LHCC Poster Session - CERN, 21 March 2012

ATLAS Detector Performance in 2011 - Calorimeters

During the 2011 data taking period, ATLAS operated with 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 and Tile Calorimeters played a significant role achieving this performance and recording high-quality physics data. The aim of this poster is to present some of the main performance results of the past year and the effort behind them. Improvements in timing performance and the LAr pointing performance are discussed. The calibration and measurement stability of the calorimeters is also presented. Finally, hardware upgrades and replacements that will ensure efficient data taking through the 2012 data taking period are mentioned.

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 %).

Liquid Argon Calorimeter Performance, Improvements and Potential

Data Taking Efficiency

The excellent performance was the result of a big collective effort from everybody at LAr Operations throughout the year:

✓ Hardware upgrades and improvements to increase redundancy and minimize recovery time in case of failure

✓ Continuous optimization of the Data Acquisition System to make it more robust and responsive

✓ Development and deployment of Online and Offline Monitoring tools to efficiently detect any minor or major issue in a timely manner

✓ Method and algorithm development to maximize data recovery

✓ Continuous training of experts and shifters to react to issues and resolve them quickly and minimize data loss

Aiming to reach 100% efficiency in 2012!

Fractional data loss in ***pp*** collisions

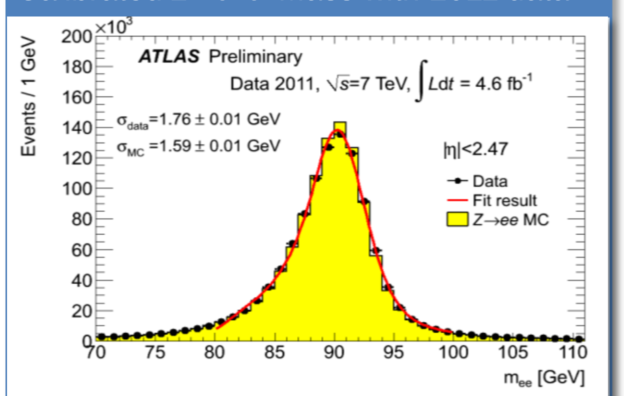
Irrecoverable			Recoverable at a future reprocessing		Total
High voltage trip	Data corruption	Large inefficient areas	Noise bursts	Noisy channel	
1.00%	**0.19%**	**0.71%**	**1.21%**	**0.16%**	**3.27%**

Luminosity weighted fraction of **data loss** in the LAr Calorimeter during 2011 stable beams in ***pp*** collisions at $\sqrt{s}$=7 TeV between Mar. 13th and Oct. 30th

Repairs During the Winter Shutdown

✓ **99.94%** of the 182,468 channels operational

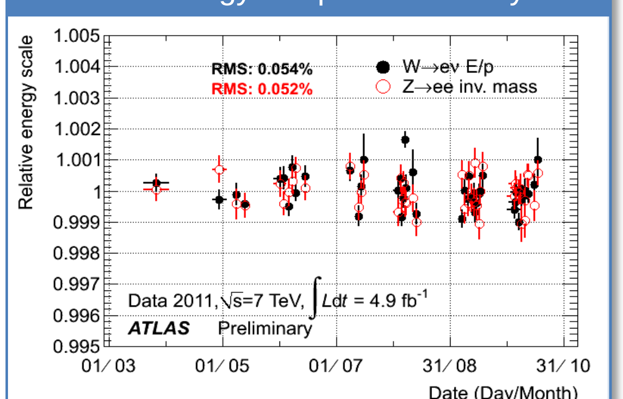
Calibrated $Z \to e^+e^-$ Mass with 2011 data



Electron Energy Resolution

$\frac{\sigma_E}{E} = \frac{a}{\sqrt{E}} \oplus \frac{b}{E} \oplus c$	Effective constant term, c_{data}
$\lvert\eta\rvert < 1.37$	$1.2\%\ ^{+0.5\%}_{-0.6\%}$
$1.52 < \lvert\eta\rvert < 2.47$	$1.8\% \pm 0.6\%$

Electron Energy Response Stability



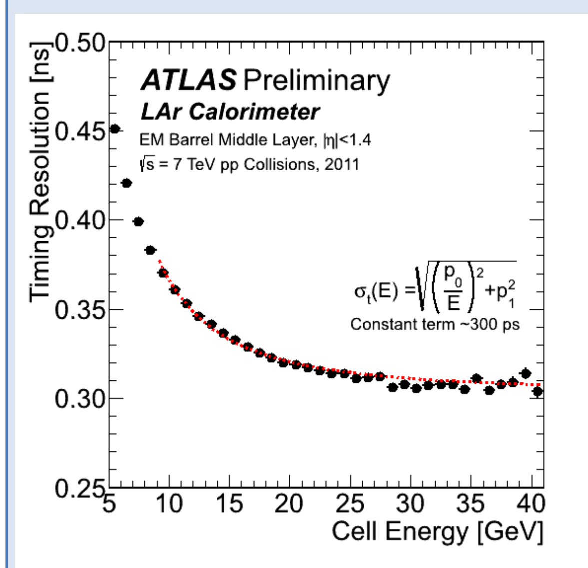
➢ Fitted peak value of the $Z \to e^+e^-$ inv. mass as well as the most probable value of the E/p distribution from electrons coming from $W \to e\nu$ decays (obtained with a Crystal Ball fit) as a function of time

