Electronic Noise in the ATLAS Tile Calorimeter

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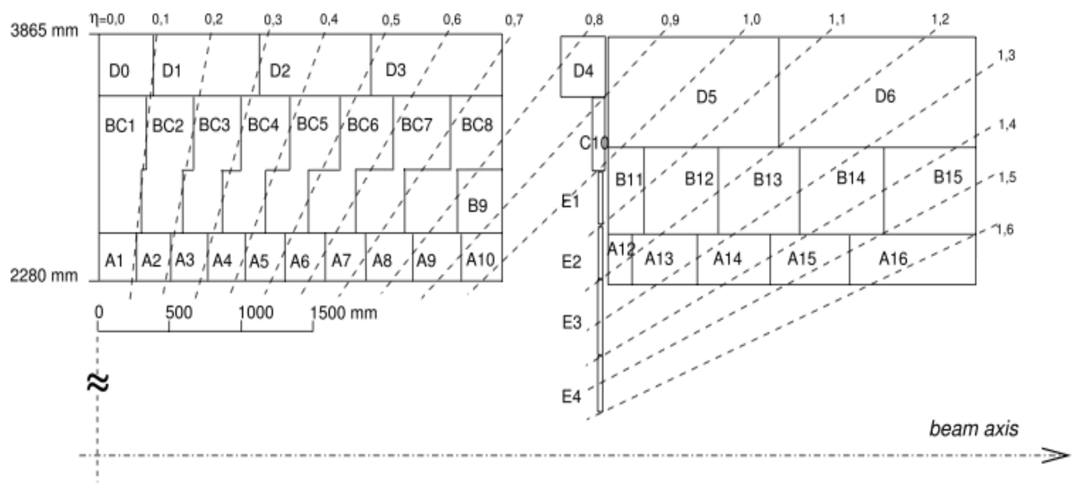
Outline

- The ATLAS Tile Calorimeter
- Noise: How and why
- Typical levels of the electronic noise
- A study of new power supplies
- Conclusions

The ATLAS Tile Calorimeter

- TileCal consists of 256 *modules* in 4 *partitions*
- Modules are divided into three *sampling layers*
- Each module contains a number of *cells,* most are read out by two *PM Tubes*
- Each PMT can be read out in *High Gain* or *Low Gain* amplification depending on signal strength.



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Noise: ***How*** and why?

- Measured in standalone pedestal (no beam) bi-gain runs with 100 000 events
- Energy in these 100k events is reconstructed, and their distribution is parametrized as a *2-Gaussian function*
- Distribution parameters are stored in the *conditions database*, on PMT level (in ADC counts) and on cell level (in MeV)
- Stored for real data taking as well as for MC.
- Stockholm University contribution: Noise expert task of keeping databases up to date, and doing performance studies of the electronic noise.

Noise: How and ***why***?

An accurate description of electronic noise is needed for:

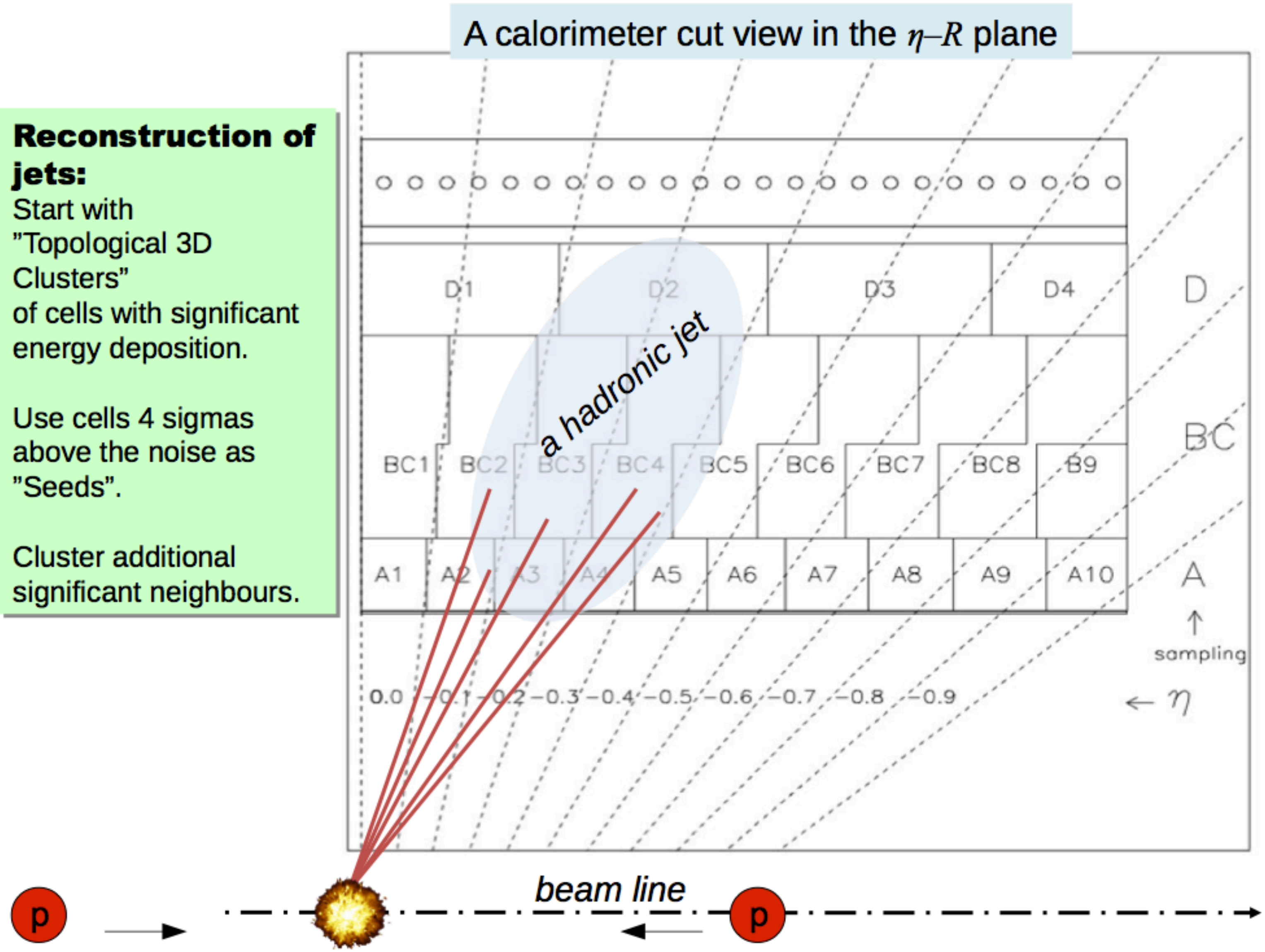
- Monitoring of detector performance
- As input to the algorithms that reconstruct energy in jets
- As input to the High Level Trigger systems

Noise: How and ***why***?

Reconstruction of jets:
Start with "Topological 3D Clusters" of cells with significant energy deposition.

Use cells 4 sigmas above the noise as "Seeds".

Cluster additional significant neighbours.



