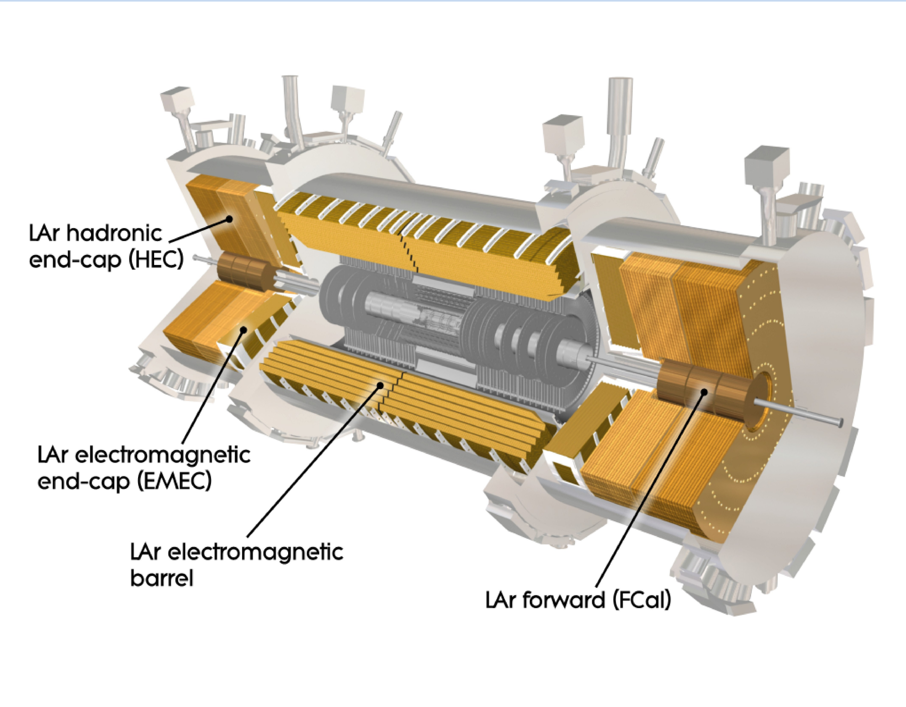
Status of the Atlas Liquid Argon Calorimeter and its Performance after two years of LHC operation

During the 2011 data taking period, ATLAS operated with an excellent efficiency, recording a preliminary integrated luminosity of 5.23 fb^{-1} in pp collisions at $\sqrt{s}$=7 TeV and 158 μb^{-1} in PbPb collisions at $\sqrt{s_{NN}}$=2.76 TeV. The ATLAS Liquid Argon calorimeter played a significant role achieving high performance and recording high-quality physics data. The aim of this poster is to present some of the main results of the past two years. The detector operation effort that will ensure efficient data taking through the 2012 data taking period is also mentioned. Improvements in the data quality system, calibration and the stability measurement of the calorimeter are presented and also the impact on the physics performance.

The Liquid Argon Calorimeter



EM calorimeter (Barrel and Endcap)
Pb+ LAr
- Accordion geometric
  - Full φ-coverage without crack
- Coverage: $|\eta| < 3.2$
  - 3 layers up to $|\eta| = 2.5$
  - 2 layers up to $|\eta| = 3.2$
- Preshower detector up to $|\eta| = 1.8$
- **~ 170k** readout channels

Hadronic EndCap (HEC)
Cu+ LAr
- Flat plates
- Coverage : $1.5 < |\eta| < 3.2$
  - 4 layers
  - 5632 readout channels

Forward Calorimeter (FCal)
Cu/ W tubes + LAr
- Coverage : $3.1 < |\eta| < 4.9$
  - 1layer EM
  - 2 Hadronic layers
- 3524 readout channels

After Winter 2011-2012 shutdown repairs	(%)	The fraction of non operational channels
EM calorimeter	0.04%	76/173312
HEC	0.39%	22/5632
FCal	0.23%	8/3524
Global	0.06%	106/182468

Detector operation

ATLAS 2011 pp run Calorimeters				***ATLAS*** 2011 PbPb run Calorimeters			
LAr EM	LAr HAD	LAr FWD	Tile	LAr EM	LAr HAD	LAr FWD	Tile
97.5	99.2	99.5	99.2	100	100	100	100

Left-most Columns: Luminosity weighted relative detector uptime and good quality data delivery during 2011 stable beams in ***pp*** collisions at $\sqrt{s}$=7 TeV between March 13th and October 30th (in %), after the summer 2011 reprocessing campaign.

Right-most Columns: Luminosity weighted relative detector uptime and good quality data delivery during 2011 stable beams in **PbPb** collisions at $\sqrt{s}$=2.76 TeV per nucleon between November 12th and December 7th (in %).

