Final Performances for electron and photon identification using the ATLAS detector in Run 2

Filip Nechanský, on behalf of the ATLAS Collaboration

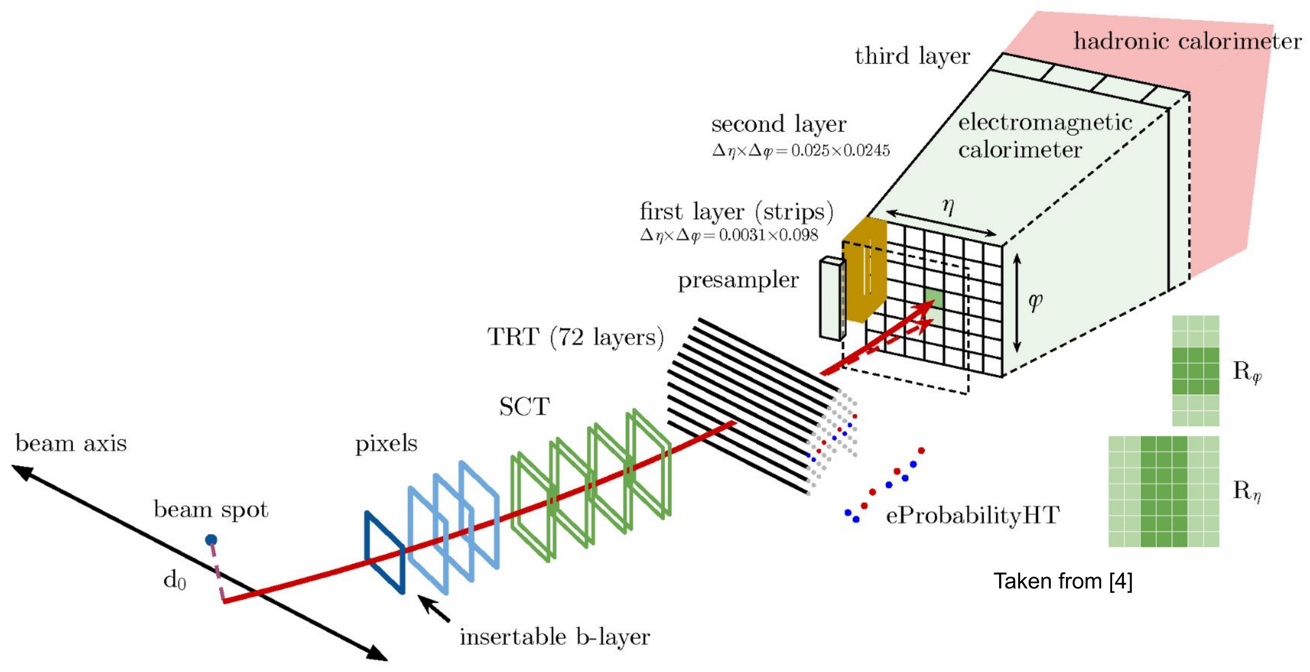
Electrons and Photons play a crucial role at LHC in several fields. Several analyses such as SM precision measurements, measurements in the Higgs sector, and searches for processes beyond the SM, rely on excellent electron and photon reconstruction efficiencies together with small misidentification probability, excellent momentum resolution, and small systematic uncertainties.

Reconstruction, calibration and selection

Reconstruction of electrons and photons on the ATLAS relies on the electromagnetic calorimeters and on the Inner Detector, system of trackers right around the beamline. Reconstruction first constructs topo-clusters from deposition in calorimeter, which are then combined into a supercluster to account for additional emissions which occurred before the calorimeter.

Calibration of electron and photon kinematics relies on multitude of step correcting the energy to match the original particle and to remove difference in response of the data and Monte Carlo [2].

