Electron identification efficiency measurements with the ATLAS detector & the impact of the pile-up

The capability to provide efficient electron identification over a wide range of energies is indispensable to the ATLAS physics program. For an optimal use in cross-section measurements and the search for new physics, it is of great importance that simulations model the electron identification accurately.

Precise efficiency measurement of both data and Monte Carlo across a wide energy range is therefore very important. Different analyses addressing different energy range, using two characteristic signatures, the Z boson and the J/ψ resonances, are used.

Electron reconstruction: from clusters to superclusters

By combining clusters originating from the primary electron with those from radiative interactions within the detector, we can

- recover the energy lost due to bremsstrahlung
- significantly improve the energy resolution
- naturally develop an EM shower in the calorimeter.

Supercluster algorithm for electrons and photons

Effect of restricting cluster size in |η| on a sample of electron supercluster in the EM calorimeter.

Electron identification

Different identification criteria are used to discriminate electrons from background objects such as:

- hadronic jets
- electrons from photon conversions
- electrons from heavy flavor hadron decays.

Electrons are identified by a track in the inner detector and a supercluster in the electromagnetic calorimeter.

Three different identification criteria: loose, medium and tight, defined by a selection on a likelihood (LH) discriminant computed from the calorimetric cluster shower shapes, track and track-to-cluster matching variables.

Electron identification efficiency measured using the Tag and Probe method.

Tag electron → strict selection criteria
Probe electron → unbiased & used for the efficiency measurements

Two different resonances used that address different energy range:

- J/ψ → ee
- Z → ee

Double differential measurement in 240 bins using two alternative methods to estimate background in Z → ee events:

Z→ee (iso-based bkg subtraction)
Z→ee (m_n-based bkg subtraction)

The impact of the pile-up

Pile-up effects vary proportionally to the average number of interaction per bunch crossing <μ>.

Increasing pile-up leads to

- higher energy deposits in the calorimeter
- widens the shower shape variables
- more tracks in the inner detector

Identification efficiency for three different working points as a function of the <μ>.

Slope well modeled in MC. Typical loss for <μ> ∈ [15,60] ~ 4 %

Reference: The efficiency measurements and the LH tuning are described in the ATLAS-CONF-2016-024

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