

Issue 6

June 2014

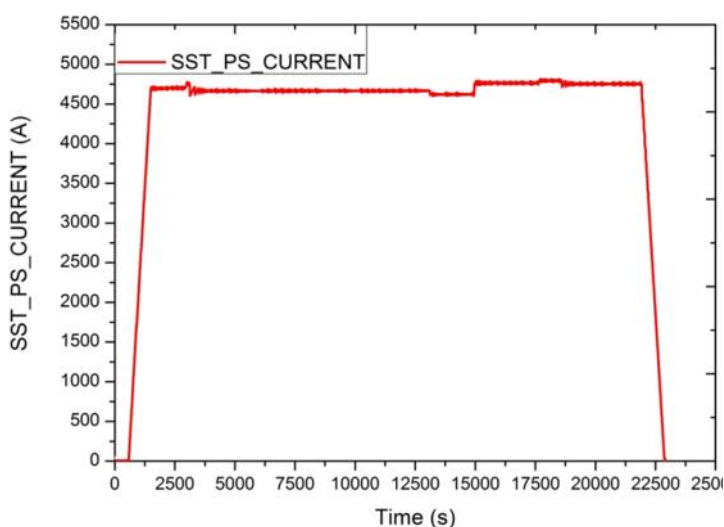
# The 4<sup>th</sup> State

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

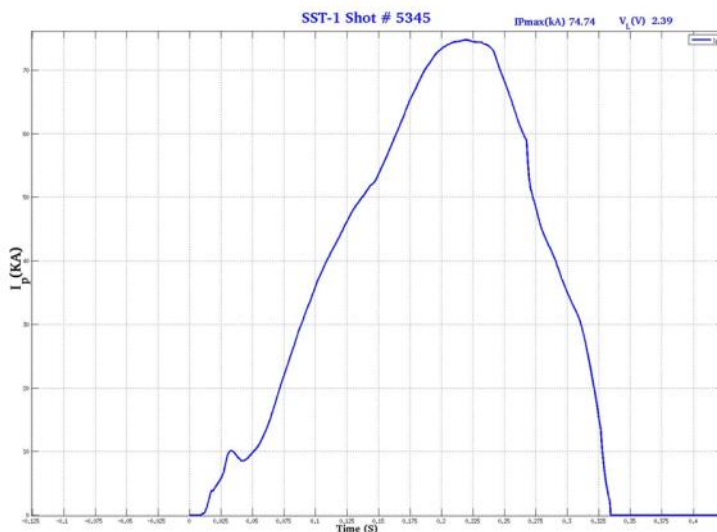
## SST-1 News

SST-1 has made significant milestone achievement during the campaign-IX that concluded on May 31, 2014. During this campaign, SST-1 Toroidal Field Magnets achieved the unique feat of operating its superconducting mode with magnetic field flat tops exceeding 20000 seconds at a field of 1.5 T on the plasma centre ( $\sim 2.8$  T on the magnet winding packs) in Two Phase cooling conditions.

As of now, SST-1 superconducting magnets are the only magnets in the world that operates in two-phase flow in a cryo-stable conditions. During the Campaign-IX of SST-1, a maximum plasma current of 74.64 KA (Fig 2) was achieved assisted with ECH based pre-ionization (in fundamental mode at 1.5 T) lasting for over a duration of nearly 340 ms for the first time. SST-1 campaign-X has begun since June 05 and would be targeted at achieving plasma current in excess of 80 KA lasting in excess of 400 ms.



The superconducting magnets operating for more than 20,000s during the IX<sup>th</sup> Campaign of SST-1.



The evolution of the plasma current during one of the shots in the IX<sup>th</sup> Campaign of SST-1

## IPR Summer School-2014

The SSP-2014 started on 2nd June 2014 and will end on 11th July 2014. This year, there are 46 students, of which 30 are Physics and 16 are Engineering students. The SSP-2014 is being managed by P. Bandyopadhyay, J.Thomas, S.Pandya, Varsha, Hiral, Vinay, Shushant and Sonam.





