Noise in Calorimeters in ATLAS Overall Calorimeters Quality

For the Testbeam+Detector session

June 24th, 2009

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Hadronic Calibration Workshop

Preface

- The material in this presentation has been provided by the following people (for the workshop or in recent presentations):
- E.Petit, F.Hubaut, P.Pralavorio, D.Varouchas, D.Rousseau, A.Olariu, H.Okawa, L.Fiorini, B.Martin, N.Makovec, A.Artamonov, L.Hervas, G.Unal, T.Davidek, L.Pribyl, A.Dotti, W.Lampl
- We thank them all!

Noise from testbeam

- Measured in standalone and combined testbeams of calorimeters (Detector paper: 2008 JINST 3 S08003)
  - E.g.170 MeV for the barrel EM for an electron cluster.
  - E.g. (1.6 ± 0.1) GeV for the area used to reconstruct a pion at the barrel EM+Tile.
- Caution: The setup was “simpler” than in ATLAS, e.g.
  - no interaction with other detectors,
  - TileCal had still the linear Power Supplies
- The discussion today is mainly from ATLAS measurements.

Noise measurement

- In special pedestal runs and in random trigger events during the physics runs
  - Able to estimate shifts in time
- Depends on nr of digital samples
  - TileCal can also use the estimation from the 1st sample for all events.
- Depends on “method”
  - Caveat: for TileCal what is now used (OF with iterations) is pessimistic wrt the OF with timing knowledge to be used during the collisions.
- Had the chance to study in ~5 months of stable running in 2008.

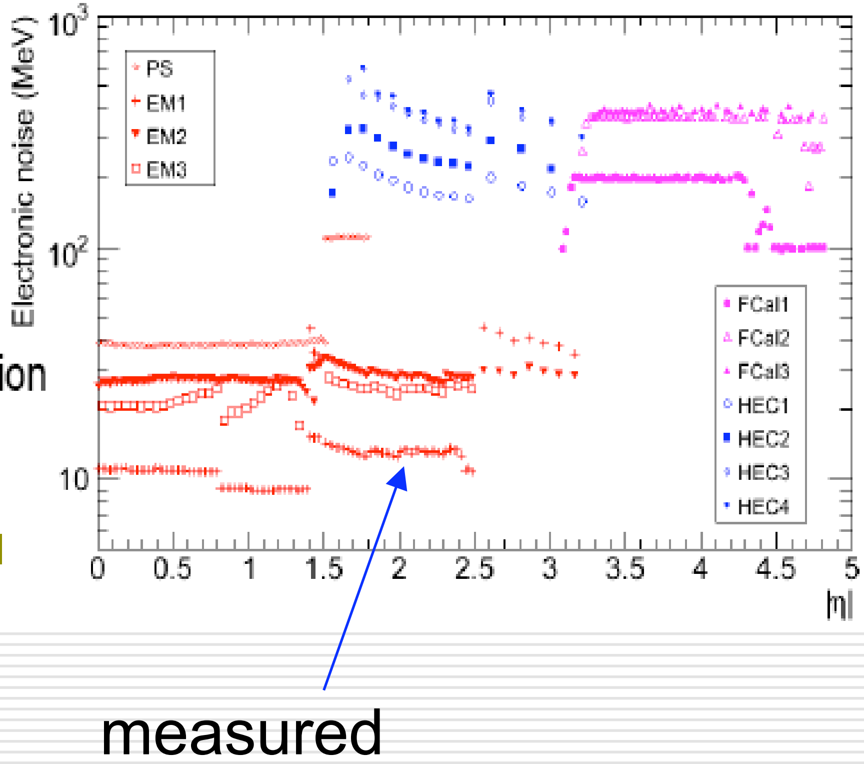
Noise in ATLAS (and consequences)

Lar electronics noise map -1

Noise status in LAr calorimeters

- Noise : calculated as the RMS of each cell energy distribution from random events
- Database filled at the end of October (21/10, run 92048)
  - ↳ But not recomputed after change of energy reconstruction for Christmas reprocessing, nor for April reprocessing

