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Issue 5  
May 2014

# The Fourth State

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

*From the editorial desk*

*The editorial committee of the IPR newsletter wishes to thank all the IPR staff members for their encouragement and support that they have given to the revived newsletter. We hope that this will continue for all the forthcoming issues of "The Fourth State". Please feel free to send any comment / suggestion to the committee at <newsletter@ipr.res.in> for improvement of*

## SST-1 News

The cool down has been started for the campaign VIII. In the mean-time the cryogenic plant was overhauled for a longer operation. The plasma shots are expected by next week (19-25 May). In this campaign experiments will be focussed to operate the TF at 1.5 T.



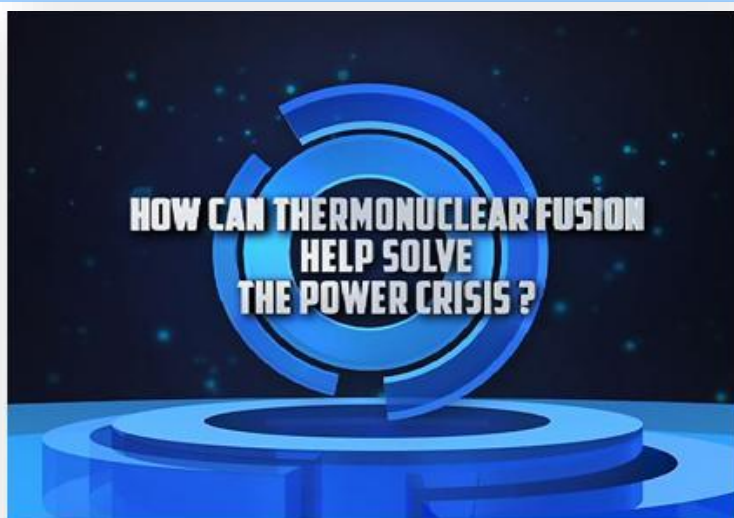
As per the regular operating procedure, it is mandatory to replace the Charcoal (granular) CN 60 DD (4 X 8 USS) after every 8000 hours of operation of the Oil Removal System (ORS) of Cryogenic Plant. It was replaced recently and successful helium leak tests were carried out and cleared for the next Campaign.



Preparation activities for the installation of First wall components have been initiated: Image on the right shows an assembled back plates in prototype vacuum vessel at MEL lab as a mock-up for positioning and alignment.



## IPR on National Television



The popularity of Fusion technology has entered into the Television era also. In an episode of the series "**A Question of Science**", information about tokamak research in the institute was telecasted under the title "*How Can Thermonuclear Fusion Help Solve The Power Crisis?*" on the Doordarshan National (DD-1) channel on Wednesday, 9th April 2014 at 9:00 hrs.



"**Eureka**" with Prof. P.K. Kaw, was broadcasted on Friday 9th May 2014 on Rajya Sabha TV. In this programme, leading scientists of India are being interviewed to showcase the scientific contributions of individuals & institutions. The programme is being produced in collaboration with CSIR-NISCAIR. (Link: <http://goo.gl/bjGvZw>)

