Year 2013
Issue 3
October

The Fourth State

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

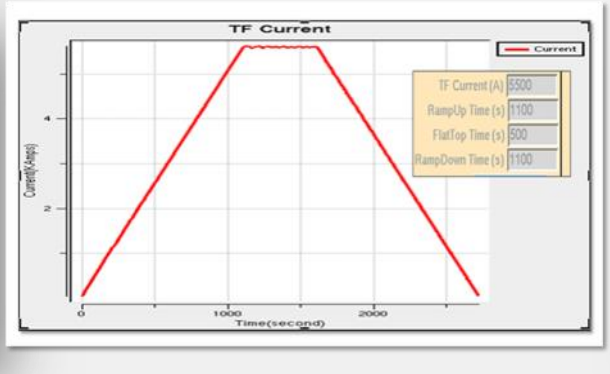
From the editorial desk

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 / feedback to the committee at <newsletter@ipr.res.in> for improvement of the look and contents of the newsletter. Thank you..

SST-1 News

- **SST-1 campaign-V experiments** were carried out from Sep 18 to Oct 06, where the pre-ionization was assisted by both fundamental O mode and second harmonic X mode of Electron Cyclotron Resonance System.
- The plasma current was attempted to be raised with the help of a limited loop voltage and this will be continued in the Campaign-VI scheduled from the second half of Nov 2013 with reduced impurities in the plasma volume.
- During campaign- V, the SST-1 Toroidal Field (TF) magnets could be operated in excess of **3600s** of flat top at 1.5 T, in which most of the plasma experiments were carried out.
- SST-1 superconducting TF magnet system also achieved **1.8T** with a flat-top of 500s. This campaign experimentally established the robust operational feasibilities of the SST-1 TF magnets in high fields.

Plasma ring formed in shot # 4500

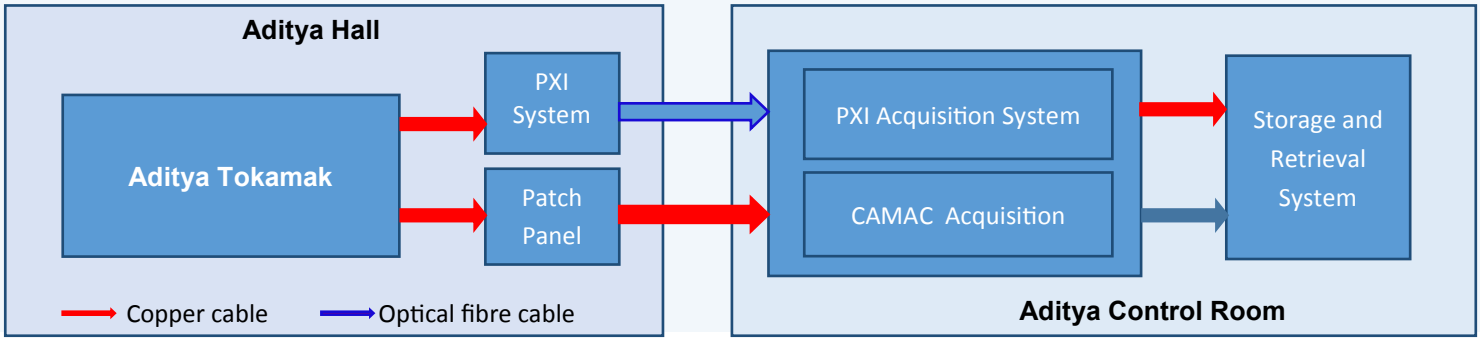


TF Magnet was charged at 1.8 T with a flat top of 500s

Plasma ring formed in shot # 4503

Aditya Data Acquisition, Retrieval and Analysis

Nearly 20 MB of data per shot from ~296 channels, (CAMAC (200) & PXI (96)) is to be acquired and stored in binary data files with relevant information and then transferred on to the data server. Regular backup of these data on DVD/LTO media is carried out on weekly basis for their permanent storage. The data is available on Intra-net and can be analyse using Matlab or MDS+. Display of data at remote site using MDS+ is also possible. The analysis of data, can be done using Matlab by specifying channel number or using MDSplus data visualization tool - jScope by specifying signal name.