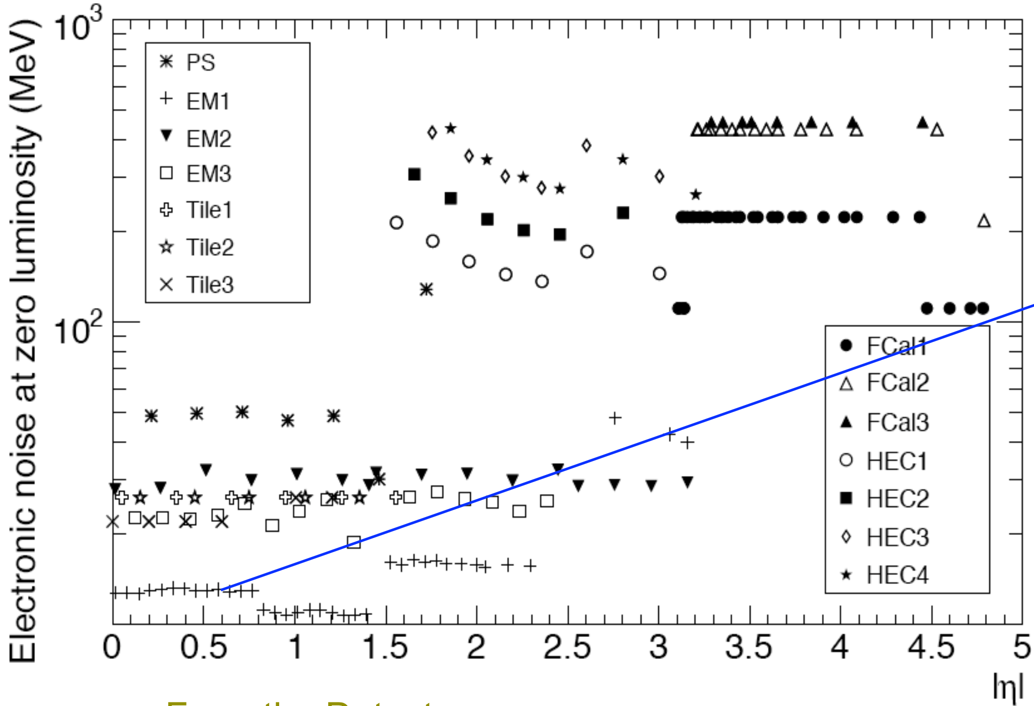
E.Petit et al



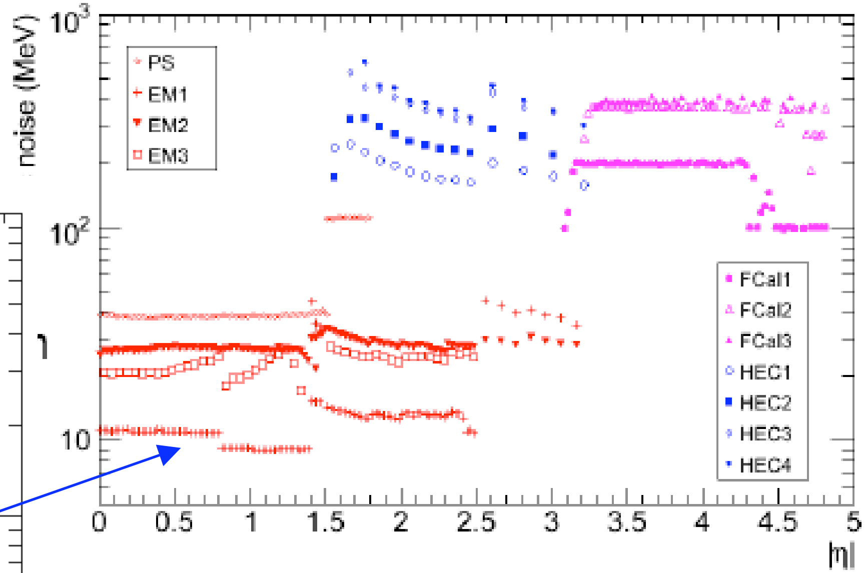
Lar electronics noise map -2

Noise status in LAr calorimeters

- Noise : calculated as the RMS of each cell energy distribution from random events

