UCLouvain

lphys2233

2021

Experimental methods in fundamental physics

10.00 credits	52.5 h + 7.5 h	Q2

Teacher(s)	Bruno Giacomo ;Cortina Gil Eduardo ;Delaere Christophe ;
Language :	English
Place of the course	Louvain-la-Neuve
Prerequisites	Having followed LPHYS2102 is an asset
Main themes	PARTIM B (5 credits) : Advanced detection methods and experiment design in fundamental physics. PARTIM C (5 credits) : Triggering, data acquisition and computing systems - Data treatment algorithms - Advanced statistics - Software tools for data treatment and simulation in fundamental physics.
Learning outcomes	**At the end of this learning unit, the student is able to :** **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 fundamental physics : detectors ; trigger, data acquisition and computing systems ; data treatment ; statistical data analysis ; 2. explain and discuss advanced nuclear electronics techniques. 3. conceive a detector setup for basic physics measurements ; 4. setup and carry out a small-scale 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.
Evaluation methods	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	- Lectures in auditorium. - Resolution of problems in auditorium. - Personal software project and report writing.
Content	PARTIM A (4 credits): "Introduction and use of GEANT": this partim is proposed to the students of the "finalité médicale " and consists of a selection of subjects from those included in partims B and C below. It focuses mostly on the propagation of particles in matter. PARTIM B (5 credits): "Advanced detection methods": this partim is proposed to all students 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. Introduction to detection methods used in gravitational wave physics PARTIM C (5 credits): "Data analysis methods": this partim is proposed to all students 9. Trigger and data acquisition systems. 10. Offline data processing systems. 11. Event reconstruction algorithms. a. Tracking, b. Vertexing. c. Clustering. d. Jets 12. Calibration and alignment techniques. 13. Introduction to data analysis methods used in gravitational wave physics 14. Statistical methods of data analysis. 15. Simulation of particle propagation in matter. 16. 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.
Other infos	This course consists of three partims, which can be taken separately by the students: Partim A (4 credits): "Introduction and use of GEANT" Partim B (5 credits): "Advanced detection methods" Partim C (5 credits): "Data analysis methods"
Faculty or entity in charge	PHYS

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