!! Congratulations !!

Dr. Tejen Kumar Basu, Raja Ramanna Fellow of DAE was awarded the "***Indira Gandhi Rajbhasha Purashkar***" for the year 2011-12.

The award presentation function was held at the Plenary Hall, Vigyan Bhavan, New Delhi on 14th September 2013 and the **Honorable President of India, Shri. Pranab Mukherjee** presented the award to Dr. Basu.

Dr. Subrata Pradhan has been conferred the '**Buti Foundation Award 2013'** by the Physical Research Laboratory, Ahmedabad, for his **o**utstanding contributions to Plasma Sciences and Technology in India. This biennial award was instituted by the Buti Foundation in 2007 New Delhi. This award carries a Citation, a Medal and Cash Prize of ` 50,000/- . Dr. Pradhan shares this award with *Dr. Prasad Subramanian* from IISER, Pune.

ITER News

Ministerial representatives reaffirm the importance of ITER

Ministerial representatives from seven ITER members gathered for a historic **ITER Council Ministerial-Level Meeting** at Saint Paul Lez Durance on 6th September 2013. The meeting was convened at the initiative of European Commissioner in charge of Energy and representative of the European Atomic Energy Community.

The Indian Team was led by **Dr. Ravi Bhushan Grover**, Member of the Atomic Energy Commission and Director of the Homi Bhabha National Institute.

It was the second time in the project's history that ministerial representatives of the seven ITER Members (China, European Union, India, Japan, the Republic of Korea, the Russian Federation and the USA) came together. They also visited site of construction to see the progress in the implementation of the project, discussed the challenges in regards to the schedule and cost containment, and reiterated their common effort towards the successful completion of ITER.


Indian staff at ITER with Prof. Grover and Prof. Bora at Saint Paul Lez Durance

Silver Stars of IPR

The journey of IPR started in early 80's, and in the last 30 years has achieved several heights of success. This overwhelming journey would not have been possible without sustained efforts, dedication and reverence of our employees. In the coming months, through this exclusive column, IPR wishes to acknowledge and express its gratitude to its employees who have been part of IPR's glorious journey for more than 25 years. They are the **SILVER STARS of IPR.** (The names will be selected at random).

A. SARDA SREE
Year of joining : 1986.
Current group : TBM (Test Blanket Division)

SHANKARA JOIYSA
Year of joining : 1983
Current group : Diagnostics (X-Ray)

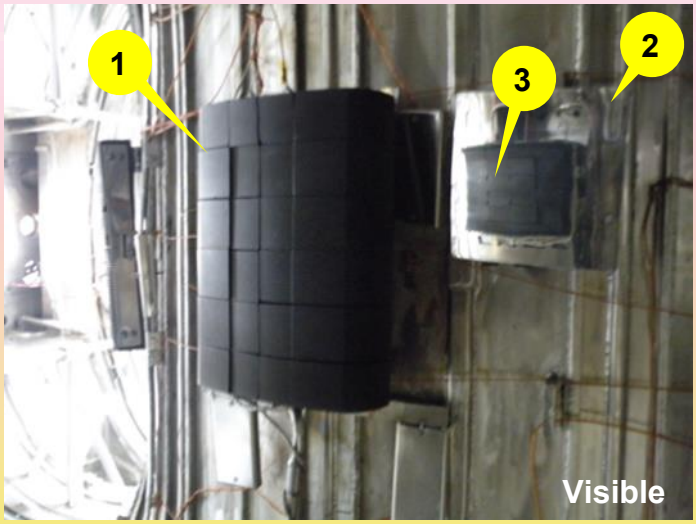
P. K. ATREY
Year of joining : 1986
Current group : Diagnostics (Microwave)