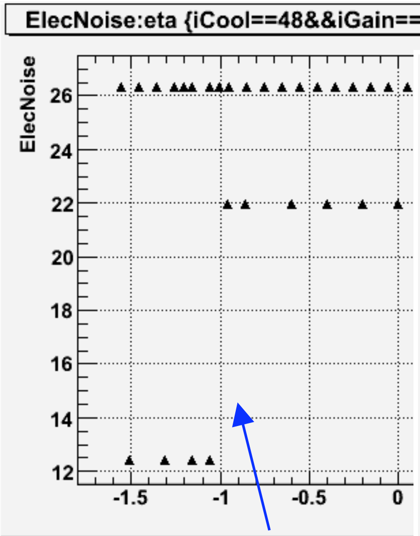


From the Detector paper



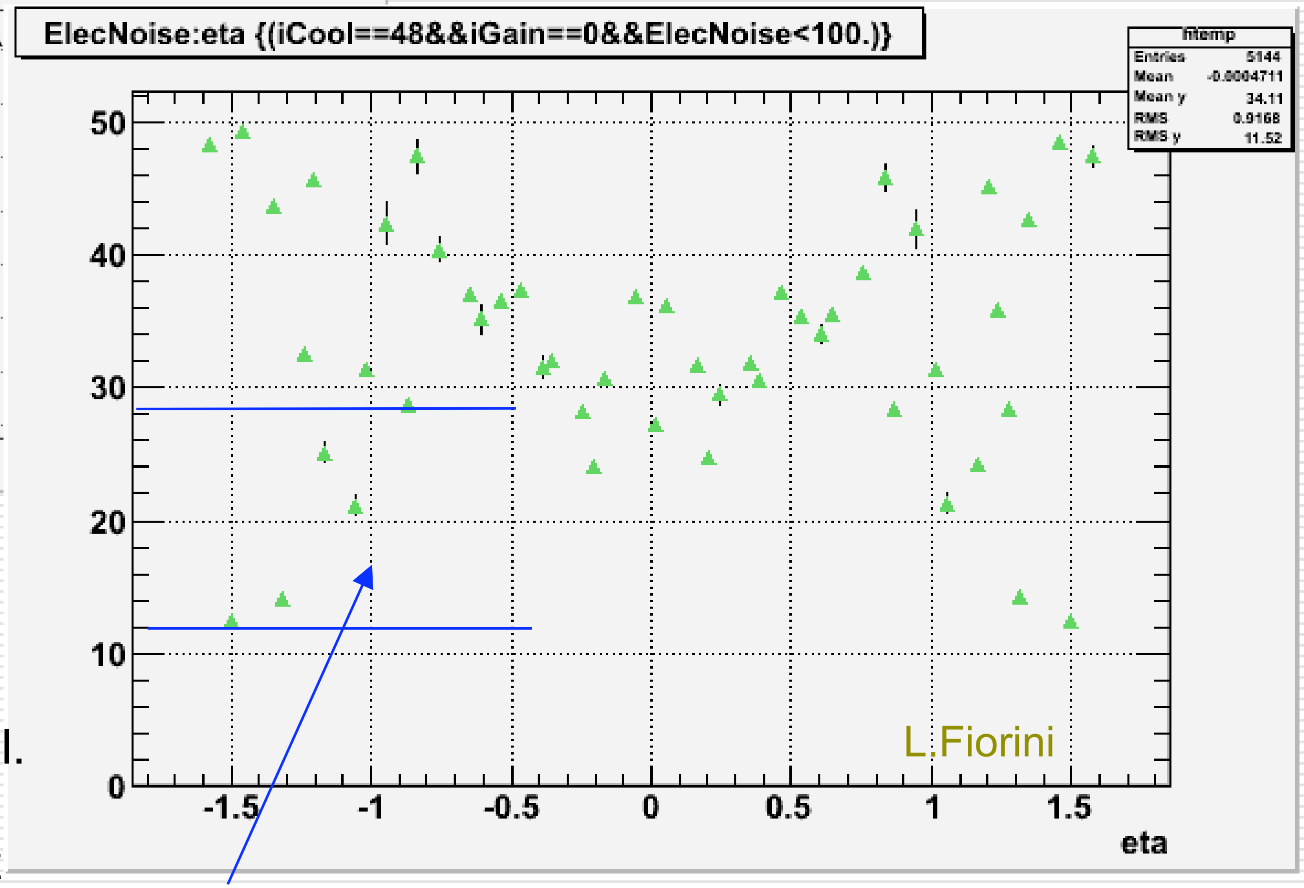
Expected and measured

TileCal electronics noise



Was expected to be like this.
(Detector paper)

- Units are MeV/cell.
- A factor of 1.14 is applied on the right plot.

