Raghavan Rangarajan, Physical Research Laboratory, Ahmedabad, on "Gravitinos, Reheating and the Matter-Antimatter Asymmetry of the Universe" (Colloquium # 271)

Prof. Laxminarayan Raja, Aerospace Engineering & Engineering Mechanics, The University of Texas at Austin, USA, gave a talk on "Computational Modeling of Microplasma-Wave Interactions for Plasma-Based Reconfigurable Metamaterial and Photonic Crystal Applications" (Colloquium # 272)

Prof. Arnab Kumar Ray, Dhirubhai Ambani Institute of Information and Communication Technology, Gandhinagar, Gujarat, gave a talk on "Evolution and Instability of Bondi Accretion" (Colloquium # 273)

Prof. B. N. Dev, Department of Materials Science, Indian Association for the Cultivation of Science, Kolkata, gave a talk on "Quantum Tunnelling: From solar fusion and life to nanotechnology" (Colloquium # 274)

Prof. G. Ravindra Kumar, Tata Institute of Fundamental Research, Mumbai and Prof. Amita Das, Institute for Plasma Research, Gandhinagar, Gujarat, gave a talk on "Mimicking Astrophysical Turbulence on a Tabletop" (Colloquium # 275)

Prof. Keisuke Hatada, Department of Physics, Faculty of Science, University of Toyama, Japan, gave a talk on "Full Potential Multiple Scattering Theory with space-filling scattering sites for X-ray absorption spectroscopy" (Colloquium # 276)

Prof. Mahendra K. Verma, Physics Department, Indian Institute of Technology, Kanpur, gave a talk on "What is the turbulence problem?" (Colloquium # 277)

Prof. R.P. Singh, Physical Research Laboratory, Ahmedabad, Gujarat, gave a talk on "Orbital angular momentum of light and applications in quantum communication" (Colloquium # 278)

Mr. Pallava Bagla, Science Editor, New Delhi Television (NDTV), gave a talk on "Clever Ways of Communicating Science, to Win the Trust of the Public" (Colloquium # 279)

Prof. Frederick Raab, LIGO Hanford Observatory, USA, gave a talk on "Exploring the Vast New Frontier of Gravitational-Wave Astronomy" (Colloquium # 280)

Prof. David Reitze, Executive Director, LIGO Laboratory, California Institute of Technology, USA, gave a talk on "LIGO, Virgo, and Gravitational Waves: A Revolution in Physics and Astronomy" (Colloquium 281)

Dr. U. Fantz, Max Plank Institute for Plasma Physics, Graching, Germany, gave a talk on "Present Status of RF-ICP Negative Ion Source Development at IPP" (Colloquium # 282)

Dr. B. Heinemann, Max Plank Institute for Plasma Physics, Graching, Germany, gave a talk on "Technical Challenges in NNBI Systems – Experiences and further Plans at IPP" (Colloquium # 283)

Dr. C. Hopf, Max Plank Institute for Plasma Physics, Graching, Germany, gave a talk on "Neutral Beam Injection for the European DEMO" (Colloquium # 284)

Prof. Anil Gangal, IISER, Pune, gave a talk on "Calculus and Differentiable Dynamics on Fractals Physical Relevance and Applications" (Colloquium # 285)

Prof. Rana Adhikari, California Institute of Technology, gave a talk on "Humanity's New Gravitational Sense" (Colloquium # 286)

E 7. SCIENTIFIC MEETINGS HOSTED BY IPR

32nd National Symposium on Plasma Science & Technology (PLASMA-2017), 7-10 November, 2017

The 32nd National Symposium on Plasma Science & Technology (PLASMA-2017) was organized by IPR during 7-10 November, 2017 at the main auditorium of the Entrepreneurship Development Institute of India (EDI), Bhat, Gandhinagar. Over 450 participants registered for the event which consisted of 15 invited talks and 31 oral presentations spread over 7 oral sessions and 438 poster presentations spread over 4 poster sessions.

