Status of the Tile Barrel Calorimeter of ATLAS

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on behalf of the ATLAS Collaboration
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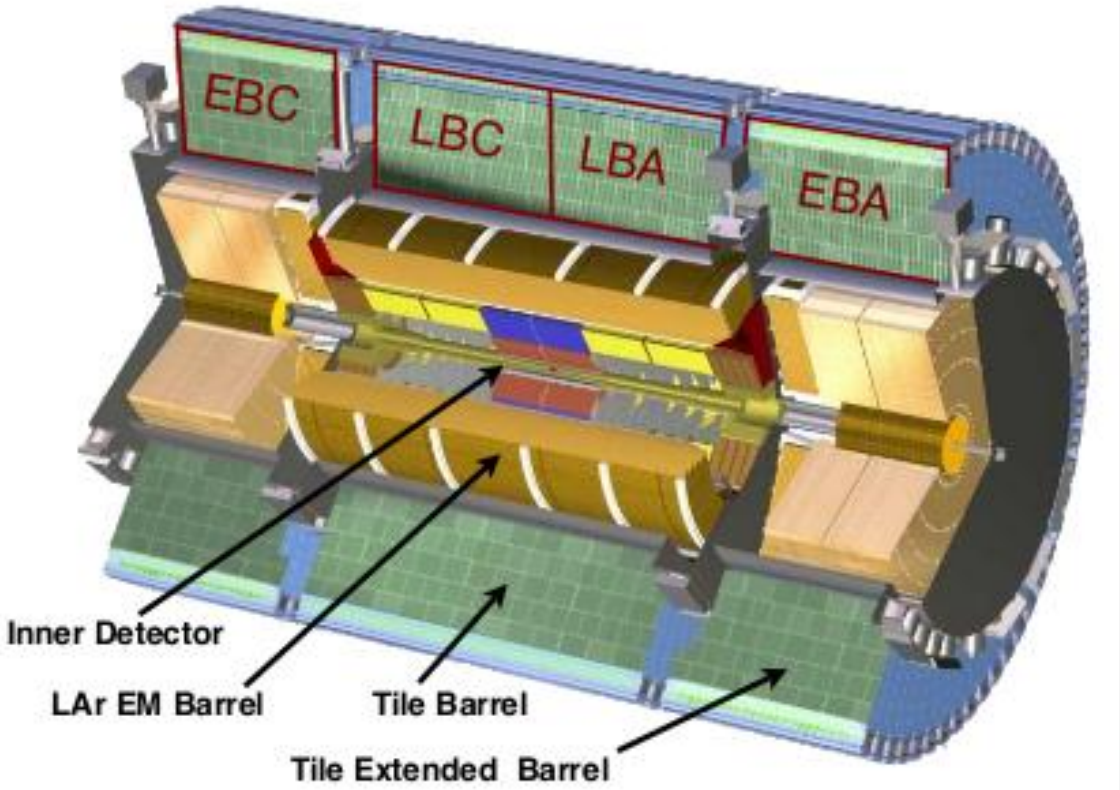
Physics in LHC era, Tbilisi, Georgia

Outline

- Introduction on TileCal
- The last two years
- Detector status and plans
- Data Integrity
- Some words on performance
- Talks on Tile Calorimeter in this conference:
  - T. Davidek: Performance of the Tile Calorimeter
  - G. Arabidze: Data Preparation in TileCal
  - I. Minashvili: TileCal upgrade program

TileCal in ATLAS



- Diameter: 8.5 m
- Length= 12 m
- Weight: 2900 T

- 3 cylinders with coverage: $|\eta|<1.7$)
- Sampling calorimeter: Fe/scintillator: 4:1
- Double PMT readout via WLS fibers (5000 cells->10k channels)
- Aim for jet energy resolution:

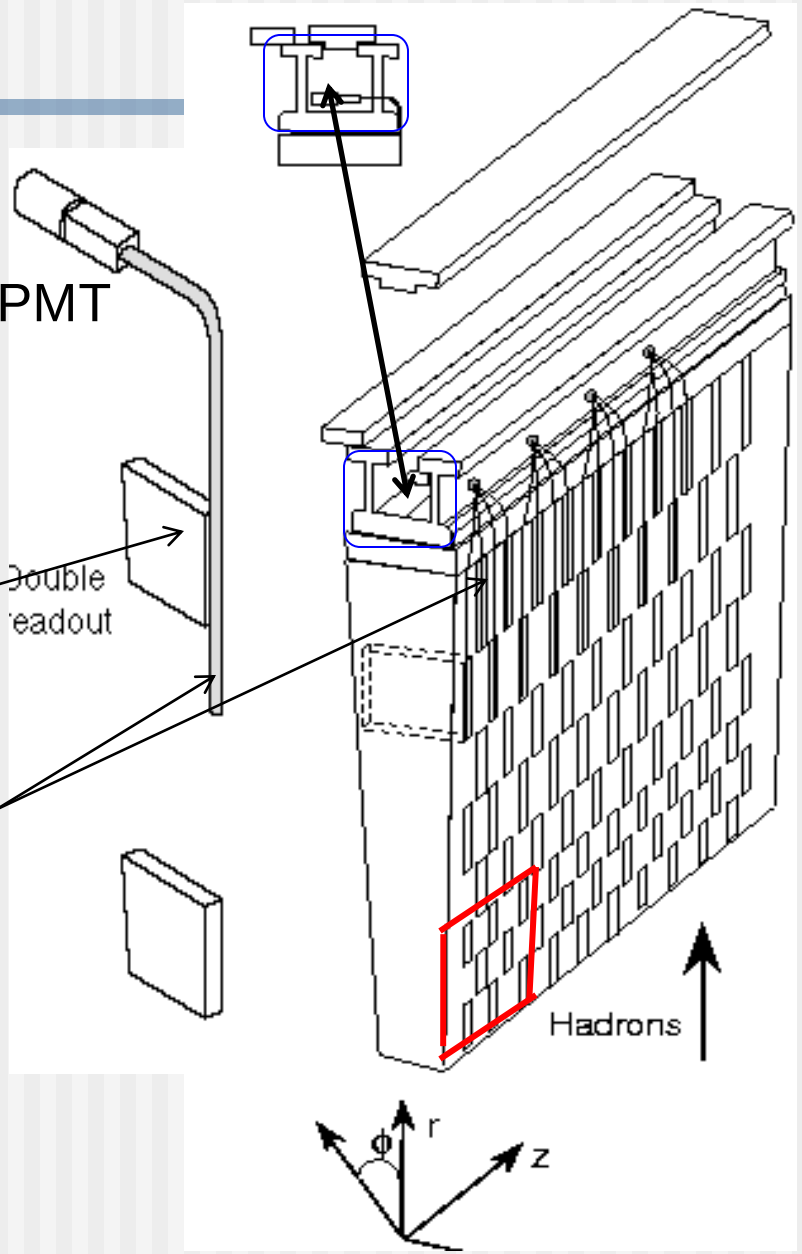
$$\frac{\Delta E}{E} \sim \frac{50\%}{\sqrt{E}} \oplus 3\%$$

Structure

Principle of TileCal:

Measure light produced by charged particles in plastic scintillator.

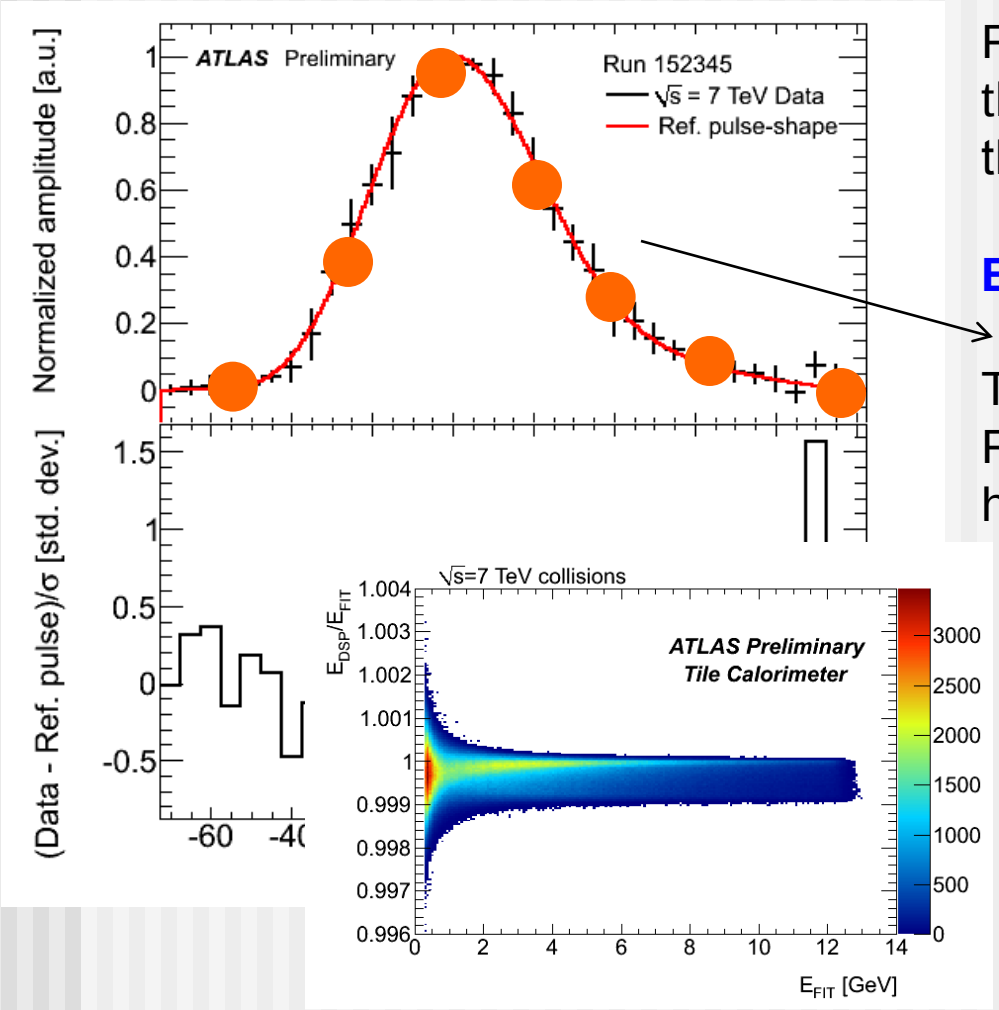
readout electronics,
PMTs are housed here



