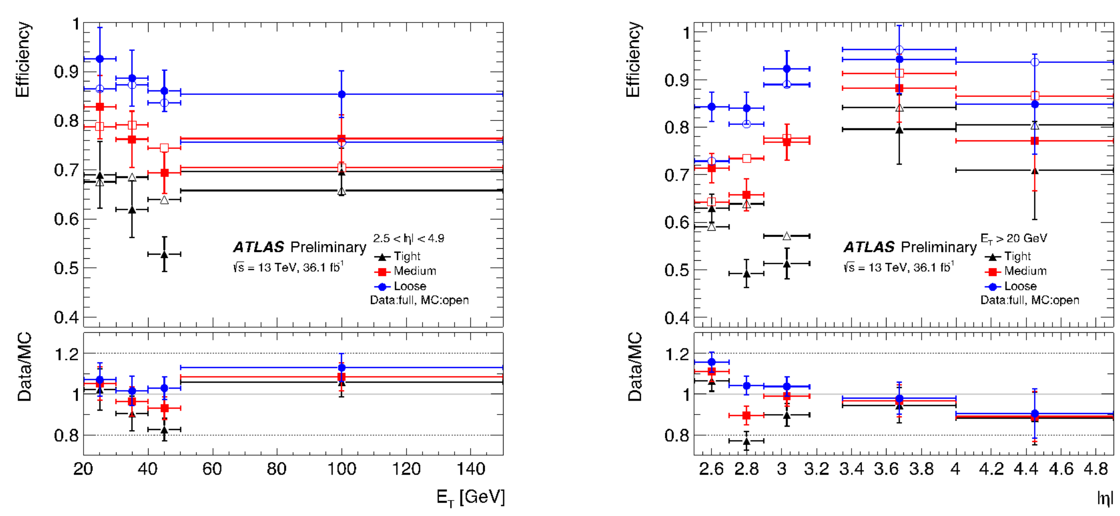
EPS-HEP-Ghent, 10-17 July 2019

Identification and calibration of high-rapidity electrons with the ATLAS detector

Motivation

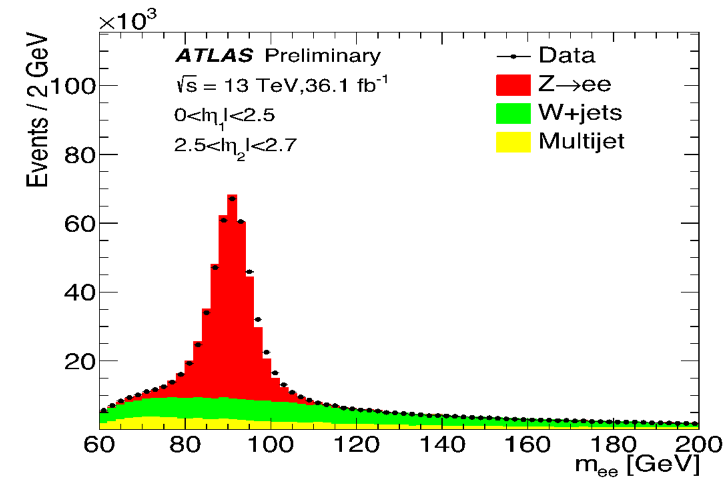
Drell-Yan events with high-rapidity electrons provide strong constraints on the proton parton density functions, and the highest sensitivity at the LHC for the measurement of the electroweak mixing angle. Optimal electron identification and energy calibration are crucial to exploit these features.

Electron identification result



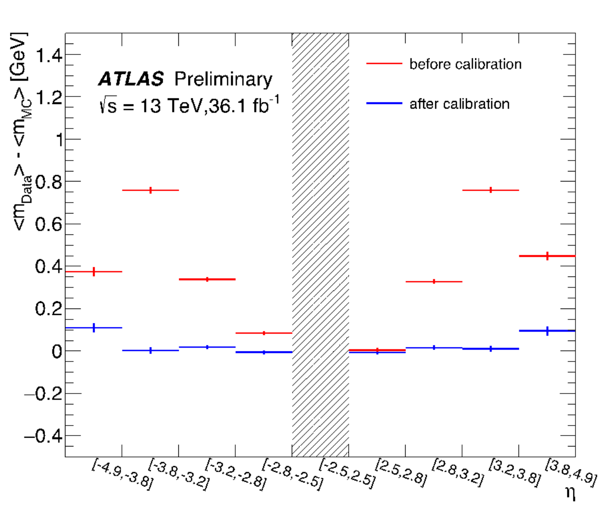
Electron identification efficiency and scale factors as a function of the transverse energy, and as a function of the pseudo-rapidity.