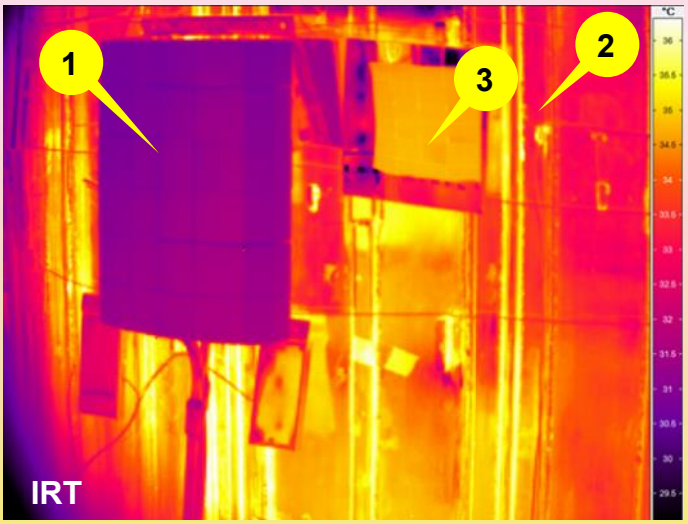
Infrared Thermography of Plasma Facing Components (PFC)

- **Infrared Thermography (IRT)** is an important plasma diagnostic used for real time **monitoring of surface temperature** of an object remotely, with wide field of view.
- The PFC tiles are highly susceptible to structural damage due to intense localized heat load under operational conditions. Further, the particles ejected from the tiles can affect plasma boundary condition.
- IRT is comparatively less susceptible to the electro-magnetic and nuclear radiation induced noises, provided suitable shielding techniques are used. For this reason, IRT is used for the surface temperature measurement of (PFCs), in-vessel inspection during plasma discharges, monitoring the health status of the limiter tiles, heat load estimation and several other physics studies.

Typical parameters of the IRT system deployed in ADITYA and SST-1 Tokamak are as follows:

- Location: Radial port#3 (ADITYA) ; Radial port#12 (SST-1)
- Spectral response: 2μm to 5μm; Pixel array: 320x256; Dynamic Temperature range: -10°C to 1200°C
- Frame rate: 150-400 Hz full frame rate (corresponding time resolution: 2.5-7 ms)
- IR transmission Vacuum view port: CaF2, Al2O3 (>95% in 2μm to 5μm range)
- Field of View: FOV~22° (horizontally) x 17° (vertically) which covers inboard limiter in direct view and outboard limiter in reflected view using SS mirror (reflectivity>90%) mounted on the inboard side for both the machines.





Visible and IRT images of the SST-1 limiter. **(1)** In-board limited (Direct view) **(2)** SS Mirror **(3)** Outboard limiter (reflected view)

IPR New Extension Labs

Under 12th Plan, several new projects have been sanctioned to various groups in IPR. In order to accommodate the laboratories of these newly sanctioned projects, an extension laboratory of IPR has been established at Gandhinagar. So far, eight new projects have set up their laboratories at this facility.

Experimental Lab	Division Head
Divertor and First wall Technology Development Division	Dr. Samir Khirwadkar
Cryo-adsorption & Cryo-pump group	Mrs. Ranjana Gangadrey
Fusion Reactor Material Development & Characterization (FRMDC) Division	Dr. P.M.Raole
Remote Handling & Robotics Technology Development Lab	Dr. Ravi Prakash
Electromagnetic manufacturing system – BARC	Dr. Rajesh Kumar
Pulse Power & RFQ development	Dr. Rajesh Kumar
Fusion Fuel Cycle Division (TBM & FFC)	Dr. Sarkar/ Dr. Amit Sircar
LIGO Project	Dr. Ajai Kumar

Can water become plasma ? For water to become a plasma, the individual hydrogen and oxygen atoms needs to be broken apart and ionized separately, and if the molecular structure is broken apart, then water is no longer water. An elemental gas like hydrogen can transition between gas and plasma and back to gas. But once water molecules are split apart and ionized, those disparate atoms will not naturally return back to a water form.

