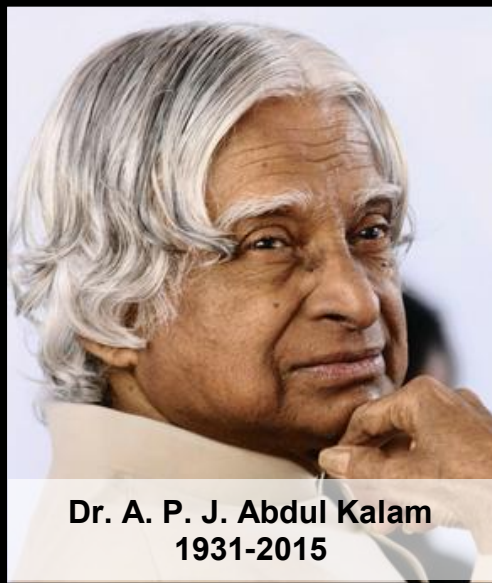


Issue 08  
August 2015

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

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

## Obituary



**Dr. A. P. J. Abdul Kalam**  
1931-2015

India has lost one of its greatest scientists of the modern era. Dr. Avul Pakir Jainulabdeen Abdul Kalam passed away on 27th July 2015 after a massive cardiac arrest while delivering a lecture at IIM Shillong. He was a scientist, a people's President and above all that, a great human being, dedicated and concerned about the future generation of India. He passed away doing what he loved to do most.. Teaching and inspiring young minds.

For someone from very humble beginnings, Dr. Kalam was a glorious example of what one can achieve in life with dedication and perseverance. Dr. Kalam's contribution to both India's space as well as defense programmes is phenomenal. He not only played an instrumental role in the SLV and PSLV missions of ISRO, but also successfully lead India's ballistic missile program which earned him the name "India's Missile man". As India's 11th President, he changed the perception of the role of the President of India with his unique endearing ways, that he was known as the "People's President"

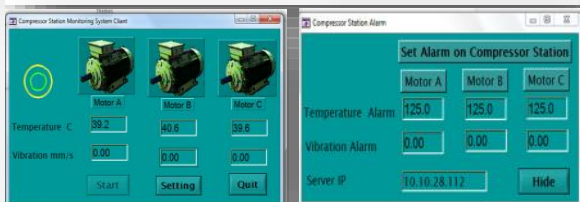
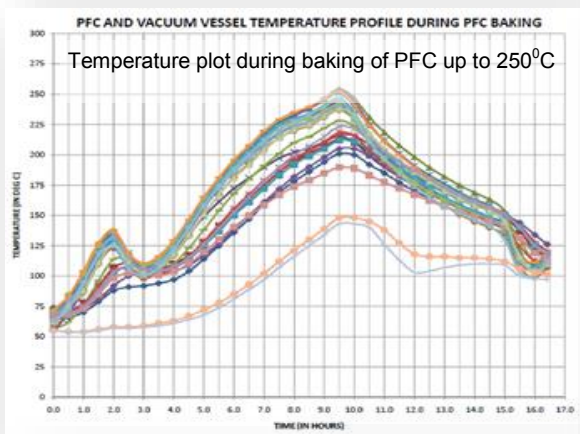
On behalf of all the IPR staff, we express our heartfelt condolences to the near and dear of Dr. Kalam's family. We will all miss him for what he was, and for what he always stood for.

*You have to dream before your dreams can come true.... APJ Abdul Kalam.*

## SST-1 Update

The 12<sup>th</sup> experimental campaign of SST-1 has begun after the cool down of SST-1 magnet system and achievement of required vacuum levels in the vacuum vessel. Before this, extensive cycles of baking of the plasma facing components (PFC) up to 250°C and glow discharge cleaning was done as a part of wall conditioning activities.

