

An Industrial Visit to Institute of Plasma Research, Gandhinagar was conducted under the aegis of IEI students chapter, EED.

A Report on

Industrial Visit to Institute of Plasma Research, Gandhinagar

Date of Visit: 08-04-2024 & 09-04-2024

Academic Visit to Institute for Plasma Research, Gandhinagar

The 1st year Electrical Engineering students from L.D. College of Engineering embarked on an enriching academic visit to the Institute for Plasma Research (IPR) in Gandhinagar, Gujarat on 8th April and 9th April, 2024. Led by their guide, Gattu Ramesh Babu, the visit encompassed a comprehensive exploration of plasma, its applications, and cutting-edge research in the field.

1. Introduction to Plasma and Tokamaks

The visit commenced with an insightful lecture by Gattu Ramesh Babu, providing a foundational understanding of plasma, its significance in various domains, practical applications, and promising future prospects. The lecture started with a concept as basic as states of matters and ended with a deeper understanding of complex concepts like higher energy states. Plasma is nothing but a higher energy state. 99.9% of universe is plasma; be it the natural plasma of lightening or the man made plasma. The students were introduced to tokamaks. The term "tokamak" comes to us from a

Russian acronym that stands for "**toroidal chamber with magnetic coils**". A **tokamak** is a device which uses a powerful magnetic field generated by external magnets to confine plasma in the shape of an axially-symmetrical torus. IPR has two indigenous tokamaks: ADITYA - U and SST-1. A tokamak is the number 1 candidate for nuclear fusion reaction for power generation. Power generated through nuclear fusion has the potential to solve all the Electricity shortage problems of the world as it's a high output source which leaves no pollution or waste behind.

2. Experimental Demonstrations

The students had the opportunity to witness several captivating experiments showcasing different aspects of plasma, including demonstrations of Tesla Coil, Plasma ladder, and plasma globe. Through these experiments, the students understood various exciting application of plasma in day to day life as well as in complex research. For example, the Tesla coil showcased that how with the use of plasma wireless power transmission is possible. Additionally, they were introduced to a model of ITER, the world's largest nuclear fusion tokamak, situated in France. **ITER** (initially the **International Thermonuclear Experimental Reactor**, '*iter*' meaning "the way" or "the path" in Latin, is an international nuclear fusion research and engineering megaproject aimed at creating energy through a fusion process similar to that of the Sun. It is a collaborations between many countries like USA, India, China, Japan, European Union etc. India joined ITER as a permanent member in 2005. ITER-India is the Indian domestic agency, a specially empowered project of the Institute for Plasma Research (IPR), an aided organization under Dept. of Atomic Energy, Govt. of India. ITER-India is responsible for delivery of the following ITER packages: Cryostat, In-wall Shielding, Cooling Water System, Cryogenic System, Ion-Cyclotron RF Heating System, Electron Cyclotron RF Heating System, Diagnostic Neutral Beam System, Power Supplies and some Diagnostics.

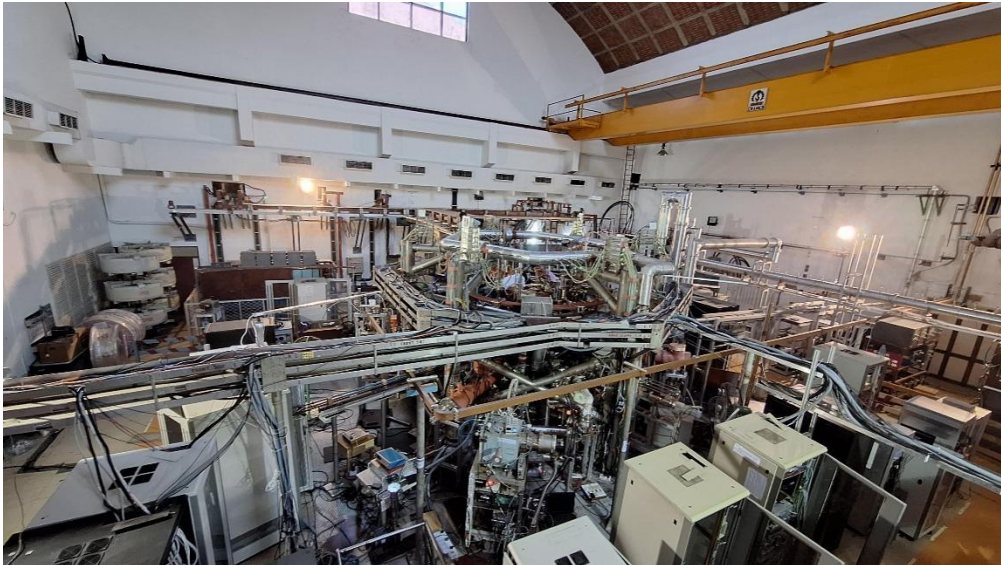
3. Substation Tour

The students were given a tour of the 132kV substation, which powers the Institute, offering valuable insights into the infrastructure supporting plasma research activities. The 132kV voltage is stepped down to 11kV for further use and distributed across various projects going on in the

IPR. Students were taught about how the whole substation is controlled through various complex softwares like SCADA.



ADITYA-U Tokamak



The highlight of the visit was the encounter with the ADITYA-U tokamak, where students learned about its operational principles and the ongoing research initiatives from scientific officers actively engaged in the project.

ADITYA, meaning "the sun" is an indigenously built nuclear fusion tokamak which has a maximum field strength of $1.2 * 10^4$ Gauss produced by 20 Toroidal field coils placed

symmetrically in toroidal direction for plasma confinement. It is the very first nuclear fusion tokamak of India.

In 2015, the ADITYA tokamak was dismantled and rebuilt with various changes and became the ADITYA - U tokamak. The first plasma obtained on ADITYA - U was in 2016. The maximum plasma pulse length obtained in the ADITYA - U tokamak is of whopping 465 ms which is a record globally in its segment.

5. SST-1 Tokamak

Furthermore, the students had the privilege to explore the SST-1 tokamak, which operates based on the principle of cryogenics. The SST 1 tokamak belongs to a new generation of tokamaks with the major objective being steady state operation of an advanced configuration ('D' Shaped) plasma. It has been designed as a medium-sized tokamak with superconducting magnets. To improve and modify some of the components, the SST-1 machine was subsequently disassembled. The improved version of the machine was completely assembled by January 2012. And by 2015, produces repeatable plasma discharges up to ~ 500 ms with plasma currents

excess of 75000 A at a central field of 1.5 T. SST-1 is also the only tokamak in the world with superconducting toroidal field magnets operating in two-phase helium instead of supercritical helium in a cryo-stable manner, thereby demonstrating reduced cold helium consumption. Through interactive sessions, they gained a deeper understanding of its functioning and relevance in plasma research.



Conclusion

The visit to the Institute for Plasma Research proved to be an invaluable learning experience for the 1st year Electrical Engineering students, offering them a glimpse into the fascinating world of plasma science and technology. The interactive sessions, experimental demonstrations, and first-hand encounters with advanced research facilities have undoubtedly enriched their academic journey and inspired them to explore further in this dynamic field. The visit left many students in awe and curiosity for new researches like these. It opens a whole new scope of research, Engineering and projects. Special thanks to Gattu Ramesh Babu for his guidance and facilitation throughout the visit.

