

Search for New Physics in “untriggerable” final states at ATLAS

A broad class of New Physics models (Supersymmetry, dark matter models, etc..) predict signatures with fantastic features such as charged particle tracks with kinks, displaced vertices, extreme multiplicities of low energy particles or exotic structures within hadronic jets. These striking signatures could be searched for with very low backgrounds from Standard Model (SM) processes; however, in many cases the standard triggers at ATLAS cannot identify such signatures. In particular for signatures like “soft bombs” [1], “emerging” [2] or “semi-visible” [3] jets, the final state reconstructed in the calorimeter system is not sufficiently different from SM QCD processes (+pileup), and therefore there are no handles to select the events with the hardware-level trigger. As a result, searching for many of these models is not possible with existing techniques!

It has been shown [4] that a sizeable amount of unbiased data at the LHC can be used for analysis by considering the additional proton-proton interactions occurring at LHC collisions. Most researchers find these additional “pileup” collisions as a nuisance, but we can exploit them for new physics searches. Such a Zero Bias Trigger (ZBT) strategy is particularly well-suited for the study of the signatures discussed above and yields the best performance when implemented directly in our software-based trigger system

The project consists of investigating key signatures and defining a trigger level analysis strategy to be implemented in the ATLAS software-based trigger (HLT) system. The student will learn how to study LHC collision events and will analyze Monte Carlo simulations of signal events to identify optimal algorithms for the reconstruction of these signatures of hypothesized new physics models. The student will then evaluate the potential of the ZBT strategy for key benchmark models. This project will ultimately provide the base for the implementation of a ZBT analysis in ATLAS.

[1] <https://arxiv.org/abs/1612.00850>

[2] <https://arxiv.org/abs/1502.05409>

[3] <https://arxiv.org/abs/1503.00009>

[4] <https://arxiv.org/abs/1608.06299>