हिन्दी दिवस समारोह

प्लाज़्मा अनुसंधान संस्थान में **12-13 सितम्बर**, 2013 को हिन्दी दिवस समारोह का आयोजन किया गया। इस समारोह में कुल नौ प्रतियोगिताओं- वैज्ञानिक या प्रशासनिक लेखन, हिन्दी पोस्टर, कविता लेखन (स्वरचित- कर्मचारियों के बच्चों के लिए), नारा लेखन, निबन्ध लेखन, हिन्दी ज्ञान प्रश्नावली, तात्कालिक भाषण, वाद-विवाद, कविता पाठ का आयोजन किया गया। इन प्रतियोगिताओं में संस्थान के अधिकारियों, कर्मचारियों, प्रशिक्षुओं व शोधकर्ताओं ने बड़े उत्साह से भाग लेकर अपनी प्रतिभा का परिचय दिया।

हिन्दी पोस्टर में विज्ञान, हिन्दी साहित्य, कविताएँ, कहानी एवं अन्य विषयों को पोस्टर के माध्यम से हिन्दी में प्रस्तुत किया गया। प्रतिभागियों ने हिन्दी भाषा के प्रति जागरूकता की प्रेरणा देने वाले, संदेश से ओतप्रोत, रोचक पोस्टर प्रस्तुत किए। नारा लेखन प्रतियोगिता के अंतर्गत बेटी बचाओ विषय पर एवं खाद्य सुरक्षा बिल या भारत की वर्तमान अर्थव्यवस्था विषय पर निबन्ध लेखन प्रतियोगिता का आयोजन किया गया। हिन्दी पोस्टर प्रतियोगिता के लिए प्राप्त पोस्टरों को प्रदर्शित किया गया। साथ ही हिन्दी साहित्य जगत की प्रसिद्ध कविताएँ, ग़ज़ल, हास्य-व्यंग्य से ओतप्रोत कविताएँ, हिन्दी भाषा की महत्ता पर कविताएँ भी पोस्टर के रूप में संस्थान के परिसर में प्रदर्शित की गई।

हिन्दी दिवस पे आयोजित विभिन्न प्रतियोगिताओं का आनंद लेते हुए आई.पी.आर जन सभा

हिन्दी दिवस समारोह कार्यक्रम में राजभाषा कार्यान्वयन समिति के अध्यक्ष श्री राजसिंह ने परमाणु ऊर्जा विभाग के सचिव के संदेश का वाचन किया। उन्होंने अपने संबोधन में कर्मचारियों को संस्थान में हिन्दी के प्रयोग को व्यापक रूप से बढ़ाने हेतु मार्गदर्शन दिया और संस्थान में हो रही हिन्दी गतिविधियों पर प्रकाश डाला। राजभाषा कार्यान्वयन समिति के सदस्य श्री हरीशचन्द्र खण्डूरी ने मनोरंजन पूर्ण ढंग से इस कार्यक्रम का संचालन किया।

इस सत्र में वाद-विवाद और कविता पाठ प्रतियोगिता आयोजित की गई जिसमें प्रतिभागियों ने अपनी तत्परता, तीक्ष्णबुद्धि, सृजनशीलता का परिचय दिया। वाद-विवाद प्रतियोगिता में सोशियल नेटवर्किंग वेबसाइट : वरदान या अभिशाप? विषय पर प्रतियोगियों ने तर्कसंगत और रोचक प्रस्तुति दी। कविता पाठ प्रतियोगिता में प्रतिभागियों ने विचारशील, गंभीर और हास्य-व्यंग्यपूर्ण शैली में कविताओं का पाठन कर श्रोताओं का मनोरंजन किया।

