

Year 2013  
Issue 1

# The Fourth State

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

## From the Director's Desk

Message from the Director : *Since 1986, this Institute has grown organically around the emphasized mandate: Science and Technology of Controlled Thermonuclear Fusion through magnetic confinement. Basically fusion technology uses a wide range of technologies which are matured in themselves. But application of those technologies in the extreme conditions of fusion plasma is still a big challenge. With India joining the ITER project and also the ongoing developments in most of the required frontier technologies, there is need to share the information about the progress in the Institute with all interested people. I hope this newsletter will be a useful medium to fulfill that in part, at the least.*

Professor Dhiraj Bora took charge as Director, IPR in January 2013. He completed his PhD in 1979 from the Physical Research Laboratory, Ahmedabad in the area of experimental multiple life time of particles in a magnetic mirror device. After his PhD work, Prof Bora worked on Bolometers on TEXT device at the Fusion Research Centre at University of Texas at Austin in 1984. He also worked as a guest scientist at the Institute für Plasmaphysik at Forschungszentrum, Juelich, Germany 1989-90 and 1992 on the ICRH heating system, multi-probe system for SOL studies and ECE diagnostics. Following India's inclusion in the ITER Programme, Professor Bora was appointed the Deputy Director General and Director for Directorate for Control, Heating and Diagnostics (CHD) in the year 2006 and continued at that post till the end of 2012. Since much of his research efforts has been in the direction of establishment of the RF laboratory and the development of IC system from mW to MW range, his research interests have been in Heating and Current Drive in Tokamak plasmas. He also has a very keen interest in basic experiments in plasma diagnostics.



Professor Dhiraj Bora, Director, IPR

## Message from the Editorial Committee

*Dear Colleagues, the IPR Newsletter "The Fourth State" is being revived after a long dormant period of over a decade. This newsletter would strive to highlight achievements, activities and other news from our Institute and take them to all the staff members of this Institute. In this context, staff members are requested to report their groups' achievements and other interesting details (along with photographs if any) to the Newsletter for publishing. We hope to make this a monthly release. Thank you !*

## DAE Chairman's Visit - 5th August 2013

Dr. R. K. Sinha, Chairman, AEC visited IPR on 5th August 2013. He spent the day visiting all the major labs at IPR and ITER-India and interacting with the Scientific and Technical staff working on SST-1, Aditya and the various labs in the campus. The Chairman was apprised regarding the progress of the deliverable packages of ITER-India. On an encouraging note at the end of



Dr. Pradhan explaining details of SST-1



Dr. Ghosh explaining details of Aditya operations



the visit he expressed his appreciation at the overall developments in the Institute and added that the work here at IPR comprises of “*extreme physics with extreme technology*”.



In the Aditya hall



Happy faces at tea time !



In the SST-1 hall



In the ITER-India Laboratory

### ITER Director General's Visit - 23rd April 2013

**Professor Osamu Motojima**, Director General, ITER Organization, France, visited IPR on 23rd April 2013.

Professor Motojima is Emeritus Professor, Advisor and Fellow of the National Institute for Fusion Science, Japan and his areas of specialization are ; Plasma Physics / High-temperature Plasma Confinement and Control, and Nuclear Fusion Reactor Engineering Systems.

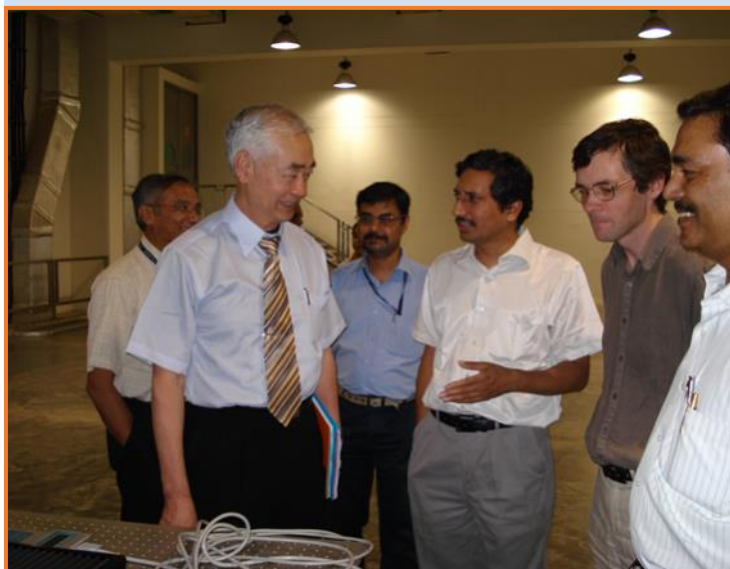
During his visit Professor Motojima reviewed the progress of vari-