Calorimeter Timing

✓ Periodic studies ensure that the whole LAr Calorimeter system is uniform and aligned in time

✓ 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

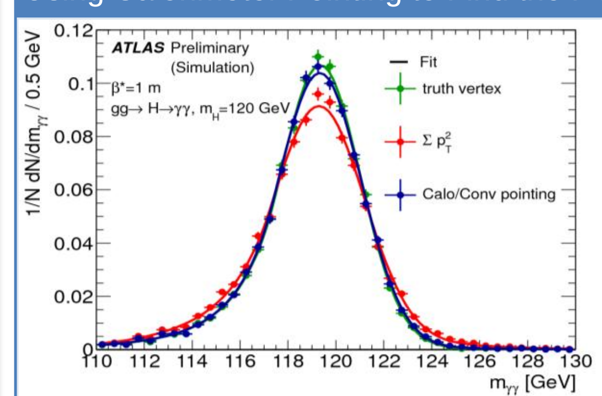
✓ Can be employed in non-prompt photon searches (e.g. GMSB scenarios)



Single Cell Time Resolution Vs Energy

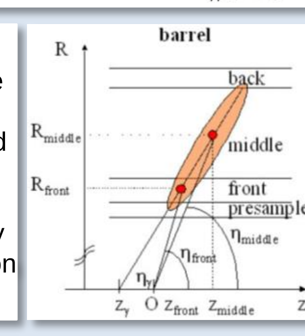
- Middle layer cells reconstructed in HIGH gain, using electrons from $W \to e\nu$ candidates
- Includes a **~220 ps** correlated contribution from the **beam spread** as determined from $Z \to e^+e^-$ studies

Using Calorimeter Pointing to Find the PV



Right

Photon Pointing: Use of the EM cluster position in the front and middle calorimeter layers to reconstruct photon pseudo-rapidity (η_γ) and point of origin on beam axis (z_γ)



➢ The plot shows the improvement to the diphoton mass resolution in simulated $gg \to H \to \gamma\gamma$ events by using "Calo/Conv Pointing" to find the Primary Vertex compared to the $\sum p_T^2$ method and MC truth information

➢ Recent studies with 2011 data show that Pointing performance is not sensitive to the change of **pileup** conditions between $\beta^* = 1.5$ m ($\langle\mu\rangle \approx 6.3$) and $\beta^* = 1.0$ m ($\langle\mu\rangle \approx 11.6$)

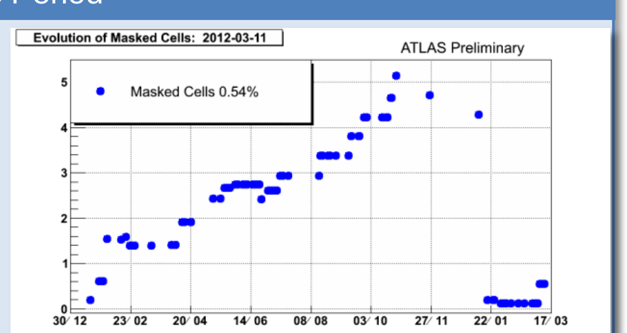
➢ Can also be used to detect **non-pointing photons**

Tile Calorimeter

Tile Major Repairs During the Maintenance Period

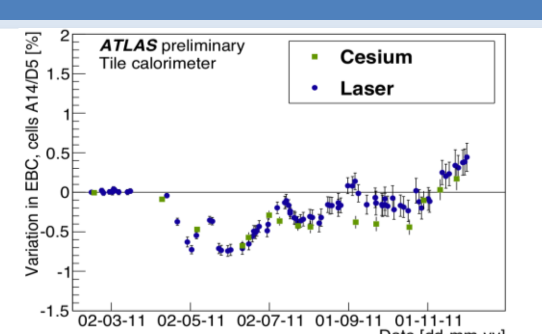
At the end of the 2011 data taking period, 5% of the cells were flagged as bad. During the repair campaign almost all cells were recovered, with 99.9% of the cells in good shape. After the repairs one module was lost and the 2012 data taking will start with 0.54% masked cells.

Solutions for the two main sources of failures (LVPS and power connector for the card receiving TTC signals) have been found, and implemented in 17% and 12% of the modules.