PFC baking system has been successfully validated as uniformity of temperatures amongst modules and the leak tightness of all the connections was achieved up to 250°C. Successful operation of SST-1 cryogenic plant was done after hydro-pressurization tanks test of the helium gas storage vessels as per CCOE Norms. Onset monitoring of temperature and vibration level of compressors is developed to enhance the reliability of the operation of compressors.



Onset monitoring of compressors



Inside view of SST-1 Vacuum vessel during glow discharge cleaning (GDC)





Electromagnetic pulse welding has many advantages over the conventional welding for nuclear reactor. Although this welding is restricted to lap joints only, it does not destroy the microstructure of material involved in welding. Recently, IPR's Pulsed Power lab, in collaboration with BARC has developed a 100 kJ capacitor bank capable of producing



(L) The EM pulse welding setup. (R) The samples of welded SS D-9 samples using this setup.

peak currents greater than 1 MA with a suitable load (coil). Using this facility, qualified welding of D-9 (Third generation nuclear grade material) with SS cylinder was achieved recently.

## IPR Built, Regulated High Voltage Power Supply System Commissioned at BARC

The in-house development of a patented 100kV, 25A rated "Regulated High Voltage Power Supply System" (RHVPS) has been fully tested and successfully commissioned at BARC site, Mumbai. This work was carried out by IPR/FCIPT on the basis of an MoU between IPR/FCIPT and BARC. This power supply is planned to be used for a klystron based "Accelerator Driven System" (ADS) in LEHIPA project at BARC. The system is under use and further 2 more such systems are to be delivered for same application at BARC. The RHVPS development team is pleased to say that the MoU with BARC and the successful completion of the project are a testament to the appropriate and timely decision by our Institute to pursue indigenous development of this technology.

It can also be said that in the long run, the success of RHVPS development can effect import substitution and contribute to the mission "Make in India" or actually "Made in India".



(L) The HV power supply during installation at BARC. (R) The HV isolator and ground switches of the system

## DAE-SRC Award



Dr. Subrata Pradhan (Scientist-H) has been conferred the prestigious 'Scientific Research Council Outstanding Investigator Awardee' of the Department of Atomic Energy (DAE-SRC OI) for 2014 in response to his research proposal and in recognition to his outstanding contributions to plasma sciences and technologies. Under this award, Dr. Pradhan will be receiving an additional monthly incentive of INR 25000 for a period of five years as well as a research grant sum totaling up to Rs. 1 Crore over the same period towards carrying out research and development activities.



The NFP workshop and theme meeting on popularization of Plasma & Fusion Science & Technology was held on the 25th and 26th June, 2015 at the Indian Institute for Engineering Science & Technology (IIST), Shibpur, Howrah (WB).

IPR staff gave detailed lectures on challenges in plasma & fusion science & technology and interacted with potential collaborators from IIST and other institutes in the eastern parts of India. S. Mukherji, P. K. Atrey, N. Ramasubramanian, N. Jamnapara, J. Ghosh, S. Sengupta and Ravi A V Kumar delivered the various lectures. Meetings in this series are aimed at generating more R&D collaborations in the fields of plasma & fusion science & technology under the National Fusion Program started in 2007, under this programme, more than 140 R&D projects have been awarded under various relevant areas. These collaborative work will go a long way in the pursuit of India's own long term fusion goals.