ous IN-DA packages which India has committed to deliver to ITER. ITER-India responsible officers gave package-specific presentations apprising the DG about ITER-India's progress in technical and project management activities. The DG appreciated India's ongoing efforts towards timely ITER construction. He also interacted with the staff of IPR and ITER-India and gave a lecture on "Progress of ITER Project" at IPR. .

At the ITER-India Laboratory





Pictures of Prof Motojima's visit to IPR and ITER-India



## IPR Institutional Document Repository

The Institute for Plasma Research (IPR) Library has set up its institutional repository using **DSpace**, which is an open source repository software package for creating repositories to deliver content to end users, and providing a full set of tools for managing and preserving the content within the application.

The institutional archive can be accessed with in the campus at <http://192.168.201.116:8080/jspui/>

The institutional repository consists of the following documents:

- Articles: 595
- Reprints: 1193
- Research Reports: 586
- Technical Reports: 240
- Thesis: 66

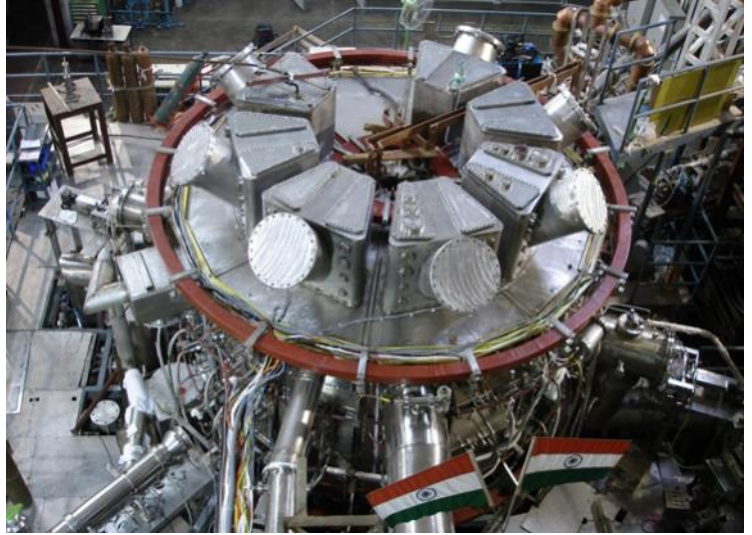
Apart from this, the IPR library also subscribes to several online as well as print versions of scientific and engineering journals.