The Aditya tokamak is the **first indigenously built tokamak in India** and is in operation for last 25 years. At present, the plasma boundary in Aditya tokamak is decided by a circular limiter of radius ~25 cm. The existing Aditya tokamak is going to be **upgraded to have a divertor instead of a Limiter**.

The main purpose of Limiters and Divertors is to separate plasma from the first wall and improve the performance of the tokamak.

Divertors have several important advantages over limiters:

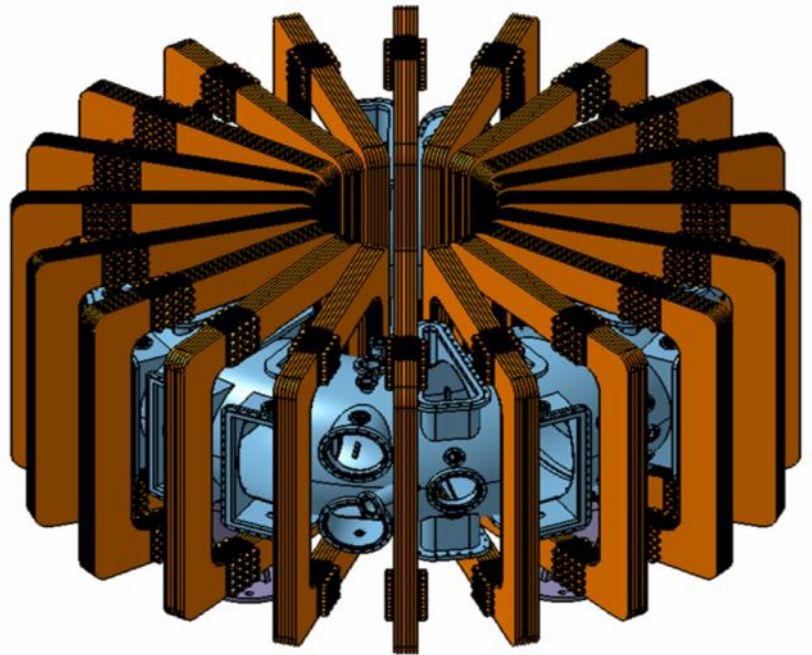
- Materials facing the exhaust plasma are not in any direct contact with the main (confined) plasma.
- Tokamaks with Divertor have lower levels of impurities in the core plasma leading to achievement of higher plasma temperatures, therefore increasing the probability for fusion reactions.
- High confinement modes (or H-modes) can be achieved nearly exclusively in the presence of Divertors.

After upgradation, the **Aditya Upgrade tokamak** will become one of the very few mid-sized tokamaks with Divertor operations in the world.

Small / mid-sized tokamaks have enormously contributed in design and development of big tokamaks both in terms of physics and engineering and Aditya Upgrade will do the same.

Aditya Upgrade tokamak will carry out specific experiments, development and testing of new ideas, technologies and materials, which are not possible or desirable in bigger Divertor tokamaks due to their operational restriction and smaller duty cycle.

3D View of the Aditya upgrade vacuum vessel with the TF coils



## Mother Nature Has Its Own Schedules & Deliverables Too !



The seasons control the schedules and deliverables of the plant kingdom, and they have no choice but to follow it year after year for their survival ! Probably this is the season when their individual work literally bears fruit well in time before the monsoon sets in. Mother nature indeed has worked out a very efficient system to make sure that the plants are ready with their seeds at the right time. Yes, they do have their own worries.. Inclement weather, overzealous and hungry animals, and of course sudden and unwarranted human intervention.. Nevertheless, all these worries are taken in the stride and life goes on ! A few of the early ones have already started dispersing their precious seeds into the wind, wrapped in cotton balls and wings. The scurrying squirrels and the chirping birds pitch in to help them ! A walk around the campus during this time of the year, no doubt, is truly exhilarating and motivating, considering the fact that we too, strive to meet our deadlines and targets !

