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Performance of the missing transverse energy reconstruction in first ATLAS data at a center-of-mass energy of 7 TeV

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The performance of the missing transverse energy (Etmiss) reconstructed with the ATLAS detector is assessed using a sample of proton-proton collisions at a centre-of-mass energy of 7 TeV collected in April and May 2010. We report on results in randomly-triggered events, soft proton proton collisions and collisions with jets at high transverse momentum. Particular attention is given to tails in the Etmiss distribution and to the measurement of the Etmiss resolution.

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1. Introduction

The performance of the reconstruction and calibration of the missing transverse energy has been tested using a sample of minimum bias events collected by the ATLAS experiment in April and May 2010. These events were recorded with stable proton beams as well as with nominal magnetic field conditions. For each run only those luminosity blocks satisfying data quality criteria for the inner detector, calorimeters, and jet and missing transverse energy were analysed. Collisions were triggered by the Minimum Bias Trigger Scintillators (MBTS) located outside the end-caps of the Inner Detector. Timing criteria based on calorimeters measurements were applied to reject residual beam background by requiring signals from both sides of the detector to coincide within 5(10) ns in the end-cap calorimeters (MBTS). The Etmiss performance is also tested using a sample of randomly-triggered events collected during the same period.

Cleaning cuts have been applied in order to remove the events containing mis-reconstructed (or "fake") jets. Jets are reconstructed using the AntiKt algorithm with radius parameter R=0.4. There are three main sources of mis-reconstructed jets: jets produced by sporadic noise bursts in the Hadronic End-Cap, jets produced by sporadic noise in the electromagnetic calorimeter, and jets reconstructed from out-of-time energy deposits in the calorimeter. Events containing at least one fake jet with p_T > 10 GeV are rejected. The integrated luminosity of the sample after all data quality criteria are applied is 0.34 nb^{-1} (15 million events).

About 20 million minimum bias events were generated using PYTHIA and passed through a full Geant 4 detector simulation with a detailed description of geometry and material. The same trigger and event selection criteria as described for the data were applied to the simulation.

2. E_T^{miss} reconstruction and calibration

The E_T^{miss} reconstruction presently used in ATLAS includes contributions from the calorimeters, corrections for energy loss in the cryostat and measured muons. In minimum bias events, the dominant term is the calorimeter term, since most of the energy is deposited by low-energy hadrons, with few events containing jets or muons. In this study, the calorimeter term is computed using a method for noise suppression that sums contributions from cells belonging to 3-dimensional topological clusters.

There are two major calibration schemes which account for the non-compensating nature of the ATLAS calorimeter: the Global Cell-energy density Weighting (GCW) and the Local Cluster-Weighting calibration (LCW). The GCW method compensates for the different response of the electrons and hadrons by applying cell-level signal weights. These weights boost low density signals, which are more likely to come from hadronic activity, and are applied to all the cells in topological clusters. The LCW method classifies clusters as electromagnetic or hadronic, based on cluster-properties, and applies corrections at cluster-level [1].

3. Performance of E_T^{miss} in proton-proton collisions

Figure 1(a) shows the resulting E_x^{miss} and E_T^{miss} distributions in minimum bias events, calculated using topological cluster cells at EM scale. The average values of E_x^{miss}, and also of E_y^{miss}, are compatible with zero and the root-mean-square values for both variables is 2.4 GeV. The histograms obtained with simulated events are superimposed, normalized to the number of events in

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the data, and are in good agreement with the data. The E_T^{miss} distribution, shown in Figure 1(b), is in overall good agreement with expectations from the Monte Carlo simulation. Above 10 GeV, the data is systematically higher than the Monte Carlo, reaching up to 20%. In data, an outllier event with E_T^{miss} = 52 GeV is due to a multi-jet event in which one of the jets points to a crack and is mis-measured.

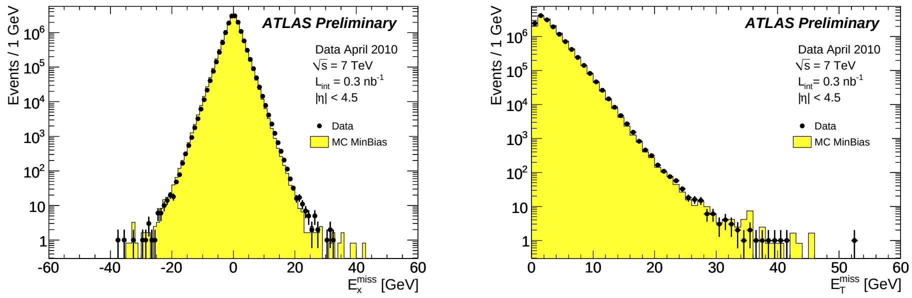

Figure 1: E_x^{miss} and E_T^{miss} in minimum bias events, calculated from topological cluster cells at EM scale.

Figure 2(a) shows the variation over time of the mean value of E_x^{miss} in each run, in both randomly-triggered and minimum bias events. The results illustrate the good stability of the detector over a period of about one month. A more quantitative evaluation of the E_T^{miss} performance is obtained from the study of the E_x^{miss} and E_y^{miss} resolution as a function of ΣE_T. This is shown in Figure 2(b), obtained with minimum bias data. The resolution scales in good approximation as $\sigma = a \cdot \sqrt{\Sigma E_T}$, with the scale factors given on the figure.

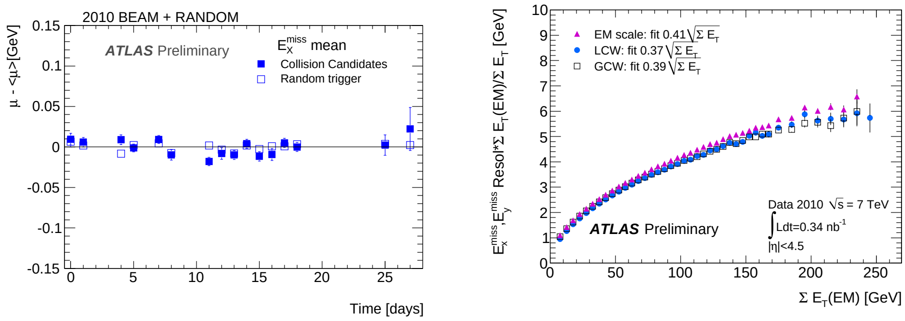

Figure 2: Left: Stability plot of E_x^{miss}, calculated from topological cluster cells at EM scale, in both randomly-triggered and minimum bias events. The abscisa represents the number of days since first 7 TeV collisions (30 march 2010). Right: Resolution plot obtained with minimum bias data and E_T^{miss} at the electromagnetic scale, and also calibrated with GCW and with LCW.

4. Conclusions

The missing transverse energy is computed from topological clusters and different calibration schemes are applied. The results demonstrate that the missing transverse energy reconstruction and calibration are well under control and reach the expected performance.

References

[1] The Atlas Collaboration, The ATLAS experiment at the LHC, JINST 3 (2008) S08003