## नगर राजभाषा कार्यान्वयन समिति, गांधीनगर की द्वितीय छमाही बैठक

10 अप्रैल, 2014 को सेमिनार कक्ष में नगर राजभाषा कार्यान्वयन समिति (नराकास) (Town Official Language Implementation Committee-TOLIC), गांधीनगर की द्वितीय छमाही बैठक का आयोजन किया गया। इस बैठक की अध्यक्षता श्री अविनाश किशोर सहाय (अध्यक्ष, नराकास एवं आयकर आयुक्त, गांधीनगर) ने की। आईपीआर के उपस्थित सदस्यों ने श्री अविनाश किशोर सहाय, श्री विनोद कुमार शर्मा (उपनिदेशक, कार्यान्वयन, राजभाषा विभाग, मुंबई), श्री नवीन कुमार यादव (सचिव-सदस्य, नराकास, गांधीनगर/अहमदाबाद) एवं डॉ. रत्नेश्वर झा (डीन, प्लाज़्मा अनुसंधान संस्थान) का पुष्प गुच्छ से स्वागत किया। इस बैठक में केंद्र सरकारी कार्यालयों के करीब 40 वरिष्ठतम प्राधिकारी एवं निगम-उपक्रमों तथा बैंको के महाप्रबंधक/प्रबंधक भी शामिल हुए। अपने अध्यक्षीय भाषण में श्री अविनाश किशोर सहाय जी ने लोगों की हिंदी में काम करने के प्रति बढ़ती रूची के लिए लोगों की सराहना की। अंत में डॉ. रत्नेश्वर झा जी ने अपने वक्तव्य द्वारा अन्य सभी उपस्थित सदस्यों को आईपीआर में हिंदी से संबंधित गतिविधियों की जानकारी दी।



मंच पर उपस्थित नराकास के उच्च पदाधिकारी



नराकास बैठक में  
उपस्थित केंद्र  
सरकारी कार्यालयों  
के प्रतिनिधि

## आम आदमी और सरकार

2

आज बहुत सहमा सहमा सा हूँ मैं ।  
आने वाली परिस्थितियों से डरा डरा सा हूँ मैं ।

आतंकवाद जो हमारे मासूम और निर्दोष भाइयों को मारता है  
जेहाद के नाम पर उनके मन-ज़हन को अंदर से डगमगाता है  
और सरकार का प्रतिनिधि केवल खोखली सहानुभूति दिखाता है  
अगर आतंकवाद को मिटाना है तो फिर कसाब को क्यों बचाना है

आज बहुत सहमा.....

भ्रष्टाचार जो आम आदमी पर करें अत्याचार हरबार  
अमीरो को देती व्यापार और गरीबों की लेती आह भरी पुकार  
आम आदमी के साथ सरकार का है साथ यह सरकार का है उच्चार  
अगर भ्रष्टाचार को मिटाना है तो फिर लोकपाल पर क्यों हिचकिचाना है

आज बहुत सहमा.....

दो अंक प्रतिशत वृद्धि दर है, देश को यह बार बार दिखाती है  
महगाई हटायेंगे, रोजगार दिलायेंगे, गरीबी हटायेंगे सुदृढ़ शासन लायेंगे  
पर यह वचन अभी नहीं नीभयेंगे यह अहसास बार बार दिलाती है  
पेट्रोल-डीज़ल और गैस के दाम सोमवार शुक्रवार रात बढ़ाती है  
अगर देश को नंबर वन बनाना है तो प्रगति राह पर क्यों नहीं आना है

आज बहुत सहमा.....

### आम आदमी का जवाब

आम आदमी हूँ मैं पर आपनी करनी और कथनी से आम नहीं हूँ मैं  
आज़ादी पाने की आग में सुलगता और भभुकता सैलाब हूँ मैं  
आतंकवाद - भ्रष्टाचार नामक राक्षस के लिये तेज़धार तलवार हूँ मैं  
हम आम जन को मत भड़काओ देश को सच्ची प्रगति की राह दिखाओ  
वरना महाभारत के कृष्ण की तरह कौरवों का विनाश हूँ मैं

कवि- भार्गव चोकसी

**Gone With the Wind:** Cynosure to the eyes for more than a decade, this beautiful bougainvillea near the canteen building was completely destroyed by the powerful storm that blew on 20th April and fell numerous trees and caused loss of life in and around Ahmedabad.



Vibrant colors rising to the sky before the storm



Deserted domes after the storm



The quest for achieving higher and higher energies in accelerated charge particles has always been an ongoing challenge ever since Earnest Lawrence's first 4" diameter cyclotron which accelerated hydrogen ions to 80 keV in 1930. Over and above that, there is also the problem of size. How to increase the energy, but not the size of the accelerator used to produce it ? Plasma Wakefield Acceleration (PWA) is one of the brightest prospects in current accelerator physics which promises to deliver very high acceleration gradients in very short lengths. The plasma (PWFA) and laser (LWFA) based technologies look at two aspects of the "Table-top" concept of high energy charged particles. While the laser based systems can generate very high energy and monochromatic charged particles from scratch, the plasma based systems can be used as after-burners on existing Linacs to boost the energy of the particles.