LAr Data Quality inefficiency in 2011

Irrecoverable			**Recoverable at a future reprocessing**		**Total**
High voltage trip 1.00%	**Data corruption** 0.19%	**Large inefficient areas** 0.71%	**Noise bursts** 1.21%	**Noisy channel** 0.16%	**3.27%**

Luminosity weighted fraction of data loss during 2011 stable beams in proton-proton collision at $\sqrt{s}$=7TeV between March 13th and October 30th

Two main sources of inefficiencies the Noise bursts and High voltage (HV) trips:

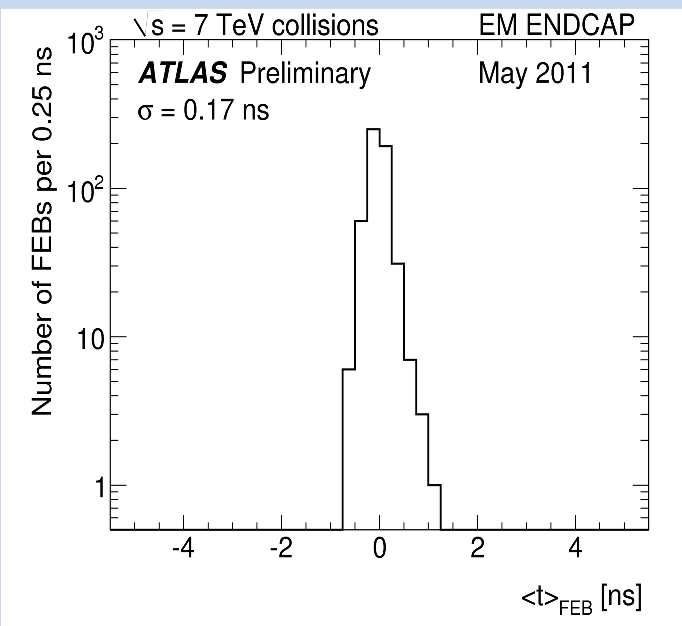
- The rate of noise bursts, where a region of the calorimeter lights up, is proportional to the instantaneous luminosity. The origin of the noise bursts is still under investigation.
- For the 2012 data-taking the data quality system was improved to minimize the data loss.

- During stable beams conditions, one HV line may trip (typically in the forward region), the other side of the electrode remaining powered.
- In 2012, the inner part of the EM calorimeter ($1.8<|\eta|<2.5$) has been equipped with more resilient modules.

Aiming at >98% efficiency in 2012

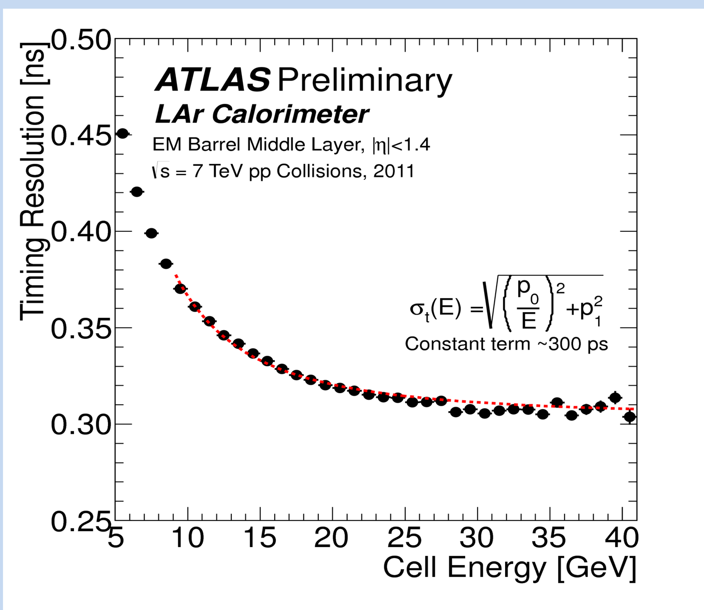
LAr Timing

Periodic studies ensure that the whole LAr Calorimeter system is uniform and aligned in time:
- After the timing adjustment implemented during the 2011 data the *global timing alignment* for the whole LAr Calorimeter is better then **1 ns** level.
- Studies using the full 2011 dataset demonstrate that a *timing resolution* of **~300 ps** can be achieved for a large energy deposit in a cell of the EM Barrel.



Average time per Front End Board in EM Endcap with 7 TeV collision data on May 2011.