5th PFRC Meeting @ CPP-IPR

The 5th meeting of the Plasma & Fusion Research Committee (PFRC) of the Board of Research in Nuclear Sciences (BRNS) was held at CPP-IPR during 27-28 November, 2017. Prof. K. Goswami and Dr. Mayur Kakati from CPP were responsible for the local organization of the meeting at Guwahati. 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 and Prof. Sangita (Scientific Secretary, BRNS), Dr. Ravi A V Kumar (Member Secretary, PFRC) and Dr. N Ramasubramanian. During this 2 day meeting, 22 new R&D projects with a budget allocation of ~ Rs.6.93 Crores as well as 21 ongoing projects were reviewed. The Committee also decided to hold a "NFP-PFRC Vision Meeting" at Ahmedabad sometime in March 2018 to commemorate 10 years of the National Fusion Programme. This meeting will have invited talks in the major areas where R&D funding has been provided through NFP, with a selected PI who will consolidate the major works carried out in that area while a PC or area expert will present an overall view of the future requirements in those areas. The two group discussion sessions will consolidate the future roadmaps in the various areas. After the meeting, a document with the new listed areas of R&D will be published on the NFP and BRNS websites to attract possible PI's. There will also be a poster presentation for the PI's to showcase their work, and we will try to get selected work published in a peer reviewed journal.

Symposium on Plasma and Allied Technologies for a Better Tomorrow @ IPR

A two-day "DAE-BRNS Symposium on Plasma and Allied

Technologies for Better Tomorrow" was organized by IPR during 7-8 December, 2017 at IPR to showcase plasma and other technologies developed at IPR to enhance the quality of life. The meeting was inaugurated by Prof. P.I. John, Prof. Abhijit Sen, Prof. Ganesh Prasad, Prof. S Mukherjee and Dr. Shashank Chaturvedi by lighting the traditional lamp. The meeting also felicitated the FCIPT Division heads. There were 22 invited talks in this symposium and these presentations emphasized on societal and industrial applications viz., health care, agriculture, food, water, waste management as well as funding opportunities for carrying out collaborative R&D in the areas of plasma applications. This symposium was attended by over 65 participants from academics and industry. This symposium will also help in meeting one of the main objectives of IPR which has a mandate to translate the R&D findings into tangible deliverables so as to reach the common people. This meeting also acted as a platform for not only disseminating green technologies, but also to fulfill the initiative of "Swachh Bharat Abhiyan". Dr. Jayanti Ravi, Health Commissioner, Gujarat State participated in the panel discussion on 8th December which was organized as part of the symposium.

National Science Day 2018 @ IPR

The National Science day was celebrated at IPR with a lot of fun and enthusiasm on 20-21 January, 2018. The event was inaugurated by IPR Director, Dr. Shashank Chaturvedi. Over 600 students from schools all over 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. A new event was organized during this NSD, especially for school teachers on "Innovative teaching aids". 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 21st January and prizes for the various competitions were given out by Shri. P K Atrey (ACAO).

Basic EPICS Workshop @ IPR

The LIGO Division of IPR organized a two-day "Basic EPICS Workshop" on 30-31st January at IPR with the support of DAC and ICH & CD Divisions of IPR/ITER India. The workshop was attended by scientists and engineers of collaborative institutes involved in building the LIGO INDIA detector as well as those involved in various LIGO control systems. In total, 30 participants from IPR, RRCAT Indore, IUCAA Pune and IIT Chennai attended the workshop. EPICS (Experimental Physics & Industrial Control Systems) is an open source software development environment which is being used for development of various local and supervisory control systems in present and upcoming LIGO detectors as well as particle accelerators, telescopes and other large physics experiments. Speakers from IPR delivered talks on various topics related to LIGO controls and EPICS during the workshop. Hands-on practice sessions were also organized as part of the workshop on 31st January at the LIGO Laboratory in Gandhinagar.

Observance of the Swachhta-Pakhwada @ IPR

"Swachhta-Pakhwada" was observed at IPR during 16-28 February, 2018. This initiative, which is part of the "Swachh Bharat Mission" of the Government of India was started in April 2016 and is observed by all Government establishments. All DAE establishments observed this during 16-28th February. As part of this drive, IPR staff were motivated to clean their offices and laboratory spaces and clear away unwanted materials. IPR also plans to award prizes for the most clean office / laboratory spaces in IPR.

