UNIVERSITÀ
DEGLI STUDI DI MILANO-BICOCCA

COURSE SYLLABUS

Particle Physics II

2526-1-F1703Q033

Aims

The aim of the course is to provide students with the ability to interpret experimental result in high-energy physics, and with the knowledge of the precision measurements carried out at the electron-positron colliders LEP and SLC and at the hadron colliders Tevatron and LHC, clarifying their role and impact in defining the theory of fundamental particle interactions (Standard Model) and tand interpret experimental measurements in high-energy physics with lepton and hadron colliders, needed to engage with current research in the field.

Knowledge and Understanding

Provide a deep knowledge and understanding of the experimental foundation of the Standard Model of particles physics, based on the experiments at the lepton and hadron colliders

Applying Knowledge and Understanding

Interpret results from experiments at collider in the theoretical framework of the Standard Model

Making Judgments

Asses the role, the importance and the limits of results from experiments at LEP, Tevatron and LHC

Communication

present results from particle physics experiment, being able of giving a general overview as well as going into details of specific topics

Learning Skills

Give the skills necessary for interpreting and analyze scientific literature on experiments at colliders, being able to indipendently explore the topics presented in the lectures or other topics related to them

Contents

Experimental measurements performed at LEP and SLC and experimental tests of the predictions of the standard model. Deep inelastic scattering and PDF for nucleons. Introduction to measurements to a hadron collider and to their interpretation. Experimental measurements at Tevatron and at LHC (W mass, top mass, search for the Higgs boson).

Detailed program

Brief summary of the standard model theory.

Observable at tree-level in positron-electron collisions: lineshape of the Z, peak cross section, asymmetries (Left-Rigt, Forwrd-Backward, polarisation). Measurements of total and differential cross sections, asymmetry measurements. Pseudo-observable at LEP, QED radiative corrections. Contributions to the measurement uncertainties : beam energy and luminosity. Results for pseudo-observables with comment on uncertainties. Invisible width measurements and number of neutrinos. SLC asymmetries measurements. Polarization measurement of tau. Identification of b quarks and measurement of the asymmetry for b quarks.

Comparison of the LEP/SLC measurements with the theoretical predictions, EWK corrections.

Brief overview of the measurements at LEP II

Deep Inelastic Scattering, definition of the relevant kinematic variables, parton model and scaling. Structure functions of the proton (PDF). Experimental determination of PDFs. Factorisation scale and PDF evolution.

Cross section in collisions with hadrons and partonic cross sections.

Introduction to hadron colliders and relevant kinematic variables: characteristics of collisions, transverse momentum (PT), (pseudo)-rapidity, missing transverse energy, transverse mass. Underlaying event and pile up. Luminosity measurements at hadron colliders.

Reconstruction of jets, measurements of cross sections of jet production, jet pairs invariant mass spectrum.

Precision measurement of the mass of the W boson.

Discovery of the top quark and measures of the mass of the top.

Spontaneous symmetry breaking, the role of the Higgs boson. Preliminary determination of the Higgs boson mass through indirect measurements, direct search of the Higgs boson at LEP and Tevatron, discovery of the Higgs boson at LHC.

Prerequisites

Students are expected to have familiarity with the topics of the courses "Particelle I" and "Fisica teorica I"

Teaching form

Lectures

Textbook and teaching resource

Books:

P. Renton "Electroweak Interactions"

M. Thomson "Modern Particle Physics"

R.Tenchini, C. Verzegnassi "The Physics of the Z and W Bosons"

Articles:

"Precision Electroweak Measurements on the Z Resonance"

"Jet Physics at the Tevatron" (10.1146/annurev.nucl.012809.104430)

"Top Quark Properties and Interactions" (10.1146/annurev.nucl.58.110707.171224)

"Measurement of the W Boson Mass at the Tevatron" (10.1146/annurev.nucl.58.110707.171227)

G. P. Salam, "Towards Jetography", arXiv:0906.1833

S. Forte, G. Watt, "Progress in the determination of the partonic structure of the proton" arXiv:1301.6754

S. Van Der Meer, "Calibration of the Effective Beam Height in the ISR"

Lectures:

G. Zanderighi, "Modern QCD", CERN 2010 Academic Training Lectures

L. Reina "TASI 2011: lectures on Higgs-Boson Physics", arXiv:1208.5504

Semester

March-June

Assessment method

Oral examination. The exam will cover all the topics discussed during the course and the student is invited to start with the discussion of a topic of his choice. During the discussion the student can use notes, graphs, to discuss the topic. Slides to help guiding the discussion are welcome. The exam will evaluate the knowledge and the level of understanding of the topics presented during the lectures, the clarity and the precison in the oral presentation and in answering the questions.

Office hours

By appointment, either agreed with the teachers in classroom or via email.

Sustainable Development Goals

QUALITY EDUCATION | DECENT WORK AND ECONOMIC GROWTH | INDUSTRY, INNOVATION AND INFRASTRUCTURE