Universitat Autònoma de Barcelona

2019/2020

Experimental Techniques in Particle Physics

Code: 44081
ECTS Credits: 6

Degree	Type	Year	Semester
4313861 High Energy Physics, Astrophysics and Cosmology	OT	0	2

Contact

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Use of Languages

Principal working language: english (eng)

Teachers

Thorsten Lux

Sebastian Grinstein

Prerequisites

No specific prerequisites are set for this course.

Objectives and Contextualisation

The main purpose of this course is to give an overview of the experimental technique used in particle physics. It covers from the basic principles used to the integration of a full complete detector.

Competences

- Formulate and tackle problems, both open and more defined, identifying the most relevant principles and using approaches where necessary to reach a solution, which should be presented with an explanation of the suppositions and approaches.
- Understand the bases of advanced topics selected at the frontier of high energy physics, astrophysics and cosmology and apply them consistently.

Learning Outcomes

1. Design a detector for a specific problem of physics.
2. Understand the different techniques for particle detection (scintillation, ionisation, Cherenkov light, etc.)
3. Understand the fundamentals of interaction of radiation with matter.

Content

Particle Interactions with matter

- General Considerations
- Atomic ionization and excitation
- Small angle multiple difusion

- Photon interactions with matter
- Electromagnetic Cascades
- Interactions of high-energy muons
- Cherenkov radiation and transition radiation

Review of electronic circuits and other technical aspects

- Circuits with reactive elements
- Propagation of electrical signals in cables

Detection Techniques

- Overview
- Photon detectors
- Scintillators
- Cherenkov radiation detectors
- Transition radiation detectors
- Thread cameras
- Gas Microdetectors
- Resistive plate chambers
- Time projection chambers
- Semiconductor detectors

Experimental Design Equipment

- Context: fixed target experiments, in the center of mass, or without beaming • Measures of position, time, quadrumoments; particle identification
- Trace and vertex detectors
- Calorimeters
- Muon spectrometers
- Fixed target Beams: Experiment design
- Colliding beams: Experiment design
- Experiments with neutrinos
- Searching for the proton decay
- Other searches: dark matter, double beta decay

Methodology

Theory lectures, exrecices and expositions by the students. Classwork and Homework.

Activities

Title	Hours	ECTS	Learning Outcomes
Type: Directed			
Discussion, Work Group, Group Exercices	20	0.8	2, 1, 3
Particle interactions with matter	25	1	2, 1, 3
Type: Supervised			
Study of real detectors	30	1.2	2, 1, 3

Assessment

Homework consisting on three sets of problems addressing sequentially the physics effects used, the detection techniques and the full detectors covers 85% of the evaluation mark. The additional 15% is based on attendance and participations to lectures.

Assessment Activities

Title	Weighting	Hours	ECTS	Learning Outcomes
Attendance and participation to lectures	15%	45	1.8	2, 1, 3
Homework Detection Techniques	30%	10	0.4	2
Homework Full Detectors	30%	15	0.6	1
Homework Physics Phenomena	25%	5	0.2	3

Bibliography

W.R. Leo. Techniques for Nuclear and Particle Physuics Experiments , Springer-Verlag