UNIVERSITÀ
DEGLI STUDI DI MILANO-BICOCCA

## COURSE SYLLABUS

# Experimental Methods in High Energy Physics

**2526-1-F1703Q008**

## Aims

**Knowledge and understanding**
At the end of the course, the student will acquire a solid understanding of the basic principles for the production of high-energy particle beams and of the apparatus for the measurement of 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 for the measurement of 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 linear momentum measurement and 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 mode 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
- "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