श्री रत्नेश्वर झा, श्री गौतमचन्द सेठिया, श्री रश्मीभाई यू पंडया, श्री प्रवीण कुमार आत्रेय, श्री सूर्य कुमार पाठक, श्री सूर्यकान्त गुप्ता, श्री रमेश डी, श्री नरेशचन्द गुप्ता, श्री हरीशचन्द्र खण्डूरी, श्री लक्ष्मीकांत बंसल, श्री हरीश मसन्द, श्री रितेश सुगन्धी, श्रीमती संध्या दवे - इन प्रतियोगिताओं के निर्णायक रहे। सभी विजेताओं को पुरस्कृत किया गया। कार्यक्रम के अंत में राजभाषा कार्यान्वयन समिति की सदस्य सुश्री प्रतिभा गुप्ता ने हिन्दी दिवस कार्यक्रम को सफल बनाने हेतु सभी को धन्यवाद दिया।

माननिय आत्रे जी द्वारा प्रतिभा गुप्ता सम्मानित

विदेशी भाषा का किसी भी स्वतन्त्र राष्ट्र के राजकाज और शिक्षा की भाषा होना सांस्कृतिक दासता है." - वॉल्टर केनिंग (ज़रा सोचिए)

Industrial Applications of Plasma for surface hardening at FCIPT

- **Surface hardening** is a process for obtaining desired characteristics in terms of hardness and toughness on the exterior of a steel component such as cams, gears, shafts etc. which are subjected to rough operating scenarios.
- **Plasma based diffusion processes** like plasma carburising, plasma nitriding are now being increasingly used as surface hardening technique in most of the industrials sectors like automobile, textiles, machinery, etc.

Salient Features of Plasma Nitriding:

- Performance, lifespan, strain limit and fatigue strength of the metals gets boosted.
- Easy to manipulate the metal surface with required phase
- The process is user-friendly - no post-nitriding operations are required on the treated objects before use.
- Saves energy since it works fastest, and causes little or no distortion.
- High reproducibility & Shorter cycle time
- No salt residues, therefore no removal expenses caused by those undesirable salt deposits on the work piece surface, in holes and threads required.

Recently installed Industrial Scale Plasma Nitriding Reactor at the Central Tool Room, Ludhiana

Gear parts undergoing plasma nitriding at FCIPT

IPR Views

View of the liquid nitrogen and liquid helium tanks of the SST 1 cooling system - Photo by K. K .Mohandas

A male weaverbird in action during summer, getting his home ready for impressing potential mates ! - Photo by Ravi A.V. Kumar

Administrative Training for IPR Staff

Nine scientific staff from IPR attended a “Capacity Building Workshop” for potential *deputationlists* to international projects of DAE at Administrative Training Institute, DAE, Anushakthi Nagar, Mumbai during 3-8 October, 2013. Activity based trainings in personality development, visual and voice communications, usage of MS office etc. were imparted to the participants. They were also given lectures related to various activities of DAE and also about various laws and conventions in International arena for nuclear energy.

IPR Participation in International Events

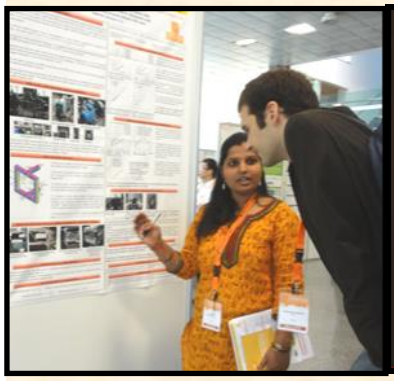
LPAW– 2013 : Laser and Plasma Accelerator Workshop (LPAW-2013) was held at Fort Aguada , Candolim, Goa from September 2-6, 2013.

