Measurement of the Energy Response of the ATLAS Calorimeter to Charged Pions from τ-lepton Decays in Run 2 Data

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September 25, 2023

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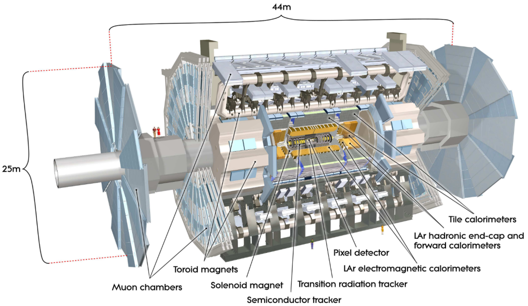
Introduction

- Considering the ratio of the energy reconstructed in the calorimeter to the momentum measured in the tracking detector to understand the calorimeter response to hadrons
- Precise knowledge of the calorimeter response at high p_T is essential for many ATLAS physics analyses
- Select events with isolated charged pions from τ-lepton decays to probe a much higher energy regime

ATLAS Detector

- Forward-backward symmetric cylindrical geometry
- 4π coverage in solid angle
- Energy and momentum measurement
- Jet reconstruction : Particle-flow algorithm



Cut-away view of the ATLAS detector

Data and Samples

- pp-collision RUN 2 data from 2015 to 2018
  - $\sqrt{s} = 13$ TeV
  - Integrated luminosity of 139 fb^{-1}
- Main signal processes
  - $W(\rightarrow \tau\nu_\tau)+$ jets
  - Top pair production $t\bar{t}$

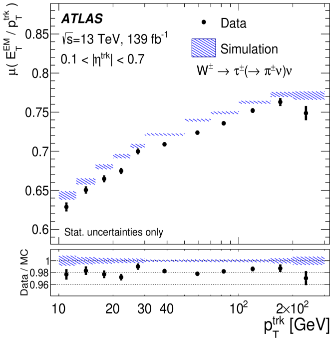
Event Selection

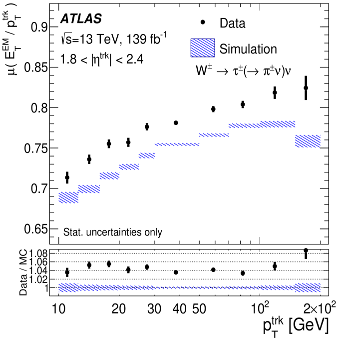
Event selection is designed to obtain a high-purity sample of $W^{\pm} \rightarrow \tau^{\pm}(\rightarrow \pi^{\pm} + \nu_{\tau})\nu_{\tau}$

- $E_T^{miss} > 150$ GeV
- Select isolated tracks associated with the primary vertex with a large number of hits to measure the momentum
- Reject tracks that are formed from electrons, muons and converted photons
- Reject events where the track does not originate from a τ-lepton

Calorimeter Response

- Calorimeter response for $10 < p_T < 300$ GeV





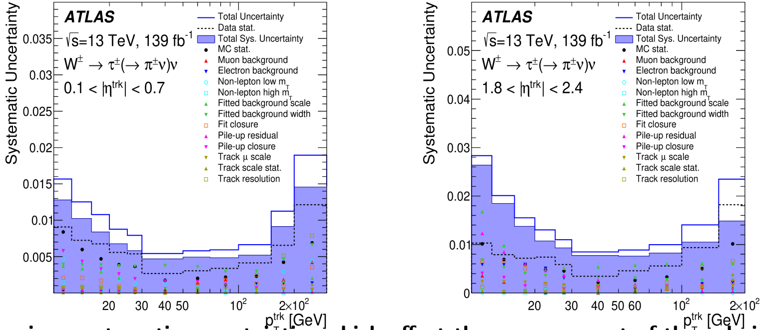
The fitted mean of the signal E_T^{EM}/p_T^{trk} distribution as a function of the track p_T in the central region

The fitted mean of the signal E_T^{EM}/p_T^{trk} distribution as a function of the track p_T in the endcap region

- 2% overestimate of the response in simulation in the barrel
- 4% underestimate of the response in simulation in the endcaps

Uncertainties in the Response Measurement

- Systematic uncertainties in E/p measurement



The various systematic uncertainties which affect the measurement of the calorimeter energy scale for charged pions as a function of p_T^{trk} in the central (left) and in the endcap (right) regions

- Only a few uncertainties are larger than the statistical uncertainty of the dataset or the simulated event samples
- Pile-up uncertainties are important at low p_T
- Total uncertainty less than 1% for 20<p_T<200 GeV in the central region and for 30<p_T<100 in the endcaps

Conclusions

- Calorimeter response was measured for a wide range of p_T using pions from $W^{\pm} \rightarrow \tau^{\pm}(\rightarrow \pi^{\pm} + \nu_{\tau})\nu_{\tau}$ process
- The calorimeter response is overestimated by 2% in the central region and underestimated by 4% in the endcaps
- Uncertainties in measurements are less than 1% for :
  - $20 < p_T < 200$ GeV in the central region
  - $30 < p_T < 100$ in the endcaps
- Better understanding of jet energy scale and its uncertainty for the highest p_T jets
- Measuring jet properties

Thank you !