ROYAL INSTITUTE
OF TECHNOLOGY

Course information

ED2245 Project in Fusion Physics 2011

ECTS Credits 4.5

Course coordinator

Per Brunsell, 08-790 6246, per.brunsell@ee.kth.se
Fusion Plasma Physics, School of Electrical Engineering, KTH
Alfvén Laboratory, Teknikringen 31, KTH Campus

Course aim

The student will learn about practical experimental research work by carrying out a small research project. The projects are performed in a research laboratory environment, the EXTRAP T2R fusion research experiment at the Alfvén Laboratory. The student will engage in a project that also leads to a more in-depth understanding of some common fusion plasma diagnostics methods.

After passing the course, the student should be able to

- understand and explain typical experimental methods in fusion physics,
- design an experiment based on a given research problem,
- perform common experimental research tasks such as experiment preparation, data collection and data analysis,
- summarize experimental research work in a short written report,
- communicate experimental work in a small informal talk.

Contents

- Experimental techniques used at small fusion research devices for plasma generation, plasma control and measurement data acquisition.
- Examples of plasma diagnostic methods that are commonly used selected among the diagnostics available at EXTRAP T2R such as magnetic measurements, electric probe measurements, soft X-ray detectors and visible spectroscopy.

Language

English

Prerequisites

Good knowledge of physics and electromagnetism.

Literature

The following course material above will be handed out at the first meeting (at no cost)

- Course book: Experimental Fusion Plasma Physics.
- Project descriptions.

Further material is available and will be handed out when needed (manuals, experimental hardware descriptions etc).

Examination

Course credits will be given for successfully completed projects. Active participation is required during all project stages.

A final meeting in the course will be for project presentations: Students present their project in a short talk with power point slides (or similar) and then receive comments from other students and the course coordinator. Each group gives in turn a presentation and the other groups comment and participate in the discussion. The time for each presentation is 15 minutes

The project report should include a description of the experimental equipment, data analysis methods and the results, with a selection of useful graphs. A listing of computer programs written for the data analysis should be attached as an appendix. The length of the report is probably around 8-10 pages (excl the appendix).

The last day for handing in the project report is **Friday May 27**.

Grades

The grade awarded will be dependent on the overall amount of activity, understanding and creativity that the student demonstrates during all stages of the project execution process, in the presentation at the project seminar, and in the handed-in written project report.

Grades given: A-F

Projects

Students work in small project groups, with two or three students in each group. All group members work together to carry out the research project. The students select a project among six available projects that have been designed (see table below). These projects are centred on a common theme: Experimental methods to obtain information about the plasma main parameters such as electron temperature and plasma flow and investigation of the effect of the plasma column symmetry on the flow. The selection of project topics is constrained by the diagnostic capabilities that exist at the EXTRAP T2R device.

Proj	**Description**
1	Plasma flow velocity from spectroscopic measurement for Doppler line shifts Plasma flowing towards or away from an observer will produce a Doppler blue- or red-shift of the spectral lines that is measured with a spectrometer. Plasma rotation in the horizontal plane (toroidal direction) and vertical plane (poloidal direction) can be measured using available viewing ports.
2	Measurement of plasma magnetic field fluctuations with arrays of pick-up coils The internal magnetic field in the device is produced by electric currents flowing in the plasma itself. This field has fluctuations due to magneto-hydrodynamic (MHD) instability eigenmodes. The magnetic field perturbations propagate with the plasma, and measurements of the fluctuations can give information on the plasma flow.
3	Edge plasma flow from electric field measurement with probes Flow of the plasma, which is a conducting medium, across a magnetic field creates an electric field when observed in the stationary laboratory frame. The electric field in the plasma can be measured with an array of inserted electrodes (probes).
4	Determination of plasma column shape from the external magnetic field The toroidal surfaces created by the magnetic field lines winding around the torus are called flux surfaces. The plasma boundary is determined by the shape of the magnetic flux surface near the vacuum vessel wall. The flux surface shape is obtained from measurements of the radial magnetic field at the wall.
5	Plasma temperature measurement using soft X-ray detectors The plasma is emitting electromagnetic radiation of the soft X-ray region. The radiation is produced by acceleration and deceleration of electrons. This type of radiation is called braking radiation (bremsstrahlung) and the intensity dependence on photon energy gives information on the electron temperature.
6	Measurement of plasma fluctuations with electric probe pairs. A plasma quantity, such as density, temperature and electric potential fluctuates in time and space. The fluctuations are due to various instabilities and plasma waves. Broadband fluctuation signals are typically measured. Statistical methods can be used to obtain the characteristic wave properties.

Course plan

The course runs over eight weeks in period 4, from week 13 to week 21. There are four scheduled meetings or experiments in which the student should participate.

1. Course start-up meeting (2h) (week 13)
2. First experiment session (half-day) (week 17)
3. Second experiment session (half-day) (week 18)
4. Project presentation seminar (2h) (week 21)

The main work is carried out in the project group, and is scheduled by the project group members themselves. The total time required to complete the course is of the order of one hundred hours, with the main time spent carrying out the work in the project groups. All students will have access to the experiment facilities during the period of the course (week 13-21). The outline of the project work schedule is shown below:

Week	**Plan**
13	Course start-up meeting (2h): Course presentation. Decide project groups, distribute projects among the groups, and set the dates for experiment sessions and the final seminar. Visit the Alfvén Laboratory and the EXTRAP T2R fusion device.
14	Project group work: Read through background material, become familiar with the experimental equipment, data acquisition, and data analysis software.
15	Project group work: Prepare for experiments, setup of the experimental equipment, prepare data analysis software.
17	First experiment session (half-day): The EXTRAP T2R device will be operated and data for the projects will be acquired.
18	Second experiment session (half-day): The EXTRAP T2R device will be operated and data for the projects will be acquired.
19	Project group work: Analysis of experimental data, preparation of graphs etc
20	Project group work: Write project report, prepare slides for project presentation.
21	Project presentation seminar (2h): Project presentations. Each group gives in turn a presentation of their project and the results obtained. Other groups should comment and participate in the discussion. The time for each presentation is 15 minutes