UNIVERSITÀ
DEGLI STUDI DI MILANO-BICOCCA

COURSE SYLLABUS

Particle Physics II

2425-1-F1701Q079

Aims

Provide students with the necessary knowledge to understand and interpret experimental measurements in high-energy physics with lepton and hadron colliders. In particular, the precision measurements and relevant discoveries carried out at the electron-positron colliders LEP and SLC and at the hadron colliders Tevatron and LHC will be discussed, clarifying their role and impact in defining the theory of fundamental particle interactions (Standard Model).

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.
- LEP-II measurements: "direct" measurement of the invisible width of the Z, measurement of mass W and TGC.
- 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 in classroom. The lectures are also recorded and made available via e-learning, except in case of technical problems with the recording equipment.

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: available in the web

- 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 student is required to present a topic of his choice, with a presentaion lasting about 15-20 minutes. For this the student can use notes and graphs, slides to help guiding the discussion are welcome. After the discussion of the chosen topic a discussion covering any of the topics discussed during the lectures will follows. The exam will test the understanding of the topics presented during the lectures, the capability ot elaborate on them and the clarity of the answers.

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