

Research Proposal – João Pela

The current knowledge in the field of particle physics is summarized in the Standard Model (SM). It is known that this model is incomplete without the inclusion of a spontaneous symmetry breaking mechanism that would explain the observation that the electroweak bosons (the W and Z particles) have mass. The easiest way to introduce such a mechanism is with the Higgs Mechanism, which suggests the presence of a new, yet to be observed particle, the Higgs Boson.

The main purpose of the Large Hadron Collider (LHC) and the Compact Muon Solenoid (CMS) experiment and also the main motivation of my PhD research, is to investigate the reasons for the spontaneous symmetry breaking.

I will be working simultaneously on two physics analysis:

- **Higgs to gamma-gamma analysis** aimed at the discovery of the Higgs Boson or rejection of Standard Model of particle physics. This is the most sensitive channel to a possible discovery considering the backgrounds in a hadron collider.
- **Vector Boson Fusion (VBF) produced Higgs decaying invisibly analysis** which in case of the Higgs discovery, is aimed at measuring its properties and, in case of the Standard Model exclusion, at looking for the invisible decay of beyond the standard model Higgs-like particles.

The LHC will be running during the course of 2012 and will stop during 2013 and most of 2014. During this time upgrades to both accelerator and experiments will be done.

It is predicted that enough data will be recorded in the 2012 acquisition run to come to a conclusion on the existence or not of a SM Higgs Boson. This data will be promptly available and I will therefore be using this dataset for my research in the *Higgs to gamma-gamma analysis*.

For my second analysis, *VBF Higgs to invisible*, I will use 2012 “parked” data which will be only be reconstructed and available after the 2013 LHC technical stop starts. It is predicted that this data will be ready for analysis mid 2013.

I started my PhD on January 2012, and will be leaving for a 2 years LTA at the detector site in Geneva in June 2012. While on LTA I will have supervision from the groups members based at CERN. Collecting data until mid 2013 leaves a year and one half from July 2013 to finish my analysis and write up my thesis before the end of 4 years for which I am funded.

My work will be mainly on 3 fronts:

- **Service Work**
 - Actual work necessary to keep the experiment running such as doing shifts or supporting roles for the data acquisition like providing on-call support.
- **Trigger Performance and upgrades**
 - Improvements to the Data Quality Monitoring (DQM) of the CMS Level 1 Trigger which will allow better monitoring to the operation of the trigger as well as ability to certify the quality of the data taken.
 - Performance monitoring of the trigger system.
 - In 2013-2014 technical stop as well as in other future stops the trigger system will be upgraded and I will participate in studies to ensure the proper operation of the new system.
- **Analysis work**
 - Most of this work will be done when the actual data is available for analysis, which will be after the 2012 technical stop starts. It will include detailed analysis of the collected data and any

limits or discovery/properties measurement made as well.

During all the stages of my work I will be writing up my work and presenting it internally at CMS and Imperial College Physics meetings as well as externally at conferences.

601 words