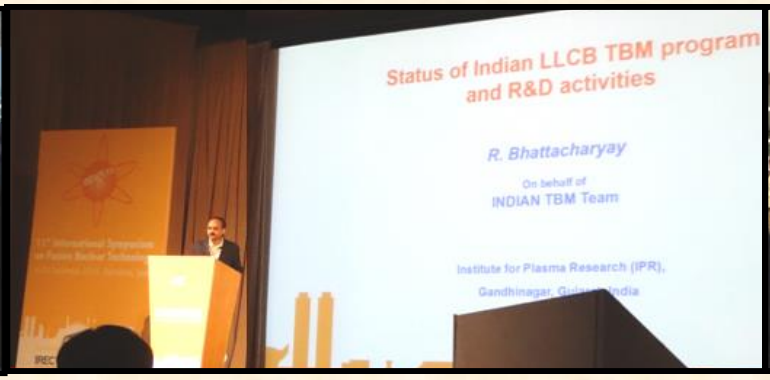
Prof. Kaw in conversation with Prof . Chandrashekar Joshi and Prof. Katsouleas during LPAW 2013

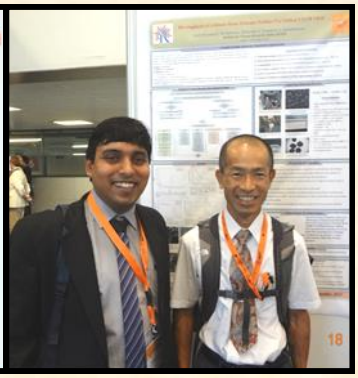
The international work shop was attended by leaders in the field and well over a hundred delegates. The work-shop was initiated with a lightning round session premièred by Prof. Kaw on "Plasma accelerator and laser-plasma interaction studies in India" . IPR delegates Deepa Verma (Basic Theory & Simulations Division), Chandrasekhar Shukla (Basic Theory & Simulations Division) and K. Mohandas (Accelerator Division) presented theoretical as well as experimental work in 4 posters.

ISFNT-13 : 11th International Symposium on Fusion Nuclear Technology (ISFNT), held in Barcelona, Spain, from 16-20 September 2013.

Anita Patel (TBM division) and Aroh Shrivastav (TBM division) presented posters while R. P. Bhattacharya (TBM division) and Sameer Khirwadkar (Divertor Technology Division) gave oral presentations







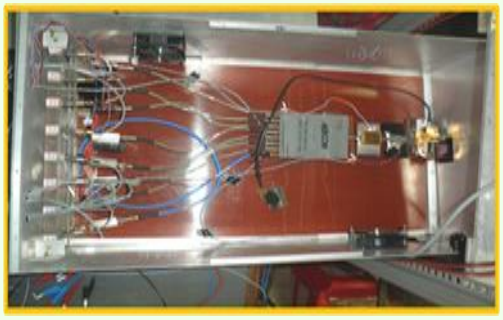
KIT SUMMER SCHOOL PROGRAMME– 2013: 7th Karlsruhe International School on Fusion Technologies was organized at Karlsruhe, Germany from 2nd Sept– 13th Sept 2013.

A variety of lectures were delivered by international experts from CCFE, CEA, ENEA, KIT and industry. IPR participant were Vinay Menon (Divertor Technology Division), Amit Sircar (TBM Division) and P. Rayjada (FCIPT).

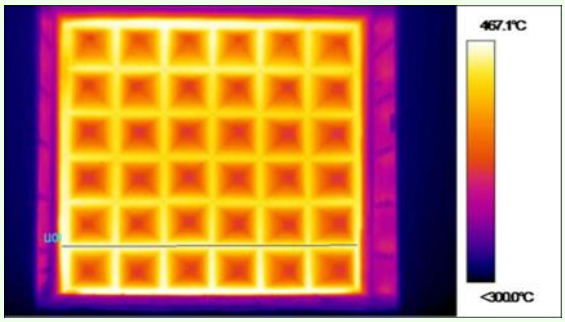
The purpose of learning is growth, and our minds, unlike our bodies, can continue growing as we continue to live - *Morris Adler*

Development of E-Band (74 – 86 GHz) Heterodyne Radiometer at IPR

- An E-Band (74 – 86 GHz) Heterodyne Radiometer designed and developed to determine electron temperature in plasma in SST-1, Calibration of which is done by the Hot-cold Dicke switch method, wherein the receiver is switched between two different temperatures.
- Instead of calibrating the system between room temperature and cold body (usually liquid nitrogen, 77K), the calibration is done with an indigenously developed black body source made of silicon carbide as our hot body source at a temperature of 600 ° C and liquid nitrogen (77K) as the cold body source and determined the calibration factors. The intensity of each channel is multiplied with calibration factor to determine the plasma temperature profile.