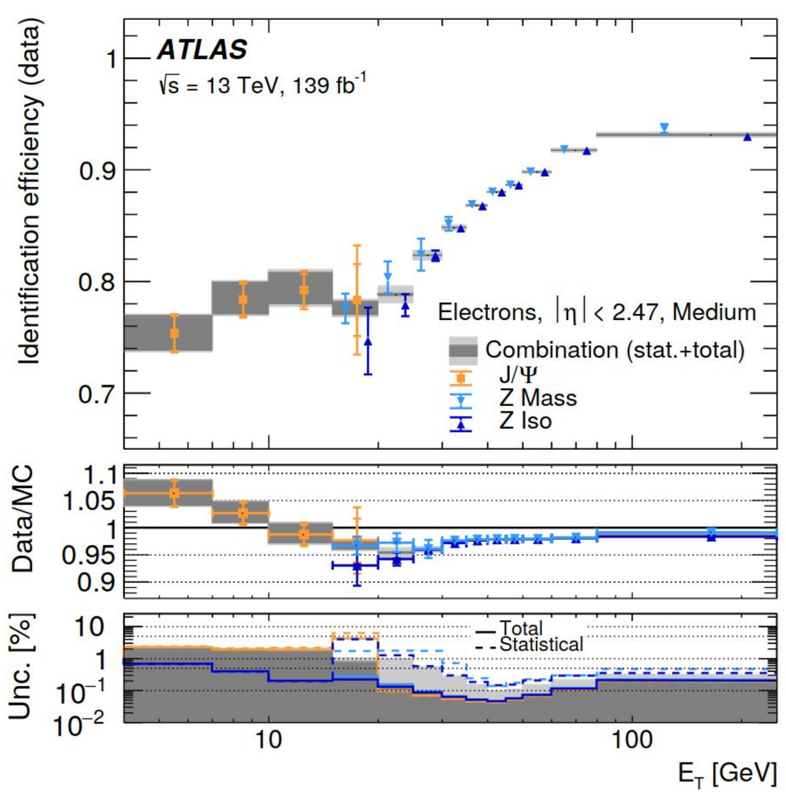
Rejection of electrons and photons wrongly reconstructed from other particles, like jets, mainly relies on the shape and other properties of the particle shower in the calorimeter. Prompt electrons from hard scattering need to be often separated from decays of unstable particles. Hence isolation selection, related to activity around the particle in the EM calorimeter and Inner Detector are usually applied.



Taken from [4]

