

# Measurement of the tau polarization and the electroweak mixing angle in Z boson decays to tau leptons

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The CMS collaboration, which analyzes proton-proton collisions at the Large Hadron Collider (LHC) at CERN, has measured the polarization of tau leptons originating from the decay of Z bosons in LHC's Run 2 2016 data [1]. The polarization (the helicity asymmetry) measures the different couplings of the Z boson to left and right-handed fermions due to its electroweak nature, and allows to measure the effective electroweak mixing angle  $\sin^2\theta_w$ , one of the fundamental parameters of the Standard Model of particle physics. The goal of the PhD thesis is to improve this very competitive result, based only on a part of the available data, with the full Run 2 dataset (2016-2018), and recently collected Run 3 data (2022-2025). The improvements for this measurement will be achieved not only by the larger datasets but in particular by new spin reconstruction techniques being developed together with the Higgs Charge-Parity analysis consortium, where the CMS-IPHC group plays a leading role. These improvements are at the core of the thesis and will finally lead to a determination of  $\sin^2\theta_w$ , which could be comparable in precision to the one obtained at the Large Electron-Positron collider (LEP).

For the second part of the thesis, the student will participate in the installation and integration of the new tracker for the High Luminosity Phase of the LHC (HL-LHC) into the CMS detector. The HL-LHC phase is expected to start in 2029. In this context, the tracker, the innermost part of the detector, will be completely replaced in order to guarantee excellent reconstruction resolution of tracks and vertices in the HL-LHC environment, and to cope with the very high irradiation. The IPHC group is heavily involved in the preparation of the external part of this new tracker. The student will participate in the installation of detector modules and their testing at the tracker integration centre at Strasbourg. He/She would also actively contribute to the overall tracker assembly at CERN, in particular for the very first operation, testing and data taking (with cosmic muons) of large sections of the tracker, maybe even of the complete tracker. Several periods of presence at CERN will be necessary for this part.

Further information: <http://www.iphc.cnrs.fr/-CMS-.html>

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[1] CMS Collaboration, Measurement of the  $\tau$  lepton polarization in Z boson decays in proton-proton collisions at  $\sqrt{s} = 13$  TeV, <https://doi.org/10.48550/arXiv.2309.1240>, [CERN Courier](#)