The IPR project aims at developing a PWFA experiment which proposes to have a short pulsed, 50 MeV, normal conducting Linear accelerator (LINAC) as the primary electron beam source. This will be used to create the wakefield in the plasma as well as accelerate the electrons. A prototype 40cm lithium photo-ionized plasma source is currently being developed for this purpose. The plasma will have an electron density of  $\sim 10^{13}$  to  $10^{14} \text{ cm}^{-3}$  which is suited for this experiment. An excimer laser of 193 nm wavelength is used to generate the plasma. Based on the results of this prototype plasma source, a 1 meter plasma source will be designed, which will be integrated with the Linac system for carrying out the PWFA experiments.



View of the Accelerator laboratory. The excimer laser and the lithium plasma source can be seen in the photograph.

## Center of Plasma Physics (CPP-IPR)



Centre of Plasma Physics – Institute for Plasma Research (CPP-IPR) is a research centre of Institute for Plasma Research (IPR), Gandhinagar, Gujarat, an autonomous institute under the Department of Atomic Energy (DAE), Govt. of India. The centre, located at Nazirakhat, Tepesia, Sonapur, about 20 km east of Dispur, Guwahati, was initially formed with a small group of scientists in 1991 as a project of the Govt. of Assam, and functioned as an autonomous institute under the Department of Science & Technology, Govt. of Assam, till May 29, 2009. Since then, the institute was annexed to the Institute for Plasma Research by the DAE, Govt. of India.

This center is currently headed by Professor K. S. Goswami and has a total staff strength of around 30. The major areas of R&D activities at CPP-IPR includes ; divertor simulator experiment, dusty plasma experiments, plasma focus, inertial electrostatic confinement fusion based experiments, high power plasma-surface experiments, negative ion beam source experiments, plasma applications etc. This newsletter, in its upcoming issues will try and bring to the readers the highlights of the work being carried out at CPP-IPR and events happening at there.





- **Thermal Plasma Processed Materials Laboratory (TPPML), CPP-IPR, Assam (India)**, is developing a segmented torch assisted high heat and particle flux system, which will simulate the extreme plasma conditions inside the Divertor region of a modern Tokamak fusion machine.
- The plasma beam needs to be thoroughly characterized in terms of heat flux, particle flux, plasma temperature etc. In order to know the ion flux of the plasma jet, it is necessary to know the ion density as well the plasma jet velocity. Plasma density can be measured from Stark broadening of  $H_{\beta}$  line. Plasma jet velocity can be calculated from the Doppler shift in wavelength when the spectra from plasma jet are taken at different angles to the plasma jet direction. This Doppler shift in wavelength is very small and hence a high resolution spectrometer is required to record it. Thus, a high resolution 1.33m spectrometer had been procured and recently installed at TPPML, CPP-IPR in the presence of Dr. Joydeep Ghosh from IPR.
- The monochromator is McPherson made design with patented "Snap-In" gratings having two mirrors, a plane grating with 1800-g/mm and 1.33 meter focal length. Mirrors and slits remains fixed while the grating is rotated for wavelength selection. This optical system has an f/9.4 effective aperture with a spectral resolution of 0.007 nm.
- The spectrometer will also be used for studying the plasma chemistry taking place inside a plasma reactor, used for synthesizing nanoparticles of different high temperature materials, which is another active activity going on at TPPML.



The complete spectrometer setup after installation; Inset (right side bottom) shows the CCD.