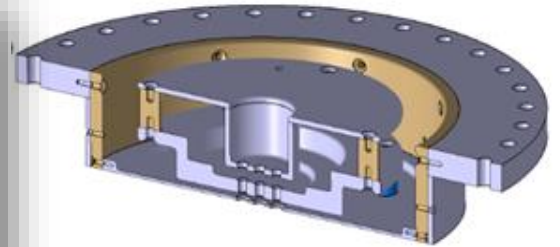


A new experimental setup was fabricated for dusty plasma laboratory, CPP-IPR under 12<sup>th</sup> five year plan at IPR Mechanical Workshop recently to extract the  $H^-$  ions where caesium coated tungsten dust is used to produce  $H^-$  ions. The main parts of the fabricated system are Plasma chamber, Dust dropper unit, Caesium coating unit, Grids assembly, Extraction chamber and Dust collection unit.

The plasma chamber will be used to create hydrogen plasma by hot cathode filament discharge technique. The Cs coating unit will be used to produce Cs coated tungsten dust. Surface ionization detector, Cs oven, view ports, Cs collector, heating and cooling layout will be incorporated with it. The grid assembly will be comprised of plasma grid, extraction grid and acceleration grid. SS will be used as a grid material and three numbers of holes will be used initially to test the extraction possibilities. The extraction chamber comprises with Calorimeter, different HV electrical feed through and additional pumping ports. The extraction chamber can be moved outside with the help of a rail fixed on the main stand. The dust collection unit will be used to collect the dust particles.



(L-R) V. Patel, Dr. B. Saikia, V. Kaila, Dr. C Reddy, Prof. D. Bora, and Mr. Jadeja with the newly fabricated system at IPR workshop.



Ultimate pressure	$\sim 10^{-7}$ mbar
Pumping scheme	TMP backed by a rotary pump
Main parts	Plasma chamber, Dust dropper unit, Caesium coating unit, Grids assembly, Extraction chamber and Dust collection unit.

## Creep Testing Facility at TBM Lab



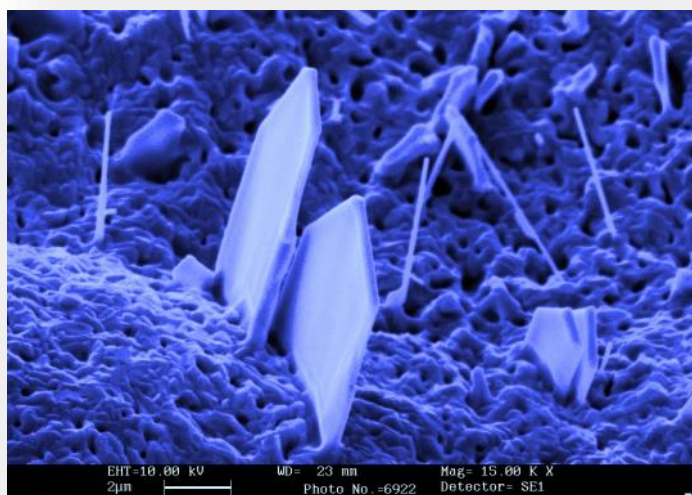
A dedicated creep testing facility has been setup for the qualification of Indian RAFM steel (used in ITER) & other fusion reactor structural materials as per the code & design requirement. According to French Code( RCC-MRx) for TBM structural material, creep test matrix has been identified up to  $3 \times 10^5$  hours.