Issue Date	Title	Author
12-Feb-2013	COHERENT STRUCTURES AND THEIR STABILITY IN INHOMOGENEOUS MAGNETISED PLASMAS	CHAKRABARTI, NIKHIL
12-Feb-2013	COHERENT, NONLINEAR AND TURBULENT PHENOMENON IN ELECTRON MAGNETOHYDRODYNAMICS SYSTEMS	DASTGEER, S
21-Feb-2013	COLLECTIVE DYNAMICS OF DELAY COUPLED OSCILLATORS	REDDY RAMANA, DOOLA V.
21-Feb-2013	COMPUTATIONAL MODELLING OF ELECTROMAGNETIC PULSE SIMULATORS	AHMED, SHAHID
26-Feb-2013	COMPUTATIONAL STUDIES OF A MAGNETIZED TARGET FUSION SYSTEM	SUBHASH, P.V.
12-Feb-2013	COMPUTATIONAL STUDIES OF RADAR CROSS SECTION OF PLASMA SHIELDED OBJECTS	CHAUDHURY, BHASKAR
26-Feb-2013	EFFECT OF PROCESS PARAMETERS ON PLASMA NITRIDING	SINHA, SURAJ KUMAR
26-Feb-2013	ELECTRON MAGNETOHYDRODYNAMIC (EMHD) STUDIES ON ELECTRON TRANSPORT IN AN INHOMOGENEOUS PLASMA MEDIUM	YADAV, SHARAD KUMAR
15-Feb-2013	ELECTRON PLASMA STUDIES IN A TOROIDAL PENNING TRAP	BAHARI, SAMBARAN
13-Feb-2013	ELECTROSTATIC TURBULENCE IN TOROIDAL PLASMA	JOSEPH, Biju K
21-Feb-2013	EXPERIMENTAL INVESTIGATION ON A LARGE LABORATORY MAGNETOPLASMA	RAVI, G
12-Feb-2013	EXPERIMENTAL STUDIES IN STRONGLY COUPLED DUSTY PLASMAS	AGARWAL, ANUJ KUMAR
26-Feb-2013	EXPERIMENTAL STUDIES ON ATMOSPHERIC PRESSURE GLOW DISCHARGE PLASMA	SRIVASTAVA, A.K.

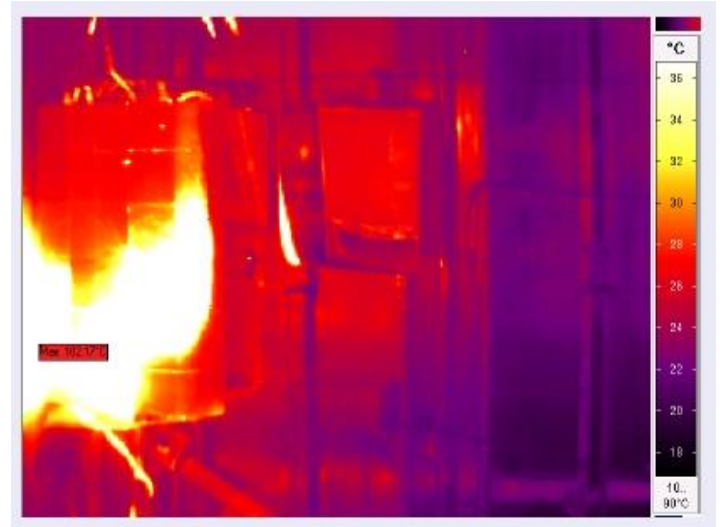
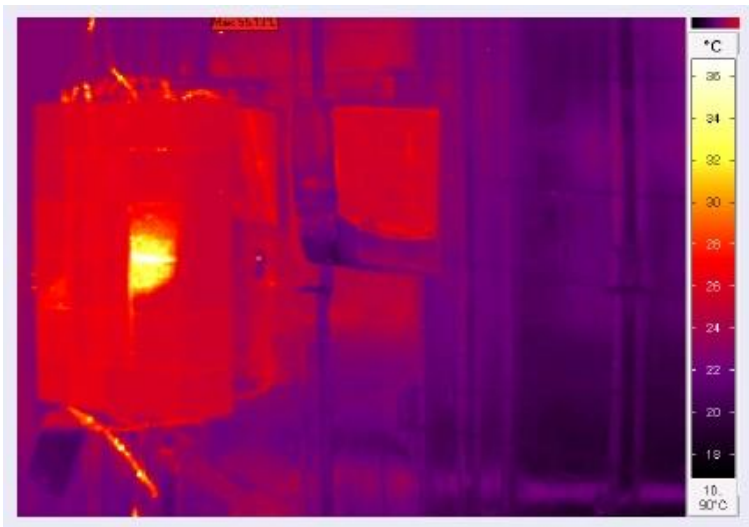
Search Interface of the IPR Institutional document repository



- The Steady state Superconductor tokamak (SST-1) has been successfully commissioned by the Mission Team. The first plasma was produced in the machine on **20<sup>th</sup> June 2013**.
- Through this success, the following engineering & technology milestones have been highlighted (i) Very big superconductor magnet with 1.5 Tesla field (ii) India's biggest cryogenic plant (iii) Large vessel with a vacuum of  $1 \times 10^{-8}$  Torr.
- The most important fact is that the commissioning has been achieved through simultaneous operation of all those critical technologies in an integrated environment.
- By this achievement, India has entered a very special club of nations, Korea, china, Japan, France, Germany having superconducting tokamaks.
- The next campaign will begin by the middle of August 2013.



