UCLouvain

lphys2233

2020

Experimental methods in particle physics

Due to the COVID-19 crisis, the information below is subject to change, in particular that concerning the teaching mode (presential, distance or in a comodal or hybrid format).

10 credits	52.5 h + 7.5 h	Q2

Teacher(s)	Bruno Giacomo ;Cortina Gil Eduardo ;Delaere Christophe ;Vischia Pietro (compensates Bruno Giacomo) ;
Language :	English
Place of the course	Louvain-la-Neuve
Main themes	Advanced particle detectors ' Particle physics experiment design ' Triggering, data acquisition and computing systems ' Data reconstruction algorithms ' Advanced statistics ' Software tools for simulation in particle physics.
Aims	**a. Contribution of the teaching unit to the learning outcomes of the programme (PHYS2M and PHYS2M1)** 1.3, 1.4, 1.5, 1.6, 2.2, 2.3, 2.4, 2.5, 5.1, 5.3, 6.1, 6.2, 6.3, 6.4, 7.1, 7.3 , 8.1, 8.2. **b. Specific learning outcomes of the teaching unit** At the end of this teaching unit, the student will be able to : 1 1. explain and discuss in detail the advanced experimental techniques of complex systems used in particle physics : particle detectors ; trigger, data acquisition and computing systems ; data reconstruction ; statistical data analysis ; 2. explain and discuss advanced nuclear electronics techniques. 3. conceive a detector setup for basic particle physics measurements ; 4. setup and carry out a small-scale particle detection experiment ; 5. develop a software project within an existing framework aiming at simulating an experimental setup in which particles propagate through matter ; 6. analyse data issued from an experiment in order to measure physical quantities through statistical inference ; 7. write a report that documents the developments and results of either a personal software project or an experiment in a laboratory. - - - - *The contribution of this Teaching Unit to the development and command of the skills and learning outcomes of the programme(s) can be accessed at the end of this sheet, in the section entitled "Programmes/courses offering this Teaching Unit".*
Evaluation methods	**Due to the COVID-19 crisis, the information in this section is particularly likely to change.** Evaluation of reports written by the students on projects concerning either the simulation of the particle propagation in matter or real systems for particle detection in a laboratory or a statistical analysis of data resulting from an experiment in physics. Evaluation of an oral interrogation on the projects and the subjects treated in the teaching unit.
Teaching methods	**Due to the COVID-19 crisis, the information in this section is particularly likely to change.** 1. Theory classes and exercises. - Lectures in auditorium. - Resolution of problems . 2. Laboratory sessions (7.5h). Mandatory presence at the following laboratories : • Large-area cosmic ray detector ; • Silicon sensors characterization ; • Construction of an RPC detector. Writing of a report on a laboratory of the student's choice. 3. Personal software project and report writing
Content	1. Signal formation : general case. 2. Tracking detectors. a. Large area counters: hodoscopes. b. Magnetic spectrometers : magnets, resolution. c. Gas position detectors : MWPC, drift detectors, jet chambers, TPCs, RPCs.

	d. Solid state position detectors : silicon detectors, scintillation fiber detectors. e. LAr TPCs. Double phase TPCs. 3. Calorimetry. a. Electromagnetic calorimeters. b. Hadronic calorimeters. c. Low temperature calorimeters. Bolometers. 4. Particle identification. a. Muon detectors. b. Cerenkov detectors : threshold, differential, RICH. c. TRD detectors. d. Time of flight. e. dE/dx. 5. Complex detector study : journal club like approach. a. Collider : CMS, DELPHI. b. Fixed target : NA62. c. Astroparticle : AMS-02, Auger. 6. Auxiliary systems. a. Low and high voltage systems. b. Gas systems. c. Cooling systems. d. Mechanical supports. e. Cabling. 7. Nuclear electronics. 8. Trigger and data acquisition systems. 9. Offline data processing systems. 10. Event reconstruction algorithms. a. Tracking, b. Vertexing. c. Clustering. d. Jets 11. Calibration and alignment techniques. 12. Statistical methods of data analysis. 13. Simulation of particle propagation in matter. 14. Projects concerning either the simulation of particle propagation in matter or real particle detection systems in the laboratory or a statistical analysis of data from a physics experiment.
Bibliography	C. Grupen, B. Schwartz, “Particle Detectors” (2nd edition). D. Green, “The Physics of Particle Detectors”. R. Fernow, “Introduction to Experimental Particle Physics”. C. Leroy, P.G. Rancoita, “Principles of Radiation Interaction in Matter and Detection”. S. Tavernier, “Experimental Techniques in Nuclear and Particle Physics”. G. Cowan, “Statistical Data Analysis”, Oxford Science Publications.
Faculty or entity in charge	PHYS

Programmes containing this learning unit (UE)				
Program title	Acronym	Credits	Prerequisite	Aims
Master [60] in Physics	PHYS2M1	10		
Master [120] in Physics	PHYS2M	10		