### Salient Features of the Creep testing Machines:

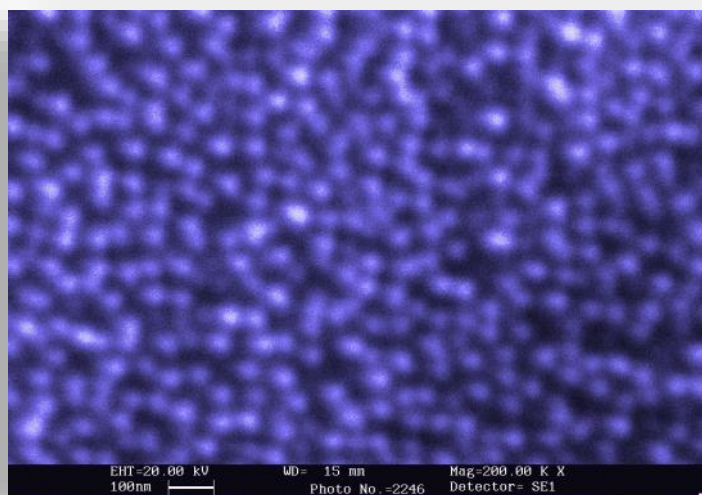
- 100KN capacity creep testing machines has been installed in TBM Lab.
- High temperature test can be done up to  $1000^\circ\text{C}$  at different stress level.
- Round as well as flat specimen can be used in this facility.
- Base material and welded samples can be used for evaluating the creep strength.



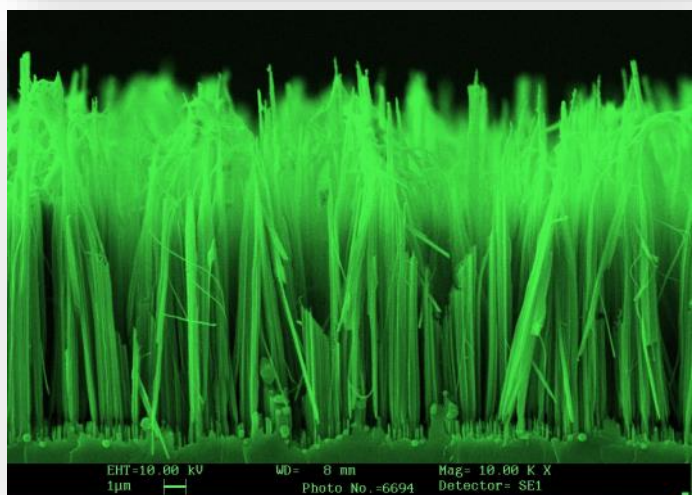
SEM (Scanning Electron Microscope) is widely used for the imaging at higher resolutions up to 1nm. The SEM model LEO 440i (Cambridge make) was installed at FCIPT in July 1996. It has W (Tungsten) as thermionic emitter as the electron source. It also has EDX (Oxford make, model 7060) and WDX (Microspec) attachments for elemental analysis.



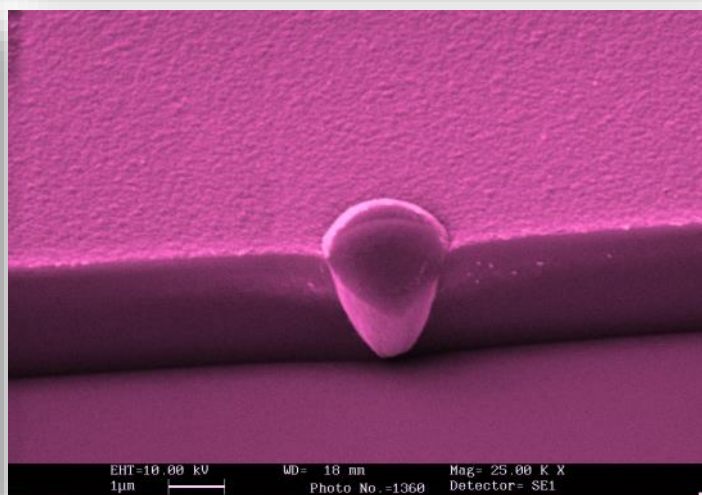
Alumina-Al<sub>2</sub>O<sub>3</sub> platelets on mild steel



GaSb nanodots



Porus silicon nanowires formed by MACE process



Si-H thin film, microcrystalline

## On The Cover Page



The image from a collaborative work done by Dr. Mukesh Ranjan (FCIPT/ IPR) entitled “An analytic approach to modeling the optical response of anisotropic nanoparticle arrays at surfaces and interfaces” was published as a cover page of the April 2014 edition of the Journal of Physics Condensed Matter Vol. 26 (2014) 145302.