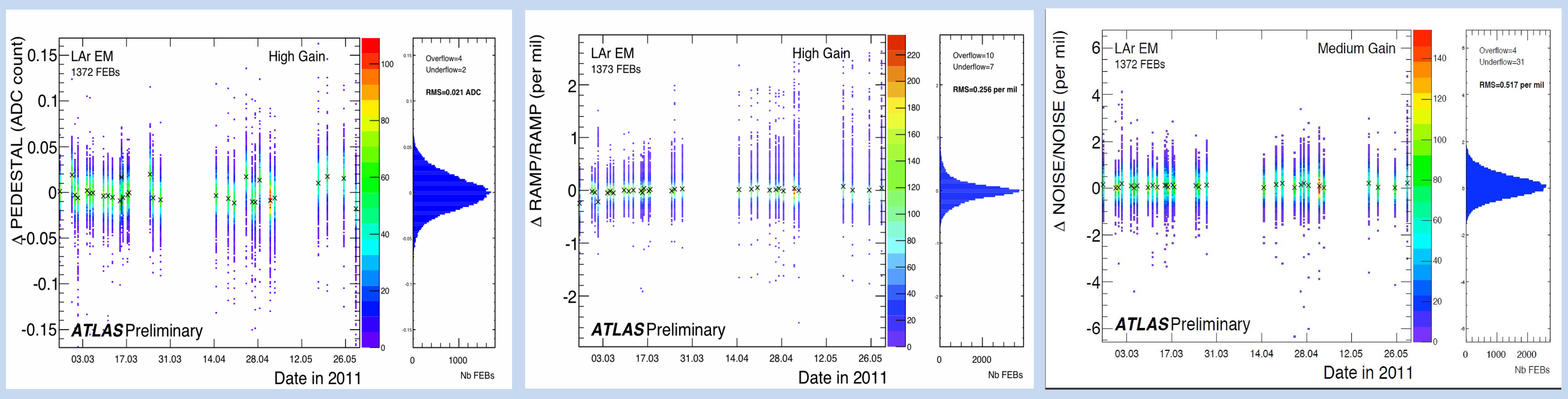
Front-End-Boards are aligned and centered to zero. The sigma value is the RMS of the distribution in a window of [-0.5 ; 0.5] ns.



Single Cell Time Resolution Vs Energy
Middle layer cells reconstructed in HIGH gain, using electrons from $W\to e\nu$ candidates
Includes a ~220 ps correlated contribution from the **beam spread** as determined from $Z\to e^+e^-$ studies

LAr Calibration stability

The stability of the calibration constants of each channel is essential for a good calorimeter performance.



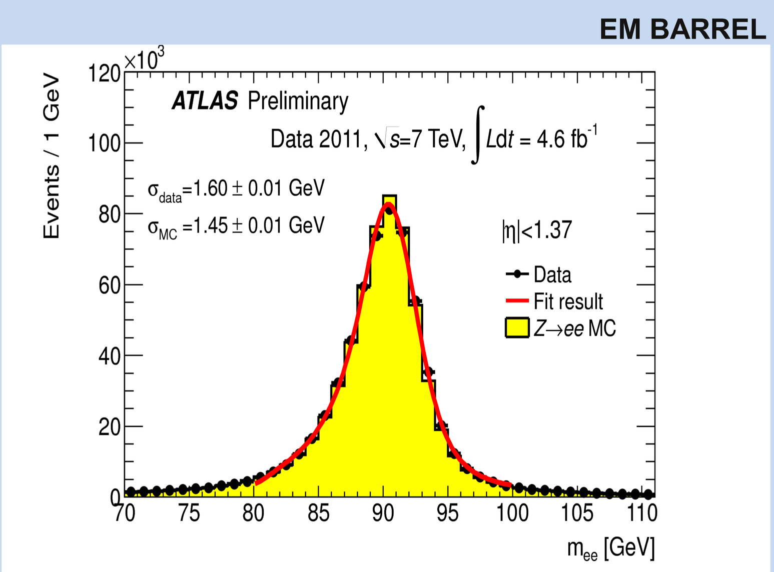
- Calibration runs are taken regularly during the inter-fill period
- Calibration constants are updated every few weeks
- Stability of the constants is monitored for long periods