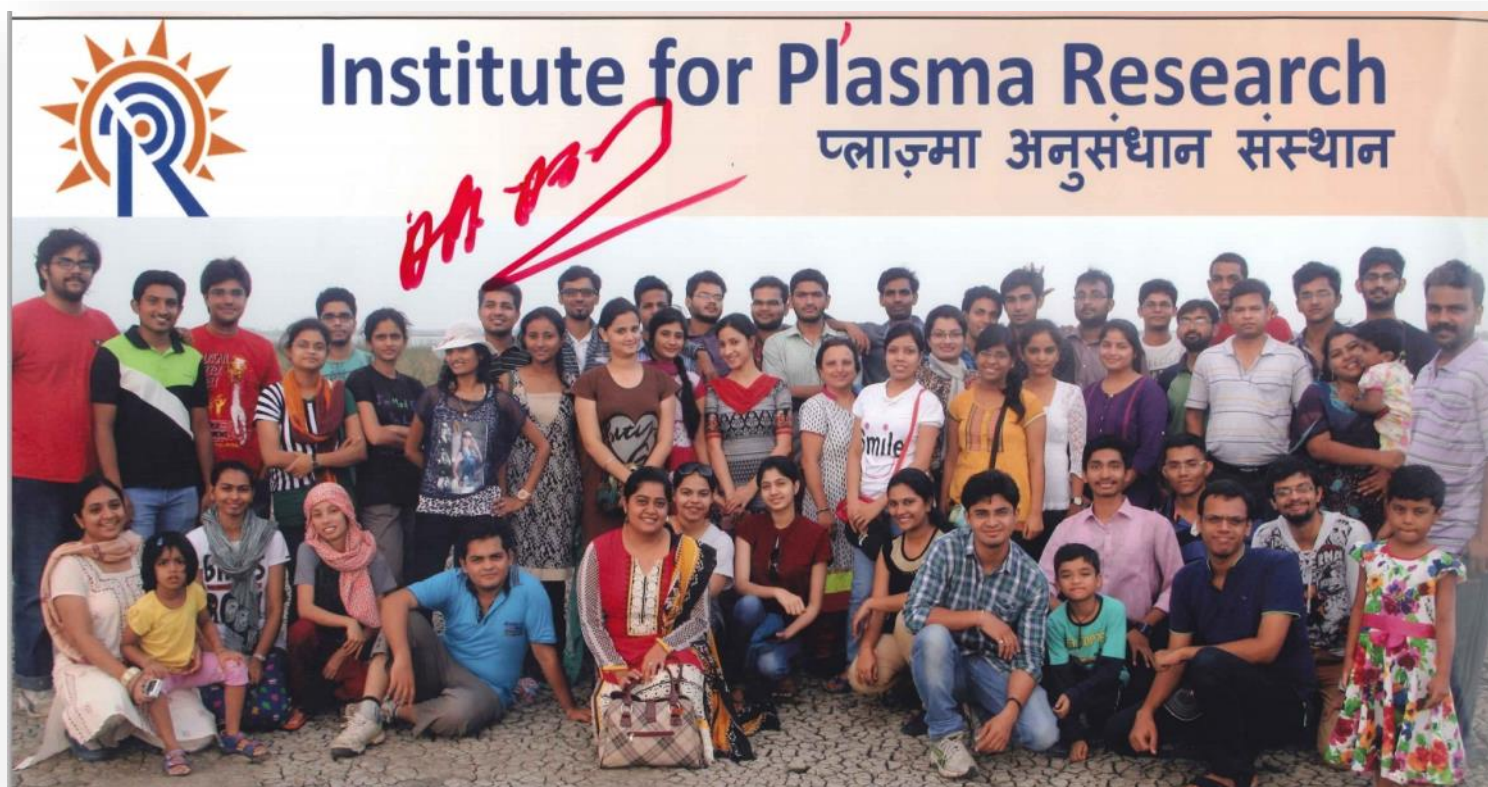


The inaugural function of the NFP popularization meeting on Plasma & Fusion Science & Technology at IIST, Shibpur

### Fostering Young Minds - SSP-2015

On 20th of June, the SSP students had an opportunity to meet the former President of India, Dr. A. P. J. Abdul Kalam at the Entrepreneurship Development Institute of India (EDII), Gandhinagar. The students interacted with Dr. Kalam and also, he was gracious enough to autograph a group photo of the SSP students.

Who would have imagined that this would be his last visit to Gujarat. We will all miss this wonderful human being.