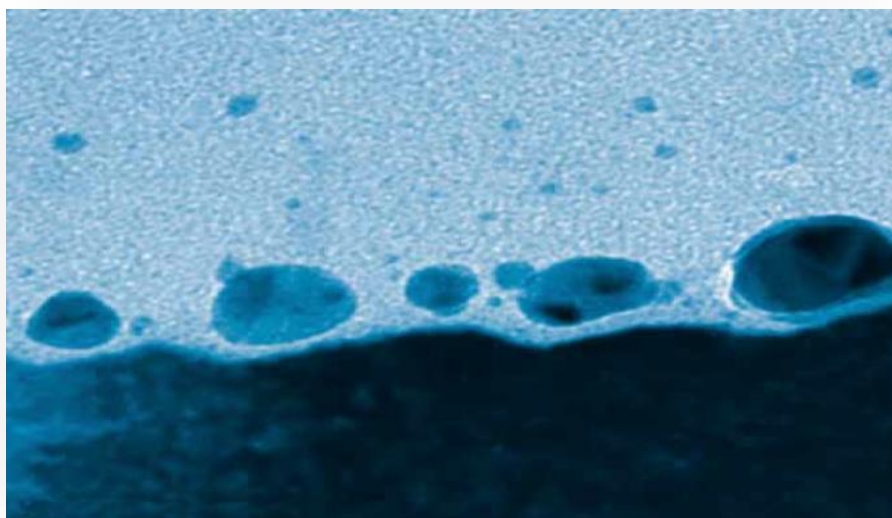


Image of anisotropic nanoparticle arrays at surfaces

The ANNUNET voice connectivity between all the DAE units has been restored at IPR. IPR staff can contact any number at any of the below listed DAE units.

No.	CITY NAME	UNIT	CODE	No. of Extn Digits		No.	CITY NAME	UNIT	CODE	No. of Extn Digits
1	Allahabad	HRI	532	4		20	Mumbai	BARC	221	5
2	Bhu-baneshwar	IOP	674	4		21	Mumbai	NPC	223	4
3	Chennai	IMS	441	3		22	Mumbai	HWB / DPS / DCSE	224	4
4	Chennai	MRPU	443	3		23	Mumbai	AERB	225	4
5	Gandhinagar	IPR	792	4		24	Mumbai	BRIT / BARC - Vashi	226	4
6	Gauribidanur	BARC - Seismic Unit	815	3		25	Mumbai	IRE	227	4
7	Hyderabad	ECIL	401	4		26	Mumbai	TIFR	228	4
8	Hyderabad	AMD	402	3		27	Mumbai	TMC	229	4
9	Hyderabad	NFC	403	4		28	Mumbai	EBC- Navi	230	4
10	Hyderabad	CCCM	404**	-		29	Mumbai	ECIL	231	3
11	Indore	RRCAT	731	4		30	Mysore	RMP	821	4
12	Jaduguda	UCIL	657	4		31	Narwapahar	UCIL	658**	-
13	Kalpakkam	IGCAR / BARC	444	5		32	New Delhi	Dhruva Guest House	111*	3
14	Kolkata	VECC	331	4		33	New Delhi	DSU	112*	3
15	Kolkata	SINP	332	4		34	Shillong	AMD	364	3
16	Kota	HWB	147	4		35	Tarapur	BARC	252	5
17	Manuguru	HWB	874	4		36	Turamdih	UCIL	659**	-
18	Mt. Abu	BARC -	297*	3		37	Vishakhapat-	BARC	891	3
19	Mumbai	DAE	220	4						

For example, if one needs to dial BARC extension number **12345**, then from IPR one has to dial **604-221-12345**. Users please note that the number of extension digits to be dialed varies from unit to unit.