- Tile readout is grouped into projective geometry cells
- 3 longitudinal layers
- Granularity $\Delta\eta x\Delta\phi=0.1x0.1$ (0.2x0.1 in 3rd layer)

Signal from calorimeter

The signal from PMT is shaped/amplified, sampled every 25 ns and then digitized.



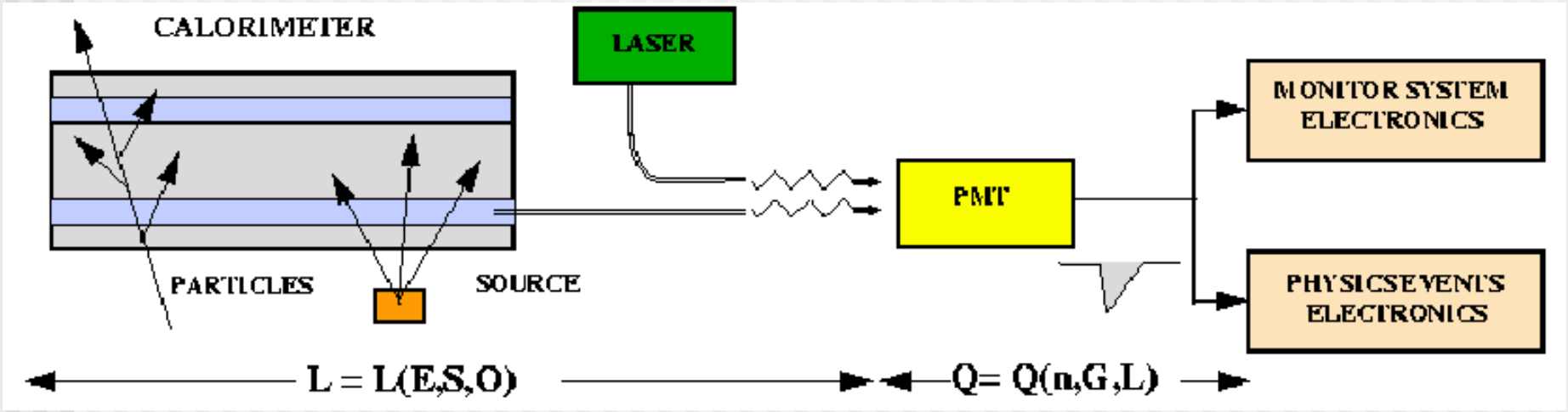
From 7 digitized measurements, the back-end electronics reconstruct the channel's:

Energy, Time and Quality Factor

This procedure uses Optimal Filtering and before that the channels have to be synchronized.

The Optimal filtering reconstruction technique has been validated against the offline reconstruction from raw digits

Calibrating and monitoring



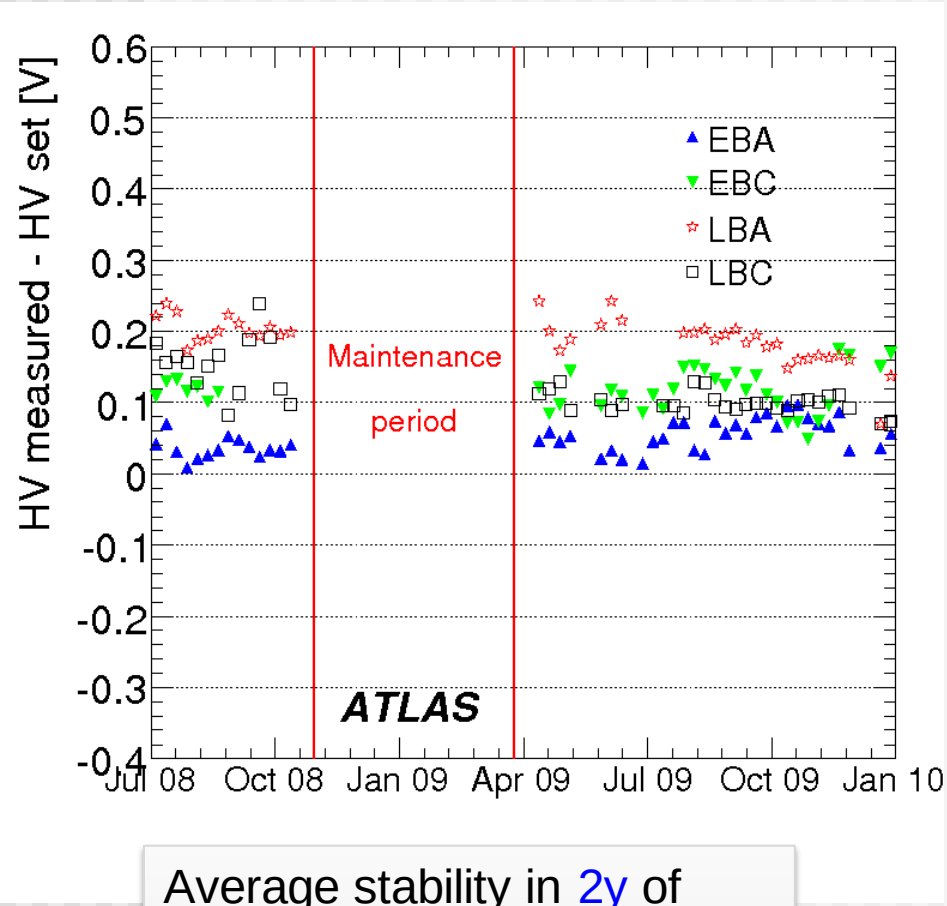
TileCal cannot be calibrated/monitored with a unique system:

- Charge injection "sees" the pulse readout electronics
- Laser "sees" the light guide + photomultiplier (pulse r/o)
- Cs radioactive system "sees" the scintillators+fibers+PMTs.
  - It is read by slow current integrating electronics
  - (these are also used to monitor the luminosity)

