UNIVERSITÀ
DEGLI STUDI DI MILANO-BICOCCA

COURSE SYLLABUS

Plasma Physics Laboratory

2122-3-E3001Q062

Aims

The 2022/2023 Plasma Laboratory is divided into three parts:

PART 1: Laboratory of nuclear diagnostics of fusion plasmas

PART 2: Laboratory of generation of cold plasmas

PART 3: Laboratory of spectroscopy of cold plasmas

Contents

Detailed program

E1: Gamma spectroscopy measurements using scintillators coupled to PMT or SiPM

E2: Measurement of energy resolution and charge collection in diamond detector using alpha source

E3: Study of the response of a Silicon X-ray detector (calibration, energy resolution ...)

For some of these experiments a detector emulator will also be used to simulate the response to a (simulated) plasma pulse for some diagnostics during fusion experiments.

For each experience, an introductory lesson will be held in which both the equipment to be used and the different steps of the experience will be explained.

Students will be divided into groups of 3-4 people.

The introductory lessons will take place remotely on the zoom platform (connection link provided in the notices on the e-learning page of the course)

A detailed schedule of both lessons and laboratory shifts will be provided.

The activities are held in room 1001 of Building U9 - Prometeo Plasma Laboratories of the Physics Department.

PART 2

The purpose of the laboratory activities in Part 2 is to experimentally introduce methods for generating cold plasmas, i.e. plasmas in which the ionic and neutral components are at temperatures close to room temperature. The two techniques used will be the hot cathode DC discharge and the radiofrequency discharge. Electrical measurements will be carried out on the hot cathode plasma to assess its main parameters. These activities will provide some basic training tools, common to many areas of laboratory plasma physics and technology, which will also be useful for future university activities and for the profession of physicist.

The activities are accompanied by a brief introduction to the plasma state, to the phenomenon of low-pressure plasma breakdown, and to the diagnostics used to characterise plasmas.

1. Classification of laboratory plasmas, breakdown of DC and RF plasmas
2. Plasma diagnostics: the Langmuir probe
3. Introduction to the experiments

The experiments will take place as part of the main activities:

- Generation of a linear hot cathode plasma, and measurement of the current-voltage characteristics of the discharge
- Plasma characterisation: measurement of macroscopic plasma profiles (density, potential, temperature)
- Generation of a radio-frequency plasma

Students will participate in the experimental activities typically in groups of three persosn, according to the calendar that will be prepared at the beginning of this part.

The introductory lessons will take place in presence.

The experimental activities will be held in the 2025 room at the second floor of the U2 Building - Department of Physics.

PART 3

The purpose of part 3 of the lab is to introduce students to the use of UV and visible spectroscopy in cold plasmas. Students will have the opportunity to build a spectrometer allowing them to learn the basics of UV and visible optics as well as CCD senosor programming. The constructed spectrometer will then be used to characterize different sources of plasmas and the measurements will be compared to a commercial spectrometer. The knowledge gained will then be used to characterize the plasmas of the GyM device at the Institute for Plasma Science and Technology. To this end, students will be introduced to the basics of collisional models of radiation in plasmas.

The topics of the introductory lectures are in the following:

1. Part 1:

- Introduction to spectroscopy in fusion plasmas and cold plasmas.
- Elements of optics for the construction of a spectrometer.

2. Part 2:

- Collisional-Radiative Models
- Introduction to the study of plasma-wall interaction

Experiments are carried out as part of the main activities:

- Construction of a USB spectrometer
- Characterization of various plasma sources
- Characterization of plasmas for the study of plasma-wall interaction

Students will participate in the experimental activities indicatively in groups of three, according to the schedule that will be prepared at the beginning of this part.

Introductory lectures will be held in presence.

The laboratory activities will be held in room 2025 on the second floor of Building U2- Department of Physics and at the Institute for Plasma Science and Technology (CNR, Milan).

Prerequisites

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Teaching form

Lessons and laboratory sessions

Textbook and teaching resource

Some slides will be written on the introductory topics and the cards of the experiments.

We recommend the text

F.F. CHEN Introduction to Plasma Physics and Controlled Fusion, Springer International Publishing

DOI 10.1007 / 978-3-319-22309-4, 2016, for a phenomenological description of the plasma state.

For the diagnostics part, the text Glenn F. Knoll Radiation detection and measurement is recommended.

Semester

Second

Assessment method

To be admitted to the exam it is necessary to prepare a report on all laboratory experiences. The oral exam will focus both on the discussion of the report itself and on general questions on the theoretical topics covered.

Office hours