SST-1 machine as on August 2012



Images of the start of the first plasma from the Infrared camera located on one of the radial ports

## Aditya Data Acquisition and Control System

- This indigenously built tokamak, Aditya, has been operational from late 80's.
- Experiments on edge plasma fluctuations, turbulence and other related works are being carried out. This has helped to study many exciting physics and to develop many technologies for plasma heating and plasma diagnostics.
- CAMAC (Computer Automated and Measurement Control) System and PXI based system Data Acquisition (DAQ) systems at Aditya have matured enough to handle data from more than 280 channels simultaneously.



Front panel of the PC based DAQ system



Labview™ GUI's for pulse generator and DAQ systems

- In the process of DAQ development for Aditya, many high cost technologies have been redeveloped here with very in-house developed hardware.
- As a spin off, low cost DAQ systems have also been designed and developed with front end LabView™ GUI as per user requirements for smaller lab experiments.

Facilitation Centre for Industrial Plasma Technologies (FCIPT), a division of IPR was set up in 1997 to promote commercialization of plasma based technologies through development, incubation, demonstration, manufacturing and transfer of technology. FCIPT is a ISO 9001:2000 (2008) certified organization. FCIPT provides technologies for:

Subsurface Modification by *Glow Discharge Plasma Nitriding* and *Plasma based ion implantation*.

- Surface Activation : Plasma etching of wool and other textiles for improved weaving and wettability properties, Plasma activation of Carbon Powders for water purification processes, and Plasma activation of Brass to improve its bond with rubber.
- Coatings of surfaces using *Plasma Enhanced Physical Vapour Deposition* and *Plasma Enhanced Chemical Vapour Deposition*.
- Waste Destruction: Plasma jet is used for Biomedical waste disposal, Energy recovery from disposal of high caloric wastes and formation of nano-powders.
- FCIPT also carries out basic experiments in application of plasma technology.
- FCIPT has also developed experimental setups based on MSc. Physics level plasma sciences syllabus as a project funded by the National Fusion Programme.



Plasma nitriding system and plasma assisted surface coated materials



Plasma torch based waste destruction device

## Helicon Double Layer Thruster

### Types of Electric Propulsion (EP) Systems

(1) Ion engine, (2) Hall thruster, and the (3) Helicon double-layer thruster (in IPR).

- Electric propulsion (**EP**) is a mechanism by which electrical energy is converted to produce thrust.
- EP systems are commonly used in satellites mostly for deep space propulsion. Because, as compared to conventional liquid propulsion (**LP**) thrusters, EP produces less force for longer time.
- An RF antenna causes breakdown of the propellant gas, forming electrons and ions, which are subsequently forced to undergo expansion in the diverging magnetic field. This spontaneously forms a double-layer near the source tube exit, which acts to accelerate the ions.
- The helicon double-layer thruster (HDLT) is a type of electrode less thruster that produces an ion beam in an RF expanding plasma with a diverging magnetic field. At low pressures (< 3 mTorr), this magnetic field causes the plasma to expand, and a potential structure, known as a *double-layer (DL)* forms spontaneously within the plasma, characterized by a sharp drop in plasma potential over a narrow spatial distance.
- This DL acts as a virtual electrode, and accelerates ions to speeds of a few tens of electron volts. Sufficient electrons appear to be able to make it across the double layer such that a charge neutral beam is formed in the downstream region, and thus a neutralizer is not needed.
- Since no electrodes are present, almost no erosion occurs, they are ideal candidates for deep space applications.