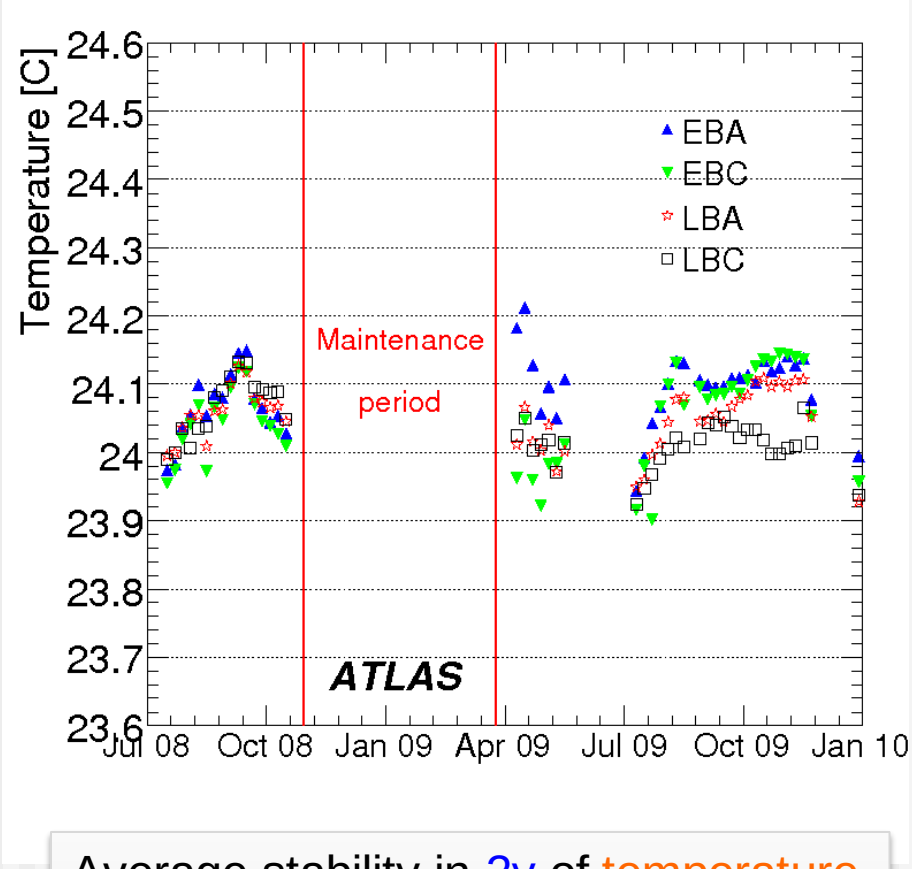
Two years ago…and after

- After a ~one year shutdown we were taking data with the calibration systems and cosmic rays and waited for the LHC collisions.
- Had the first collisions in March-April 2009 and kept on until December 2010 with ~ 35 pb^{-1} (pp) collected
- During the Christmas break 2010-11 the detector known problems were repaired.
- Restarted data-taking in spring 2011.
- Today we have 4.9 fb^{-1} (pp) collected.
- We have made maintenance plans for the Christmas shutdown 2011-12.
- We are getting prepared for the 2013-14 shutdown to consolidate our detector before the 2014-15 data-taking (at design LHC luminosity).
- Next Tbilisi conference (2013) will be in the middle of the LHC long shutdown-1.

Stability of operating parameters

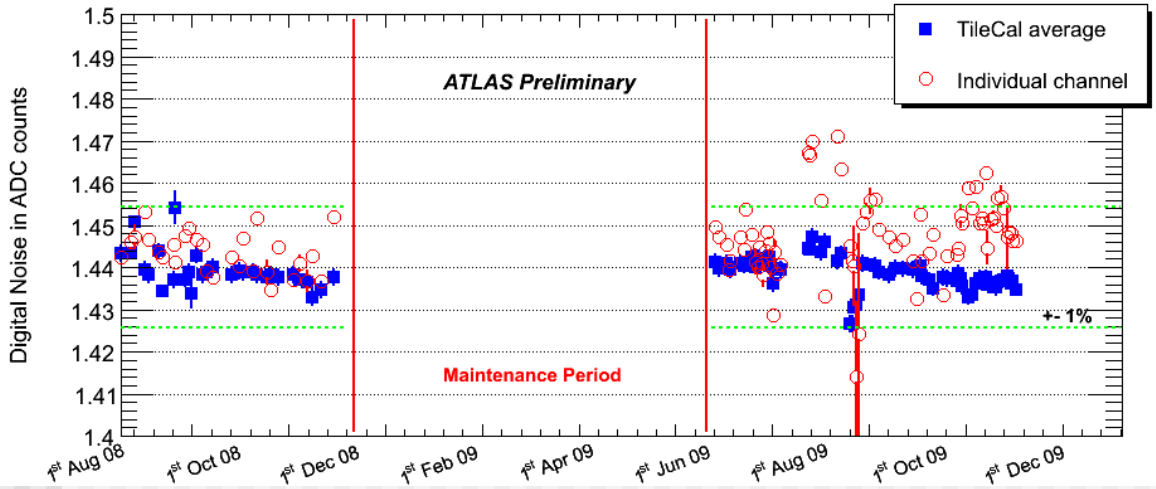


Average stability in 2y of applied HV to PMTs < 0.3 V.
Effect on gain <0.3%

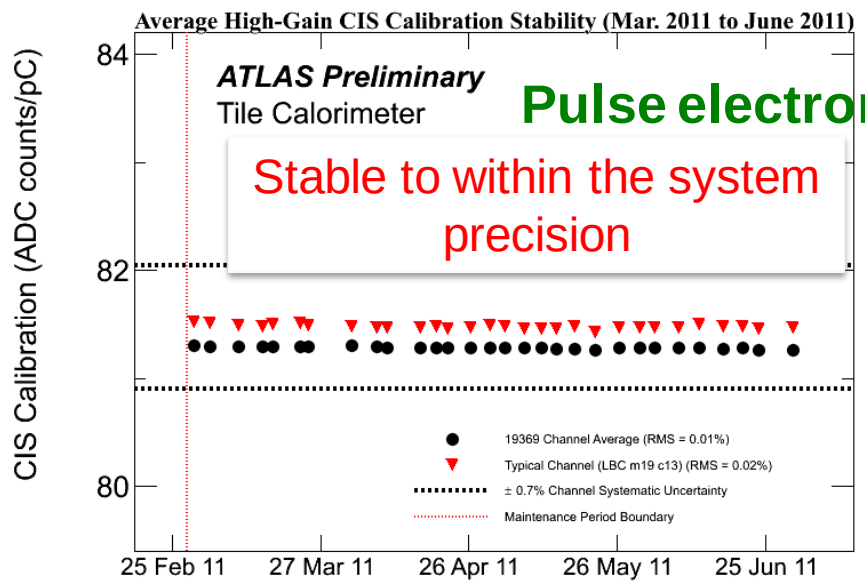


Average stability in 2y of temperature close to PMTs < 0.25 deg. C.
Effect on gain <0.05%