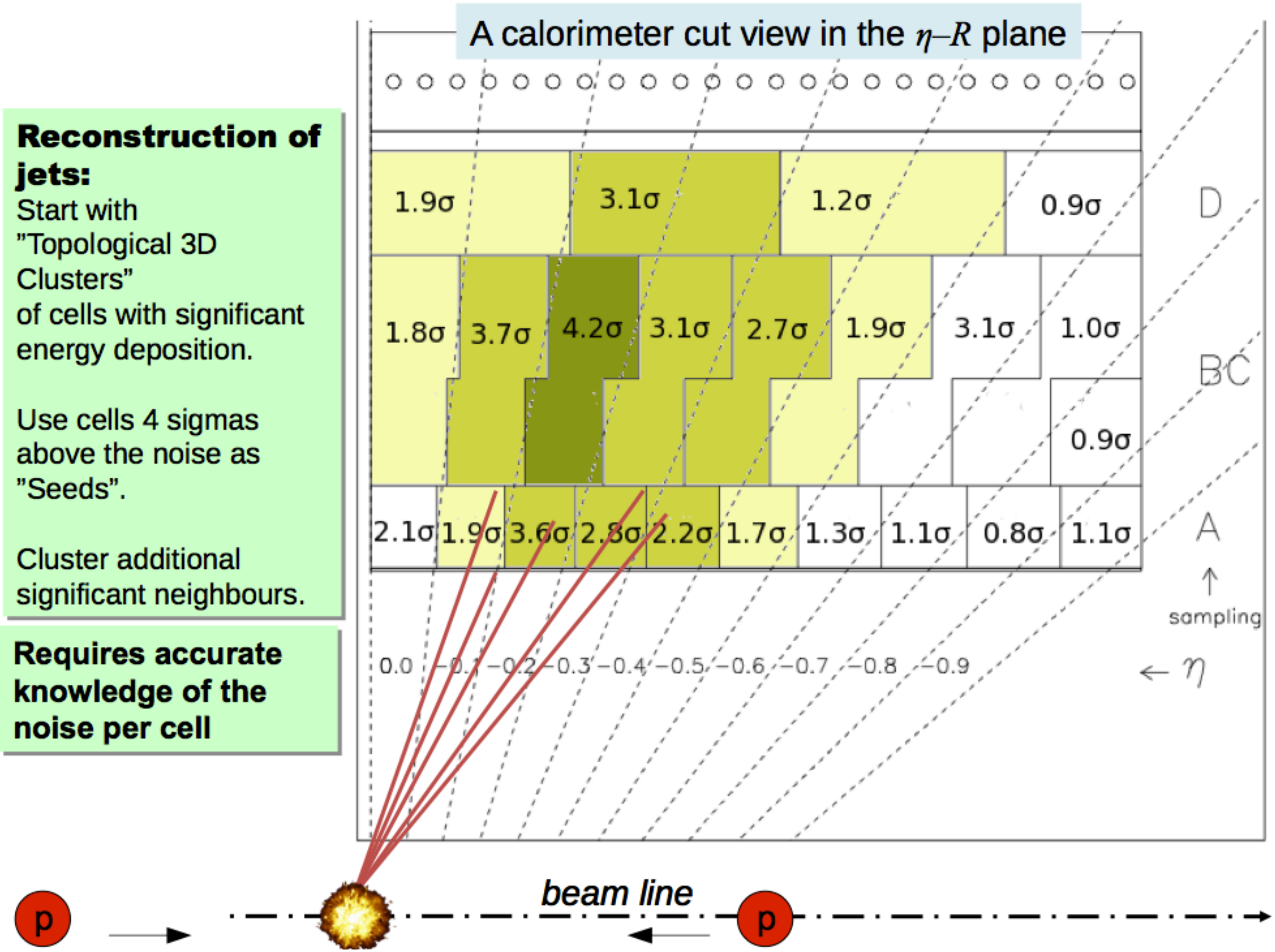
Noise: How and *why*?

Reconstruction of jets:
Start with "Topological 3D Clusters" of cells with significant energy deposition.

Use cells 4 sigmas above the noise as "Seeds".

Cluster additional significant neighbours.

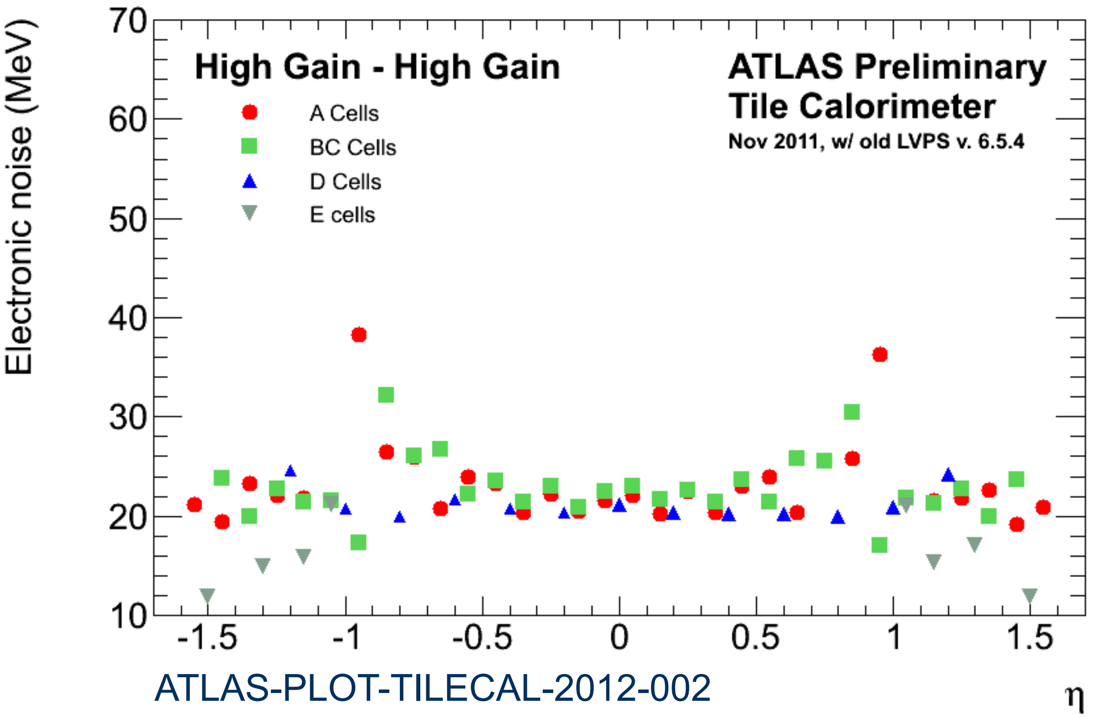
Requires accurate knowledge of the noise per cell