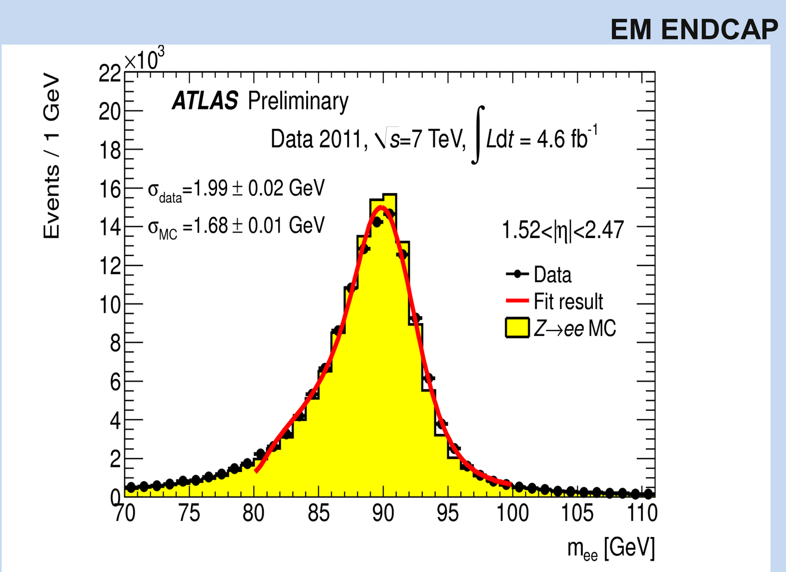
Pedestal: response of the readout electronics without any injected signal into the LAr cells.
Delay: response of the readout electronics after amplification and shaping of a injected current.
Ramp: response of each cell as function of the injected current.

Robust calibration procedure
Good electronic stability

Electron Performance

Calibrated $Z\to e^+e^-$ Mass with 2011 data



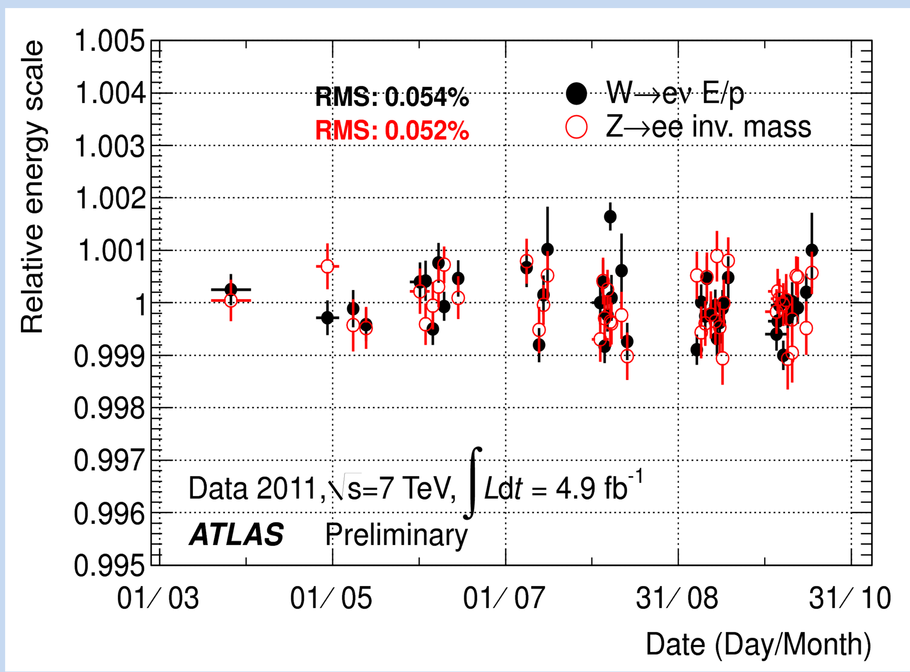


$$\frac{\sigma E}{E} = \frac{a}{\sqrt{E}} \oplus \frac{b}{E} \oplus c$$

The observed di-electron invariant mass distribution follow the Z line-shape obtained from Monte Carlo where the resolution constant term was set to zero. The energy corrections applied to the electrons are within 0.5% in the barrel region (EMB), and within 1% in the endcaps (EMEC-OW and EMEC-IW).
The mass peak resolution has been determined by fitting the distributions with a Breit-Wigner distribution convoluted with a Crystal Ball function.

Sub-system	η-range	Effective constant term, c_{data}
EMB	$\|\eta\| < 1.37$	$1.2\%^{+0.5\%}_{-0.6\%}$
EMEC-OW	$1.52 < \|\eta\| < 2.47$	$1.8\% \pm 0.4\%$
EMEC-IW	$2.5 < \|\eta\| < 3.2$	$3.3\% \pm 1.1\%$
FCal	$3.2 < \|\eta\| < 4.9$	$2.5\%^{+1.0\%}_{-1.5\%}$

Electron Energy Response Stability



Fitted peak value of the $Z\to e^+e^-$ inv. mass as well as the most probable value of the *E/p* distribution from electrons coming from $W\to e\nu$ decays (obtained with a Crystal Ball fit) as a function of time

The excellent performance of the ATLAS LAr Calorimeter system is the result of a big collective effort from everyone in the LAr Community throughout the year. Hardware upgrades and improvements, continuous optimization of the Data Acquisition System, development of Online and Offline Monitoring tools and finally new method development to maximize data recovery **aim to minimize the data loss and keep high the performance.**

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