Measurement of the lepton polarisation in hadronic tau-decays with the CMS detector at LHC

The LHC has started two years ago with proton-proton collisions at a centre of mass energy of 13 TeV. This energy and relatively high luminosity will allow to probe the Standard Model of particle physics for possible deviations and new physics with high precision. The effective weak mixing angle, weak vector- and axial- couplings of tau leptons can be extracted from the polarization of tau leptons in decays of the $Z^0 \rightarrow \tau\tau$. This is a non-trivial task and requires besides a good theoretical understanding a careful optimization of the analysis. The central subject of the internship will concentrate on new possibilities in the analysis of a variety of hadronic tau decays, like $\tau \rightarrow \pi$, $\rho$, $a_1$ and their multi-hadron final states. This work involves the application and further improvement of analysis software being developed by the CMS group in Strasbourg in collaboration with other institutions and will be an excellent preparation for the thesis proposed by the group to measure electroweak parameters, for example the effective weak mixing angle in the decays $Z^0 \rightarrow \tau\tau$ with the best precision possible. The topic is also of the highest relevance for further studies of the CP nature of the Higgs Boson at the future high luminosity LHC machine.

The group at the IPHC is involved on the tracker of the CMS experiment, particular on the data acquisition electronics and its upgrade for the High Luminosity phase of the LHC and on the high-level trigger. On the analysis side, the group works on b-quark identification, top-quark physics, direct searches for Supersymmetry and the determination of the Higgs-couplings to fermions.

The work during the internship will start with a study of the tau-polarization in one decay-channel, first using simulated data and then learning how to access the LHC data at 13TeV and how to compare the results obtained in simulation to the data. If time allows a further channel can be looked at. The goal of the internship will be to estimate the possible precision achievable on the tau polarization-asymmetry and on the effective electroweak mixing-angle.

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