National Safety Week – 2018 @ IPR

The 47th National Safety Week was celebrated at IPR from 4-10 March 2018. The institute organized various competitions during this week to create safety awareness among its employees. Competitions were organized on Slogan in Hindi & English, Cartoon Making, Quiz and Essay Writing in Hindi & English based on decided topics for the employees of IPR, FCIPT & ITER-India. Encouraging response was received from the employees for various competitions. Demonstration of use of fire extinguisher was conducted for the employees as well as security staff at IPR during this week. A mock drill on electrocution scenario was conducted for Electrical Power Distribution Section. An awareness program on "Importance and Understanding of Personal Protective Equipment (PPEs)" was conducted by M/s. Honeywell International India Limited. Employees have acquainted themselves during this program by practical demonstration of PPEs.

In the concluding session that was held on 9th March 2018, Mr. D V Modi welcomed the gathering and a talk on "Safety Procedures and Practices during Electrical Works" by Shri C.K. Gupta. Mr. Ujjwal Baruah, Dean (Admin.) expressed his thoughts on safety and he also administered

the "safety oath" to the IPR staff present. A safety quiz for the audience was organized by Mr. Bharat Doshi and Dr. D. Chenna Reddy, Dean (R&D) read out Director's message, which highlighted that everyone is accountable for safety performance and the four 'Cs', i.e., Competence, Control, Co-operation and Communication are very important for a positive safety culture. The prize distribution followed and the vote of thanks was delivered by Mr. Sunil Kumar, the Chairman of the Safety Committee of IPR.

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F. OTHER ACTIVITES

F.1 Outreach

The following activities were undertaken for outreach purpose during the report period;

1. IPR participated in the ADMAT-2017 Exhibition being organized by VSSC-ISRO during 14-16 Dec, 2017. IPR's work related to theory & simulation in the area of plasma thrusters was highlighted in this exhibition

2. Organized the National Science Day event at IPR (Jan 11-14, 2018). Over 600 school children from schools across Gujarat state participated in the event which had science exhibition, various competitions and skits. This two-day programme showcased over 100 science projects from schools from all over Gujarat as well as those from IPR staff.

3. Participated in the Science Day of GMRT, Pune (28 Feb, 1 Mar 2018). IPR's contribution to Fusion and ITER was the main focus at this event which was attended by over 20,000 visitors.

4. Participated in the exhibition organized by the AIA Industrial Expo-MSME National Vendor Development at Ankleshwar to showcase technologies developed by IPR. IPR's contribution to applications of plasma technology to industrial and societal applications was highlighted at this exhibition.

5. Participated in the science exhibition organized as part of the Gujarat Science Congress- GSC 2018 at Bhavnagar (4-7 Feb, 2018). Live plasma demonstrations as well as other basic science experiments along with technology demonstration displays were the focus of this event.

6. Participated in the exhibition at the Technology Showcase, EDI Empresario, EDI, Gandhinagar (10-11 Mar, 2018). At this event, IPR showcased the technologies developed by it in the areas of applications of plasma technology to industrial and societal applications.

7. Organized several scientific tours to IPR with more than 1000 visitors from schools and colleges from several states in India during the last one year.

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: Eighth half yearly meeting of Town Official Language Implementation Committee (TOLIC), Gandhinagar conducted in IPR by Dena Bank on 21th April, 2017. Institute has been honored with third prize under the TOLIC Gandhinagar Official Language Award: 2016-17 in TOLIC meeting for the best performance in the official language. Dr. Sandhya P Dave, Junior Hindi Translator has been honoured with third prize for the outstanding contribution in the implementation of Official Language.

Hindi Seminar: Hindi Seminar on Scientific and Administrative topics was conducted on 12th May, 2017. Total 5 papers, out of which 3 papers on scientific topics and 2 on Administrative topics were presented in this seminar. Hindi Quiz competition based on the papers presented in the Seminar was also conducted for the audience.