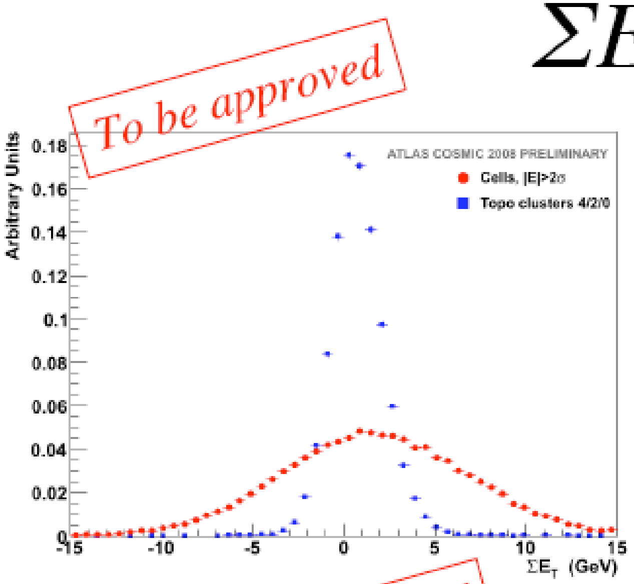


This is how it really is when one plots the σ of a Gaussian fit.

Noise and MET in RNDM triggers

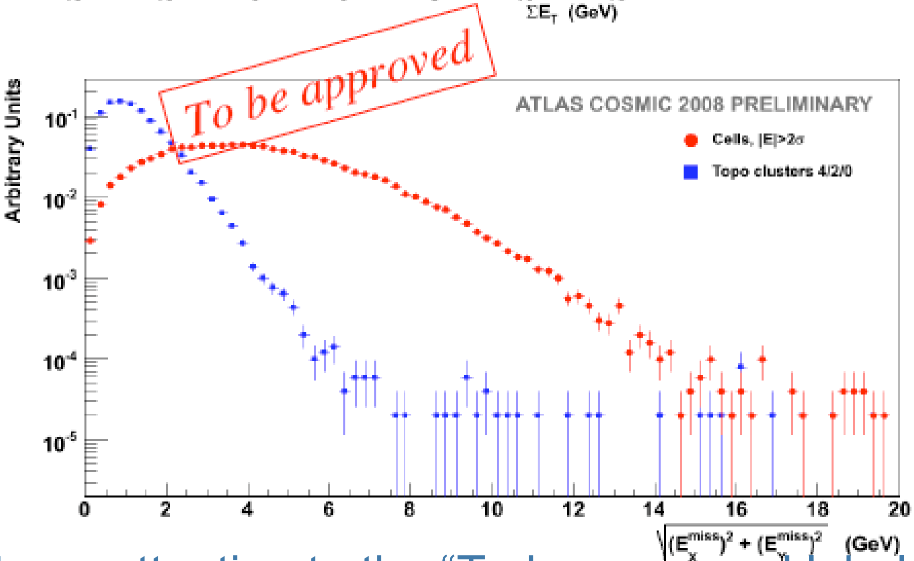
ΣE_T , E_T^{miss}

Run 91639
Random triggger
50k events



ΣE_T	Mean (GeV)	RMS (GeV)
Cells, $\|E\|>2\sigma$	1.71	5.13
Topo clusters	0.76	1.39

- TopoClusters better resolution
- Some tails in E_T^{miss}
  - *0.06% of events with E_T^{miss}>16GeV for Cell based*
  - *0.08% of events with E_T^{miss}>8 GeV for TopoClusters*



E_T^{miss}	Mean (GeV)	RMS (GeV)
Cells, $\|E\|>2\sigma$	4.29	2.28
Topo clusters	1.22	0.74