### Silver Stars



**Mr. Jayesh C Gandhi** joined the Mechanical Engineering workshop in 1987. He has been instrumental in precision machining and fabrication of many important components which are parts of many experimental systems at the institute



**Mr. Subodh M Patel** joined IPR in 1987. Presently he heads a section which maintains 45000 sqm constructed area and 20000 Sqm landscaping at the main campus and other campuses of IPR .



**Mr. Bhavarsinh P Chauhan** joined the institute in 1987. He takes care of the postal and courier dispatch section and in the distribution of documents as well as payments of various utility bills and other general duties..



A 15 kW/3600s/35-65 MHz Solid State Power Amplifier for ITER R&D source commissioned successfully at ITER-India ICRF lab.

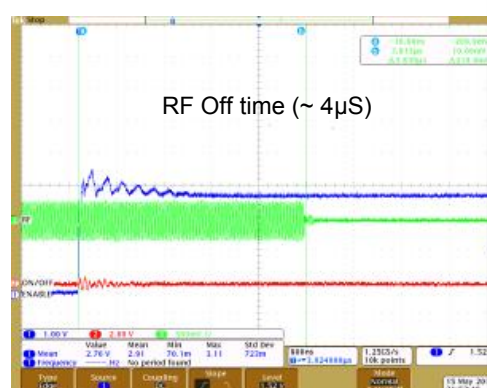
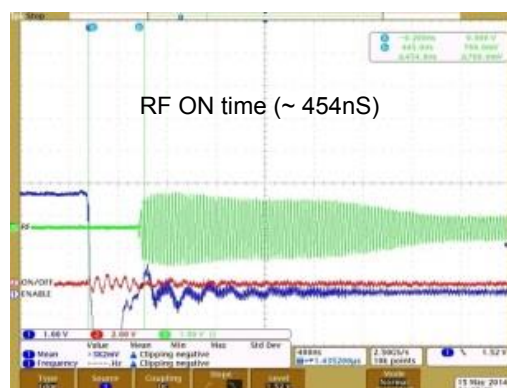
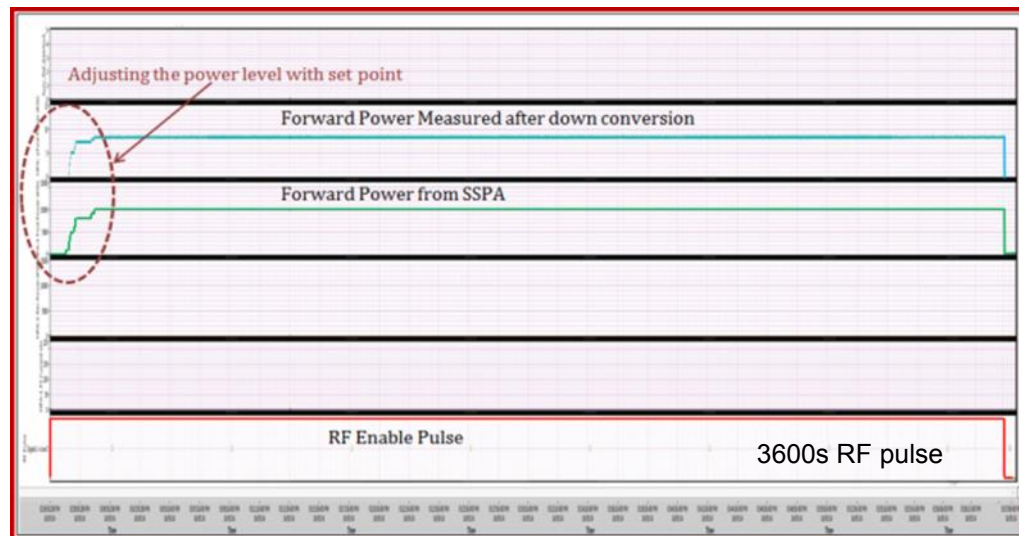
An R&D activity has been initiated at ITER-India ICRF lab for identifying the best technology for ITER ICRF Source. In this activity, two end stage power tubes, EIMAC 4CM2500KG and TH 628 will be tested extensively on dummy load as well as on mis-matched load condition. ITER-India ICRF lab is getting ready for conducting high power RF test at 1.5 MW (1.7 MW) level at VSWR 2:1 (1.5:1) for duration of 3600s in the frequency range 35-65 MHz. As a part of R&D activity, development of the low power RF section, the PLC & PXI based controls and the first stage 15kW amplifier, for which solid state technology is used, is completed and has obtained very good results. The output of 15 kW amplifier will drive second stage 150 kW amplifier and subsequently output from 150 kW will be connected to MW level third stage amplifier for getting final required output from a single chain of amplifiers.