## International Conference on Dusty Plasmas (ICDP) 2014

International Conference on Dusty Plasmas was held at Delhi on 3<sup>rd</sup>- 7<sup>th</sup> March 2014. IPR participants included Prof. Kaw, Prof. Sen, Prof. A. Das, P. K. Chattopadhyay, S. Mukherjee, M. Kundu, D. Sharma, R. Ganesh, Pintu Bandyopadhyay, Swati Barua, Sanat Tiwari, Manjit Kaur, Vikram Dharodi, Akansha Gupta, Harish Charan, Surabhi Jaiswal and Modhu L.



Group picture of ICDP-2014 Conference



Manjit Kaur receiving the Best Poster Award



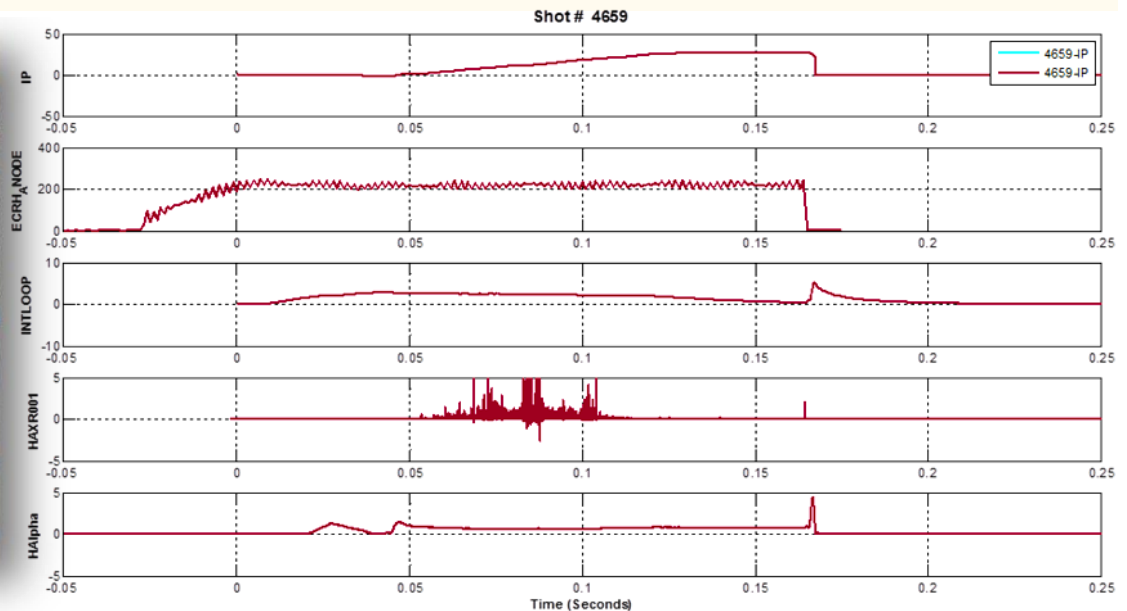
Enjoying lighter moments after brain storming sessions!

*Keep your face towards sunshine, and you will never see a shadow. - Hellen Keller*

- ◆ **ECRH** system is being used to carry out experiments related plasma breakdown, start-up, heating and current drive in SST-1 as well as Aditya. The breakdown with ECRH is essential in superconducting tokamaks like SST-1 to avoid sharp rise in ohmic (di/dt) as it may trigger quench in superconducting magnets. Also, pre-ionization with ECRH helps in reliable start-up of tokamak even at higher error field in tokamak. It saves the volt-second consumption, which helps in elongation of plasma shots. The ECRH also helps in MHD suppression and instability control like NTM suppression and saw-tooth control.
- ◆ A standard ECRH system consists of high power microwave source- Gyrotron, corrugated waveguide based transmission line and mirror based launcher. The Gyrotron is a delicate high power microwave tube operating at very high voltages ( $\sim 50\text{kVDC}$  beam voltage and  $+20\text{kV}$  anode voltage), and requires dedicate protection system to remove high voltage within 10microseconds. An Ignitron based crowbar system has been developed successfully at IPR, which removes the high voltage within the safe limit. Approx. 20m long transmission line consists of a matching optic unit, DC breaks, circular corrugated waveguides, miter bend and polarizer which transmit the power from Gyrotron to Tokamak. The Launcher consists of focusing and plane mirror combination to launch focussed beam in tokamak.
- ◆ In SST-1, two ECRH system are used (1) 42GHz/500kW/500ms ECRH system for 0.75T and 1.5T operation and (2) 82.6GHz/200kW/CW ECRH system to carry out experiments at 1.5T and 3.0T operation.
- ◆ The 42GHz ECRH system has been successfully commissioned and integrated with SST-1. ECRH power has been launched in fundamental O-mode and second harmonic X-mode and thus successful plasma discharges have been achieved at 0.75T and 1.5T operation. Approx 200-300kW ECRH power is launched around 50ms before the loop voltage for pre-ionization in the tokamak for duration of 150ms. The pre-ionized density with ECRH varied from  $5 \times 10^{12}$  to  $1 \times 10^{13}$  per  $\text{cm}^{-3}$ .



