Master Internship

DEVELOPMENT OF A SYNTHETIC DIAGNOSTIC FOR LANGMUIR PROBES

Laboratoire de Mécanique, Modélisation et Procédés Propres M2P2

Location: M2P2 Laboratory, Marseille, France
Collaborations: ENS Lyon, PIIM (Marseille), LAPLACE (Toulouse)
Duration: 5 months — February/Mars 2026 to June/July 2026
Level: Master 2 (Physics, Plasma Physics, or Computational Science)

Context: Plasma diagnostics are instruments and techniques used to measure the properties of a plasma — a state of matter composed of charged particles (ions and electrons). These diagnostics provide key quantities such as density, temperature, electrostatic potential, particle fluxes, and light emission. Among the many diagnostic tools, Langmuir probes play a central role in laboratory plasmas. By inserting a small conducting tip into the plasma and sweeping its voltage, they allow direct measurement of the local electron temperature, plasma potential, and density. However, interpreting their signals becomes difficult in partially magnetized or turbulent conditions, where analytical models fail.
A synthetic diagnostic is a virtual model of a real diagnostic instrument. It reproduces, through simulation, the same signals that the physical device would measure under identical plasma conditions. This approach creates a bridge between numerical modeling and experimental measurements, enabling validation of simulations and improved interpretation of experiments. By embedding the probe model into a Particle-In-Cell (PIC) plasma simulation, one can compute the synthetic current-voltage characteristics directly from particle dynamics and electromagnetic fields.

Internship objective:
The goal of this internship is to develop a synthetic Langmuir probe diagnostic adapted to the plasma conditions of the MISTRAL and Von Karman Plasma (VKP) experiments. The student will integrate a realistic probe geometry into a PIC code and analyze the resulting simulated signals. The synthetic results will then be compared to experimental data to improve the understanding of plasma fluctuations and transport.

Main tasks:

- Implement a variable-geometry Langmuir probe model in a PIC plasma simulation.
- Compute synthetic I–V characteristics under various plasma regimes.
- Compare simulation outputs to experimental probe data (MISTRAL, VKP).
- Contribute to the interpretation of density fluctuation measurements.

Required skills:

- Background in plasma or computational physics.
- Familiarity with numerical simulation (PIC, Python, or C++).
- Interest in modeling and data–experiment comparison.

Supervision:
The internship will be hosted at M2P2 (Aix-Marseille University), in collaboration with ENS Lyon, PIIM, and LAPLACE laboratories.

Contact: Anna Glasser – anna.medvedeva@univ-amu.fr