The Basic Plasma Group of IPR conducted an informal idea exchange meeting on 15th July 2015. The meeting was attended by all the Basic group members as well as some of the academic committee members and PhD scholars. Summary of the work done in all the projects under the Basic Plasma Group were presented and discussions on the results, issues faced and future plans of the projects were also discussed. The Basic Plasma Group consists more than 40 staff / students working on around 13 different projects on both theoretical and experimental basic plasma physics.

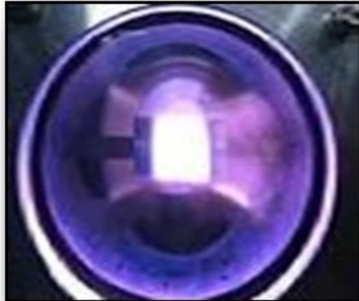


(L) Prof. Prabal Chattopadhyay and (R) Prof. R. Ganesh giving the presentations of their projects during the meeting.

## TiN Thin Films Deposited by DC Reactive Magnetron Sputtering

Titanium nitride (TiN) thin films are widely used in many applications ranging from diffusion barrier coatings in microelectronics industry to wear-resistant, hard and protective coatings on cutting tools and also as decorative coatings due to their gold like appearance.

- DC magnetron based sputtering unit has been developed in-house for depositing metal nitride films on various types of substrates (metals, glass, ceramics, etc.).
- It uses argon for sputtering and nitrogen as reactive gas.
- By adjusting sputtering voltage, argon to nitrogen ratio, pressure and bias voltage on the substrates, high quality films can be deposited.
- TiN films have been deposited with excellent quality in a short time (deposition rate = 1.5 micrometres / hour).
- The hardness achieved is as high as 3500 HV which is 15 times that of a typical steel material (230 HV).



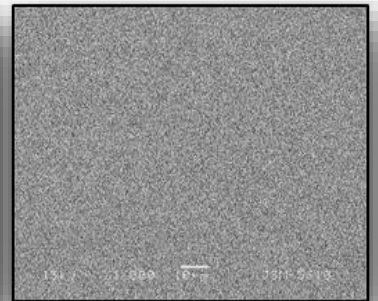
TiN deposition by dc reactive magnetron sputtering



TiN coated cylindrical SS304 samples

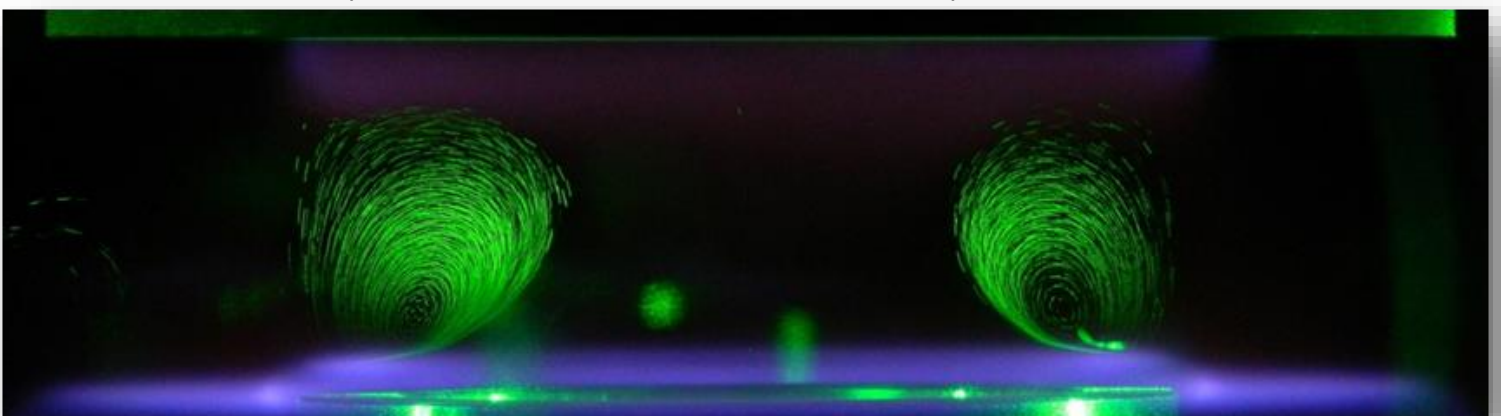


(L) SEM image (cross-section) showing the thickness (2.1 μm) of the film. (R) SEM image (top surface) showing uni-