Noise: Typical levels

Cell noise:

- Increases with increasing η
- When both PMT's read out in High Gain: Ranges from 15 – 40 MeV.
- This applies to cells where the modules had a Low Voltage Power Supply of older type
- As a comparison: A typical cosmic muon deposits ~500 MeV in a D cell.



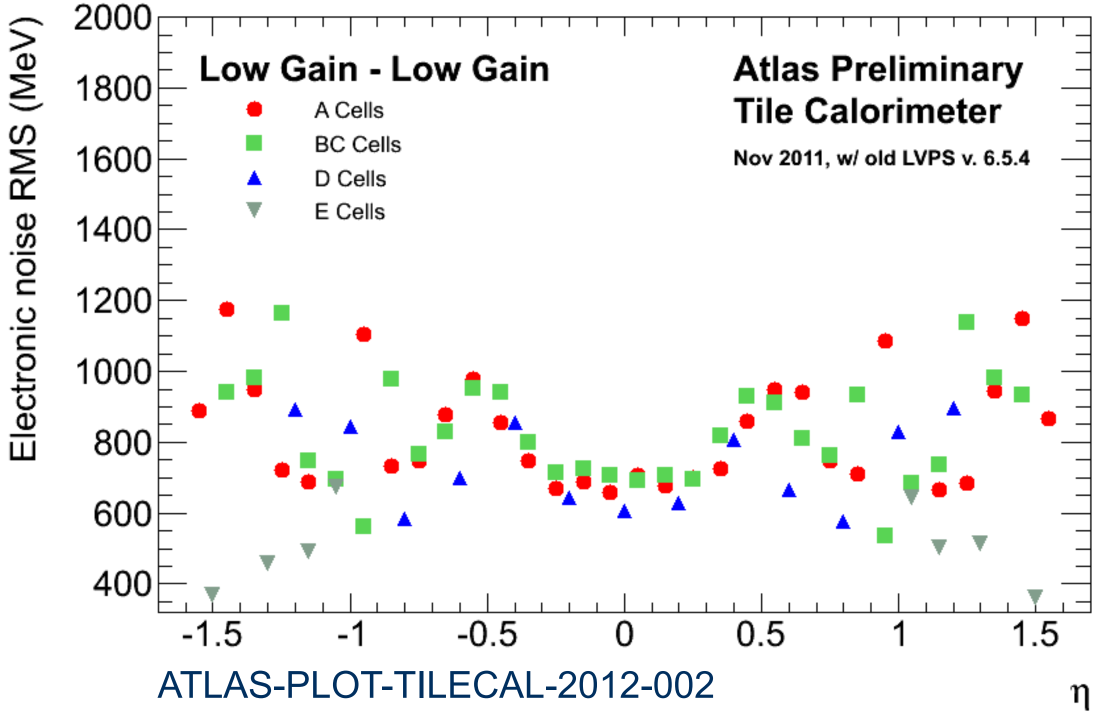
ATLAS-PLOT-TILECAL-2012-002

Each point is an average of the 64 cells of the same type.

Noise: Typical levels

Cell noise:

- When both PMT's read out in Low Gain: Ranges from 400 – 1200 MeV.
- Low Gain readout applied in a PMT when signal is > 12 GeV
- (So for LGLG energy deposited in cell is > 17 GeV).