D.Varouchas et al

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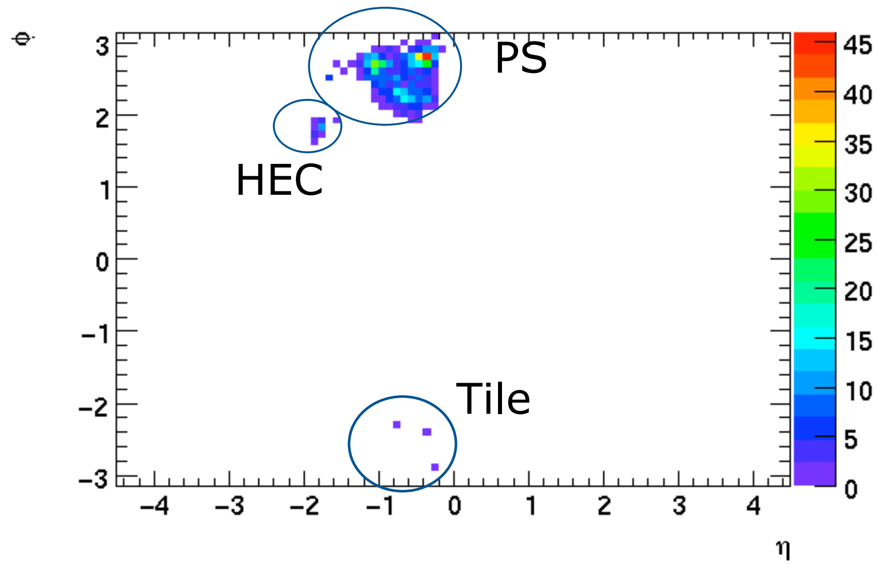
Don't pay attention to the "To be approved labels"

Noise and jets in RNDM triggers

- Excess of jets come from events a region of the presampler with large coherent noise.
  - Hardware fixed
- The HEC population is due to “sporadic” noise bursts from 5 unmasked channels.
- Few TileCal unmasked cells serve as seeds as well.

N.Makovec



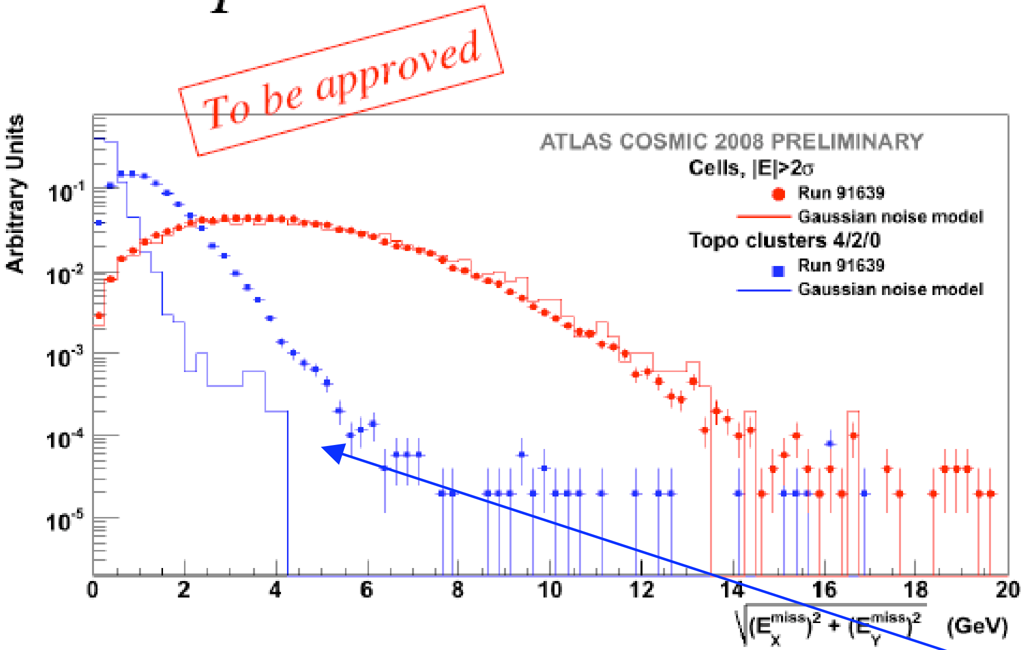
Jet Occupancy for AntiKt4TowerJets

1.1M triggers used

Noise and Gaussian model in MET from RNDM triggers

E_T^{miss} Vs Gaussian noise model

Run 91639
Random triggger
50k events



D.Varouchas et al

- Gaussian noise model agrees very well with Cell based data
- Poor for TopoClusters based data