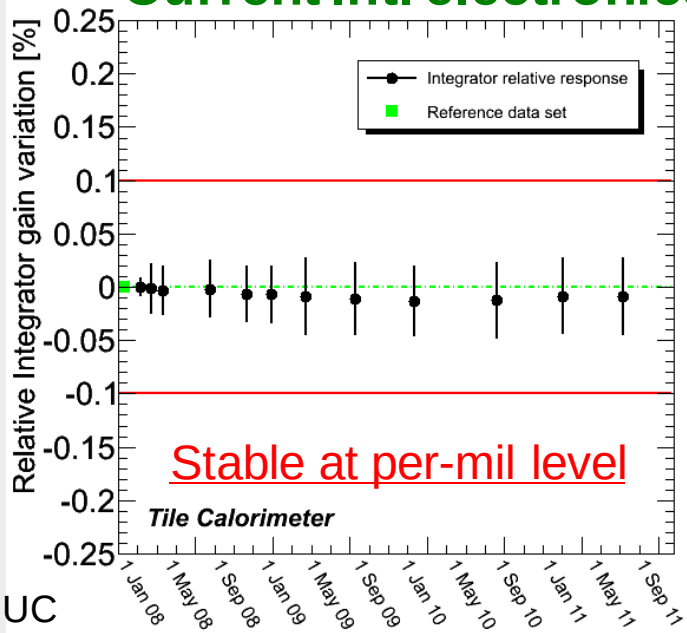
Stability seen by calibration systems

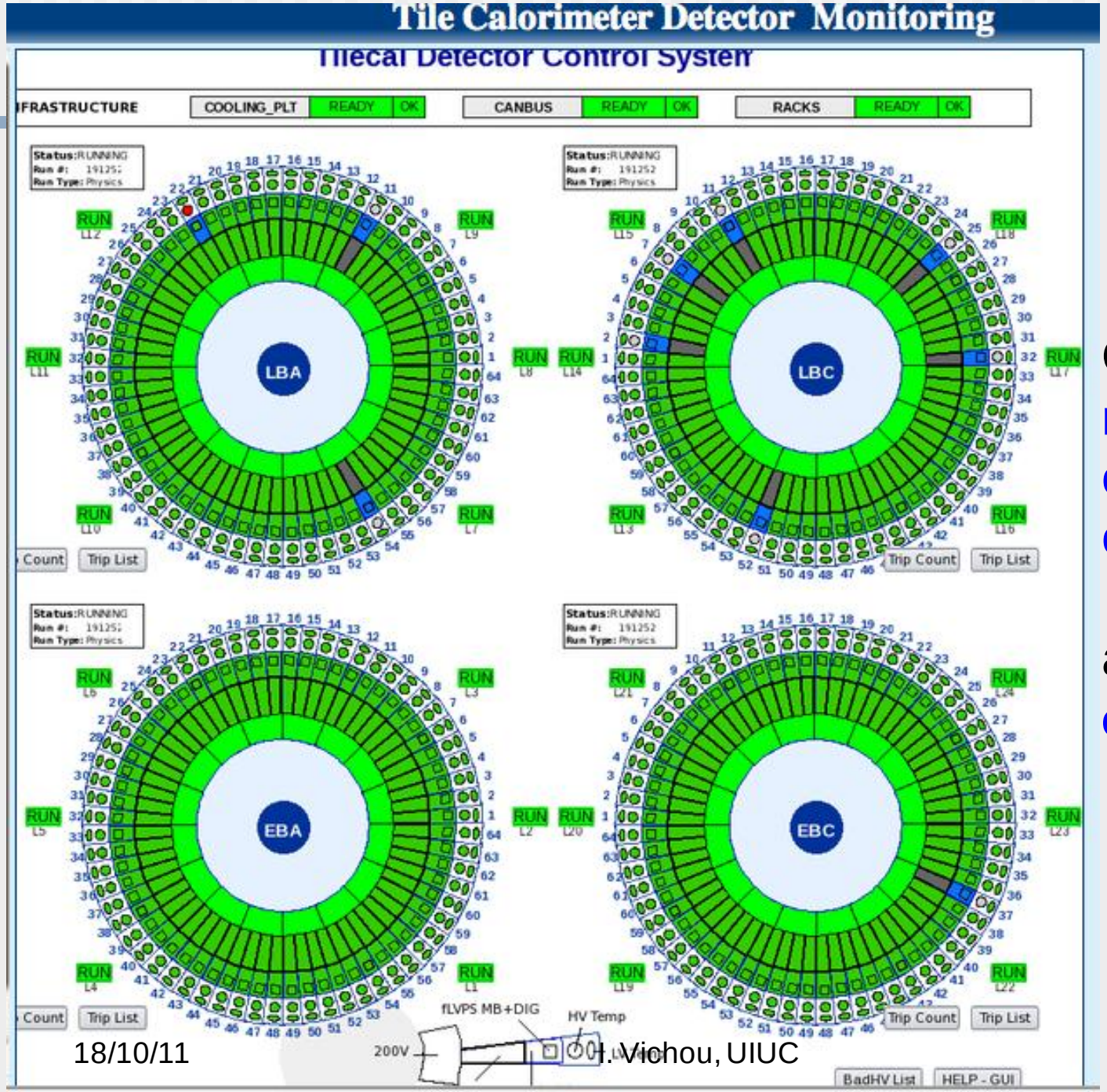


The channel noise is stable to within 1% on average



Current Int. electronics

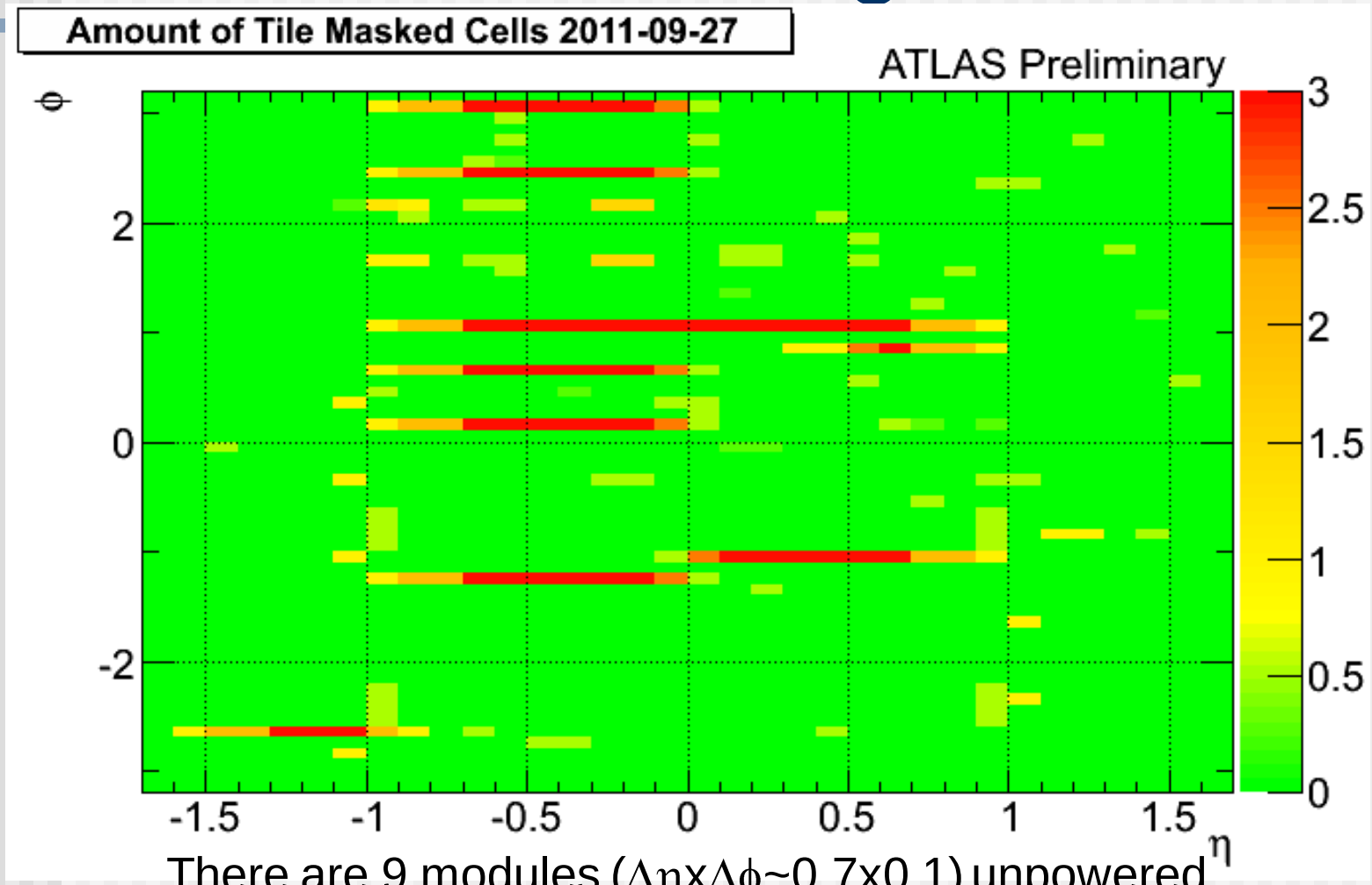




Online monitoring of detector conditions

as seen on shift…

Detector coverage



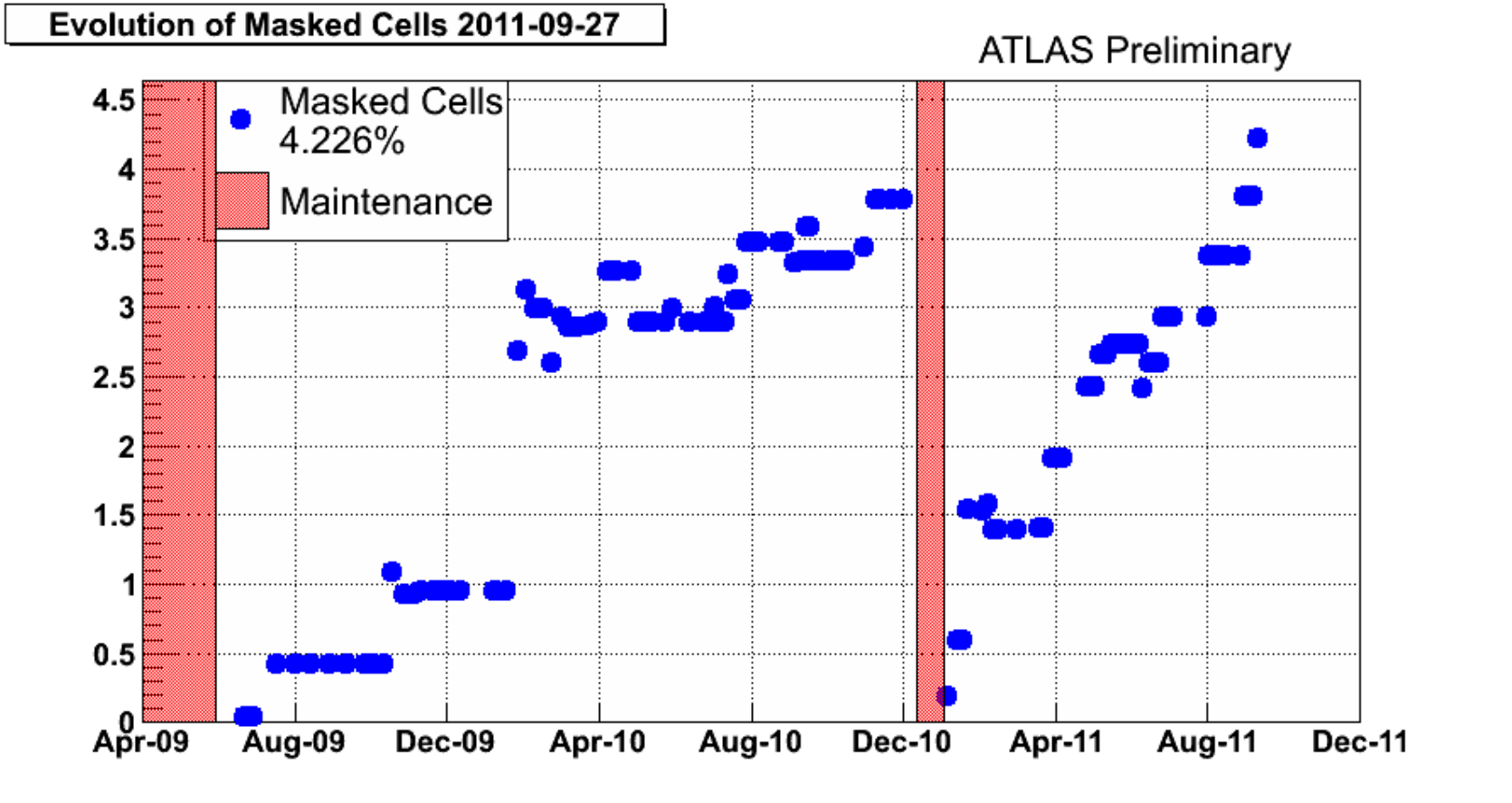
There are 9 modules ($\Delta\eta x\Delta\phi$~0.7x0.1) unpowered.