Electron efficiency measurements

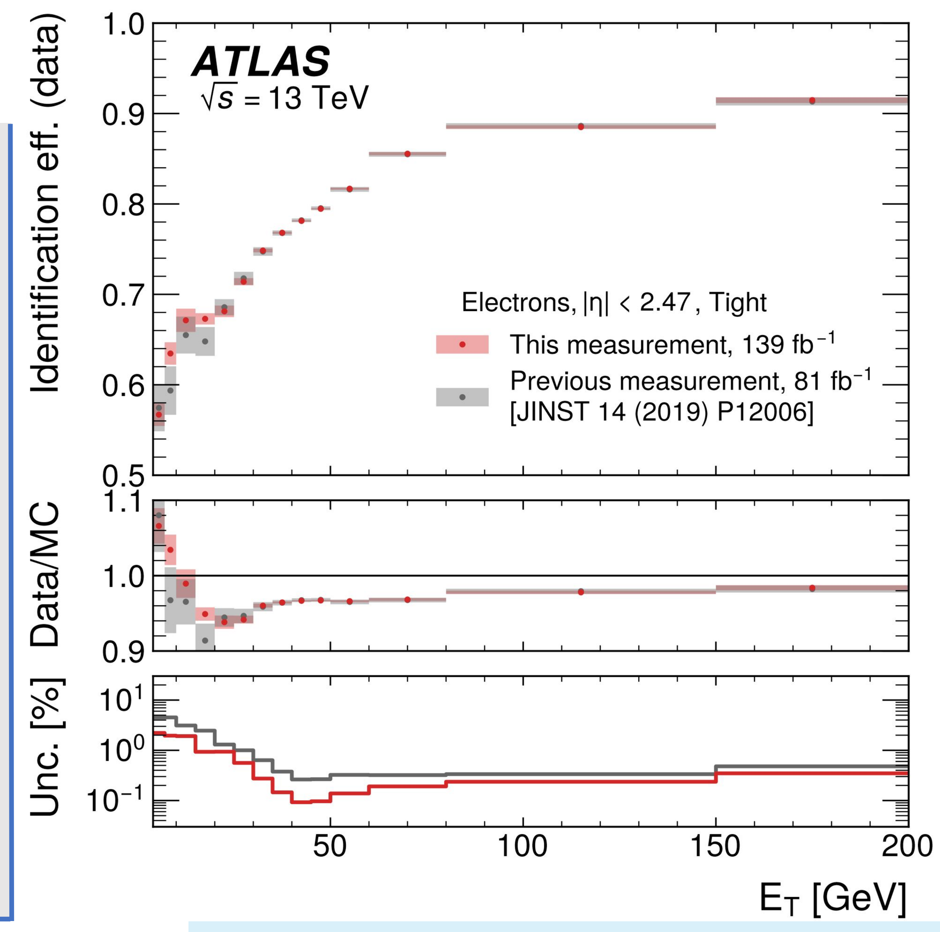
For electrons, it is important to measure efficiencies of the three main selection steps: reconstruction, identification and isolation. Precise measurement in both data and Monte Carlo then allows to correct any differences between the two.

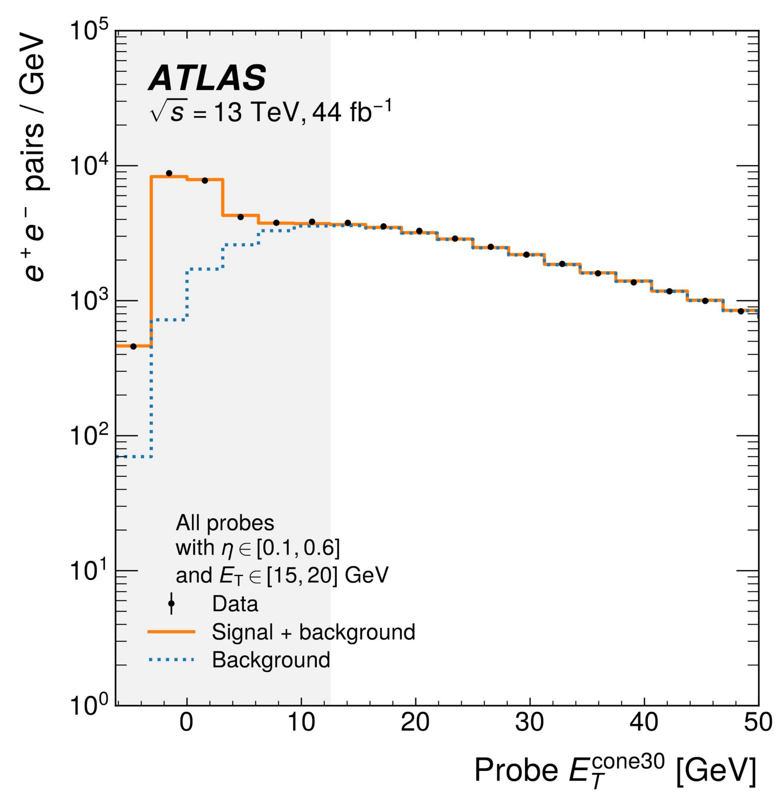


In case of identification, three methods are combined:

- J/Ψ: From invariant mass of J/Ψ resonance, using functional fit to estimate the signal and background. Allows to measure electrons down to 4 GeV.
- Z Mass: From invariant mass of Z→ee resonance with data-driven estimation of background
- Z Iso: Using isolation to separate the signal from the background, measured also in the Z→ee resonance with data-driven background

The comparison of results of the three methods can be seen on the left.