## Self-organized Poloidal Dust Rotation in DC Glow Discharge

When micron sized dust particles are kept in plasma, they acquire negative charges of the order from  $10^3 e^-$  to  $10^5 e^-$  depending upon their size and background plasma conditions. Due to presence of the high charges on each particle, they interact very strongly with each other and with the surrounding plasma species and give rise to many new phenomena. In this article, we discuss one such phenomenon related to the vertical rotation of dust particles.



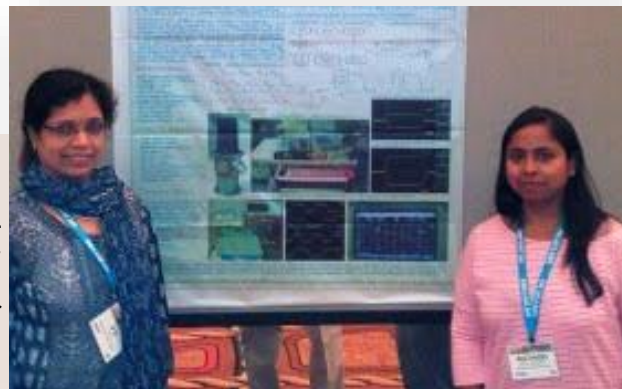
Two diametrically opposite poloidal cross-sections of the toroidal dust structure.

These studies are being carried out in the **Complex Plasma Experimental Device (CPED)** located in the Basic Lab, IPR. Steady poloidal rotation of mono-dispersed dust particles in toroidally symmetric structures is obtained experimentally in cold cathode DC Glow discharge plasmas at high pressures in absence of any external magnetic field. One poloidal plane of the dust torus, illuminated by a vertical laser sheet passing along its diameter. It is observed that a strong radial gradient in the plasma density is localized near the rotating dust particles which induces a radial gradient in the ion drag force experienced by the dust particles and is identified as the Principal cause of dust rotation. The whole phenomena can be understood in the following manner: The metallic ring kept on the lower electrode creates an inhomogeneity (mainly horizontal, in the present case radial) in the plasma which further gets enhanced by keeping the dust particles on the surface of the lower electrode i.e., cathode. The inhomogeneity in the plasma or gradient in the ion density gives rise to a gradient in the downward directed ion drag force which acts as a torque on the levitated dust particles and makes them rotate. Thus, a gradient in the ion drag force is causing the poloidal rotation of dust particles while the frictional neutral force is helping to keep the rotating structure stationary. The cause of rotation is further confirmed by conducting additional experiments which further strengthens the density gradient induced ion drag gradient as the cause behind the rotation of mono-dispersed dust particles.

## IPR @ Conferences



Dr. Subrata Pradhan gave an invited talk on **`Experiment and Up-gradation Status in SST-1'** at the 8th IAEA Technical Meeting on Steady State Operation of Fusion Devices at Nara (Japan) on May 27, 2015. International Fusion Community engaged in steady state operation of superconducting Tokamak now recognize SST-1 to be an 'in-operation' experimental device.