The heterodyne radiometer system



The temperature profile of the hot calibration source

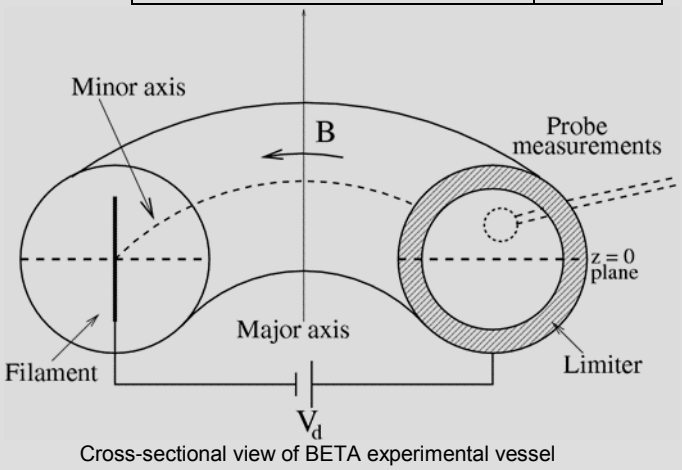
Achieved System Parameters	
Noise Temperature	1 eV
Noise Figure	16 dB
S/N Ratio	14
Sensitivity	$5x10^9$ V/W

A Simple Magnetized Torus at IPR

- **Basic Experiments in Toroidal Assembly (BETA)** which can be termed as the "mother of IPR's Tokamaks" is simple magnetized torus, which was conceived, designed and built in the early days of IPR over 3 decades ago. It was the experience gained on this machine that led to bigger projects such as Aditya, and SST-1.
- The experimental results on BETA provides a wide scope to study phenomena similar to edge plasma in tokamaks, fluctuations, instabilities and intrinsic flow generation.

Parameters of BETA	
Major radius	45 cm
Minor radius	15 cm
No. of TF coils	16
No. of VF coils	2
Maximum toroidal Field	0.1 T
Neutral/ working gas pressure	10^{-4} Torr
Total no. of ports	40

The BETA experimental device



Cross-sectional view of BETA experimental vessel

Outstanding Staff Member of the Year (OSMY) Award

The OSMY award was instituted in 1988 in order to motivate and encourage the scientific and technical support staff of IPR. The award is given every year (except in 1996,1998 and 2000) during the annual day of IPR. This award carries a citation and a cash prize of Rs.5000/-. The following are the list of all previous winners of this award.

1988	K. Sathyanarayana	1994	Sunil M. Belsare	2003	Pratibha Semwal	2009	Vijaykumar Chauhan
1989	U. N. Savai	1995	S. R. Shah	2004	S. J. Jadeja	2010	S. J. Jadeja
1990	J. D. Patel	1997	C. K. Adak	2005	Chetan G. Virani	2011	Chirayu Patil
1991	A. N. Joshi	1999	Pankaj Srivastava	2006	Adam B. Sanghariyat	2012	Sanjay Pandya
1992	B. M. Parmar	2001	Dasarath Sonara	2007	Silel T. Shah		
1993	K. Sathyanarayana	2002	O. R. Kaila	2008	Ketan M. Patel		

