प्लाज़्मा अनुसंधान संस्थान

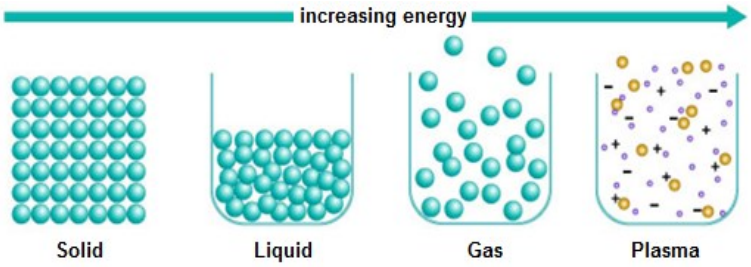
Institute for Plasma Research

Introduction

Institute for Plasma Research (IPR) is located in a peaceful and green campus on the bank of river Sabarmati, near Indira Bridge, Gandhinagar, Gujarat. It was established in 1986 as an autonomous institute under the Department of Science and Technology (DST) with a mandate to pursue research in Plasma Science and technology. The institute grew rapidly and came under the administrative umbrella of the Department of Atomic Energy (DAE) in 1995. Over the years, IPR has developed competence in advanced fields like Theoretical Plasma Physics, Computer Modeling and Simulation, Superconducting magnets and Cryogenics, Ultra High Vacuum technologies, sophisticated Plasma Diagnostic systems, RF and Neutral Beam Heating systems, High Voltage Engineering systems, Pulsed Power systems, Computer based Data Acquisition and Control systems besides, Industrial, Environmental and strategic plasma applications. A multi-disciplinary team of around 400 scientists and technologists carries out these tasks.

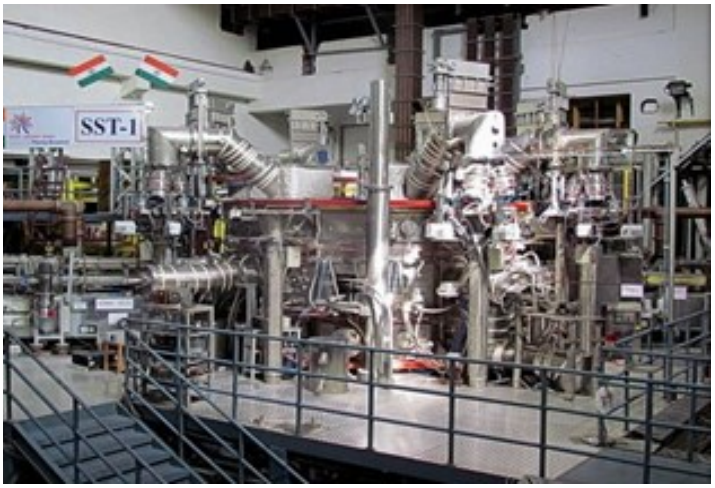
What is plasma?

Plasma is the fourth state of matter, the other states being solid, liquid and gas. When a gas is heated to very high temperatures, the electrons and ions of the gas atoms are ripped apart and form a collection of charged particles called plasma. The plasma particles being charged, can be influenced and confined by magnetic fields, the basis of magnetic confinement fusion.



What is Nuclear Fusion?