42GHz ECRH system at IPR



SST plasma shot assisted with ECRH

## High Temperature X-Ray Diffraction System

**X-Ray Diffraction** system is a non-destructive materials characterization equipment that can identify the atomic and molecular structure of crystalline materials metals, alloys, coatings etc.

### Salient features of the machine:

- ◆ Phase analysis of various materials (in the powder form less than  $10\mu$  size) such as steels, super-alloys, ceramics etc and calculation of crystallite size.
- ◆ High temperature XRD studies can be done from  $30$ - $1200^\circ\text{C}$  at different time and temperature intervals.
- ◆ However, the sample should be in the form of a compacted pellet (of typically  $10\text{ mm}$  diameter and  $0.8\text{ mm}$  thick) for the high temperature XRD studies.

Recently a High Temperature XRD machine (BRUKER, D8 Discover with HT module, Bragg Brentano mode) has been installed at FCIPT, IPR.





- ◇ A workshop on “Prevention and Response to nuclear/radiological Threats / Emergency” was arranged during April 2 – 4, 2014. This was to develop awareness among the first responders in the Gujarat State in case of a nuclear or radiological threat.
- ◇ Dr. Pradeepkumar A. S, Head, Radiation Safety Systems Division from BARC inaugurated the workshop and delivered the keynote address.
- ◇ 67 participants attended in which 13 lectures and 5 specific practical sessions were delivered by faculty members from BARC and IPR.
- ◇ RSSD/BARC will be installing Radiation Detection Systems (RDS) on two special patrolling police vehicle provided by the Gujarat Police. Also 2 Mini Rad Monitors and Digital Dosimeters will be given to them.



