Search for Dark Matter produced in Proton collisions with ATLAS data

Dilli Ram, Karuna Biswa, Samtem Sherab, Sonam Phuntsho
Sherubtse

Introduction

- Dark Matter is a hypothesised type of matter that does not interact with the electromagnetic force.
- Dark matter is thought to account for approximately 85% of the matter of the universe
- Searching of dark matter will help gain an understanding of its properties
- We will also gain an understanding about the larger scale structures of the universe

Searching for dark matter with particle collisions

- Before each collision, the protons travel along the direction of the the LHC beams, and not in directions perpendicular to beams, their transverse momentum is zero
- If we add up the transverse momenta of all visible particles produced in the collision and find it not zero, then this could be because we missed the momentum carried away by invisible particles
- Atlas already measures many processes involving invisible particles such as the neutrino

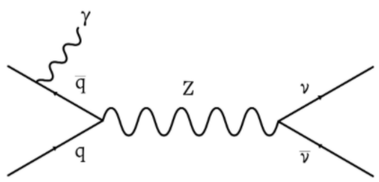


Figure 6: Diagram of a Z boson decaying into a neutrino-antineutrino pair where the Z boson is produced in association with a photon. (Image: ATLAS Collaboration/CERN)

- A similar technique can be used for detecting the presence of dark matter particles

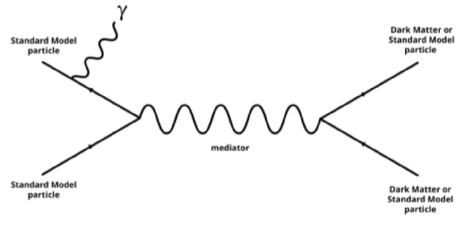
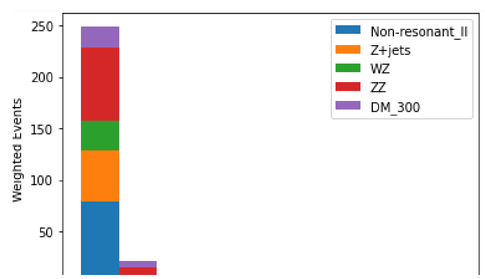


Figure 7: Diagram of a new mediator particle decaying into a pair of dark matter particles, produced in association with a photon. (Image: ATLAS Collaboration/CERN)

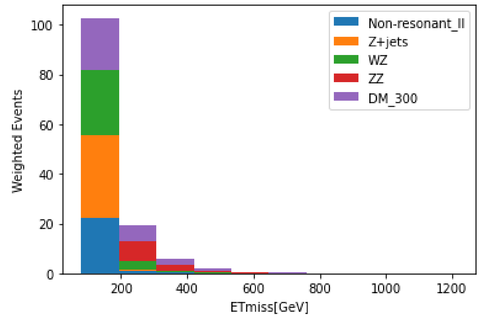
- We cannot distinguish processes on a collision-by-collision basis since the detector signature of the processes is identical.
- We collect a large number of events that have large amount of missing transverse momentum and a highly energetic object.
- Then we estimate precisely the expected number of events from the Standard model processes ("background"), and look for an excess of additional events that could be due to dark matter processes.

Results

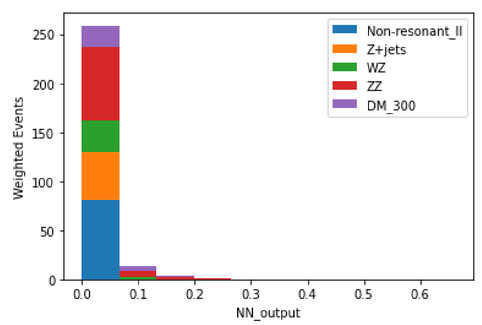
- The signal used for the analysis is DM_300
- The background processes include Non-resonant_ll, Z+jets, WZ, ZZ
- The histogram of ETmiss for the proton proton collision before applying cuts is:



- The significance was found to be about 2.51
- ZZ events with ETmiss > 200 Gev, Z+jets and WZ events with ETmiss > 60Gev, and resonnant_ll events > 80Gev were selected. The histogram after the event selection is:



- The significance is found to be about 3.1
- In particle physics, we declare that we have evidence for a process such as Dark Matter if we find a "significance" over 3.
- Multi layer Perceptron (MLP) was used to obtain a higher significance. The Histogram after training:



The significance was found to be about 3.8