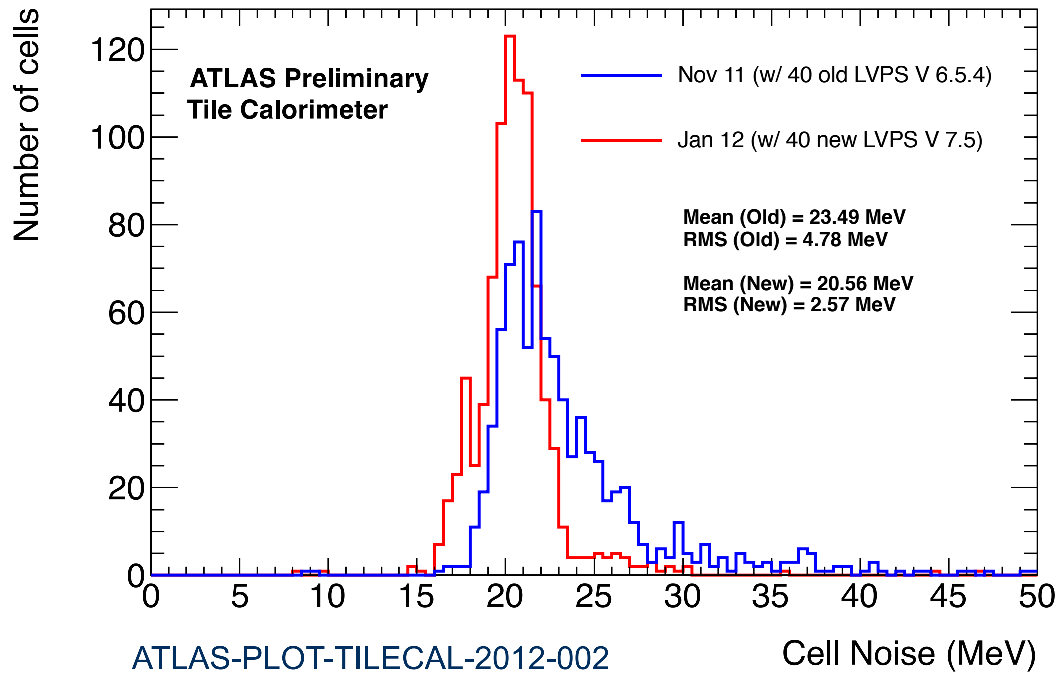


ATLAS-PLOT-TILECAL-2012-002

Each point is an average of the 64 cells of the same type.

Study of new power supplies

- In december/january 2011-2012 40 new Low Voltage Power Supplies (LVPS) were installed in TileCal modules.
- Aim: Reduce the number of trips by reducing the electronic noise, e.g. by improving grounding, implementing noise filters
- Noise is reduced by ~13% using new type LVPS



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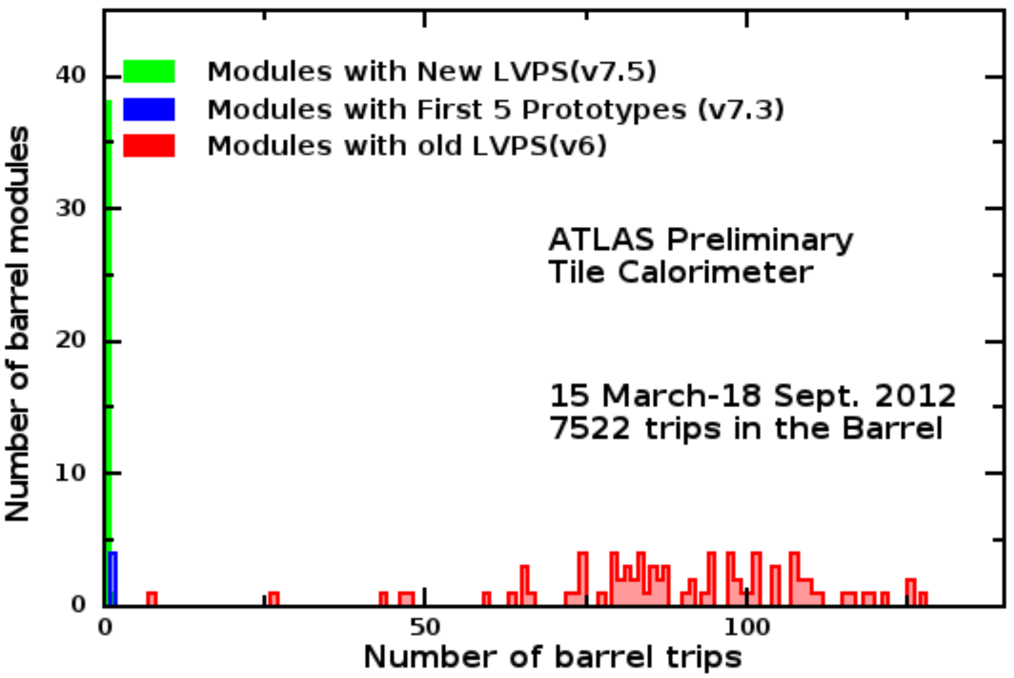
Study of new power supplies