The 20th IEEE Pulsed Power Conference (PPC) and the 26th IEEE Symposium on Fusion Engineering (SOFE), was organized at Austin, Texas, USA, during 31st May – 4th June, 2015. V.P. Anitha and R. J. Priyavandana from SYMPLE (SYstem for Microwave PLasma Experiments) group attended the conference. V.P. Anitha presented a talk on "A System for Microwave-Plasma Interaction Experiments" and a poster "A Magnatron Pulsed Modulator for Microwave Plasma Interaction Studies" was presented by R. J. Priyavandana

## Aditya Upgrade Update

The fabrication of both the semi tori of new vacuum vessel have been completed. Both the semi-tori passed the helium leak test for leak rate at all the joints less than  $10^{-9}$  mbar-liter/second. They have been connected to form one torus and carried out final dimension check on 20th July, 2015. The acceptance test including baking, vacuum and leak tests are planned in the last week of July, 2015. The vacuum vessel is expected to arrive at IPR in the first week of August, 2015.



(L) Torus Assembly of vacuum vessel for Aditya Tokamak as on 20-7-2015 (R) The old Aditya vacuum vessel after dismantling.



## SSP-2015

This year's Summer School Program which began on 1st June 2015 drew to a close on 10th July 2015. A poster presentation on the projects carried out by the students during the course of the Summer School was held on 9th of July 2015.

A valedictory function was held on 10th July and Prof. Abhijit Sen addressed the students and also distributed the prizes for the best poster presentations. On behalf of IPR, the Newsletter team wishes them all a bright future !



Physics 1st	Neha Gupta &
Physics 2nd	Ravi Teja
Engineering 1st	Kamal Karan
Engineering 2nd	Navneet Manval
Engineering 3rd	Rahul K Chauhan



(L-R) The judges evaluating the posters of the SSP students. Prof. Abhijit Sen distributing the prizes for the best posters.



(L) Prof. Abhijit Sen distributing the prizes for the best posters. (R) Prof. Dhiraj Bora interacting with the SSP-2015 students



The SSP 2015 students with the organizing committee members after the valedictory function.



Staff Club-2015 successfully conducted table tennis, chess and carrom tournaments for IPR staff 2<sup>nd</sup> July to 10<sup>th</sup> July 2015. There was an overwhelming response from IPR staff for these sporting events.



IPR staff participating in the table tennis and carrom tournaments

IPR Staff Club: Table Tennis, Chess and Carrom tournament 2015

Event	Category	Participants	
		Winner	Runner up
Men's Carrom	Singles	Alpesh I Patel	Jay Joshi
	Doubles	P Ajesh & Ronak	Alpesh I Patel & Bhargav
Men's Table Tennis	Singles	Girish Gupta	Arvind Kumar
	Doubles	Girish Gupta & Aditya P Singh	Deepak Yadav & Sudhir Rai
Women's Carrom	Singles	Hetal D Pathak	Chesta
Women's Chess		Sandhya P Dave	Chesta
Men's Chess		Rohit Kumar	Yogesh Yeole



## New Facilities @ IPR Canteen

By popular demand, the renovated IPR canteen has now been equipped with two Café Coffee Day vending machines which now provide IPR staff a verity of hot beverages such as Cappuccino, Latte, Espresso and also various types of tea.

In addition to the hot beverages, alternate lunch facility was started in IPR canteen annex where items like sandwiches, salads and fresh cut fruits could be ordered. This is helpful for those who wish to snack or do not wish to have the regular canteen meals.



The new vending machines for hot beverages and the alternate meals facility at the IPR canteen

*The scientist is motivated primarily by curiosity and a desire for truth..... Irving Langmuir*

- ◆ **Dr. P. N. Maya**, ITER-India, Institute for Plasma Research, Gandhinagar, gave a talk on "*Highlights of 15th Conference on Plasma Facing Materials and Components for Fusion Applications (PFMC15)*" on 3rd July 2015
- ◆ **Dr. V. P. Singh**, Chief Scientist, CEERI, Pilani, gave a talk on "*R&D activities on RF Windows at CSIR-CEERI Pilani*" on 14th July 2015