#### Comparison of exhaust velocities

LP	EP
2900 – 4500 m/s	3000 – 100 000 m/s



The Helicon antenna being used at IPR



Some facts about our **SUN** - Nature's own fusion device. Diameter ~ 1,392,684 km, Mass ~  $1.989 \times 10^{30}$  kg, of which 3/4th is Hydrogen, rest Helium and the remaining 1.69% (which is 5600 x Earth mass) are heavier elements like oxygen, carbon, neon and iron and so on. The magnetic field of sun flips every 11 years and is expected to do so once again in the coming years. The surface temperature of the Sun is ~ 5778 K, the black sunspots indicating cooler areas of temperature ~3000–4500 K.

IPR's first tokamak "**Āditya**" (Sanskrit: आदित्य, pronounced [a:di'tjɐ]) means the Sun.



The following IPR staff were nominated to the Executive Committee of the Staff Club for the term 2013-14 April 2013. Sutapa Ranjan (President), Rajesh Kumar (General Secretary), Ankit Gandhi (Sports Secretary), Smita Parmar (Cultural Secretary), Ashlesh Shah (Treasurer).

The environmental day was celebrated at IPR on 5th June 2013. The Director, IPR inaugurated a Herbal Garden at IPR where more than 30 herbal plants like Tulsi, Aloe vera, Vasaka (Ardusi), Hogweed (Patharchatta), Lindi piper etc. were planted.

More than 1000 saplings (*Lal Mehendi, Tulsi, Bougan-villia, Champa, Duranta, Jambu, Asopalav, Karan, Jasood, Rose*, etc.) were distributed to ITER-India staff and also planted at various loca-

Job done !  
Now for the  
refreshments

Bougan-  
Tikoma,  
IPR/FCIPT/  
tions in the  
campus.



The Staff Club Team



Inauguration of the Herbal Garden



The saplings ready for distribution



Foliage in the western wing of the main campus building

## Hidden Talents



The water lily bloom in IPR campus—Photo by Ravi A. V. Kumar



We can create food in plenty. But we are neither able to store or transport it to the needy on time. Only empowerment with (electric) power can bring real change. - Sketch by **Raju Daniel**

Wisdom alone is the science of other sciences - Plato



The Institute expresses its gratitude for the services of the following employees who have retired from IPR during the period of 1st January 2012 to 30th May 2013.

**Professor P. K. Kaw** retired as Director, IPR on 31<sup>st</sup> January 2013 after almost 31 years of service. He joined service on 26<sup>th</sup> July, 1982. He has been awarded the “*Year of Science Professorship of the Department of Science & Technology (DST) for 5 years, tenable at any Institute in India*” under which, Professor Kaw continues to work at IPR since March 2013.



**Dr. C. V. S. Rao** retired as Scientist-SG on 31<sup>st</sup> March 2013. He joined service on 19<sup>th</sup> April, 1982 as a Research Associate in Plasma Physics.



**Professor S. K. Mattoo** retired as Senior Professor on 31<sup>st</sup> May 2013. He joined service on 1st September 1974.



**Shri. H. D. Pujara** retired as Engineer-SG on 30th September 2012. He joined service on 4th September, 1973



**Mrs. P. J. Pathak** retired as Librarian-SG on 30th November 2012. She joined service on 24th June, 1982.



**Shri. M. Sourabhan** retired as the Personal Secretary to the Director, IPR on 31<sup>st</sup> May 2013. He joined service on 15<sup>th</sup> April, 1982.



**Shri. P. Balachandran** retired as the Personal Secretary to the Director, IPR on 30<sup>th</sup> April 2013. He joined service on 2<sup>nd</sup> February, 1987.



**Shri. Ashok R. Chavda** (Electrical) on 30<sup>th</sup> June. March, 1987.



retired as Tradesman - H  
He joined service on 12<sup>th</sup>

## Welcome

Best wishes to the new staff members who have joined IPR in various permanent positions during January 2012-2013

