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Performance of the Missing transverse energy triggers for the ATLAS detector.

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The ATLAS detector is one of the two general-purpose detectors at the Large Hadron Collider (LHC) at CERN, designed to explore a wide range of physics, including the discovery of new particles, precision measurements of known particles, and searches for signs of new physics beyond the Standard Model. One of the essential parts of the ATLAS experiment is the trigger system, which manages large amounts of data generated by particle collisions and subsequently identifies the most interesting events, such as the presence of energetic leptons, photons, hadronic jets, τ lep, or large amounts of missing energy for further analysis. Only a small fraction of the events can be kept due to limitations in storage and processing. This means that a large number of events are discarded and are not available for future analysis. Where the ATLAS physics program uses trigger selection for events containing invisible particles. However, selecting these events is challenging as they don't register in the detector. The strategy used is to deduce the presence of these invisible particles from the apparent imbalance of the momentum calculated from the visible particles. In practice, the imbalance in the direction parallel to the proton beams is not sensitive since the fraction of each proton's momentum that participates in the collision is unknown, and much of the outgoing momentum in the beam direction is not observed. Rather, the quantity of most significance is the imbalance in momentum in the plane perpendicular to the proton beams; this is referred to as the missing transverse momentum, and its value is commonly represented by E_T^{miss} (MET). The E_T^{miss} used in the wide range of physics processes, like searches for supersymmetry, searches for final states with stable long-lived particles, and searches for dark matter condidate that is not predicted by the Standard Model (SM), but many theories beyond the Standard Model (BSM) offer the study of DM, such as 2HDM with a pseudo-scalar mediator (2HDM+a) and a simplified model for dark matter production.

The MET trigger relies on data from calorimeters, which measure the energy deposited by particles in the transverse plane. The ATLAS trigger system has been significantly upgraded during LS2 (2019–2022). The performance of Missing Transverse Energy (MET) triggers is a crucial aspect of ensuring the efficiency and accuracy of data collection. For that, we will study the performance of the MET trigger by using data collected during 2023 and 2024. Performance in terms of efficiency, trigger stability, background rejection, etc. studied as a function of several quantities, including run conditions and pile-up. One of the major challenges is pile-up. This can complicate the accurate measurement of MET. The particles from pile-up collisions can contribute to the overall energy detected in the event, artificially inflating the measured MET. This makes it difficult to distinguish the true missing energy associated with the particles of interest from spurious contributions.

In the future, the HL-LHC phase will witness an increase in luminisity and thus an increase in pile-up events. One of the efforts made to reduce the pil-up event is the HGTD detector. The HGTD will provide the timing information to reduce the density of vertices for a given track, so that will provide a good distinction of pile-up events.

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