

## MAP-fis Essay Proposal, 2016-2017

(please write in English)

### Supervisor

*Name: Nuno Castro*

*e-mail: nfcastro@lip.pt*

### Title

Study of new interactions of the top quark with LHC data

### Area

(Materials, Optics, Condensed Theory, High Energy Theory,...);

Experimental High Energy Physics

### Summary of Proposal

The top quark is the heaviest elementary particle discovered so far and the study of its properties and couplings provides not only an important test of the Standard Model (SM) of particle physics, but also a window to physics beyond it. At the run-1 and run-2 phases of CERN's Large Hadron Collider (LHC), both the ATLAS and CMS collaborations developed an extensive program devoted to precision measurements and searches in the top quark sector. Nonetheless several of the analysis done so far can benefit from more data, either because they are statistically limited, or because such increased dataset will allow the use of more elaborate techniques, not accessible so far. Given the increase in the collected luminosity expected for the next years, new exciting opportunities will be opened, allowing to expand our knowledge on the top quark sector and, consequently, on Particle Physics.

The increase of luminosity will allow to probe with unprecedented precision rare events, such as the production of top quarks via flavour changing neutral (FCN) couplings to the SM gauge bosons. In the SM, the production or decay of top quarks via Flavour Changing Neutral Currents (FCNC) is extremely suppressed but some of its extensions predict a significant enhancement of the probability for such processes. A highly sensitive way of probing the FCN coupling  $tqZ$  (with  $q$  being a up or charm quark) is the search of  $tZ$  production via FCNC. A similar search would also allow us to probe the  $tqg$  FCN coupling (where  $g$  denotes a gluon). Furthermore, the study of the  $tZ$  production in the context of the SM is an important measurement, providing information relevant to many other important results (as background), such as the measurement of the  $ttZ$  and  $ttH$  cross-sections. In the scope of the current proposal, the candidate will study FCNCs through the single top production with a  $Z$  boson using data collected by the ATLAS detector. Furthermore, a



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phenomenological study of the interference between  $tZq$  (FCNC in top decays) and  $tZ$  (production via FCNC) can be performed and the obtained results will be incorporated in the global strategy of the ATLAS searches for these processes. A close collaboration with phenomenology experts is foreseen, allowing to fully explore the consequences of the obtained experimental results.

## References

(to allow students first look at topic)

- C. Degrande, F. Maltoni, J. Wang, C. Zhang, Automatic computations at next-to-leading order in QCD for top-quark flavor-changing neutral processes, [Phys.Rev. D91 \(2015\) 034024](#).
- J. A. Aguilar-Saavedra, A Minimal set of top anomalous couplings, Nucl. Phys.B 812, 181 (2009)
- CMS Collaboration, Search for associated production of a Z boson with a single top quark and for  $tZ$  flavour-changing interactions in pp collisions at  $\sqrt{s} = 8$  TeV, arXiv:1702.01404 [hep-ex].