4.2 % of TileCal cells are unavailable for physics

No significant effect on jets/missing ET

Using interpolation from neighboring alive modules

Dead cells evolution

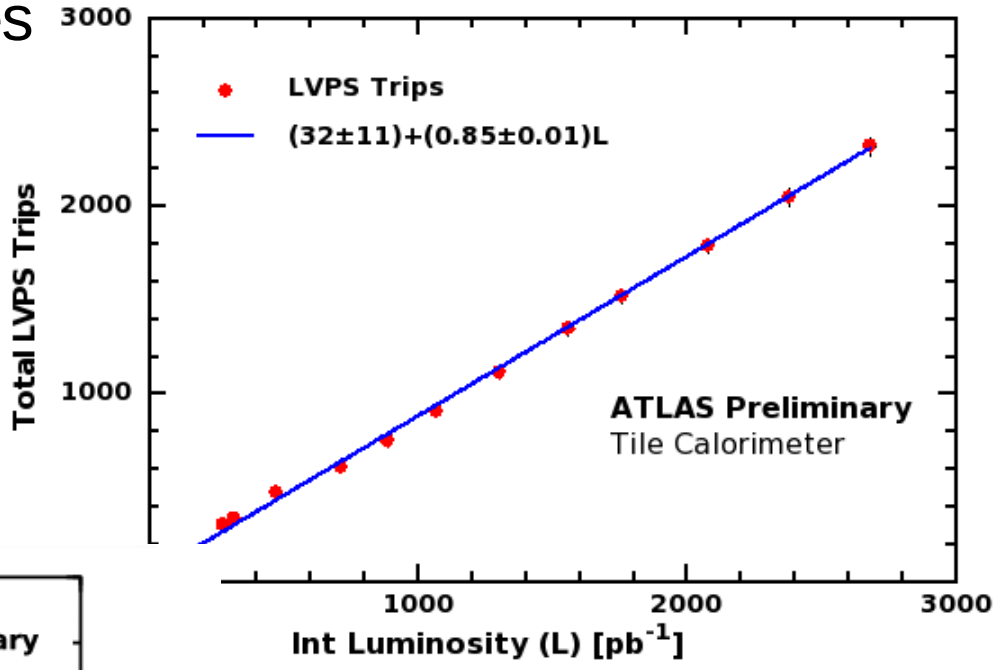


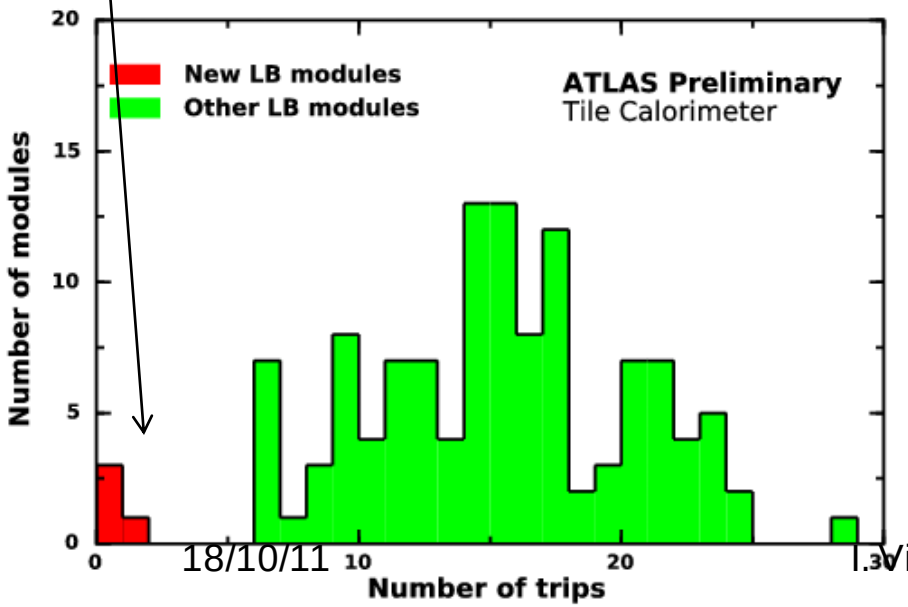
Time and data also brought more dead cells …
After every maintenance the detector coverage is 99.1%.
This year: Out of 9 modules, 5 power supplies, 4 front-end.
Will fix all in the shutdown.

Low Voltage Power Supplies

Our low voltage power supplies trip for few minutes at a time.

We have a new version that is immune to trips (5 already on detector).

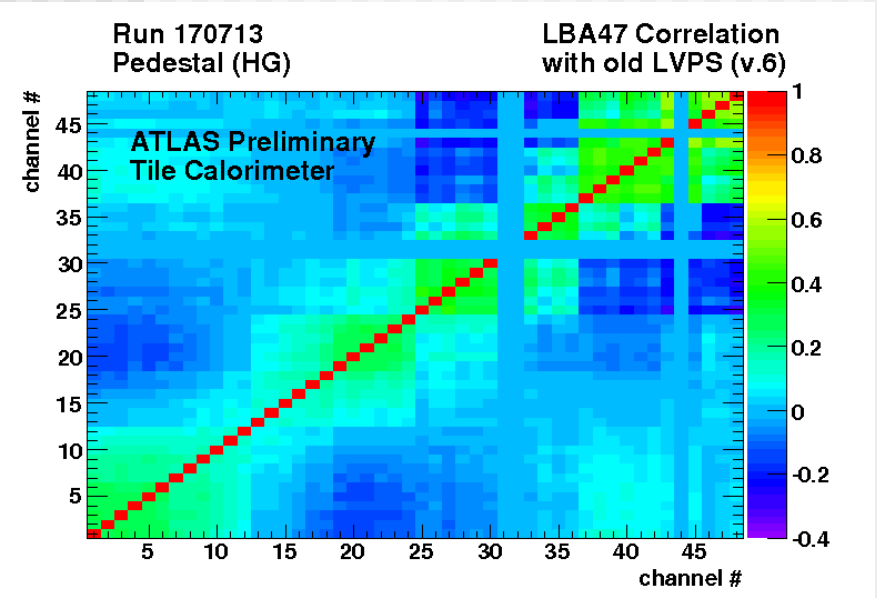


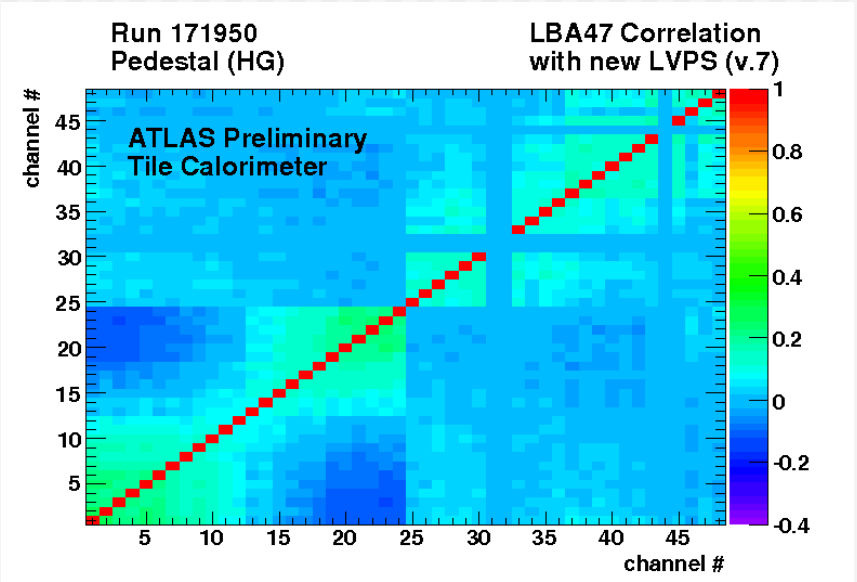


Will install 40 new LVPS in Christmas shutdown.

