First Year Report

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Research Activity

My PhD program is a collaboration between the University of Genoa and the ATLAS group at the DESY center in Hamburg. My supervisor here at DESY is Dr. James Ferrando, while my supervisors at the University of Genoa are Dr. Simone Marzani and Dr. Carlo Schiavi.

The project of my PhD takes place within the framework of particle physics, in particular I am working in ATLAS, one of the experiments of CERN. The ATLAS experiment is based on the ATLAS detector whose purpose is to measure the particles produced in high energy proton-proton collisions that occur in the circular collider at CERN, the *Large Hadron Collider* (LHC).

During the first year, my activity focused on two projects: the *Qualification Task* and an analysis project to measure the cross section of a physical process. Furthermore I have attended some University courses as expected by the Doctoral program. The *Qualification Task* (QT) is a project that all the ATLAS collaborators have to accomplish in order to become ATLAS authors. It is viewed as a way to make the people collaborate in the maintenance of the ATLAS detector. My QT is on the *Inner Detector Alignment*: the ATLAS detector, with its cylindrical shape, is built around the beam line in which the proton beams flow and collide. The detector is organised in various concentric parts (that focus on different type of measurements) and the innermost, the *Inner Detector* (ID), is composed by various cylindric layers of silicon and gaseous detectors. The ID is also embedded in an intense magnetic field ($\sim 2\,\mathrm{T}$) and its purpose is to measure the signals produced by the charged particles in order to reconstruct their tracks and obtain the values of the charge and momentum. The ID is composed by more than 3×10^5 modules, like for example the single silicon detector plates. The exact position of each detector element is important for the precision of the track reconstruction and it has been verified that slight movements of the detector, of the order of the single modules resolution, occur with time. The main purpose of the *ID Alignment* group is to monitor these movements and periodically obtain the positions of each ID components.

My project is focused on the so-called *weak modes*, collective movements of the detector that are not detectable with the standard alignment procedure and require some dedicate studies. In particular my QT is based on the process of updating the analysis code used to monitor these weak modes: the aim is to

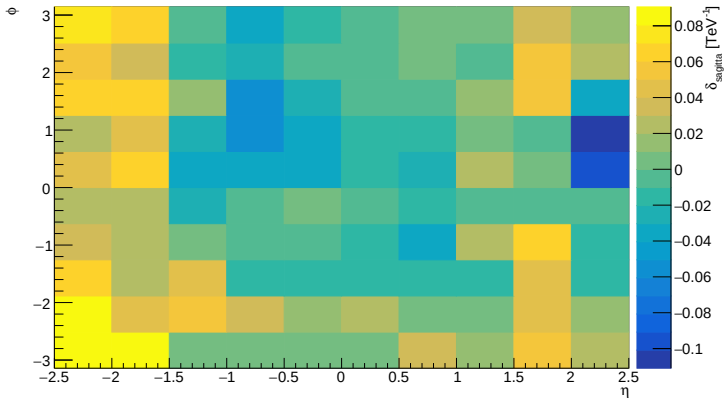

Figure 1: Example of a 2D map of the detector distortion due to the Weak Modes. The quantity $\delta_{sagitta}$ shown in the map is way to parametrise these distortions.

make it more maintainable and more user-friendly for the future. An example of the detector distortion maps produced by the software is reported in Figure 1.

For the analysis project, I joined the *low mass Drell Yan* analysis group. The Drell Yan is a process in which a quark and an anti-quark annihilate producing a lepton pair through a vector boson decay, in particular the decay into two muons is considered in this case. The purpose of the analysis is to measure the differential cross section of the process in proton-proton collisions at the centre of mass energy of $\sqrt{s} = 13\,\text{TeV}$ and for relatively low values of the di-muon invariant mass (in particular we are considering the masses range between $\sim 7\,\text{GeV}$ and $\sim 60\,\text{GeV}$). The phase space region considered in the analysis is at the edge of the one that can be investigated at the LHC.

In this region the perturbative theoretical predictions could fail and the measurement is interesting to test the needing in the calculation of semi-perturbative results (like resummed results). The analysis is at an advance stage for a subsample of the full 13 TeV collision energy data. I joined the group learning how to use use the analysis tools and helping them performing the cross check studies required at this stage. An example of these studies is reported in Figure 2 where it is shown the efficiency of the triggers used in the analysis as a function of the di-muon invariant mass.

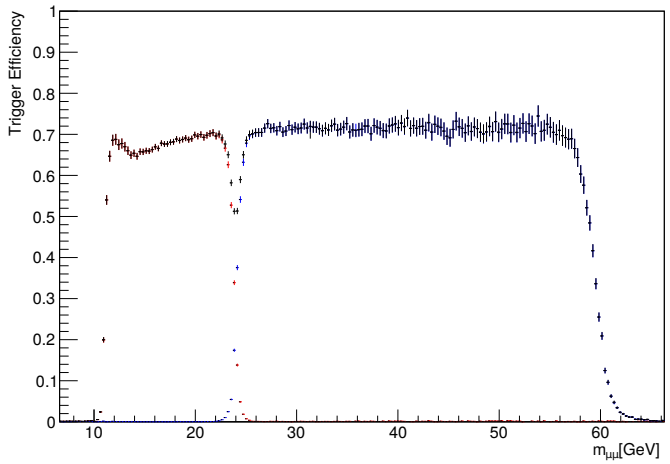

Figure 2: Study of the efficiencies for the triggers used in the analysis.

Attended Courses and Given Exams

During the first year of my PhD I have attended the following classes:

- Rivelatori di particelle (✓)
- Statistica per l'analisi dati (✓)
- Physics at the Large Hadron Collide (at the Hamburg University) (✓)
- Astrofisica Nucleare e Neutrini
- Elettronica e Acquisizione Dati

Of the courses in the list I took the exams for the first three, those with the check mark.