

PHYS-732

Plasma Diagnostics in Basic Plasma Physics Devices and Tokamaks: from Principles to Practice

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Cursus	Sem.	Type
Physics		Opt.

Language of teaching	English
Credits	2
Session	
Exam	Written
Workload	60h
Hours	36
Courses	16
Exercises	10
TP	10
Number of positions	

Frequency

Every 2 years

Remark

Next time: Spring 2026 (Block course)

Summary

The programme will allow students to learn plasma diagnostics and data processing methods of modern fusion experiments and to bridge the gap between diagnostics theory and experimental practice.

Content

Introduction: students will be taught the basics of both TORPEX and TCV facilities. The lecture will be followed by a visit of the experimental installations.

Theory of magnetic probes: Rogowski-coil, Flux loop, Diamagnetic loop, Poloidal field probes, Non-axisymmetric measurements, Poloidal field probes, Saddle loops. Data analysis techniques: mode identification using MHD spectroscopy (spectrogram - autocorrelation), Cross-correlation, Toroidal mode decomposition/general least square fit/Sparse spec, Singular Value Decomposition. Practicum: calibration of magnetic probes and measurements of transfer function, analysis of TCV data.

Theory of various types of electrostatic probes, including single, double, and triple probes, Katsumata, ball pen, emissive probes, Mach probes, energy analyzers, turbulent particle flux probes. Data analysis techniques: Fourier analysis, Higher order Fourier analysis, Statistical analysis, Conditional sampling. Practicum: measurements of time averaged quantities and fluctuations in TORPEX and TCV data using single, double and triple probes; measurements of fluctuations in TORPEX, including statistical properties (skewness, etc.) perpendicular wave number and particle flux.

Theory of plasma emission and fast imaging. CMOs/CCD cameras, fast framing cameras, streaked cameras; Image intensifiers; Gas-puffing systems. Data analysis techniques: Fourier based techniques (linear and higher-order techniques); space-based techniques (structure identification, etc.). Practicum: installation and use of the fast camera to image radially propagating blobs in TORPEX; determination of physical quantities such as blob speed and size; use of advanced data analysis techniques, such as conditional sampling and box-averaging. On TCV: data analysis of camera data.