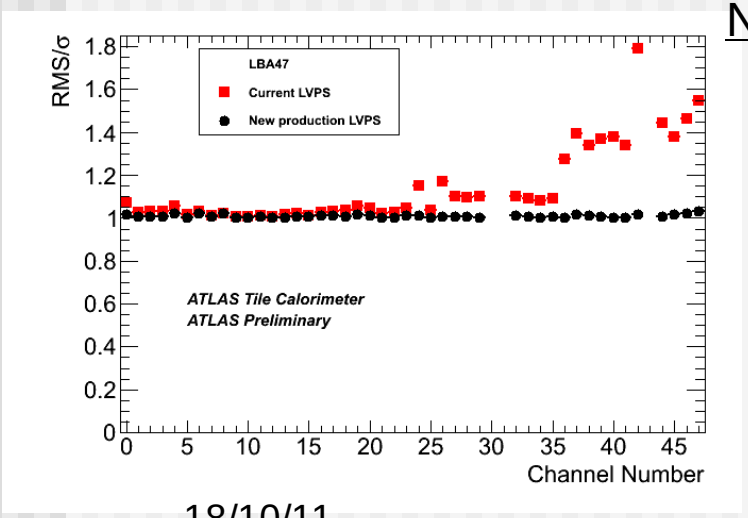
LVPS Improvement

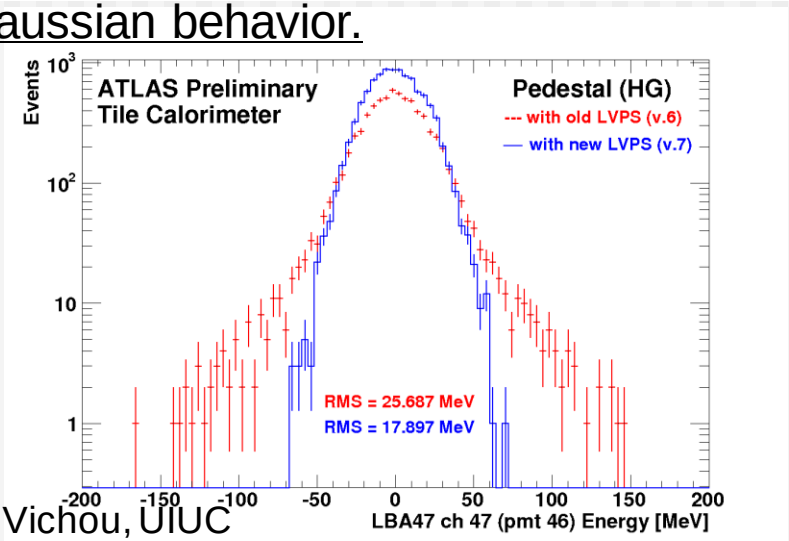
New LVPS have better noise behavior too! Less correlated noise.





Now Gaussian behavior.





Plans for amelioration

- Next Christmas shutdown and further:
- 40 LVPS will be installed on the detector
  - (out of 256 in total to be replaced in 2013-14
- FE electronics to be repaired.
  - Plan to increase connector robustness in all in 2013-14.
- If we had this already in place, 7 out of 9 of our failures wouldn't have been there.

Data and treatment

We check continuously our detector with:
- Data Quality of physics data and calibration data.
- Analysis/study of response of calibration data taken between particle beam bunches (with laser)
- Studies of ad hoc calibration/timing/noise data (no beam)
- This effort is called Data Preparation.

Inner Tracking Detectors			Calorimeters				Muon Detectors				Magnets	
Pixel	SCT	TRT	LAr EM	LAr HAD	LAr FWD	Tile	MDT	RPC	CSC	TGC	Solenoid	Toroid
99.9	99.9	100	90.0	91.3	94.8	98.2	99.5	99.7	99.9	99.6	99.6	99.4

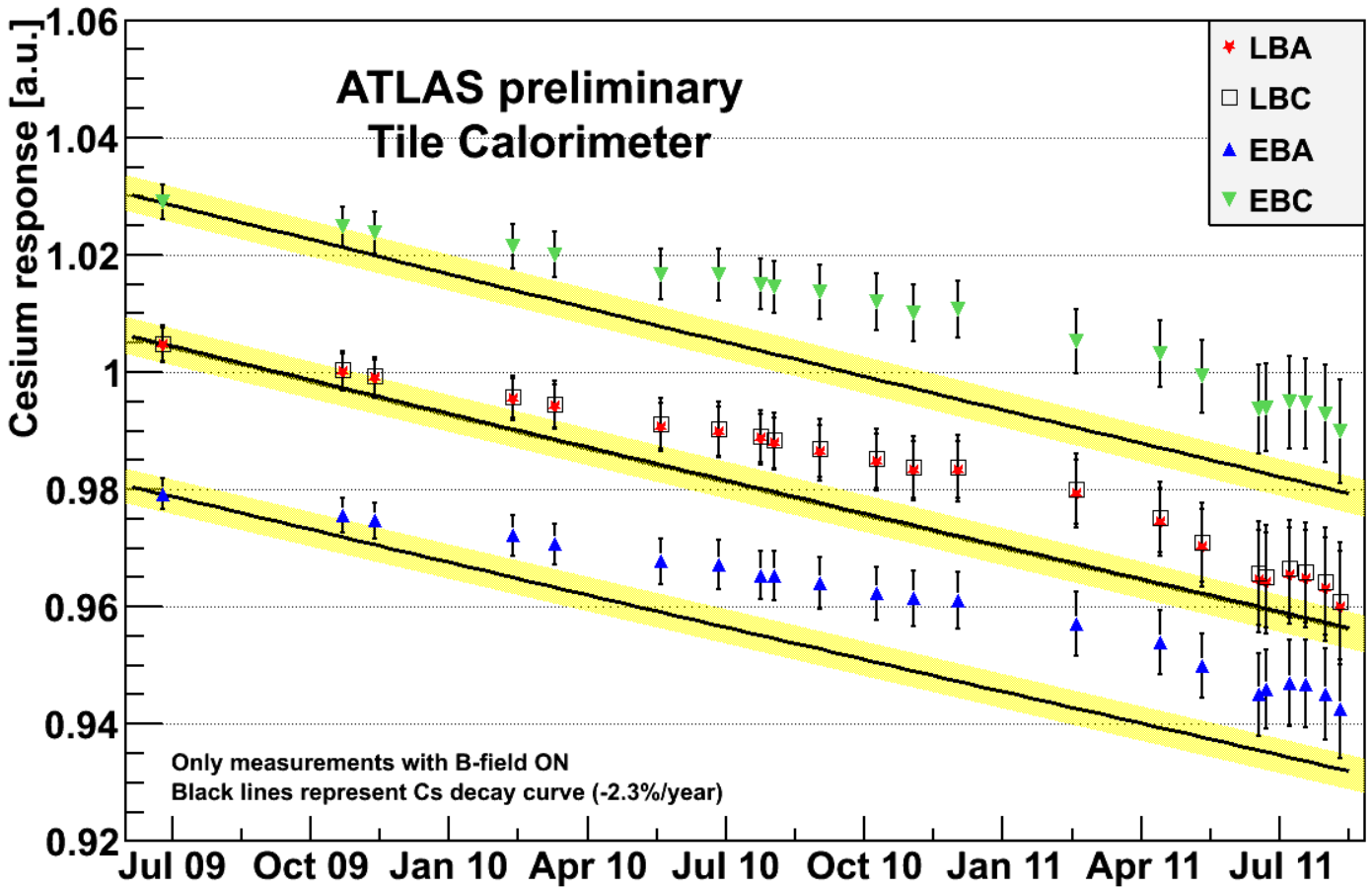
Luminosity weighted relative detector uptime and good quality data delivery during 2011 stable beams in pp collisions at $\sqrt{s}$=7 TeV between March 13th and August 13th (in %). The inefficiencies in the LAr calorimeter will largely be recovered in the future.

Checking the performance

- The TileCal performance was checked with cosmic ray muons before collisions.
  - Timing, energy scale and uniformity was validated
- Also with “splash” events of horizontal particles.
  - Timing and layer uniformity was checked.
- Collision particles offered a rich field for evaluating the ultimate performance:
  - muons, single hadrons through E/p,…
- The frequent calibrations help in preserving this performance in time.