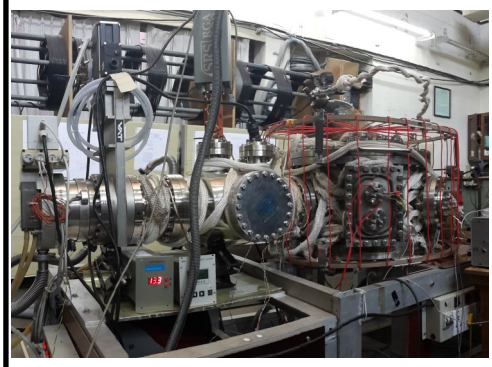
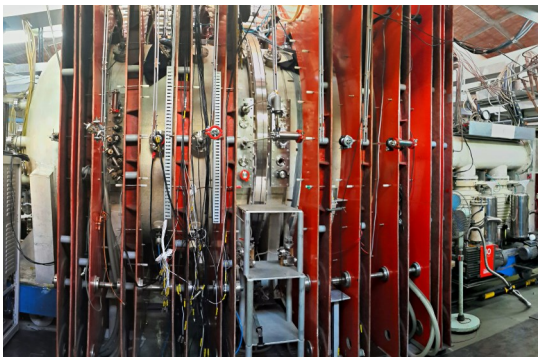
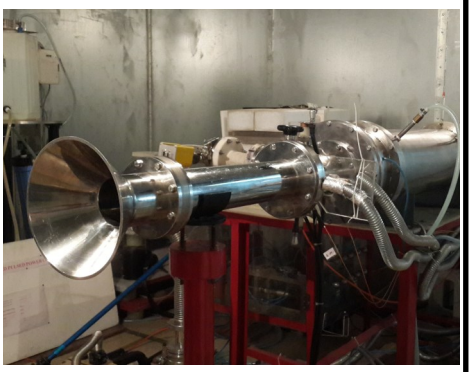
Fusing two light ions, e.g. those of Deuterium and Tritium (isotopes of hydrogen) can give enormous energy which can be used to produce electricity. Both ions being positively charged, require very high energy (temperature 150M C) to fuse together to overcome their repulsion. But thermo-nuclear fusion, in which fusing collisions are probabilistic, require slightly less temperature. Still at those temperatures matter will be in plasma state and their confinement needs special arrangement like magnetic bottles, e.g. tokamaks- a Russian word with the synonym 'toroidal chamber in magnetic field'. In IPR, there are two tokamak experiments: **Aditya tokamak:** This is the first tokamak indigenously built in India, started plasma operations in 1989 and still experiments are routinely carried out. **Steady-State Superconducting Tokamak -1 (SST-1):** This is one of a very few steady-state tokamaks in the world operating with massive superconducting magnets made of Niobium-Titanium alloy which would be cryogenically cooled by liquid Helium at 4.5 K.



India's first indigenous tokamak "Aditya" and the Supercon-

Fundamental Plasma Physics

Since an expected 99% or more of the matter existing in this universe is being in the plasma state, the studies on the fundamental plasma characteristics are not only very exciting, but also very useful. In this institute there are few interesting experimental systems : Large Volume Plasma Device (LVPD), Basic Experiments in Toroidal Assembly (BETA), high power microwave plasma interaction, magnetized beam plasma interaction studies, high power plasma torches, plasma wake-field acceleration experiments, Non-neutral plasma in a toroidal trap, dusty plasma, Multicusp plasma etc.

Some of the Basic plasma physics experiments (L-R) : Non neutral plasma, LVPD, microwave vircator

Theory and Simulation

With one of the best computing facilities in the country, various physics evolutions of the plasma state are being simulated and computed along with the relevant theories. The current interesting topics include Fusion reactor studies, tearing modes and blob dynamics in tokamak physics, fluid and molecular simulations, phase transition studies, Gyro-Kinetic simulations, various instabilities along with non-linear studies etc. The simulation of the evolution of vortex crystals is shown below.

Facilitation Centre for Industrial Plasma Technologies (FCIPT)

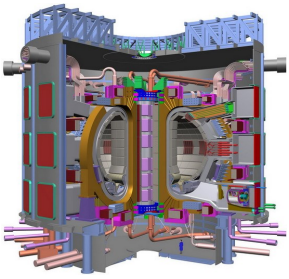
Societal benefits from plasma technologies are enormous - from modification of materials surfaces to waste disposal using environment friendly plasma based processes. Facilitation center for industrial plasma technology (FCIPT, situated at GIDC, Gandhinagar) develops these technologies and deploys them on various sites. FCIPT interacts closely with entrepreneurs through the phases of development, incubation, demonstration and delivery of technologies.



(L-R) : Plasma nitriding, Plasma pyrolysis, Plasma torch

ITER - INDIA

International Thermonuclear Experimental Reactor (ITER) is an international project being built in France and is a step towards future production of electricity from fusion energy. India is one of the partner nations (of the 7 countries) to this multinational effort. India will be contributing about 10% of the ITER construction cost, mostly in kind. ITER-India (situated at Gandhinagar) is the Indian Domestic Agency, formed with the responsibility to discharge the Indian contribution of the ITER mandate.




Fusion Technologies

With the international exposure through ITER participation, IPR is also working to absorb and indigenize all the available state of the art technologies required for a fusion reactor. The developmental works on all the major technologies like superconducting magnets, Blanket module for tritium breeding, Neutral beam technologies, cryogenics, cryo-pumps, divertors and other first wall technologies, Remote handling etc. have been started at the institute. Efforts are also on to bring in more Indian institutions and industries into the fusion technologies umbrella through various funding agencies of Department of Atomic Energy.

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