UNIVERSITÀ
DEGLI STUDI DI MILANO-BICOCCA

COURSE SYLLABUS

Experimental Methods in High Energy Physics

2627-1-F1703Q008

Aims

Knowledge and understanding
At the end of the course, the student will acquire a solid understanding of the basic principles of high-energy particle beam production and of the apparatus used to measure physical quantities in a high-energy physics experiment

Applying knowledge and understanding
The student will be able to understand the design choices and the functionality of the components of an apparatus used to measure physical quantities in a high-energy physics experiment

Macking judgments
The student will develop the ability to evaluate the advantages and limitations of the detectors used in high-energy physics through the analysis of practical examples

Communication skills
The student will be able to present the knowledge acquired with clarity and appropriate language

Learning skills
The student will acquire conceptual and methodological tools to independently study the topics covered during the course and to understand scientific articles related to a high-energy physics apparatus

Contents

- Particle accellerators
- Detector principles
- Detectors for measuring linear momentum and decay topology

- Detectors for particle identification
- Detectors for energy measurement

Detailed program

- Accelerator physics: basic concepts, linearization of the beam transport-equation, Liouville's theorem, evolution of the phase-space ellipse, emittance and luminosity
    - Beam exploitation: collider and fixed target experiments
    - Secondary beam production: pion, kaon, photon and neutrino beams
- Detector principles: main features, limits and performance of the most important detectors (scintillators, wire chambers, Time Projection Chambers, solid-state detectors and Cerenkov detectors)
    - Theory of signal formation: derivation of Ramo’s theorem
    - Organization of detectors in an experimental apparatus
- Momentum measurement with a magnetic spectrometer and achievable resolution
- Particle ID by time-of-flight, threshold/differential/ring-imaging Cerenkov detectors, and transition-radiation detectors
- Energy measurement and particle identification by total absorption of particles: electromagnetic and hadronic calorimetry
    - Energy resolution of calorimeters and the compensation challenge

Prerequisites

Foundations of Mechanics, Electromagnetism, Optics, Special Relativity, Structure of Matter, and Particle Physics

Teaching form

Frontal lectures

Textbook and teaching resource

- "An introduction to the physics of particle accelerators" Conte, MacKay
- "Particle detectors" Grupen, Shwartz
- "Detectors in high-energy physics experiments" Eigen
- "Review of Particle Physics" J. Beringer et al. (Particle Data Group), Phys. Rev. D110, 030001 (2014)
  For further information
- "Basic Course on Accelerator Optics" Rossbach
- "Experimental techniques in high energy physics" Ferbel
- "Semiconductor detector systems" Spieler
- “Calorimetry: energy measurement in particle physics” Wigmans

Semester

Second semester

Assessment method

There are no tests during the semester. The final oral exam consists of an interview on the topics of the course. Clarity of exposition, the depth of knowledge of the topics presented (with respect to the syllabus), and the ability of critical analysis and design choice of instrumental configurations about the measurement objectives are evaluated

Office hours

On student's request

Sustainable Development Goals

QUALITY EDUCATION