Advanced techniques of experimental physics

Lecturers
Denis TERWAGNE (Coordinator), Juan Antonio AGUILAR SANCHEZ and Pascal VANLAER

Course mnemonic
PHYS-F482

ECTS credits
5 credits

Language(s) of instruction
English

Course period
First term

Campuses
Plaine and Other campus

Course content

This course covers advanced techniques in experimental physics.

A first part concerns experimental techniques related to soft matter and frugal science.

A second part deals with data analysis techniques (inference, machine learning) and their application in particle physics.

Objectives (and/or specific learning outcomes)

Learning of selected experimental techniques in soft matter physics, frugal science, data analysis and particle physics.

Teaching method and learning activities

Ex-cathedra teaching, computer and laboratory work.

Part 1: Soft matter and frugal science (experiments)

In this part, students will be asked to contribute to the technical part of an open and topical experimental research question in the field of soft matter and/or frugal science. Based on a research document (scientific publications, research project,...), students will reproduce and evolve a part of the experimental device and/or the scientific tool they are inspired by in a research laboratory.

To do so, students will be introduced to the design, fabrication and use of research objects and scientific tools, to project management techniques, to open tools and communities of practice, and to the fabrication of open science hardware. Students will work in a fablab environment with access to digital fabrication tools and will be able to rely on a transdisciplinary community of practice sharing an open, collaborative and open-source philosophy.

The experimental object that the students will realize will be documented, for sharing with and contribution to the community, and a presentation will close this first part.

Part 2: Particle physics (data analysis)

In this part, students will learn how to extract as much information as possible from data by fitting techniques, hypothesis testing techniques, and simple Machine Learning techniques.

Theoretical courses cover the statistical aspect of data, simulation techniques of experiments (pseudo-experiments), parameter estimation, hypothesis testing, and the different methods of Machine Learning.

The practical work on computer allows to reproduce the randomness of an experiment, to apply the techniques learned in the theoretical course, and to simulate the expected performances for these different techniques in some representative cases. We take advantage of the interactive environment of the jupyter "notebooks" with the python language.

Contribution to the teaching profile

Become familiar with modern experimental techniques, including prototyping and modeling; contribute to the self-sufficiency of students and graduates who encounter situations where these techniques are implemented.

References, bibliography and recommended reading

- Université virtuelle: https://uv.ulb.ac.be/course/view.php?id=94643
- Citizen Cyberlab, CERN, unitar, University of Geneva : https://www.citizencyberlab.org/
- Open-source Lab, Joshua Pearce : https://www.elsevier.com/books/open-source-lab/pearce/978-0-12-410462-4
- Frugal Science, BIOE271, Stanford University : https://www.frugalscience.org/
- Center for Bits and Atoms, MIT : http://cba.mit.edu/about/), tools :http://cba.mit.edu/tools/
- G.Cowan, "Statistical data analysis", Oxford university pressFichier

Other information

Place(s) of teaching

Other campus and Plaine

Contact(s)

Denis TERWAGNE (coordinnateur), Denis.Terwagne@ulb.be

Evaluation method(s)

Other, Oral presentation, Oral examination and Written report

Evaluation method(s) (additional information)

Oral presentation, oral exam and lab report (alone or in groups)

Determination of the mark (including the weighting of partial marks)

Part 1 - soft matter and frugal science: 50% of the final grade

- Oral presentation: 50% of the grade for Part 1
- Laboratory report: 50% of the grade for Part 1

Part 2 - Particle Physics: 50% of the final grade

- Oral exam: 50% of the grade for Part 2
- Laboratory report: 50% of the grade for Part 2

Attendance at lectures and practical/laboratory work is a prerequisite for the student's success in the relevant course. A student who does not attend the lectures and practical or laboratory sessions will be marked absent as an overall grade for both the 1st and 2nd session.

Main language(s) of evaluation

French and English

Programmes

Programmes proposing this course at the faculty of Sciences

MA-PHYS | Master in Physics | finalité Research/unit 1 and finalité Teaching/unit 1