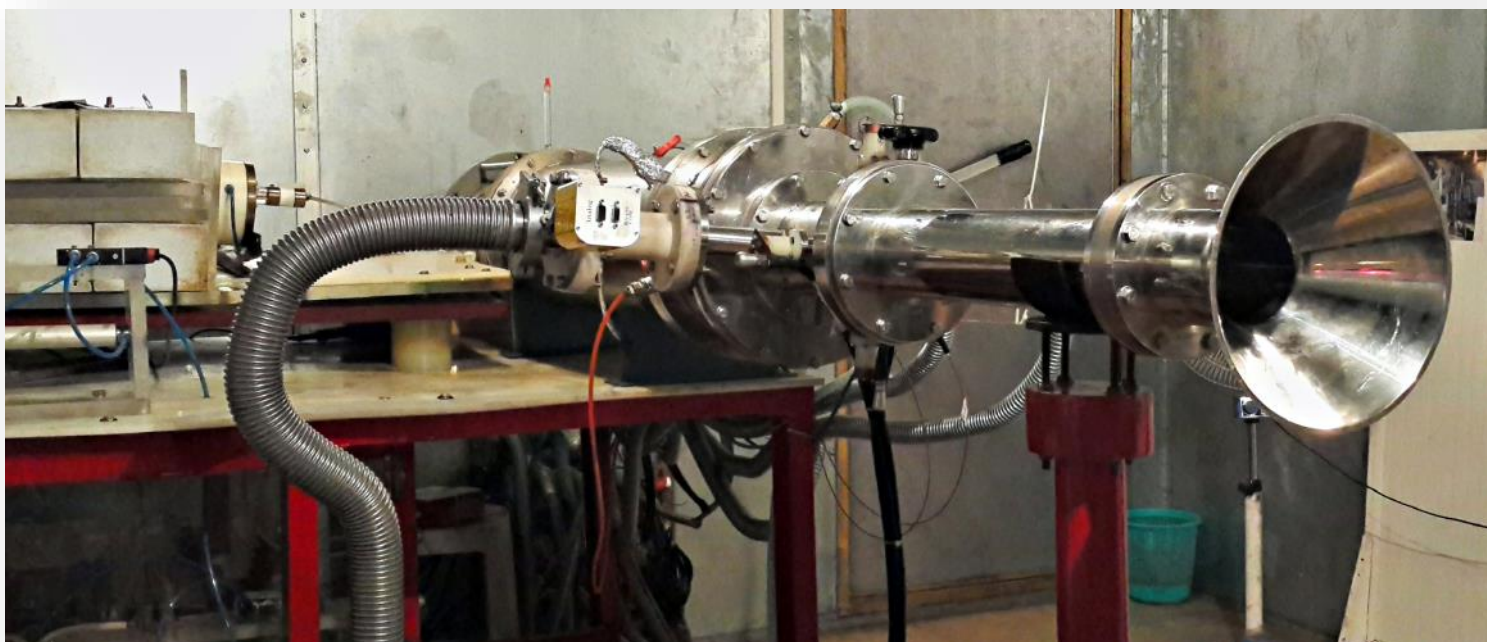
**IPR is one of the 22 DAE-Emergency Response Centers spread over country**



## VIRCATOR Studies at IPR

VIRCATOR (Virtual Cathode Generator) and Relativistic Magnetrons are two of the few HPM (High Power Microwave) generators which are currently being studied at IPR.

- VIRCATOR requires pulsed high voltage ranging from -200 kV to -1 MV and current from 10 kA to several kAs with fast rise times. This whole system generates electrical powers well in excess of 20 GW.
- The power pulse delivered to the load attains 6 GW when the pulse forming line is charged to about 300 kV and an even higher power output can be delivered if required.
- The success of this work opens the way toward a very compact and repetitive table-top generator for producing an electrical power in excess of 20 GW when coupled to a HPM load such as VIRCATOR.



View of the VIRCATOR assembly. The high power microwave generated exits through the conical horn.





L-R : Piyush Raj, Parvez Mir , Ashok Mankani and Karishma Quereshi

A new executive committee was elected by the GBM at the meeting held on 25th April, 2014. The outgoing committee members *Sutapa Ranjan* (President), *Rajesh Kumar* (General secretary), *Smita Parmar* (Cultural secretary), *Ankit Gandhi* (Sports secretary) and *Ashesh Shah* (Treasurer) expressed their gratitude towards the Director and staff members of IPR for their support and participation in all the endeavors of the Staff Club.

## Newly elected members of the Staff Club Executive Committee

<b>President</b>	Mr Ashok Mankani
<b>Secretary</b>	Ms Karishma Qureshi
<b>Sports secretary</b>	Mr Piyush Raj
<b>Cultural secretary</b>	Ms. Sapna Mishra & Mr. Amaliar Rajnikant G
<b>Treasurer</b>	Mr Parvez Mir

## The Tree Of Heaven!



Come March–April every year, this tree, known as The Tree of Heaven (*Ailanthus Excelsa*, અર્જુસો in Gujarati) gives a look and feel of it itself living through hell. Anyone who passes casually under these trees are sure to get themselves enmeshed in an invisible web of silk threads of the larvae swinging down from the tree to possibly escape the hot summer sun. The vibrant and thick green foliage of these trees are completely devoured by the larvae of Ailanthus silk moth that is said to produce silk which is more durable and cheaper but of inferior finish and gloss. It is said that a cycle of ten generations of this moth passes through a tree every year peaking by the end of the winter. The swarms of larvae on the tree makes it look both revolting and bewitching at the same time ! By the first week of May, these trees having got rid of the larvae, once again regain their lush green foliage. The larvae are such that small and weak trees may not possibly survive this onslaught. Maybe the large black & red stork nesting on the top of the tree in the picture knows a lot more about this whole affair, not to mention the free lunch of protein rich larvae that it gets !

