UNIVERSITÀ
DEGLI STUDI DI MILANO-BICOCCA

# SYLLABUS DEL CORSO

# Fisica delle Particelle II

**2122-1-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 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

## 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" https://arxiv.org/abs/hep-ex/0509008

"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 this topic. Slides to help guiding the discussion are welcome.

## Office hours

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