





Universidade do Minho Escola de Ciências LABORATÓRIO DE INSTRUMENTAÇÃO E FÍSICA EXPERIMENTAL DE PARTÍCULAS partículas e tecnologia

# Searching for Dark Matter with the ATLAS Detector using Unconventional Signatures

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# Dark Matter Motivation

- Major matter component of our Universe;
- Does not interact with the electromagnetic field;
- Interacts very little with baryonic matter.





the rotation curves of spiral galaxies," 2011.









Colliders

SM particles collisions

recoil

# Dark Matter with a MonoTop Signature

# MonoTop Signature Phenomenology

- Looking for top quark + large missing energy with the full Run-2 dataset;
- Different models:
  - DM Monotop: Resonant and Non-Resonant;
  - VLQ Production
- Only hadronic channels considered.





- Signal samples generation and scan over masses performed:
  - Influence on the kinematic variables.
- Next-to-leading order vs leading order study:

Using K-factors, 
$$K = \frac{NLO}{LO}$$
.

# MonoTop Signature Strategy

ML is the science of computer algorithms that improve automatically through experience.

#### Supervised Learning:

- Labeled examples;
- Minimise loss function;
- Regression problems;
- Classification problems.



Classification problem: distinguish between signal and background.

Goal: Implement a NN to separate signal from background ⇒ calculate limits and interpret the results.

# Dark Matter using the ATLAS Forward Proton Detectors

# ATLAS Forward Proton Detectors Search for Dark Matter

- The Minimal Supersymmetric Standard Model (MSSM) offers a good candidate for DM: the **neutralino**. It can be produced by the decay of a slepton;
- CEP of a sleptons which decays into two SM leptons and two neutralinos (DM candidate);
- Central Exclusive Production (CEP) is a subtype of diffractive processes where two protons remain intact but can

radiate particles that interact on the central detector;



# ATLAS Forward Proton detector Location and Anatomy

- Located at ~200 m from the interaction point;
- Composed of two subdetectors: **silicon tracker** and **time-of-flight**.



# ATLAS Forward Proton detector Events Identification - Trigger Strategy

To improve the analysis efficiency, a development of a trigger chain is being

done.

• Lepton reconstruction in the central detector: algorithms developed by

the varied trigger signature groups;

- AFP track reconstruction;
- Extrapolate protons' position in AFP with the di-leptons from the

central detector;

• Match protons with tracks reconstructed by AFP.



# ATLAS Forward Proton detector Validation Plots

Production of samples for two different mass points





# Summary

# Summary and Next Steps

• A search for DM using a **monotop signatures** with the full Run-2 datasets being done. Group contribution:

- Signal studies for NLO vs LO generation were done;
- Progress with the use of a NN to distinguish background and signal events was done;
- Next steps: Limit calculation and results interpretation.
- AFP is being used to search for DM in association with the production of two leptons:
  - Validation plots were produced for two different mass points;
  - Trigger chain implementation is in progress;
  - Next steps: Kick-off meeting to start the analysis.
- Di-jets samples were produced for di-jet trigger implementation performance studies: qualification task.

# Thank you!

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