Thesis abstract Salah El Dine Hammoud

"Study of vector boson scattering with the ATLAS detector and design of the High Granularity Timing Detector for HL-LHC"

Vector-Boson Scattering (VBS) is a key process for probing the non-Abelian gauge structure of the electroweak sector of the Standard Model, since it involves both the self-couplings of the vector boson sand their coupling with the Higgs boson. In the absence of the SM Higgs boson, the amplitudes for VBS would increase as a function of partonic center-of-mass energy and ultimately violate unitarity. The study of the VBS process provides an important check of the SM by testing whether the Higgs mechanism is the sole source of electroweak symmetry breaking. Any deviation from the Standard Model prediction would be a hint of physics beyond the Standard Model. The experimental signature of the Standard Model is characterized by the presence of a pair of vector bosons and two forward jets with a large separation in rapidity of jets and a large dijet invariant mass. The data used in this analysis corresponds to Run-2 and partial Run-3 datasets, allowing for better constraints on physics beyond the Standard Model in particular in the context of Effective Field Theory, compared with previous analyses. I have participated in the semi-leptonic analysis, in which one of the gauge bosons decays leptonically and the other hadronically. My main contribution was to optimize the sélections for this channel to maximize the sensitivity to anomalous quartic gauge couplings (aQGC) generated using a superset of Eboli model operators. I also provided preliminary likelihood fit results for the ft0 operator. In order to improve the pile-up rejection in the forward region for HL-LHC, where the collision rate will be increased by a factor of 10, a new detector will be installed called the High Granularity Timing Detector. It will be located in front of the liquid Argon end-cap calorimeters and will be composed of several layers of Silicon sensors (LGAD) providing a precision timing measurement for minimum ionizing particles with a time resolution better than 50 picoseconds per readout cell. I contributed to the characterization of the front-end ASIC prototypes, ALTIROC2-3-A, using a probe station. In particular, I contributed to the development of the analysis software and led extensive studies to evaluate the performance of the Time-Of-Arrival (TOA) Time-to-Digital-Converter (TDC) discretization step (LSB). Furthermore, many test-beam campaigns were conducted at both CERN and DESY, in which I participated extensively in the data analysis. My main power was evaluating the time resolution performance by means of different methods, and studying the coherence between bench test calibration and collected data.