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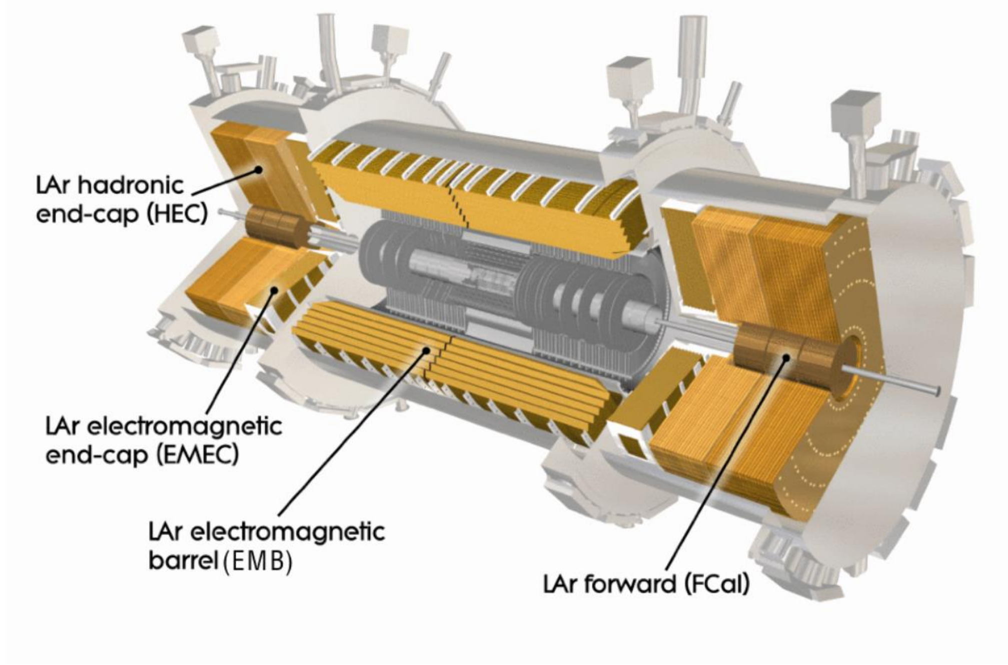
ATLAS Liquid Argon Calorimeters Operation and Data Quality During the 2017 Proton Run

Uptime & good data quality efficiencies [%] [1]

	2016	2017
ATLAS	~94	93.6
LAr Calorimeters	99.3	99.4

ATLAS operated with high efficiency during the 2017 pp data-taking period, recording approximately 43.8 fb^{-1} of good physics data. The Liquid Argon (LAr) Calorimeters contributed to this effort by providing a high data quality efficiency. This poster provides an overview of the LAr calorimeters, data quality, and performance of the LAr Calorimeters in 2017.

