Experimental Techniques in Particle Physics

Code: 44081
ECTS Credits: 6

<table>
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<tr>
<th>Degree</th>
<th>Type</th>
<th>Year</th>
<th>Semester</th>
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<tr>
<td>4313861 High Energy Physics, Astrophysics and Cosmology</td>
<td>OT</td>
<td>0</td>
<td>2</td>
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</tbody>
</table>

Contact

Name: Oscar Blanch Bigas
Email: Desconegut

Teachers

Thorsten Lux
Sebastian Grinstein

Use of Languages

Principal working language: english (eng)

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 diffusion
• 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, exercises and expositions by the students. Classwork and Homework.

Activities

<table>
<thead>
<tr>
<th>Title</th>
<th>Hours</th>
<th>ECTS</th>
<th>Learning Outcomes</th>
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<tbody>
<tr>
<td>Type: Directed</td>
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<tr>
<td>Discussion, Work Group, Group Exercises</td>
<td>20</td>
<td>0.8</td>
<td>2, 1, 3</td>
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<tr>
<td>Particle interactions with matter</td>
<td>25</td>
<td>1</td>
<td>2, 1, 3</td>
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<td>Type: Supervised</td>
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<td></td>
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<tr>
<td>Study of real detectors</td>
<td>30</td>
<td>1.2</td>
<td>2, 1, 3</td>
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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

<table>
<thead>
<tr>
<th>Title</th>
<th>Weighting</th>
<th>Hours</th>
<th>ECTS</th>
<th>Learning Outcomes</th>
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<tbody>
<tr>
<td>Attendance and participation to lectures</td>
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<td>45</td>
<td>1.8</td>
<td>2, 1, 3</td>
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<tr>
<td>Homework Detection Techniques</td>
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<td>10</td>
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<td>Homework Full Detectors</td>
<td>30%</td>
<td>15</td>
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<tr>
<td>Homework Physics Phenomena</td>
<td>25%</td>
<td>5</td>
<td>0.2</td>
<td>3</td>
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Bibliography

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