**Self-protection against :** VSWR ( $>3:1$ ), Over Current, Over heating, Over drive, Internal fault

**Gain flatness:** 1.5dB over entire band & 0.75 dB over any 12MHz sub-band ; **RF Leakage**  $<1\text{mW}/\text{cm}^2$  at a distance of 10cm;

**Constant o/p power** up to 1.5:1 VSWR; **Harmonics**  $<20\text{ dBc}$



Operation of the 15 kW/3600s/35-65 MHz Solid State Power Amplifier

Local control unit



IPR Staff Club organized “**World Environment Day-2014**” on **5<sup>th</sup> June, 2014** with the theme “*Raise your Voice, not the Sea Level*”. The event was organized, coordinated and celebrated at all centers viz. IPR, ITER-India and FCIPT and over 500 staff members participated in total.

The highlights of this environment day celebration were:

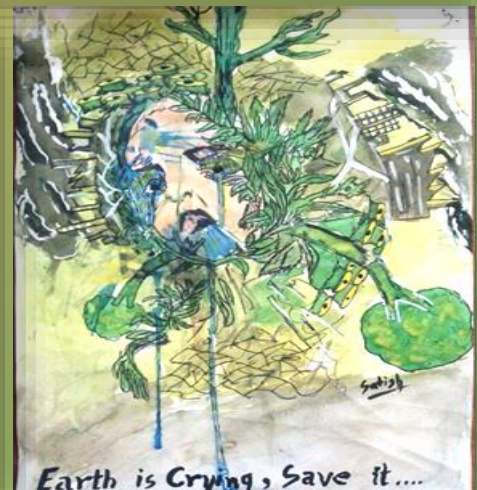
- Over 50 tree planted near new office building and around 400 plants were distributed to staff;
- A talk on “**Energy Management: Methodology & Approach by DESL, Ahmedabad**” was also organized at seminar hall
- An open **Painting Competition** was organized where staff members and their family members presented their paintings. *Satish Tailor* from IPR and *Ms. Maionica Bandhopadhyay* won the contest;
- A **Mobile Energy Conservation Demonstration Van** from GEDA/EQDC, Gandhinagar was also invited at IPR campus to provide general awareness about various methods for energy conservation in domestic life. . The Demo Van was equipped with various Energy Efficient electrical appliances. Posters, exhibition panels, educational slide shows, films and publications were also demonstrated inside the Mobile Van. A brief comparison between conventional appliances and intelligent energy saving devices were demonstrated.



Director, IPR inaugurating the “Mission Plantation”



Innovative artists of IPR exhibited their colorful paintings



Prize winning painting by Satish Taylor



In all smiles after planting a tree



YES ! They indeed will !



After a job well done !



Mobile Energy Conservation Demonstration Van by GEDA/ EQDC Gandhinagar on display at IPR.