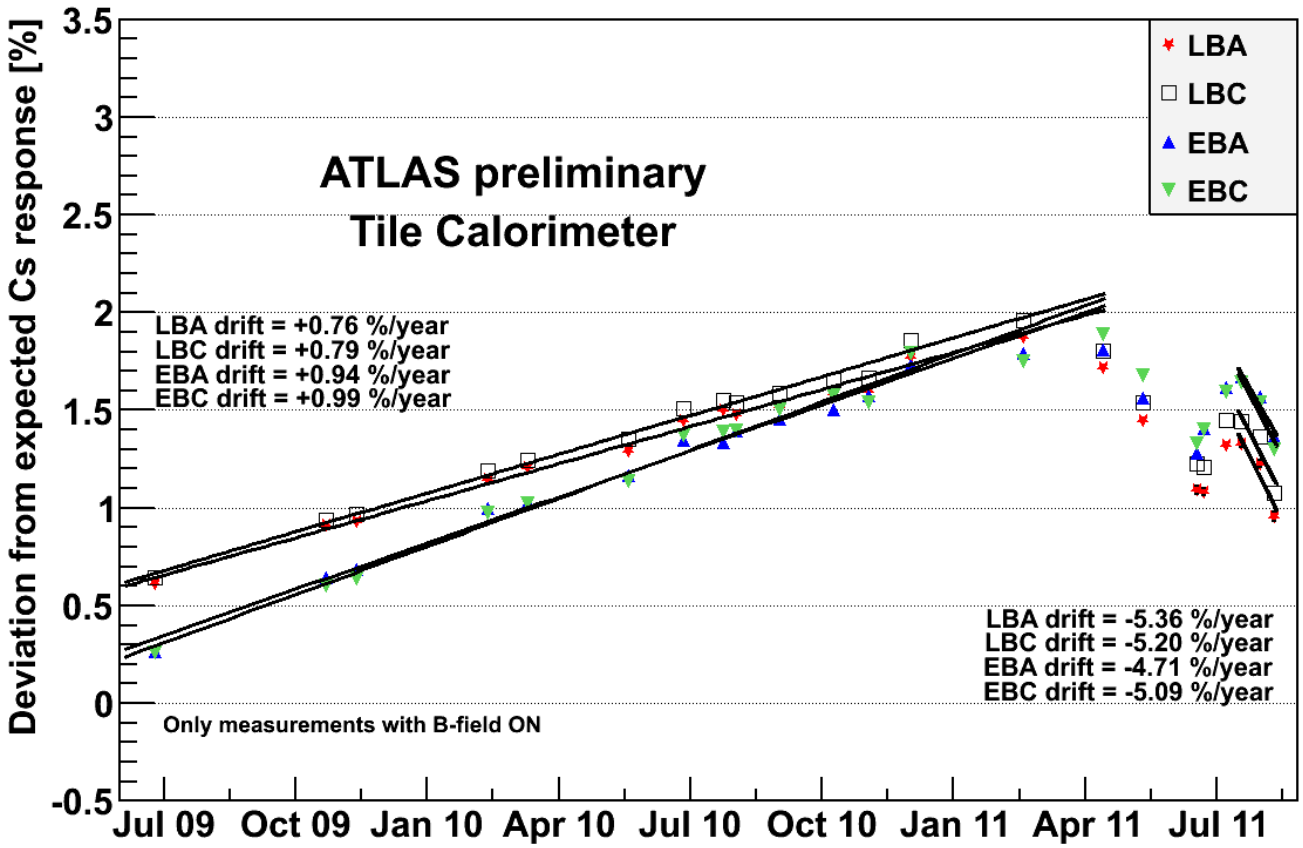
Response measured by Cs

Energy scale as monitored by Cs vs time



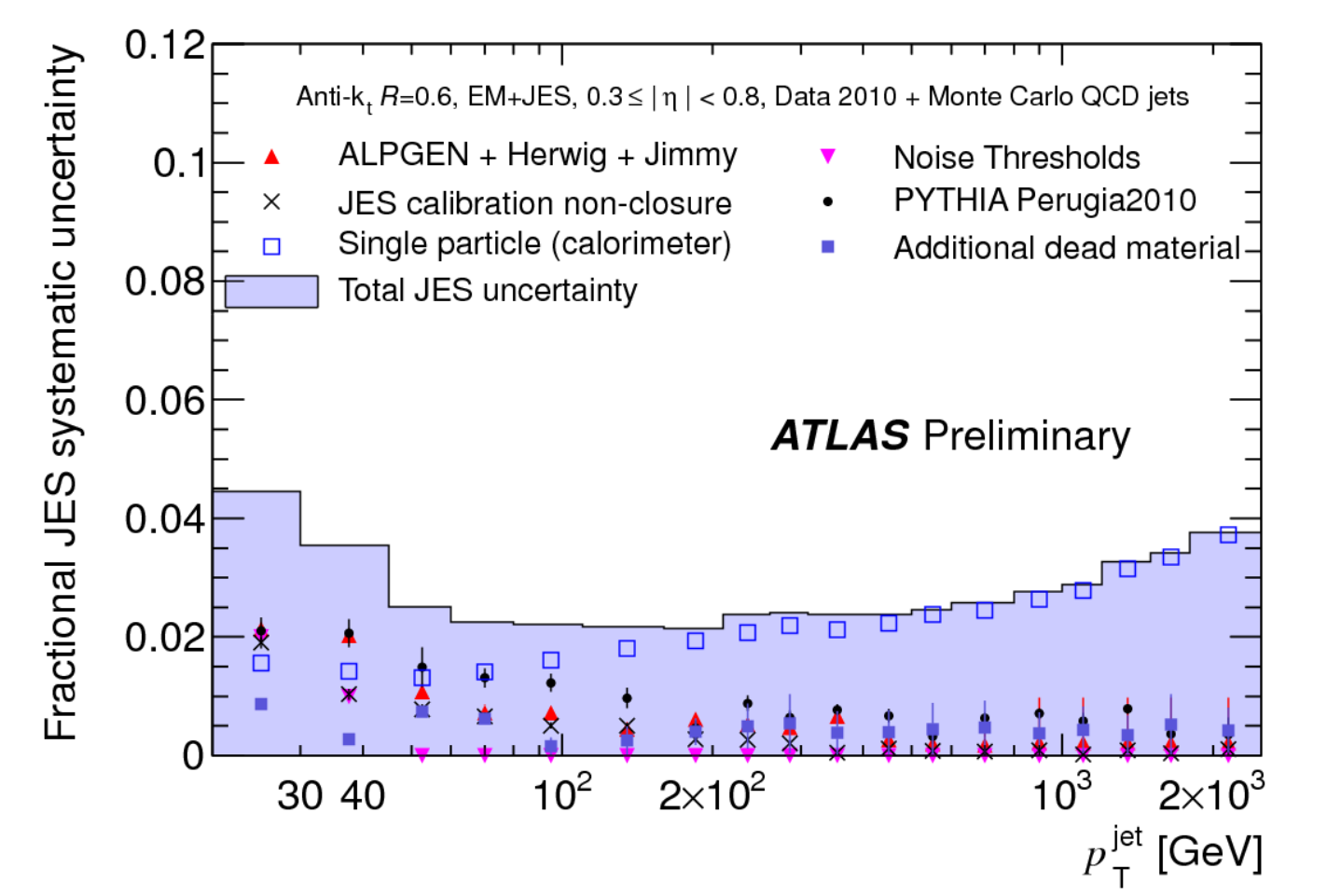
Deviation from expectation

Our system is able to follow long-term changes of 0.5% !
We correct the cell energy scale for these changes.