TOLIC Competition: Institute's staff members are encouraged to participate in TOLIC, Gandhinagar Competition. Mrs. Shilpa Khandker, Scientific Assistant - C, awarded 1st prize and Ms. Hiral Joshi, Scientific Assistant - B awarded Consolation prize in Online Story Competition conducted by IPR at TOLIC, Gandhinagar level. 3 staff members participated in Hindi quiz competition conducted by Directorate of Census Operations, Gujarat under the auspices of TOLIC, Gandhinagar.

• 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, 2017, June, 2017, September 2017 and March 2018 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 21 candidates have qualified the Hindi Parangath Exam and 2 candidates have qualified Hindi Praveen Exam conducted in the May 2017 session and 6 candidates have qualified the Hindi Parangath exam and 1 candidate qualified Praveen exam for November 2017 Session under Hindi Teaching Scheme, Ahmedabad.

Hindi Workshop: To train the employees for working in Hindi; workshops have been conducted regularly. Desk to desk workshop also conducted for group of people for Hindi typing on computer.

Hindi Talk: A Hindi talk has been delivered by Shri. H.K. Sharma, then Account Officer on 24th May, 2017 on the topic "Role of Administrative Officers in a Research Institute". On behalf of SHWW committee two Hindi talks have been convened, one by the representative of ''Chetna" institute on Sexual Harassment and another talk about women's safety & health conducted on Women's Day.

Home Magazine: 23rd issue of IPR's Half yearly Home magazine has been published and distributed to all DAE Institutes and other institutes situated all over India.

Computer Training: Institute's two Staff members participated in 5 Days Hindi Computer Training from 12th June - 16th June, 2017, conducted by Hindi Teaching Scheme, Ahmedabad.

Hindi Pakhwada Celebration 2017: The Institute celebrated Hindi Pakhwada from 1st September to 15th September, 2017. During this period total 15 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 Director on the occasion of closing ceremony.

Translation: Translation of Activity Report, Annual Review Report 2016-17, Office Orders, Covering letters, Tenders, Standard forms, matters sent by DAE, Mumbai and various matters of day- to-day activities have been completed.

Display Board: 35 display boards containing Hindi matter to create awareness about Hindi Language and Official Language Policy has been fixed at various places of IPR campus (Laboratory, Reception, Director's Office etc.)

Hindi Inspection: Hindi Inspection of Administration – III

(Recruitment, Review & Medical) on 22nd November, 2017 and Purchase section on 25th May, regarding implementation of Official Language policy was done by Hindi Inspection committee and the review report was submitted to Director.

Inspection of Official Language Implementation by DAE Representative: On 16th January, 2018, Joint Director (OL), Department of Atomic Energy, Mumbai visited IPR and inspected the implementation of Official Language. During the inspection he visited different sections of the institute and examined the Hindi work in each section. He appreciated the activities related to official language at the Institute and also gave directions to the section heads for further progress.

Vishwa Hindi Diwas Celebration 2018: The Institute celebrated Vishwa Hindi Diwas on 17th January, 2018. Shri Achleshwar Singh, Joint Director (OL), DAE Mumbai delivered a talk on Parliamentary Official Language Committee Inspection.

• The institute has been honored with the following awards in 18th DAE All India Official Language Meet held at Kalpakkam, Chennai on 22nd March, 2018: (1) *Official Language Shield (for best performance) in Aided Institute Category of DAE for the year 2015-16;* (2) *Best Official Language Home Magazine Award in Aided Institute Category of DAE for the year 2015-16;* (3) *Consolation Prize for Best Official Language Home Magazine in Aided Institute Category of DAE for the year 2016-17*

• Hindi Translated version of English book "Living with Plasma" and "Plasma Activity Kit" was also got published during this period and have been released by DAE's dignitaries in 18th DAE All India Official Language Meet held at Kalpakkam, Chennai on 22nd March, 2018.

• Junior Hindi Translator participated in the workshop conducted during 23 & 24th March, 2018 at MAPS, Kalpakkam and also gave a presentation on the Official Language Activities being conducted in IPR.

F.3 Right To Information

During the report period, a total of 44 RTI applications were received, out of which 38 were of new, while the other 6 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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