Efficiency study in the search for neutral particles of long half-life disintegrating to hadrons in the ATLAS detector

Research Project / Research Group Description:
One of the main objectives of the Large Hadron Collider (LHC) is the search for new physics. Among the theoretical models that try to cover the limitations of the Standard Model (SM), there are scenarios that predict new particles with sufficiently long half-lives for the disintegration to be observable in the detector (Long-Lived Particles, LLPs).

Standard searches, designed to identify new particles that disintegrate immediately after their creation (prompt), have a very low sensitivity in these models. That implies that if in the LHC this type of new physics is being generated, we could be ignoring it if these particles are not searched with specific analyzes.

The ATLAS experiment has searches of LLPs on several channels that depend on where in the detector they disintegrate. If the LLP disintegrates immediately after its creation, the signature on the detector will be indistinguishable from a standard jet (prompt). If the decay occurs in the Inner Detector (ID), the signature will be a displaced vertex (DV ID). If it decays in the calorimeter, the signature will be a jet with very specific characteristics (displaced jet, DJ). In the muon system the signature will be a displaced vertex (MS DV). Most models predict the creation of LLPs in pairs. Different combinations of these types of signatures cover different ranges of the half-lives of LLPs.

Currently the combinations prompt-prompt, ID DV-ID DV, DJ-DJ, MS DV-MS DV are being studied in ATLAS, covering ranges of half-life from 10^-4 to 10^-3 meters (prompt-prompt) and from 10^-1 to 10^2 meters (other combinations). The prompt-DJ combination, which until now has not been studied, can cover part of the existing gap (10^-3-10^-1 m).

Job position description:
The objective of this Thesis will be a study of the sensitivity of this channel, prompt-DJ. The student will use Monte Carlo simulations in both signal samples of the theoretical model and in background samples of the SM. He/she should develop a selection that favors the signal over the background and estimate the sensitivity in the model considered and the range of half-lives that the analysis could cover. The result of this study will be considered for the decision to perform this analysis or not in real data

As a professor at the Universtiat de València and the Master of Advanced Physics, a research project is proposed, within the IFIC research group (With CSIC researchers at IFIC, researchers at CERN and UV professors at IFIC) and framed within the master of advanced physics of the Department of Atomic, Molecular and Nuclear Physics of the Universitat de València. The final objective is the realization of the PhD Thesis.

This work would be done co-directed with Dr. Emma Torró Pastor, who is currently doing her research at CERN, hired by the University of Washington (Seattle, USA) in the working group "Unconventional Signatures and Exotcis Higgs - UEH" within the Exotic group of ATLAS.

Group Leader: Santiago González de la Hoz
santiago.gonzalez@ific.uv.es

Research project/Research Group website
ATLAS Tier2/ific.uv.es