

Title: Measurement of Higgs boson in final states with heavy quarks in associated production channels and upgrade of the ATLAS tracking detector

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Equipe: ATLAS

Description:

The ATLAS¹ experiment is one of the four main detectors installed at the Large Hadron Collider (LHC) hosted by the CERN² laboratory, close to Geneva, Switzerland.

The data collected during Run1 (2010-2012) and Run2 (2015-2018) allowed to observe a Higgs boson (H) of a mass of about 125 GeV, first in bosonic final states and then in fermionic ones. Run3 started in 2022, and will last till 2026, with the goal to integrate by that date about 350 fb⁻¹ of data, more than double the amount collected at the end of Run2.

The APC ATLAS group has been deeply involved in the optimization and calibration of jet flavor tagging algorithms, and in the measurement of Higgs boson production in final states with heavy quarks for more than 5 years, contributing to the discovery analysis and to some of the tightest constraints on HH production using the bb $\gamma\gamma$ final state.

The candidate will work on the full Run2 and Run3 dataset – an aggregated threefold increase in the amount of data – focusing on final states with b and c quarks. The project will comprise activities on flavor tagging algorithm performance – the crucial tool to reject background events in the analysis of final states with b and c quarks – on signal and background modelling, as well as on analysis of the ATLAS Run3 data to measure Higgs boson production in one of the aforementioned decay channels when the Higgs boson is produced in association with a vector boson (W or Z).

In parallel to data taking, upgrades are taking place to transform the LHC into a high luminosity machine (HL-LHC); the final goal is to integrate data between 2029 and 2040 arriving at 3000-4000 fb⁻¹, to fully exploit the potential of the machine. This will allow to perform high precision measurements of Standard Model (SM) parameters and test several Beyond SM scenarios. To achieve this goal in a reasonable timespan not only the LHC will see its instantaneous collision rate increasing by a factor 5-7, but also several detectors of the ATLAS experiment will be upgraded. In particular, the actual tracking and vertexing detector will not be able to sustain the high fluxes of particles of HL-LHC, nor the accumulation of radiation damage to its silicon sensors correlated with that, a factor 10 larger than today.

For these reasons a new Inner Tracker (ITk³) is being developed; the ITk detector will consist of pixels detectors in its innermost part and microstrips in the outer part. According to the current plans ITk should be ready for data-taking in 2030 when collisions will resume.

¹ atlas.cern

² cern.ch

³ <https://twiki.cern.ch/twiki/bin/view/AtlasPublic/ITkPublicResults>

The APC ATLAS group has been strongly involved in silicon pixels R&D for ITk since many years, contributing to the studies on pixel sensors design, simulation, test, performance modeling and pre-production of ITk pixels modules.

The candidate will participate to the efforts of the pixel detector modules for ITk, by analyzing data collected during testbeams⁴ in European laboratories (CERN, DESY⁵). The results will be compared to precise TCAD and MonteCarlo simulations to tune radiation damage models that later will be used to extrapolate detector performance in different data-taking conditions (voltage, radiation fluence). The candidate will also give a contribution in understanding the performance of the actual ATLAS pixel detector with the accumulation of radiation damage, a preparatory work for the ITk pixels part of the project.

Master internship: contribution to the ongoing analysis of Higgs bosons decaying into pairs of b and c quarks

Working place: APC, Paris

Mobility: regular trips to CERN and DESY for testbeams. Presentation at an international conference and participation in a summer school in high energy physics.

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⁴ Depending on future accelerators schedule the candidate could also participate to testbeams

⁵ desy.de