Calibration and Stability

The response of TileCal cells is monitored periodically with the Cesium and the Laser calibration systems. Since both systems show a similar behavior, the observed drifts can be attributed mostly to a variation of photomultiplier response and not to the scintillator irradiation. Downdrift is observed in periods of data taking with high instantaneous luminosity and updrift during technical stops. The cell energy scale is preserved at the level of 0.5%

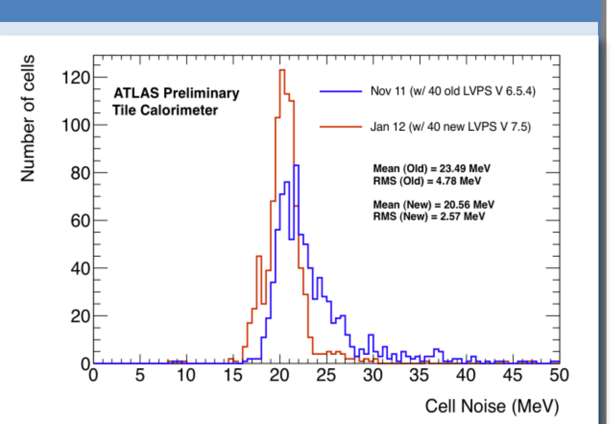


New Low Voltage Power Supplies

A major issue during the 2011 data taking were the frequent low voltage power supplies (LVPS) trips.

A solution at the hardware level was found and new LVPS will replace the current ones, with 40 being installed now and the full production scheduled for 2013. These LVPS are more reliable and robust under the high luminosity conditions that are expected.

The new production benefits also from a better noise performance, reducing it about 15%, less correlation among pairs of channels and non-Gaussian tails are strongly reduced.

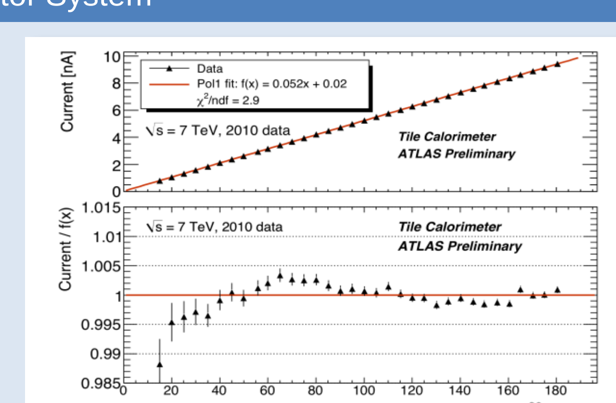


Luminosity Measurement with the Integrator System

The current measured from the integrator can be used as a measurement of the luminosity.

Dedicated studies show a linear dependence between the integrator signal and the instantaneous luminosity measured by the forward LUCID detector.

A special configuration of the integrator allows the measurement of the luminosity during van der Meer scans, providing an absolute calibration at very low luminosity

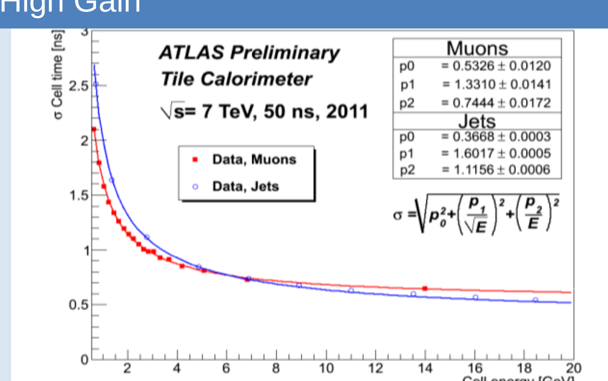


Tile Single Cell Timing Performance in the High Gain

Two separate analyses of the timing performance of TileCal were performed with jets and muons from collision events.

Both analyses correct for the measured mean time of the cells, and for the difference in distance from the impact point to the cell center in the case of muons.

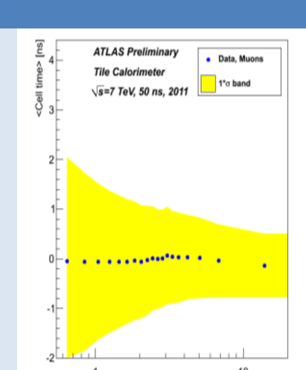
The measured resolution dependence with energy is qualitatively similar, with an expected resolution of ~0.5 ns for high energy depositions.

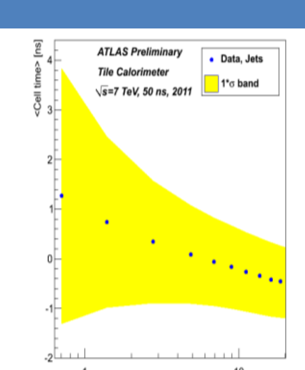


The different nature of the energy deposition results in a difference in the measured mean time.

The contribution of slow hadrons in the jet becomes relevant at low energies, shifting the mean time to higher values.

This effect is not present in muon events, translating into a flat response of the measured mean time with energy.





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ATLAS EXPERIMENT