*We do not inherit the earth from our ancestors, we borrow it from our children - Native American proverb*



- ♦ **Dr. Bhawna Pandey**, Post-Doctoral Fellow, Fusion Neutronics Laboratory, IPR, gave a talk on "*Neutron Cross-section for Fusion Materials and Surrogate Technique*" on 22nd May 2014
- ♦ **Mr. Rana Pratap Yadav**, Research Scholar (DGFS-Ph.D), Institute for Plasma Research, gave a talk on "*Design and developmental aspect of high power ultrawide-band 3dB hybrid coupler for the ICRF heating in tokamak*" on 27th May 2014
- ♦ **Dr. Namita Yadav**, Banaras Hindu University, Varanasi, gave a talk on "*Studies of bremsstrahlung spectra under impact of keV electrons on thick and thin targets*" on 28th May 2014
- ♦ **Mr. Paritosh Chaudhuri**, Institute for Plasma Research, gave a talk on "*Studies on Thermal-hydraulics of Plasma Facing Components for SST-1 Tokamak*" on 29th May 2014
- ♦ **Dr. Animesh Kuley**, Department of Physics and Astronomy, University of California, Irvine, USA, gave a talk on "*Particle Simulation of Radio Frequency Waves in Fusion Plasmas*" on 30th May 2014
- ♦ **Mr. Pravesh Dhyani**, Research Scholar, Institute for Plasma Research, gave a talk on "*Biased Electrode Experiments in ADITYA Tokamak*" on 30th May 2014
- ♦ **Dr. Sharad Kumar Yadav**, University of Iowa, USA, gave a talk on "*Rotational dynamics of cation in Ionic liquids and Ionic liquids mixture*" on 2nd June 2014
- ♦ **Prof. Hideaki Takabe**, Institute of Laser Engineering, Osaka University, Osaka, gave a talk on "*International joint experiments and theoretical studies on laboratory astrophysics in ILE, Osaka University*" on 4th June 2014

## Upcoming Events

- ♦ 10th International Vacuum Electron Sources Conference and International Conference on Emission Electronics and International Conference on Computer Technologies in Physical and Engineering Applications and International Workshop on Beam Dynamics and Optimization (IVESC-ICEE-ICCTPEA-BDO-2014), Saint-Petersburg, Russia, 30 June - 4 July 2014 <http://www.ivesc2014.com/>
- ♦ African School on the Impact of the Sun on Ionosphere: Physics and Applications, Kigali, Rwanda, 30 June-11 July 2014 [http://cdsagenda5.ictp.trieste.it/full\\_display.php?id=a13251](http://cdsagenda5.ictp.trieste.it/full_display.php?id=a13251)
- ♦ 20th International Conference on Gas Discharges and their Applications (GD 2014), Orleans, France, 6-11 July 2014 <http://gd2014.sciencesconf.org/>
- ♦ 17th Electromagnetic Launch Technology Symposium, San Diego, California USA, 7-11 July 2014 <http://www.emlsymposium.com/>
- ♦ 16th Advanced Accelerator Concepts Workshop (AAC 2014), San Jose, California, USA, 13-18 July 2014 <https://aac2014.stanford.edu/>
- ♦ 51st Culham Plasma Physics Summer School, Abingdon, Oxfordshire, United Kingdom, 14-25 July 2014 <http://www.culhamsummerschool.org.uk/>
- ♦ 22nd Europhysics Conference on Atomic and Molecular Physics of Ionised Gases (ESCAMPIG XXII), Greifswald, Germany, 15-19 July 2014 <http://www.escampig2014.org/>
- ♦ Plasma Processing Science: Non-Equilibrium Plasma Diagnostics, Modeling, and Applications (Gordon Research Seminar), Smithfield, Rhode Island, USA, 26-27 July 2014 [http://www.grc.org/programs.aspx?year=2014&program=grs\\_plasma](http://www.grc.org/programs.aspx?year=2014&program=grs_plasma)

## IPR in the News

The Times of India, on May 14, 2014 published an article, "**Raising our own sun**". This article can be read at: <http://goo.gl/Agruyd>

The Times of India, on May 19, 2014 published an article, "**Homegrown promise of cheaper and safer N-power**". This article can be read at: <http://goo.gl/3BNWbl>

## The Newsletter Team

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