## Silver Stars



**Dr. Arvind K Agarwal** joined IPR in 1986 and has been working in the field of plasma equilibrium and stability in tokomaks, experimental time series data analysis, non-linear dynamics and chaos. Currently he works on 12-D non-linear dynamical system to unify space-time and to determine collective non-co planar dynamics of particles in spherical geometry.

**Mr. Jayeash M Gandhi** joined IPR in 1986. He looks after the general personnel air-conditioning systems and its maintenance. He runs the computerized automation system (BMS) as per the requirement at premises like Aditya Tokomak hall.

**Mr. Bindeshkumar M Parmar** joined IPR in 1987. He takes care of water/drainage systems at IPR premises including ITER (I) and FCIPT and is also involved in maintenance of office furniture, minor repairs and also in organizing various official functions and events.

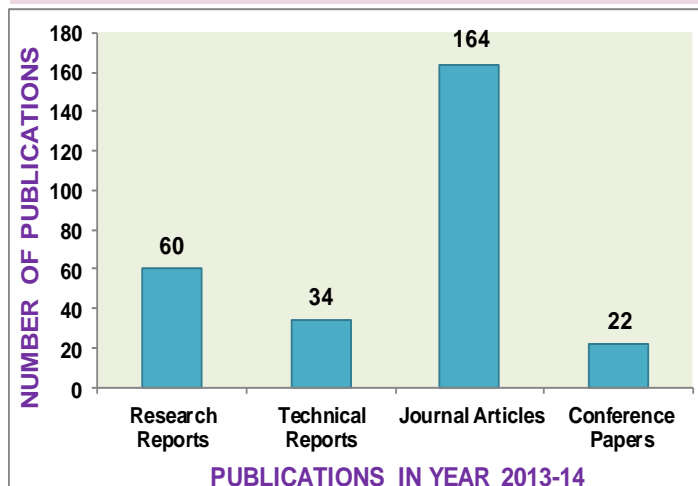


- ♦ **Dr. Shailesh Desai**, Director, Cardio Uno Plus Heart Disease Prevention Centre, Ahmedabad, gave a talk on "Health Education Awareness" on 13th May 2014.