- In the ATLAS experiment, forward electrons (2.5 < |η| < 4.9) are reconstructed using a topological clustering algorithm, and identified using a likelihood-based discriminant[1].
- The efficiencies for a Loose, a Medium and a Tight working points are measured double differentially in 5 bins is |η| and 4 bins in ET, using Z --> ee events with one tightly identified central electron (|η| < 2.47) and one forward electron.
- The contributions from backgrounds are estimated using a template fit to the electron pair invariant mass distribution.
- The scale factors are obtained from the ratio of efficiencies measured in data and simulation and used to correct the simulation.

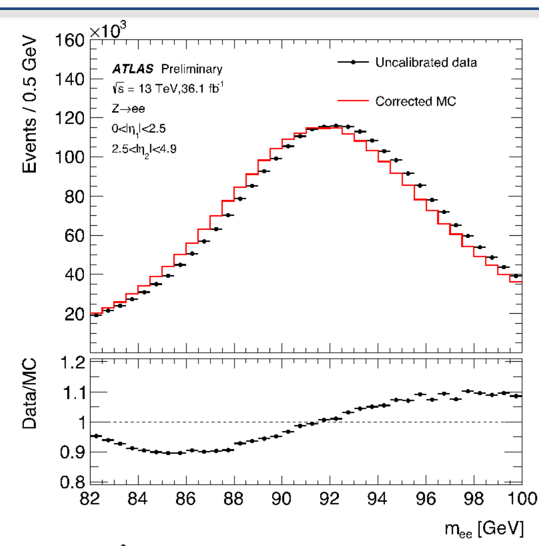


- Illustration of the background estimation method for electrons with 30 GeV<E_T<40 GeV and 2.5<|η|<2.7.
- The invariant mass distribution of backgrounds with an isolated central electron and a misidentified forward electron, such as W+jets production, is estimated from events containing a muon and an electron, and normalized in a control region with high missing transverse energy.
- The distribution of the multijet background, where both electrons are misidentified from jets, is estimated by reversing central and forward identification cuts.

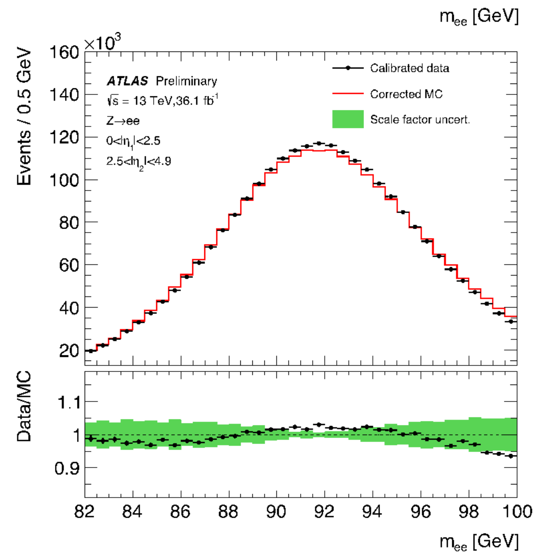
Electron energy calibration



- Difference of the mean values of the invariant mass distribution in data and simulation, as a function of the electron pseudo-rapidity, for Z->ee events with one central and one forward electron, before (red) and after (blue) the forward electron calibration.



- Invariant mass distributions in data and simulation, for Z-boson decays with one electron in the central region and one electron in the forward region before applying the forward electron calibration. Energy corrections (energy scaling)[2] are applied for the central electrons in data and resolution corrections are applied to the simulated central and forward electrons..
- A difference in the position of the peak between data and MC is observed.



- Invariant mass distributions in data and simulation, for Z-boson decays with one electron in the central region and one electron in the forward region after applying the forward electron calibration. The comparison between the data and MC is improved.
- The uncertainty band reflects the forward electron calibration uncertainties, and is dominated by the uncertainty due to the variation of the mass window used for the calibration, and by the uncertainty from the correlation between the forward calibration scale factors.

Conclusion

- The identification of forward (2.5 < |eta| < 4.9) electrons relies on a multi-variate likelihood technique to separate prompt electrons from hadrons. Measurements of the forward electron identification efficiency are performed using the tag-and-probe technique and large samples of Z boson decays.
- A new method is used to perform the energy calibration, accounting for possible non-linearities in the energy response.

References

[1] ATLAS Collaboration, ATLAS-CONF-2016-024
[2] ATLAS Collaboration, JINST 14 (2019) P03017

Jun Gao (University of Science and Technology of China) on behalf of the ATLAS Collaboration