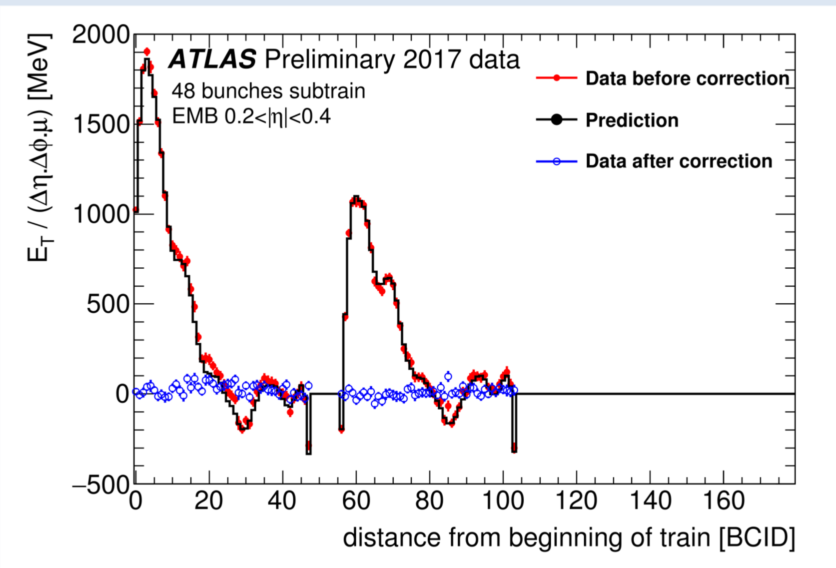
ATLAS Liquid Argon Calorimeters

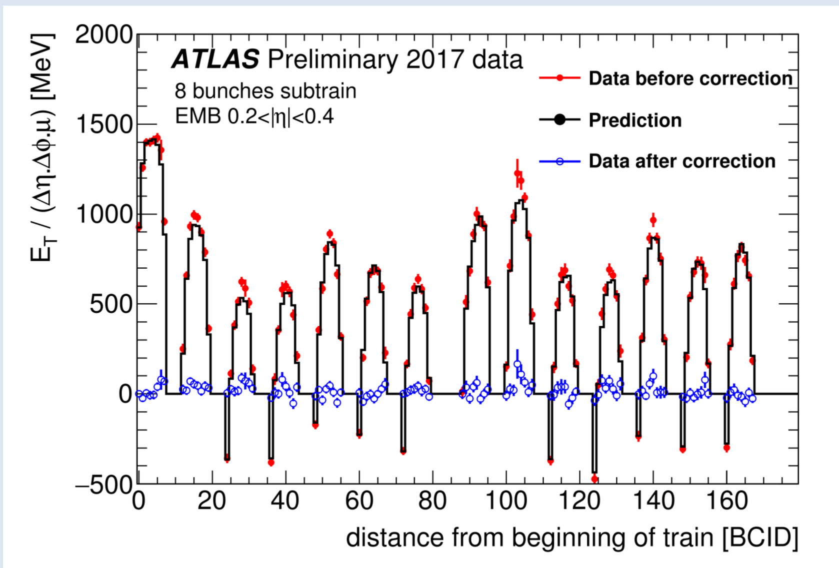


- Combination of electromagnetic (EM) and hadronic sampling calorimeters that use liquid argon as the active (ionizing) medium with ~180,000 readout channels [2].
- The electromagnetic barrel (EMB) and end-cap (EMEC) calorimeters are comprised of accordion structures with lead plates acting as passive material, providing full azimuthal coverage and fast readout. The EMB and EMECs cover a pseudorapidity range $|\eta| < 1.475$ and $1.375 < |\eta| < 3.2$, respectively.
- The hadronic end-cap (HEC) calorimeters use a conventional parallel-plate electrode design made of copper plates. The HECs cover the region $1.5 < |\eta| < 3.2$
- Forward calorimeters (FCal) use a novel rod and tube electrode structure to cope with the extreme particle flux in the region $3.1 < |\eta| < 4.9$

Pileup Corrections

- During 2017, LAr adapted to the use of the 8b4e filling scheme and the high μ. The pileup baseline correction for this filling scheme is larger.