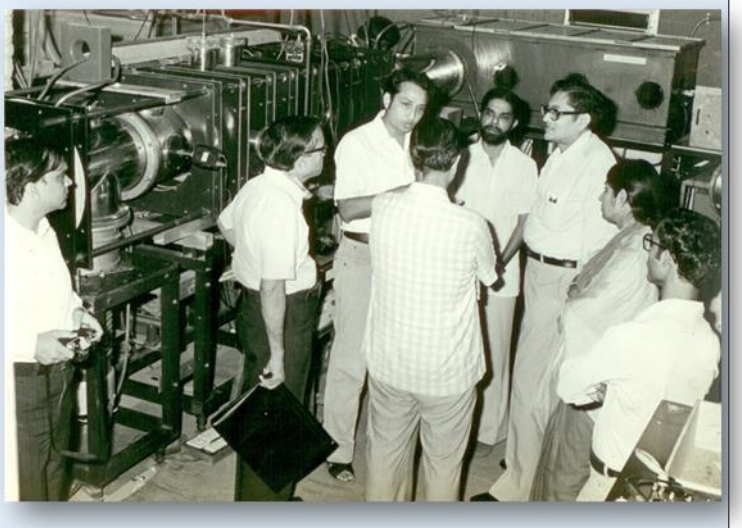
Past Events @ IPR

- **Prof. Ram K. Varma,** Ex-Director, Physical Research Laboratory, Ahmedabad given a talk on "A novel macro-scale matter wave dynamics embedded in the Lorentz trajectory – a consequence of quantum entanglement (Colloquium #223) on 16th September 2013
- **Dr. Vishwa Bandhu Pathak,** Instituto Superior Técnico, Lisbon, Portugal, gave a talk on "Controlled self-injection of electrons in the laser wakefield acceleration" on 18th September 2013
- **Dr. A T T Mostako,** Laser and Photonics Lab, Indian Institute of Technology Guwahati, gave a talk on "Studies on pulsed laser deposited Mo, W and Rh thin films for First Mirror application" on 30th September 2013

Upcoming Events

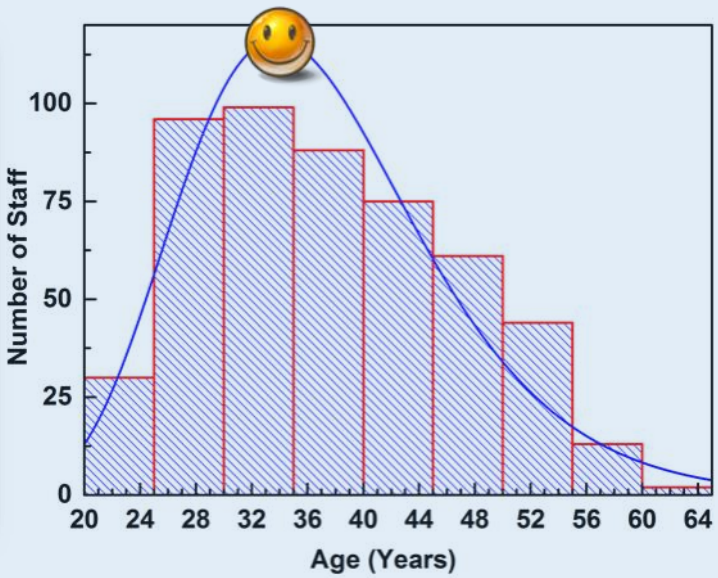
- **IPR annual day** 19th October, 2013
- **Topical Conference on Atomic Processes in Plasmas** (ISAMP-TC-2013) @ IPR from 18-20 November 2013
- **PLASMA - 2013** @ KITT University, Bhubaneswar from 3-6 December 2013

From the archives of IPR



Early days of the Plasma Physics Programme (PPP) which later evolved to become the Institute for Plasma Research. Prof. Saxena, Prof. Sen and Prof. John in a discussion in front of the REB generator based experiment.

IPR Staff - Age distribution



A look at the statistical distribution of the age of IPR employees shows that maximum number of staff are in the age group 32-36 years. IPR is indeed "Young" !

The Team

Mohandas K.K.
Shravan Kumar
Swati Roy

Chhaya Chavda
Ramasubramanian N.
Ravi A V Kumar

Hiral B. Joshi
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When the heavens opened up on 8th October, 2013 — Ravi A. V. Kumar

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