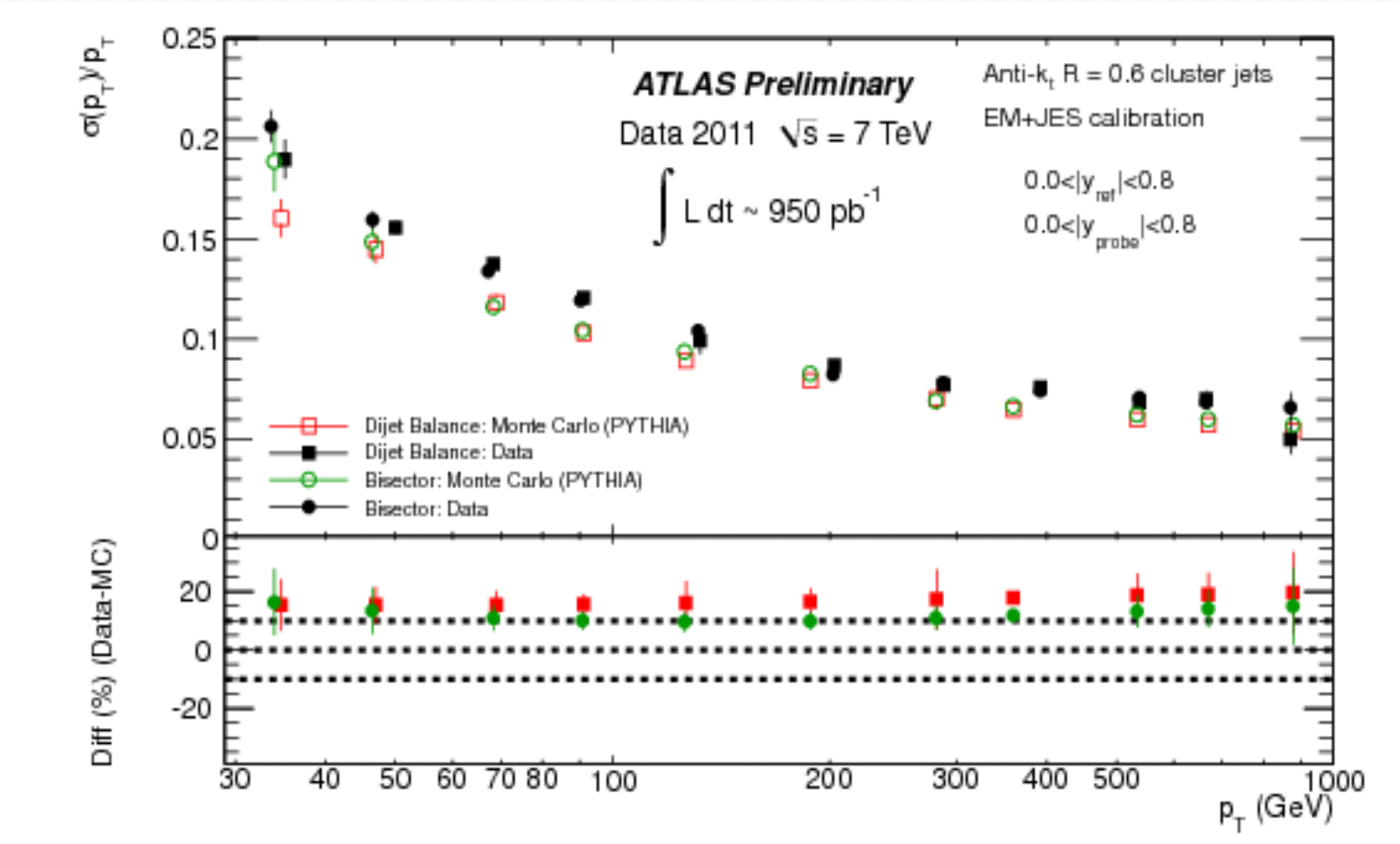


Performance in physics

Jet energy scale uncertainty in the barrel

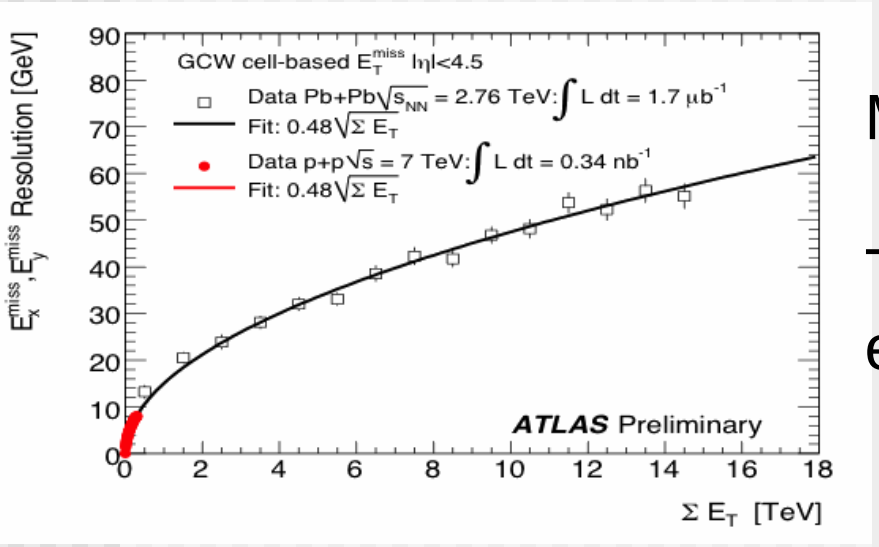


Resolution of jets in the barrel



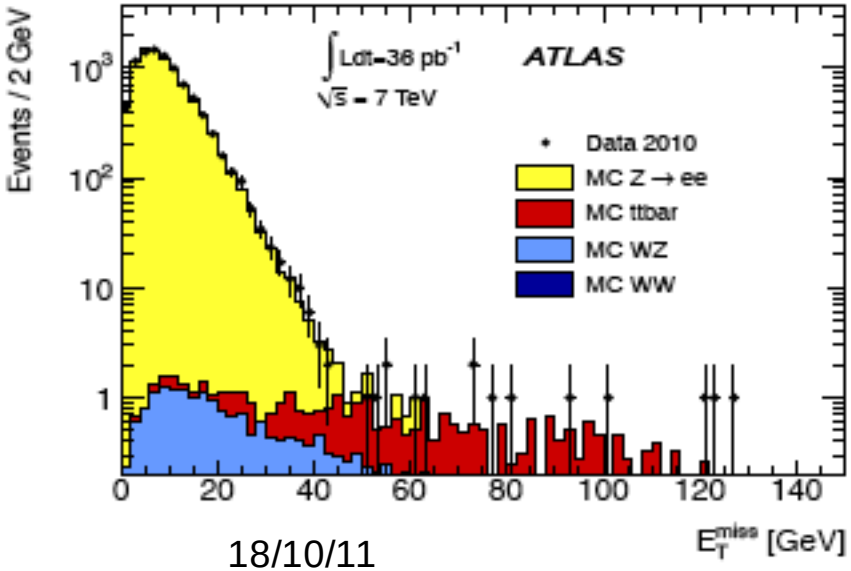
Pile-up treatment should improve the agreement to simulation

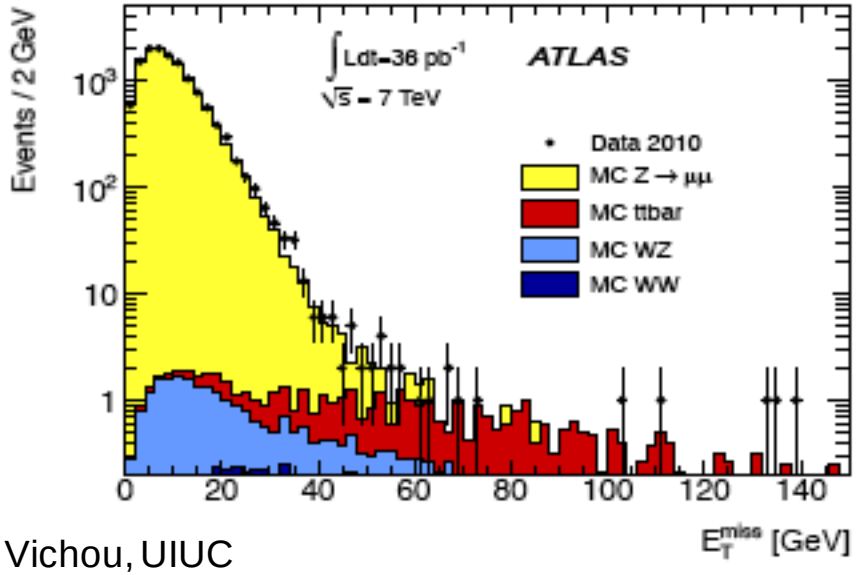
Missing Et



Missing Et uses all the calorimeters

Tails would reveal that detector effects are not in good control



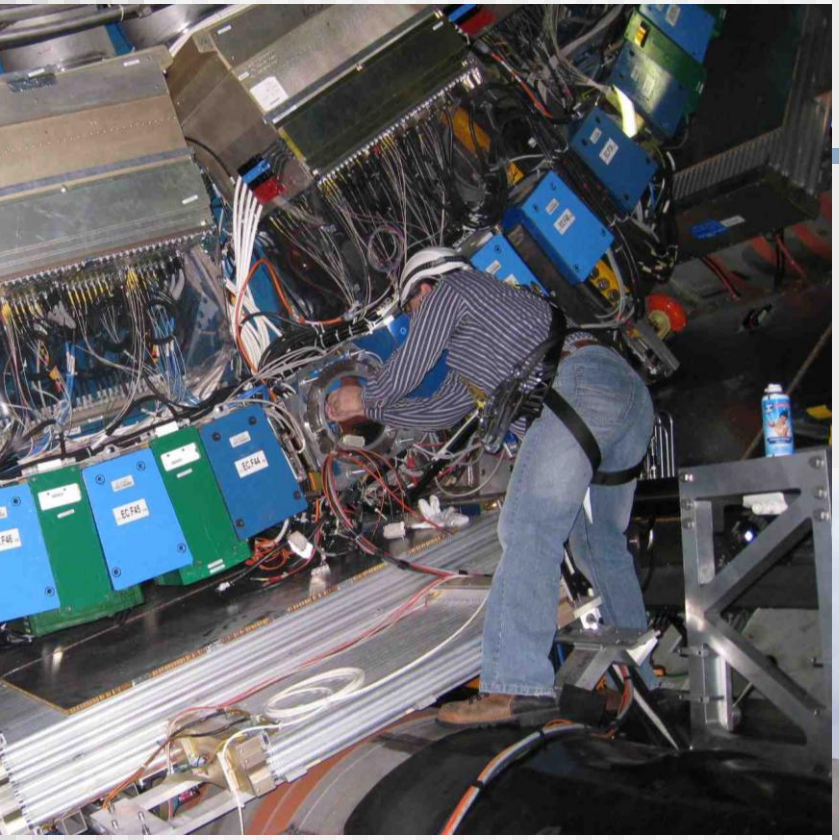


Conclusion

- TileCal has been operating successfully for ~5 pb^{-1} already!
- The few problems faced are well under control and a plan for improvements is in place.
- The data provided is of good quality and this is reflected to the physics objects that TileCal is involved.

Last…

- Thanks a lot to the conference organizers for the invitation!
- Sincere acknowledgements to the Tbilisi team in TileCal and their contributions:
  - energy scale and simulation
  - maintenance and consolidation
  - operation (shifts, data quality)
  - online and DAQ
  - (to mention only few…)



Detector maintenance
Christmas shutdown 2010-11