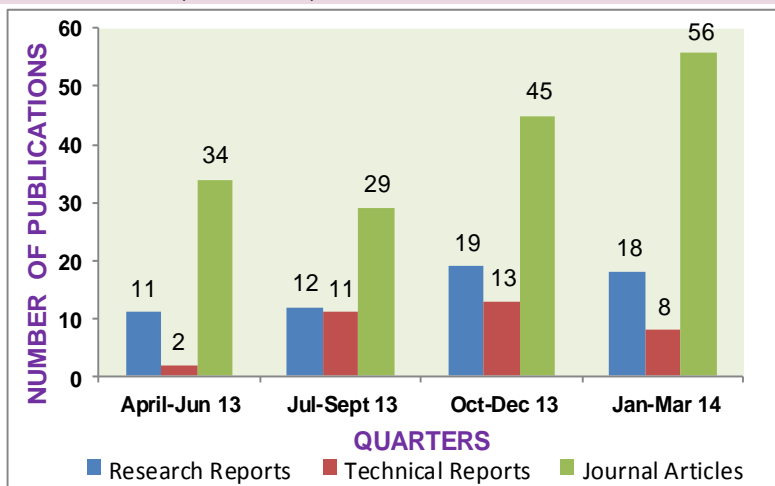
## Upcoming Events

- ♦ 20th Topical Conference on High-Temperature Plasma Diagnostics (HTPD 2014), Atlanta, Georgia, USA, 1-5 June 2014. Web link: <http://web.ornl.gov/sci/fed/HTPD2014/index.html>
- ♦ 2014 IEEE International Power Modulator and High Voltage Conference (2014 IPMHVC), Santa Fe, New Mexico, USA, 1-5 June 2014. Web link: <http://www.eng.auburn.edu/pmhvc2014/>
- ♦ 7th Chaotic Modeling and Simulation International Conference (CHAOS2014), Lisbon, Portugal, 7-10 June 2014. Web link: <http://www.cmsim.org/>
- ♦ 12th Kudowa Summer School "Towards Fusion Energy", Kudowa Zdroj, Poland, 9-13 June 2014. Web link: <http://www.kudowaschool.ipplm.pl/>
- ♦ 5th International Particle Accelerator Conference (IPAC 14), Dresden, Germany, 15-20 June 2014. Web link: <http://www.ipac14.org/>
- ♦ 26th Symposium on Plasma Physics and Technology (SPPT), Prague, Czech Republic, 16-19 June 2014. Web link: <http://www.plasmaconference.cz/>
- ♦ Plasmas, Surfaces and Thin Films, London, United Kingdom, 19 June 2014. Web link: <http://www.iopconferences.org/iop/550>
- ♦ High Tech Plasma Processes (HTPP 2014), Toulouse, France, 22-27 June 2014. Web link: <http://htpp2014.sciencesconf.org/>
- ♦ 9th International Conference on Plasma Assisted Technologies (ICPAT-9), Saint Petersburg, Russia, 23-26 June, 2014. Web link: <http://www.plasmacombustion.com/iwepac.html>
- ♦ 41st EPS Conference on Plasma Physics, Berlin, Germany, 23-27 June 2014. Web link: <http://eps2014-berlin.de/>
- ♦ IPR Summer School Programme (SSP-2014) begins on 2nd June, 2014 at IPR.

## IPR Publication Statistics (2013-14)

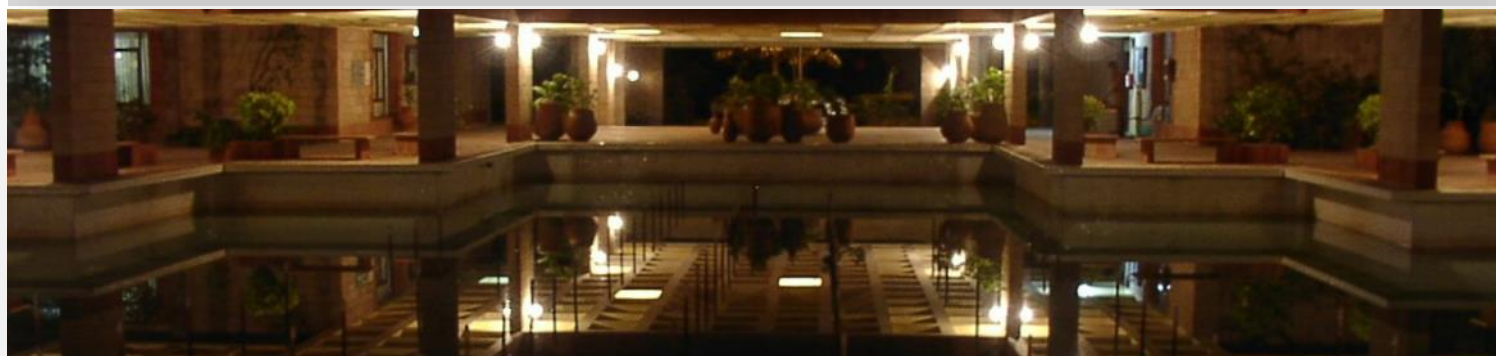


Publications in the year 2013-14



Quarterly distribution of publications

## From the IPR Archives



Night view of the old water body of IPR

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Issue 5, 15-May-2014

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