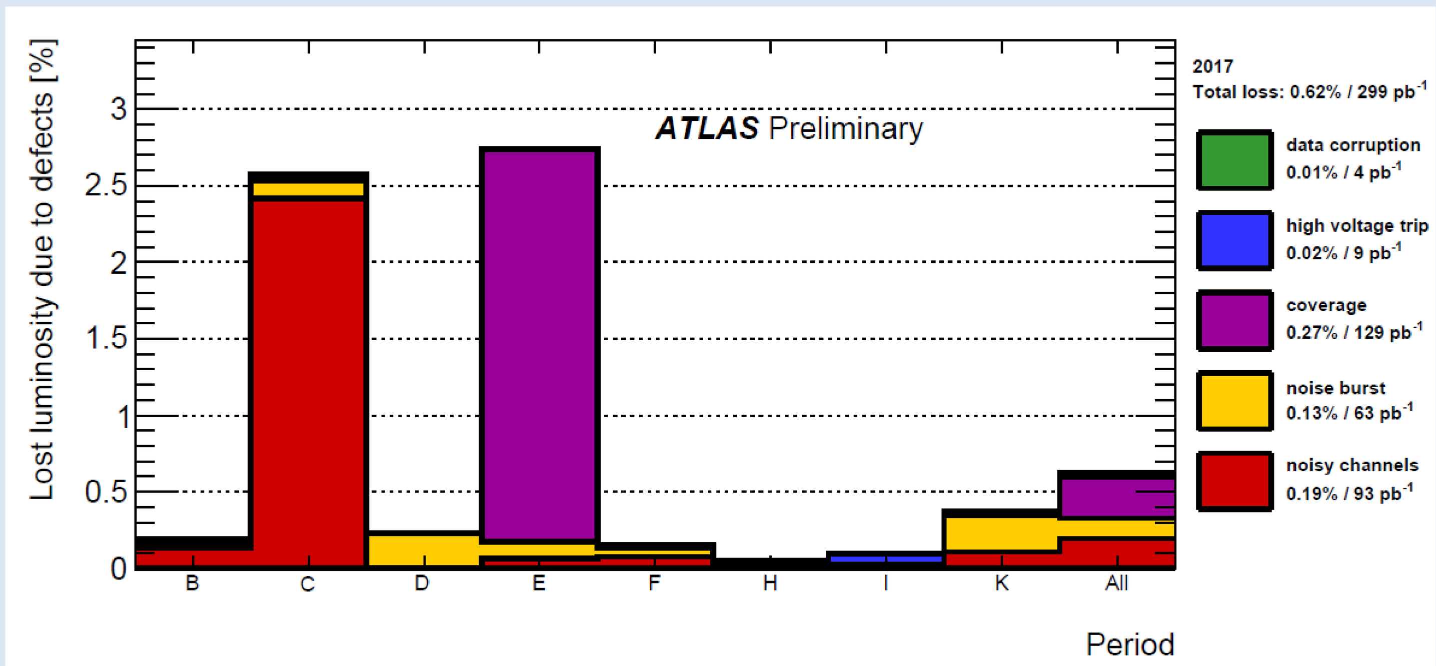




- With long trains, the average shift after 20 BCID is close to 0 as bipolar shaping is applied in the readout. This shaping leads to the contribution from out-of-time pile-up cancelling the in-time pile-up contribution.
- With the 8b4e filling scheme this cancellation is never perfectly achieved.
- A correction on the cell energy is computed using the luminosity per bunch, the pulse shape, and the optimal filter coefficients. This correction is compared to data recorded proportionally to the instantaneous luminosity.
- The residual shift in the transverse energy is less than 10 MeV at μ=40 for the cluster size ($\Delta\phi \times \Delta\eta$ = 0.013 [7x3 cells]) used to measure electron and photon energies [3].

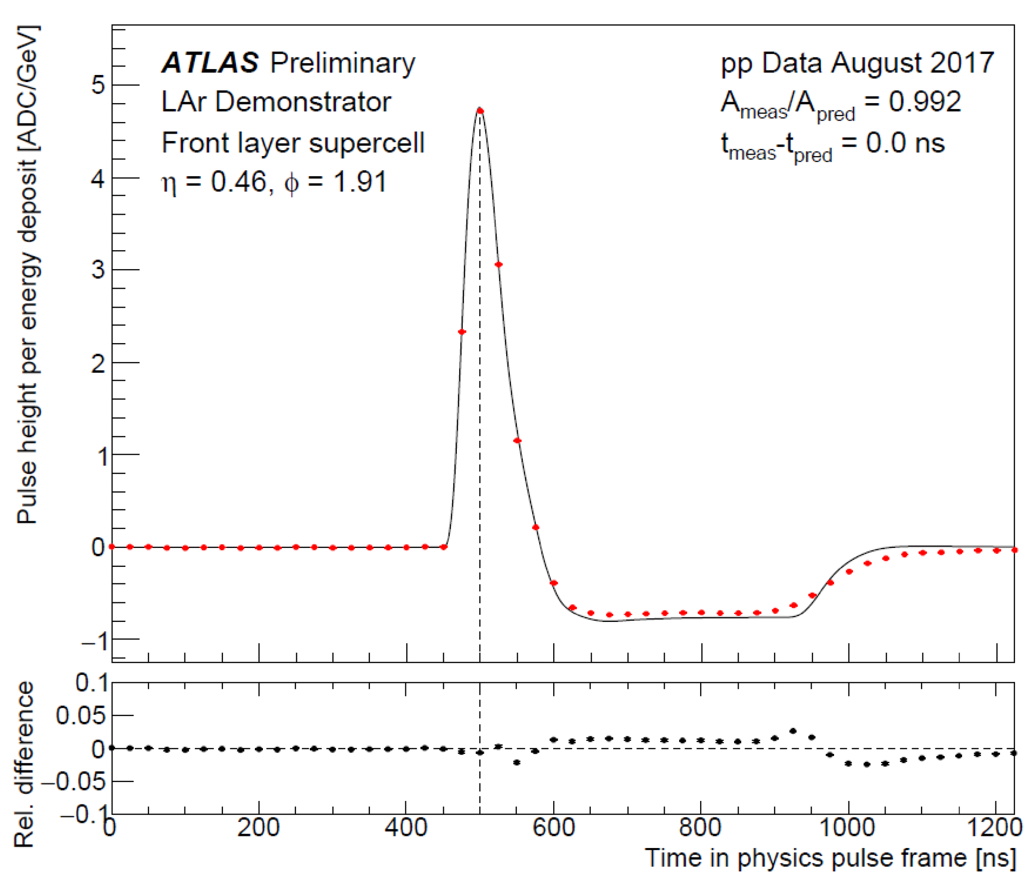
Data Quality

- LAr collected a high amount of good-quality data during the 2017 run. The main data losses were due to coverage (0.27%), noisy channels (0.19%), and noise bursts (0.13%).
- The coverage loss is attributed to a single run failure of a LAr back end readout crate which was caused by a water leak.
- A noise burst is defined coherent noise that affect a large fraction of the detector during a very short time (~1 μs). This effect is typically treated by a time veto. In 2017, an additional 14 pb^{-1} of loss occur due to this time veto [3].
- Noisy channels are treated by masking them, either permanently or selectively when their quality factor is incompatible with a LAr ionization.