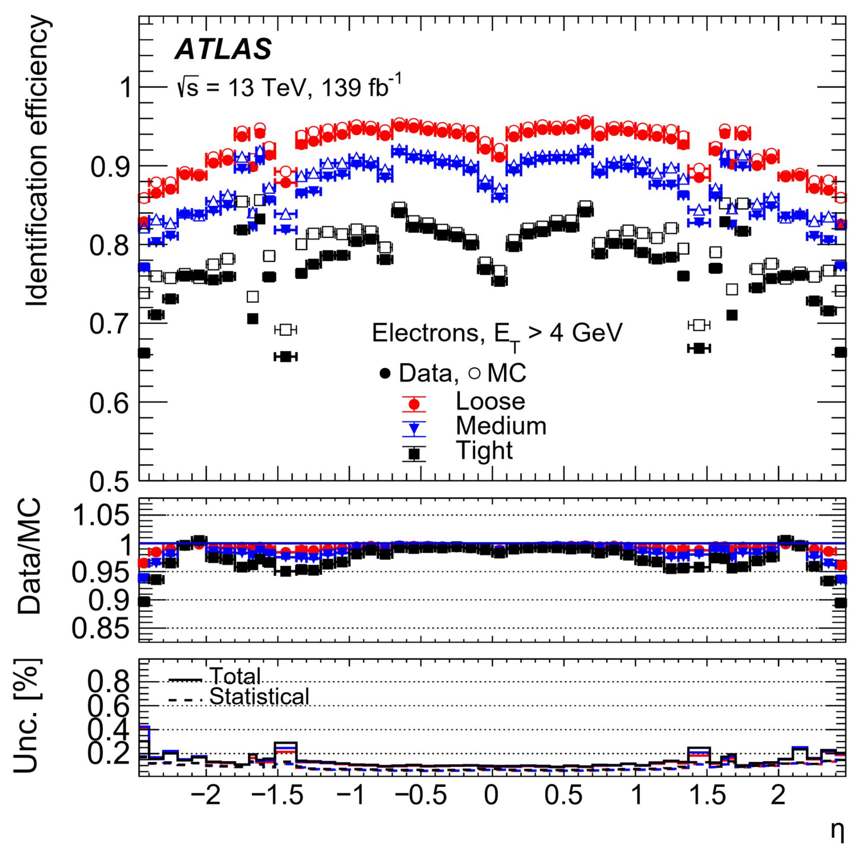




On the left is distribution before identification used in the Z Iso measurement of identification efficiency.

E_T^{cone30} refers to transverse energy deposited in the calorimeter in cone around the electron of size 0.3 in the η-ϕ plane.

The background shape is estimated in a background rich region.



The new measurement [1] results in significant improvement of identification efficiency compared to the previous measurement [3] (above).

