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A.A. 2022-2023

Experimental Particle Physics

Part I - Particle detectors: current performance and challenges for future colliders (I. Vai) - Period: March-April 2023 - 10 overall hours

1. Experiments at the LHC vs experiments at future colliders (4h)
 - Experiments at the LHC: design and performance obtained.
 - Experimental challenges at the future colliders.
 - Designing an experiment for a future collider: status of the different proposals.
2. The role of fast timing detectors in future colliders experiments (4h)
 - Background rejection, 4-D tracking, etc..
 - Examples of fast timing detectors and their usage in particle physics experiments.
3. Applications of fast timing detectors beyond high energy physics (2h)
 - Medical applications (eg. TOF-PET), industrial applications, space..

Part II - From theory calculations to results particle physics results: an overview analysis of methods. (G. Barone) - Period: March-April 2023 - 10 overall hours

1. Real-world collider physics event description and generation (2h)
 - The Standard Model from an experimentalist's perspective.
 - From fixed-order calculations to final states in hadronic interactions.
 - Factorisation, scale dependency, and parton distributions functions evolutions.
 - The modern event simulation: matching perturbative predictions to parton showers.
2. Lessons learned at LHC Run-2: a detailed map of the fundamental particles with the Higgs boson (2h)
 - Higgs boson couplings to vector bosons.

- Higgs boson couplings to fermions.
 - Constraints to Beyond the Standard Model phenomena.
3. Experimental analysis methodology at the LHC and collider experiments (2h)
- Reconstruction of final state objects, jets, muons, and electrons.
 - From complex detectors to physics quantities: A modern view on object-level calibration.
 - The hunt for signals over big backgrounds.
 - Measurement of the Higgs boson mass: a concrete example from start to finish.
4. The systematic bracketing of new physics at the LHC (2h)
- Searches for direct indications of deviations.
 - (Precision) measurements for the indirect hunt of new physics.
 - Effective Field Theory viewed from the experiment.
5. Current theoretical and experimental foundations for the future: Run-3 to future circular colliders & experiments (2h)
- LHC program at Run-3 & High Luminosity LHC.
 - Analyses in future collider experiments: lepton colliders.
 - Analyses in future collider experiments: hadron colliders.
 - High-Energy picture on non-collider experiments.

For registration, please contact Daniela M. Rebutti (daniela.rebutti@unipv.it).
Lectures will be held in Aula Dottorato of the Physics Department (University of Pavia) and/or online. In this case, Zoom links will be circulated among participants few days before.