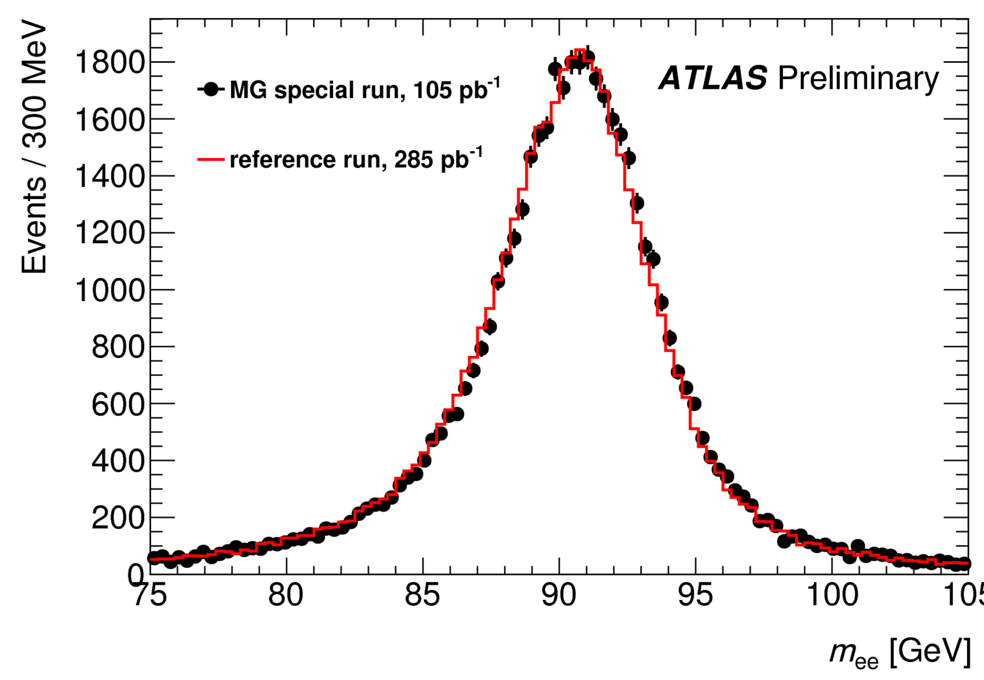
Phase-I Upgrade Trigger Demonstrator

- In preparation for the increased instantaneous luminosity foreseen during Run 3, an upgrade to the L1 trigger readout path is planned for LAr during LS2 [4]. A small scale demonstrator has been in place in the LAr EMB since 2015 to validate the design and hardware feasibility.
- The system utilizes super cells (clusters of cells) which have a smaller granularity than the current trigger tower based system.
- The demonstrator ran parasitically for most of the 2017 data-taking.
- An example of a measured pulse shape from the front layer supercell (comprised of 8 cells) of the LAr Demonstrator [5]. The measured values (red) are compared to the predicted value (black). Very good agreement is observed, with slight normalization offsets due to preliminary supercell calibration.



Physics Measurements

- Precision energy measurements of high energy electrons and photons require a good linearity of the energy response as $Z \rightarrow ee$ decays are used to set the energy scale.
- The relative calibration of the Medium (MG) and High (HG) gains of the readout chain in the EM calorimeter is probed using special runs taken in 2017 where the thresholds for the gain transition of the second layer of the EM calorimeter were lowered.
- A comparison of the $Z \rightarrow ee$ mass distribution between this special run and data taken with the standard gain thresholds allows one to probe the relative calibration of the two gains with accuracy better than 0.1%.



Distribution of the dielectron invariant mass for $Z \rightarrow ee$ candidates recorded in 2017 during LHC fill 6035. The difference in the average value of the reconstructed mass is (0.15 ± 0.02)% where the error is statistical only.

References

[1] ATLAS Collaboration, Data Quality Information for Data https://twiki.cern.ch/twiki/bin/view/AtlasPublic/RunStatsPublicResults2010

[2] ATLAS Collaboration, The ATLAS experiment at the CERN Large Hadron Collider, JINST 3 (2008) S08003

[3] ATLAS Collaboration, ATLAS Liquid Argon Calorimeter Phase-I Upgrade Technical Design Report, CERN LHCC-2013-017, ATLAS-TDR-022

[4] ATLAS Collaboration, Phase-I Upgrade Plots https://twiki.cern.ch/twiki/bin/view/AtlasPublic/LArCaloPublicResultsUpgrade

[5] ATLAS Collaboration, LArCaloPublicResults2015 https://twiki.cern.ch/twiki/bin/view/AtlasPublic/LArCaloPublicResults2015

Christopher Hayes (Stony Brook University),
for the ATLAS Collaboration

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