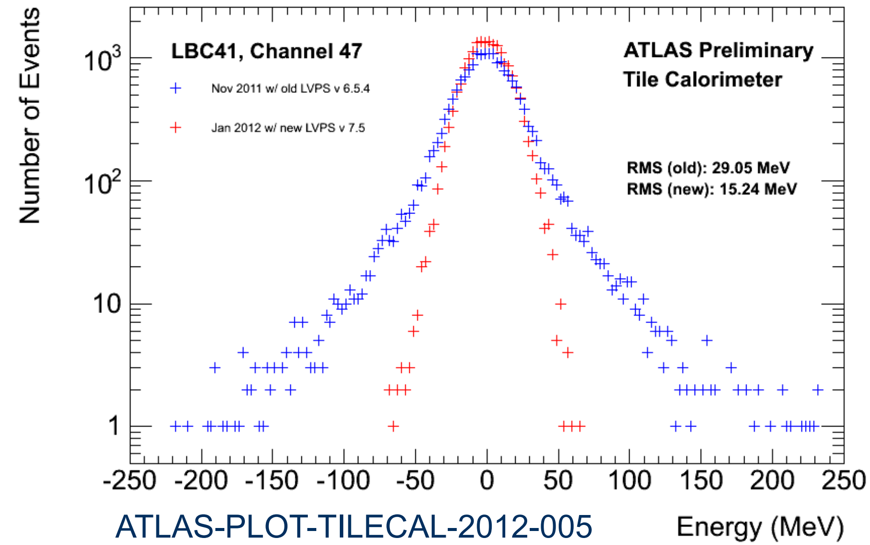
- Of ~7500 trips between March & September, only 5 were in modules with newer type LVPS.
- ~18% of the modules, 0.07% of the trips

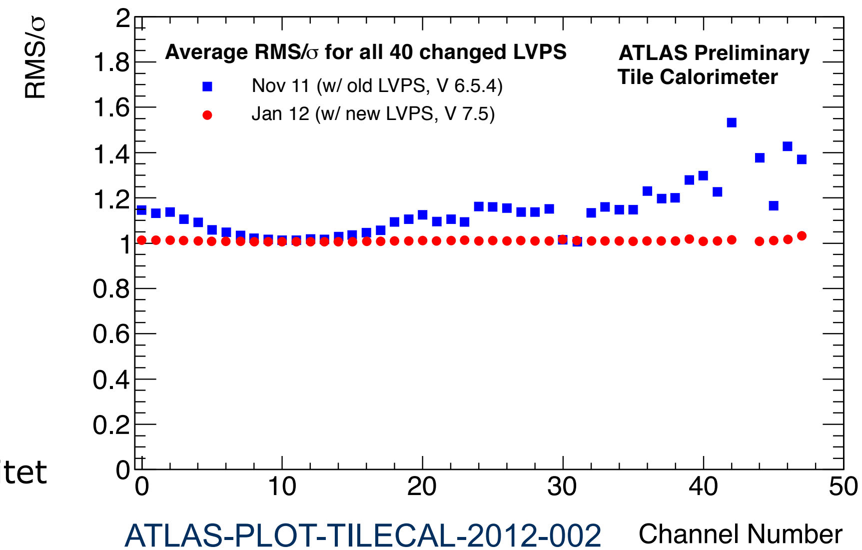


Study of new power supplies

In addition to lower noise levels:

- Previously distribution had large non-Gaussian tails
- This is not true for modules with new LVPS
- A measure of gaussianity: RMS/σ = 1 (see lower plot)
- The cumbersome 2-Gaussian description might not be necessary any more.





