Thesis defence Anastasia Kotsokechagia

17 mars 16h00

« Participation in the construction of the ATLAS tracker in view of the high-luminosity Phase-2 upgrade (ITk). – Search for electroweak Vector Boson Scattering in semileptonic final state with the ATLAS detector. »

Abstract :

The non-Abelian nature of the Standard Model (SM), predicts the existence of Quartic Gauge Couplings (QGC) that opens a window to study the details of the Electroweak Symmetry Breaking (EWSB) mechanism. Moreover, thanks to the Higgs boson and its specific couplings to the vector bosons the VBS cross section does not violate unitarity at about 1 TeV. Thus, measuring the QGC in Vector Boson Scattering (VBS) is considered a unique independent test of the SM nature of the Higgs boson. VBS results into topologies with two vector bosons and two jets produced at the forward region of the detector. In this thesis the VBS in semileptonic final states is studied. In the semileptonic VBS final states, one of the two bosons decays leptonically while the second hadronically into a pair of quarks. Due to the very low production cross section VBS is a very challenging channel to measure. What makes this process distinguishable with respect to other processes in LHC, is the two forward jets that accompany the boson scattering. During my thesis I worked in many aspects of the analysis such as; the background modelling, the MVA discriminant, the systematic uncertainties considered in the measurement as well as the statistical analysis of the results.
Forward jet performance is of paramount importance in this analysis. Therefore the thesis work starts with a detailed study of optimizing the jet reconstruction, in particular developing an algorithm to mitigate the pileup jets in the forward region; in ATLAS, in order to make use of valid physics data , in any analysis, the physical process (namely hard-scatter process) has to be distinguished from secondary collision processes (namely pile-up interactions). This is mainly achieved by the use of tracking information. The forward part of the ATLAS detector, lacking this information is thus highly challenging. An alternative way of tagging in the forward region, based on momentum conservation between forward activity and activity happening within the tracking coverage, is being employed in this algorithm. The algorithm has been optimized and various methods have been tested.
The actual ATLAS Inner Tracker is compatible with the LHC design luminosity of 10^{34} cm-2 s-1. The foreseen increase of luminosity towards the High Luminosity (HL) LHC phase requires a fundamental re-design of the complete inner detector due to both, increased radiation damage, and substantial occupancy of the sub-detectors. For the HL-LHC, the current inner detector of ATLAS will be replaced by an all-silicon Inner Tracker (ITk). The ITk pixel detector design features a much higher active area and granularity with respect to the current pixel detector. Two different silicon based detector technologies are considered; planar-pixel sensors and 3D-pixel sensors. The sensors are equipped with a new readout chip, able to meet all the requirements needed for the high luminocity LHC. A prototype version of the readout chip, called RD53A, was designed by the RD53A collaboration. In the third part of this thesis a characterization of the RD53A readout chip is performed. Moreover, the much larger number of modules and the much finer granularity used by ITk, results in a significant increase in the power density in the detector. For this reason a serial powering (SP) scheme has been chosen. In this scheme, the readout chips of the pixel modules are powered in series by a constant current; while the sensors of several modules will be connected to a common supply line for the depletion voltage. This architecture results in an effective forward bias on some sensors under certain operating conditions. Although the forward bias will be small, it can still lead to

non negligible currents between the sensor backside and the readout chip, in particular for irradiated sensors with large saturation currents. Therefore, the behavior of such a serial powering chain is also studied as part of this thesis.