 Vijaykumar N. Patel Engineer-SC DOJ : 17-Jan-2012	 Kedar S. Bhoje Scientist-SC DOJ : 19-Jan-2012	 Parag R. Panchal Office Clerk-A DOJ : 16-Aug-2012	 H. R. Suthar Office Clerk-A DOJ : 22-Aug-2012	 Hetal D. Pathak Office Clerk-A DOJ : 22-Aug-2012	 Arvind Kumar Engineer-SC DOJ : 03-Sept-2012	 Rakesh Kumar Engineer-SC DOJ : 03-Sept-2012	 Atul K. Prajapati Engineer-SC DOJ : 03-Sept-2012	 Deepak Aggrawal Engineer-SC DOJ : 03-Sept-2012	 Someswar Dutta Engineer-SC DOJ : 03-Sept-2012
 Surajkumar Gupta Engineer-SC DOJ : 03-Sept-2012	 Ashish Ranjan Engineer-SC DOJ : 03-Sept-2012	 Arnab Das Gupta Engineer-SC DOJ : 03-Sept-2012	 Deepak Yadav Engineer-SC DOJ : 03-Sept-2012	 Sudhir Rai Engineer-SC DOJ : 03-Sept-2012	 Dushmantha Mohanta Engineer-SC DOJ : 03-Sept-2012	 Nitin V. Katara Office Clerk-A DOJ : 04-Sept-2012	 A. M. Panchasara Office Clerk-A DOJ : 28-Sept-2012	 Pintu Bandyopadhyay Fellow DOJ : 03-Oct-2012	 Bhavesh G Patel Scientist-SD DOJ : 11-Jan-2013

## Obituary

**Shri. Kirit D. Upadhyay** Senior Lab Assistant passed away on 19th November 2012. He had joined IPR on 11th June, 1990.



A day without fusion is like a day without sunshine....

## Upcoming Events at IPR

National Symposium on High Power RF & Microwave (HPRFM-2013), 4-6 September 2013 at IPR, Gandhinagar.

For details visit: <http://www.ipr.res.in/HPRFM2013/>

Topical Conference on Atomic Processes in Plasmas (ISAMP-TC-2013), 18-20 November 2013 For details visit:

<http://www.ipr.res.in/TC2013/>

## Dignitaries' Visit to IPR

- Mr. Juan Luis Fernandez Hernando, Responsible Engineer for ITER Central Interlock Systems in Control System Division of ITER organization gave a talk on Issues related to ITER Central Interlock System and machine protection on 17<sup>th</sup> April, 2013 at IPR, Gandhinagar
- Shri. S. C. Chetal, Ex Director, Indira Gandhi Centre for Atomic Research, Kalpakam, gave a talk on "Metallurgical Aspects of 300 Series Stainless Steel" on 11th June 2013
- Dr. Jessica R. Chocha, Saurashtra University, gave a talk on "Synthesis and Characterization of Some Mixed Oxide Functional Ceramics" on 14th June 2013
- Dr. Ashwin Joy, Department of Chemical Physics, Weizmann Institute of Science, Israel, gave a talk on "Shear Band Direction in Amorphous Solids - An Atomistic Theory" on 1st July 2013
- Dr. Tuong Hoang, CEA-IRFM, Cadarache, France, gave a talk on "IRFM Science and Technology activities & results" on 10th July 2013
- Dr. Alain Becoulet, CEA-IRFM, Cadarache, France, gave a talk on "Areas of Collaborations with IPR" on 10th July 2013

## The IPR Logo



प्लाज्मा अनुसंधान संस्थान

Institute for Plasma Research

This logo was designed by National Institute of Design, Ahmedabad for the Institute in the year 2011. The visual abstract of the symbol represents the toroidal confinement of plasma and the rays of the Sun highlights the fusion energy. The orange color represents the sun and the blue color represents the confined plasma. Ideally the logo and the symbol should be used together. The English fonts are from "Kozuka Gothic pro" family (from Adobe) and the Hindi fonts are from "DV-Natraj" family (from C-DAC). The color models for different applications are as follows : for Orange color (i) CMYK - 0,62,100,0; (ii) RGB - 240,124,31 (iii) Pantone 716 C (iv) Hexadecimal - #EF7A18 for Blue color (i) CMYK - 100,72,0,0; (ii) RGB - 0,86,165 (iii) Pantone 2945 C (iv) Hexadecimal - #13519E

Chhaya Chavda  
Ramasubramanian N  
Ravi A V Kumar  
Shravan Kumar

## The Team

Hiral B. Joshi  
Prabhat Kumar  
Priyanka Patel  
Swati Roy



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