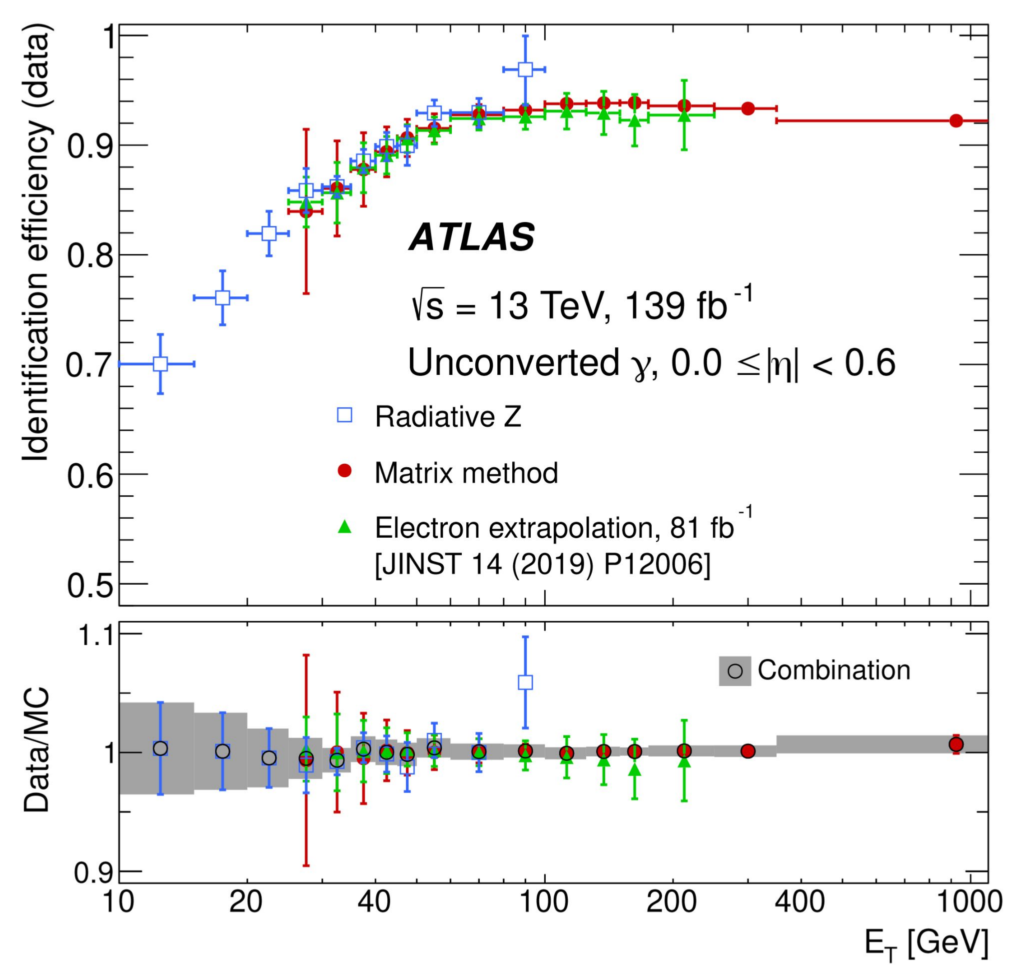
The larger statistical sample also allowed to measure the efficiencies in finer binning of pseudorapidity (left) with uncertainties smaller than 0.5% for most of the spectrum.

Photon identification efficiency

Efficiency of photon identification has been updated, separately for converted and unconverted photons. Several methods are employed and combined which target wide range of photon energies:

- Radiative Z: Measure photons through Z resonance in radiative decay Z→llγ targets lower transverse energy of photons down to 10 GeV.
- Matrix method: Uses inclusive sample of photons, targeting higher transverse momentum. The dominant background from hadronic jets is then estimated from several selection regions based on identification and isolation criteria.
- Electron extrapolation: Extrapolation from electron measurement in non-radiative Z→ee decay. Electron shower shape variables are transformed to match those of photons.

Larger statistical sample leads to reduction of uncertainties of 30-40% compared to previous result [3].



References:

[1] ATLAS Collaboration, Electron and photon efficiencies in LHC Run 2 with the ATLAS experiment

[2] ATLAS Collaboration, Electron and photon performance measurements with the ATLAS detector using the 2015-2017 LHC proton–proton collision data, JINST 14 (2019) P12006

[3] ATLAS Collaboration, Electron reconstruction and identification in the ATLAS experiment using the 2015 and 2016 LHC proton-proton collision data at $\sqrt{s}$ = 13 TeV, Eur. Phys. J. C 79 (2019) 639,922

Deutsches Elektronen-Synchrotron DESY
Ein Forschungszentrum der
Helmholtz-Gemeinschaft