Electron calibration for the Level-1 Calorimeter trigger at the ATLAS Experiment

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1. Introduction

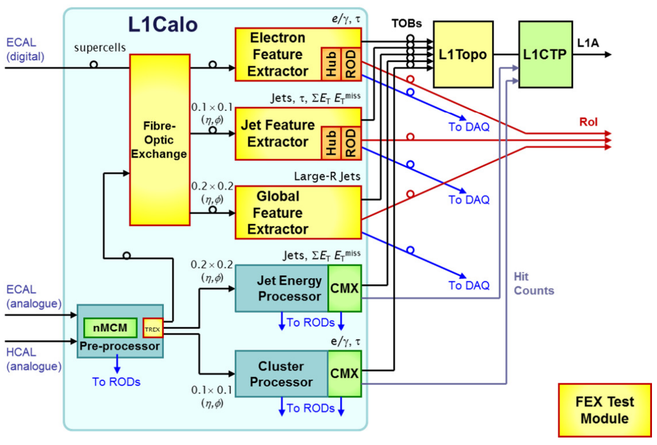
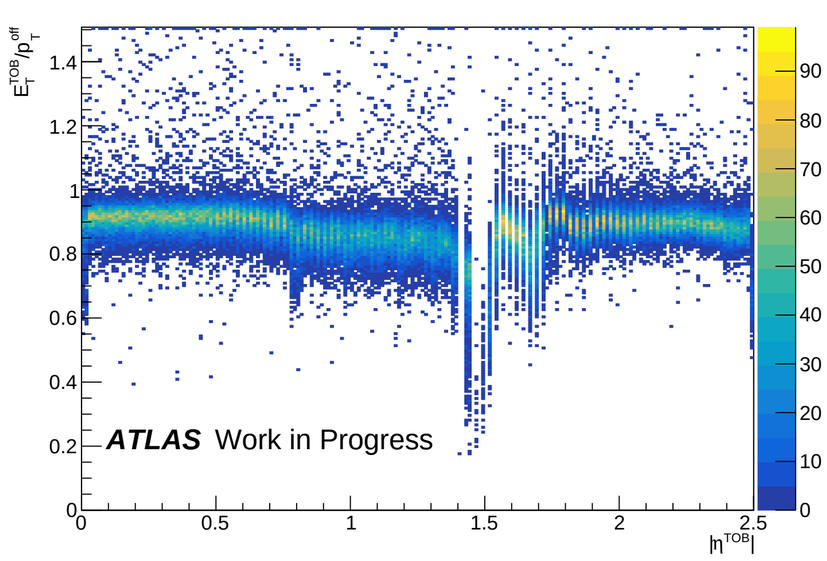


Image from [1]

- As the luminosity is increased for Run-3, controlling trigger rates while keeping the physics signal efficiency high is a priority at the ATLAS experiment
- A new system of feature extractor modules will be added to the L1Calo system for Run-3, including the electromagnetic feature extractor (eFEX), whose function is to identify e/γ and τ candidates using data from the EM and hadronic calorimeters
- The eFEX will use higher granularity digital information from the LAr detector, to produce more precise trigger objects, with new e/γ algorithms to analyse shower shapes and provide discrimination power from jet background

2. Motivation

- The ratio between the offline electron p_T and trigger object (TOB) E_T is shown in the plot below, using a $Z \rightarrow e^+e^-$ sample
- Ideally, this ratio would be constant throughout the η region, and equal to 1
- A position-dependent calibration procedure is presented for the electron object E_T, following the cluster reconstruction
- This calibration can substitute the currently applied position dependent trigger energy thresholds



3. Calibration

- New trigger tower configuration (see figure below) allows corrections to be added to the E_T summation
- Formula for calibration strategy, inspired by [2]:

$$E_{T,cluster} = a \cdot E_{T,PS} + b \cdot E_{T,1} + c \cdot E_{T,2} + E_{T,3}$$

- Using 100k $Z \rightarrow e^+e^-$ events, performed minimisation to extract parameters a, b and c in $|\eta|$ bins with width 0.1 by minimising $\frac{(E_{T,cluster} - p_T^{off})^2}{\sigma_{off}^2}$
- Pre-sampler layer exists only in $|\eta| < 1.8$ region
- Parameters a, b and c estimated with resolution 1/128, to emulate the resolution available at the hardware-level

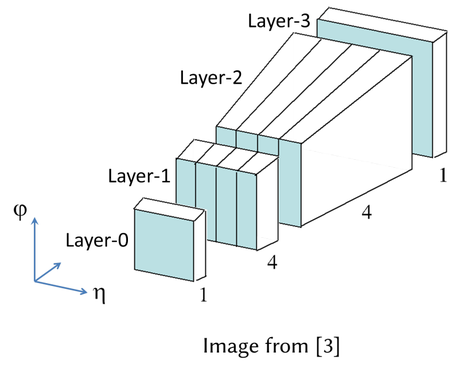


Image from [3]

4. Calibration Results

- Applying the calibration to the $Z \rightarrow e^+e^-$ sample improves the energy response, especially in the barrel region ($|\eta| < 1.475$)

5. Efficiency

- To test the effect of the calibration, efficiency turn-on curves are obtained for calibrated/uncalibrated electrons, at thresholds giving the same background rate
- Rates are calculated using 100k $Z \rightarrow e^+e^-$ and 1M dijet background events, normalising the rates to the cross section for each sample
- Calibration gives sharper turn-on curve

References

[1] ATLAS Collaboration, *Design and test performance of the ATLAS Feature Extractor trigger boards for the Phase-1 Upgrade*, ATL-DAQ-PROC-2016-024.
[2] ATLAS Collaboration, *Combined Intercalibration and Longitudinal Weight Extraction for the ATLAS Liquid-Argon EM Calorimeter*, ATL-LARG-2004-012.
[3] ATLAS Collaboration, *Technical Design Report for the Phase-I Upgrade of the ATLAS TDAQ System*, ATL-DAQ-PROC-2016-024.

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