## Upcoming Events

- ◆ 33rd Young Physicists Colloquium, Saha Institute of Nuclear Physics, Kolkata, 20-21 August 2015  
<http://www.iacs.res.in/ips/ipsprogram.html>
- ◆ International Conference on Quantum, Atomic, Molecular and Plasma Physics, Brighton, UK, 1-4 September 2015  
<http://quamp2015.iopconfs.org/home>
- ◆ 21st Symposium on Physics of Switching Arc, BRNO University of Technology, Nove Mesto na Morave, Czech Republic, 7-11 September 2015 <http://www.uvee.feec.vutbr.cz/conference/FSO/>
- ◆ International Conference on Research and Application of Plasmas, Warsaw, Poland, 7-11 September 2015  
<http://plasma2015.ipplm.pl/>
- ◆ International Conference on Plasma Science and Applications (ICPSA2015), Isfahan, Iran, 8-10 September 2015  
<http://icpsa2015.ir/>
- ◆ International Conference on Application of Lasers in Manufacturing (CALM 2015), Pragati Maidan, New Delhi, India, 09-10 September 2015 <http://www.calm2015.in/aboutus.php?uid=1>
- ◆ 4th International Workshop on Diagnostics and Simulation of Dusty Plasmas, Kiel, Germany, 9-11 September 2015  
<http://www1.physik.uni-kiel.de/dsdp/>
- ◆ 15th International Workshop on Plasma Edge Theory in Fusion Devices (PET15), Nara, Japan, 9-11 September 2015  
<http://bpsl.nucleng.kyoto-u.ac.jp/pet15/Welcome.html>
- ◆ Stochasticity in Fusion Plasmas, Physikzentrum Bad Honnef, Germany, 10-12 September 2015  
<http://www.iek-yig.de/597thWEH/index.htm>
- ◆ 12th International Symposium on Fusion Nuclear Technology (ISFNT 12), Jeju Island, Korea, 14-18 September 2015  
<http://www.isfnt-12.org/>
- ◆ 8th International Conference PLASMA PHYSICS AND PLASMA TECHNOLOGY, Minsk, Belarus, 14-18 September 2015 <http://ifanbel.bas-net.by/pppt-8/>
- ◆ 9th International Conference on Inertial Fusion Sciences and Applications (IFSA 2015), Seattle, Washington, USA, 20-25 September 2015 <http://ifsa15.org/>
- ◆ 4th PSSI-Plasma Scholars' Colloquium (PSC-2015), Jadavpur University, Kolkata Aug 6-7 2015

## Know Our Colleagues



**Mr. Dilip C. Raval** joined the Institute in 1993 in the Aditya Vacuum group and was involved in the operation and control of Vacuum system as well as in the general operation of the Tokamak. He joined the SST-1 group in 2002 when the SST-1 was first assembled and contributed in assembling the Vacuum system which included cryostat, LN2 panels and vacuum modules and also in the testing of TF coils at its functional parameters. He is currently the division head of SST-1 Vacuum and First Wall Division and took part in the refurbishment of the Tokamak and in successfully installing and testing the plasma facing Components.



**Mr. Jagdish V Vihola** joined the Mechanical Engineering workshop of the Institute in 1993. He has been involved in the precision fabrication of different systems and components which now constitute parts of many working systems at the Institute.



## The IPR Newsletter Team

Ritesh Srivastava	Tejas Parekh	Ravi A. V. Kumar	Priyanka Patel	Swati Roy	Mohandas K.K.
Suryakant Gupta	Ramasubramanian N.	Chhaya Chavda	Shravan Kumar	Hiral B Joshi	

Institute for Plasma Research  
Bhat, Near Indira Bridge  
Gandhinagar 382 428,  
Gujarat (India)



Web : [www.ipr.res.in](http://www.ipr.res.in)  
E-mail : [newsletter@ipr.res.in](mailto:newsletter@ipr.res.in)  
Tel : 91-79-2396 2000  
Fax : 91-79-2396 2277