



Hands-on Lab on Nuclear Fusion

Measuring the electron distribution function in the edge of TCABR plasmas using Langmuir probes

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The role of the tokamak edge plasma in influencing the fusion energy gain in present tokamaks is now widely recognized. This is particularly reflected in the increasing efforts devoted to the experimental and theoretical study of the so-called scrape-off (SOL) layer physics. Of particular concern are aspects of the plasma-surface interaction leading to impurity production and the subsequent impurity transport and contamination of the core plasma. The distributions of the charge state and energy of the ion flux incident on limiter or divertor plate surfaces are the most important factors determining the magnitude of impurity release by physical sputtering. Chemical sputtering, however, is dependent on the constituent elements of the surface and of the impinging plasma, and the plate surface temperature. The impurity transport depends strongly on the background properties of the SOL plasma, such as temperatures, densities, transport coefficients and flow velocity.

Among the various diagnostics that can be used to investigate plasma properties, Langmuir probes are one of the oldest and simplest kind of electrostatic probe that can be used to determine the electron distribution function, and consequently the electron temperature and density, floating potential, and Mach number, in the edge of a tokamak plasma. Essentially, a Langmuir probe is a small electrode, usually a tungsten or platinum wire, that is inserted into the plasma and connected to a power supply capable of polarizing it with positive and negative voltages relative to the plasma. From the measurement of the current collected by the tip of the probe as a function of the applied potential, the so-called I-V characteristic, Figure 1, it is possible to obtain local information of the plasma parameters listed above.

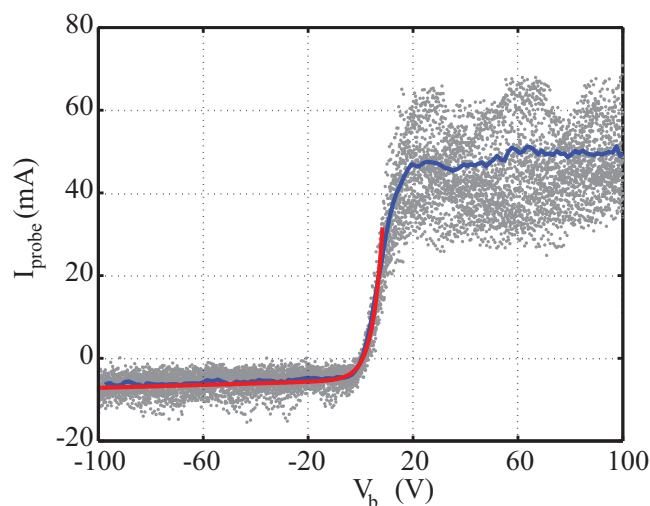


Figure 2: Typical I-V characteristic obtained from a Langmuir probe.

In this hands-on lab, the students will be able to measure the properties of the plasma edge in TCABR plasmas. The TCABR tokamak is a machine operated at the Institute of Physics of the University of São Paulo, Figure 2. This work includes manipulating a set of Langmuir probes, pre-processing and calibrating crude data to obtain a calibrated I-V characteristic, application of smoothing and fitting techniques to extract the plasma parameters of interest.



Figure 2: (a) The Plasma Physics Laboratory in which (b) the TCABR tokamak is operated.