Summary

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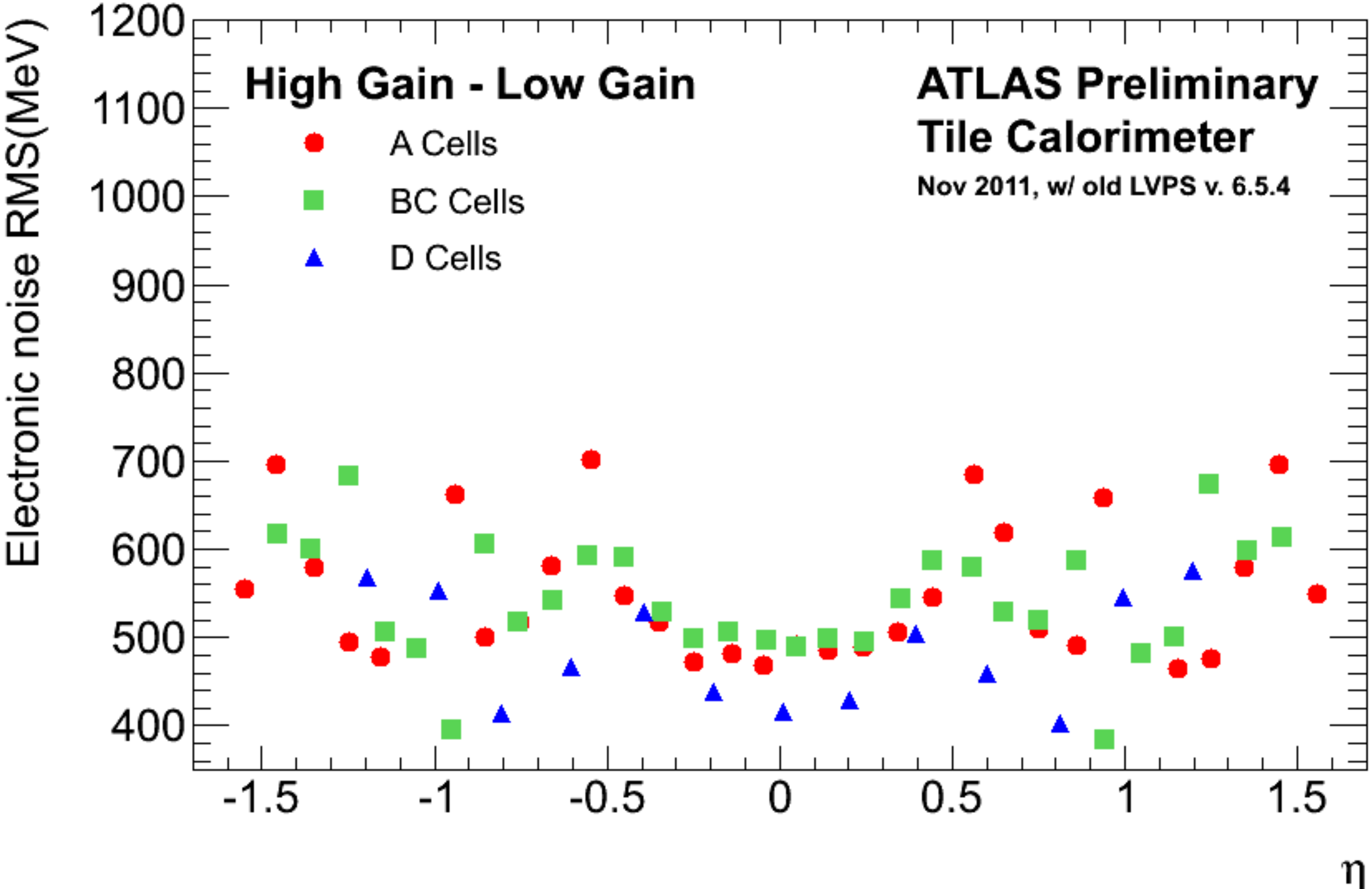
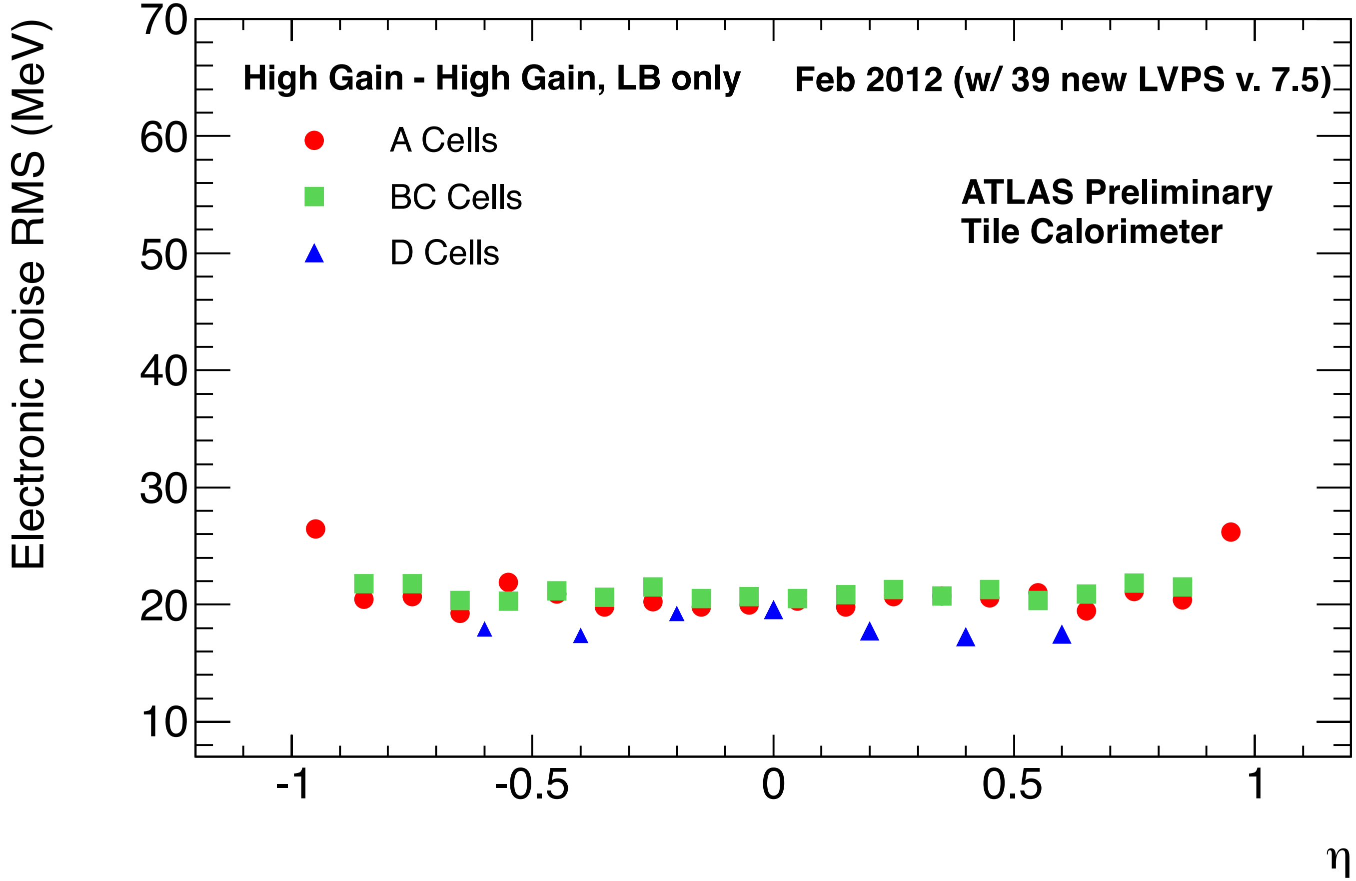
- Additional studies of stability of noise over time have also been performed. It is found to be very stable. Results are available in note referred below
- An adequate description of electronic noise in TileCal is needed for a number of reasons, monitoring as well as for input to physics
- Noise in TileCal modules with old type LVPS varies greatly between cell types: The mean value in HGHG readout is around 23 MeV.
- A new type of LVPS was installed in 40 modules in winter 2011/2012 – this led to lower noise levels (as well as more Gaussian noise distributions.
- All this is summarized in ATLAS internal note ATL-COM-TILECAL-2012-035 (https://cdsweb.cern.ch/record/1476904?), and soon partially published in conference proceedings of the 2012 Physics In Collisions conference.

BACKUP



High Gain - Low Gain
A Cells
BC Cells
D Cells
ATLAS Preliminary
Tile Calorimeter
Nov 2011, w/ old LVPS v. 6.5.4
Electronic noise RMS(MeV)
1200
1100
1000
900
800
700
600
500
400
-1.5
-1
-0.5
0
0.5
1
1.5
η



High Gain - High Gain, LB only
Feb 2012 (w/ 39 new LVPS v. 7.5)
A Cells
BC Cells
D Cells
ATLAS Preliminary
Tile Calorimeter
Electronic noise RMS (MeV)
η
70
60
50
40
30
20
10
-1
-0.5
0
0.5
1