Cells, $|E|>2\sigma$		Mean (GeV)	RMS (GeV)
E_T^{miss}	Data	4.29	2.28
E_T^{miss}	Noise model	4.49	2.38

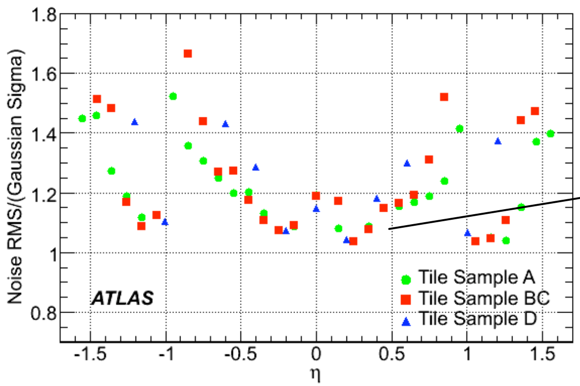
Topo clusters		Mean (GeV)	RMS (GeV)
E_T^{miss}	Data	1.23	0.82
E_T^{miss}	Noise model	0.36	0.32

> Agreement for cell based BUT NOT for topocluster based!
> Reason is TileCal non-Gaussian noise.

Don't pay attention to the "To be approved labels", see ATL-PHYS-INT-2009-045

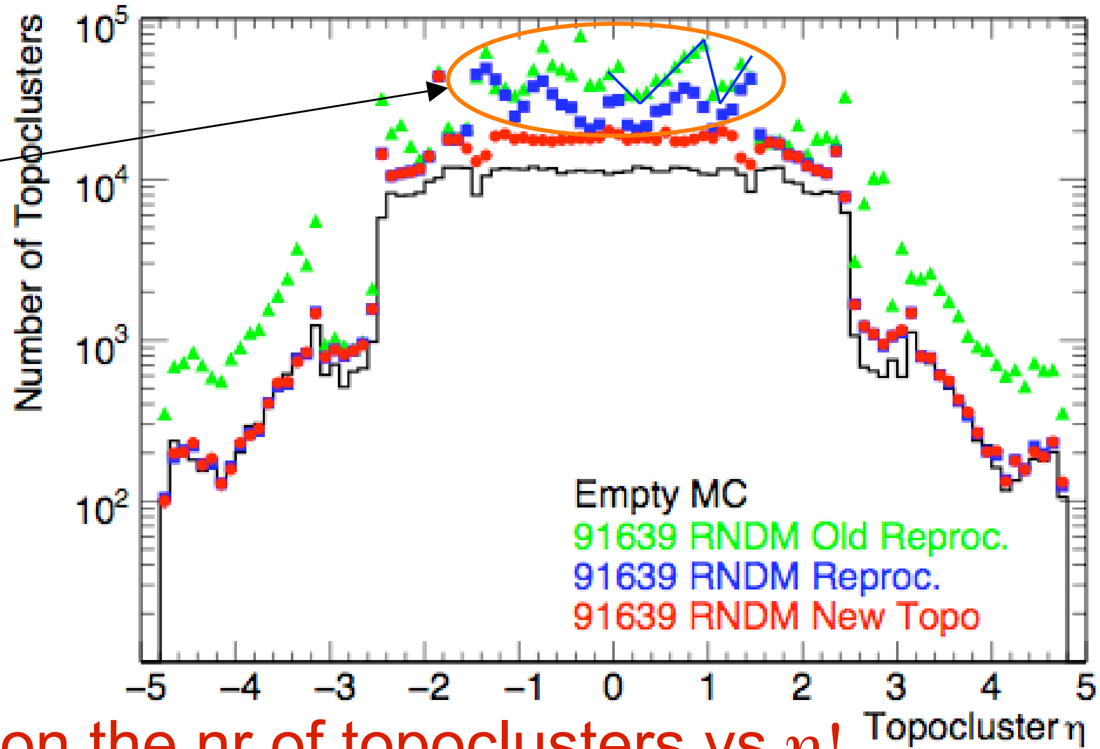
Explaining the non-Gaussian behavior

TileCal noise behavior is non-Gaussian, that's why a 2σ description is not OK for the topoclusters.



Noise RMS/Gaussian σ

H. Okawa

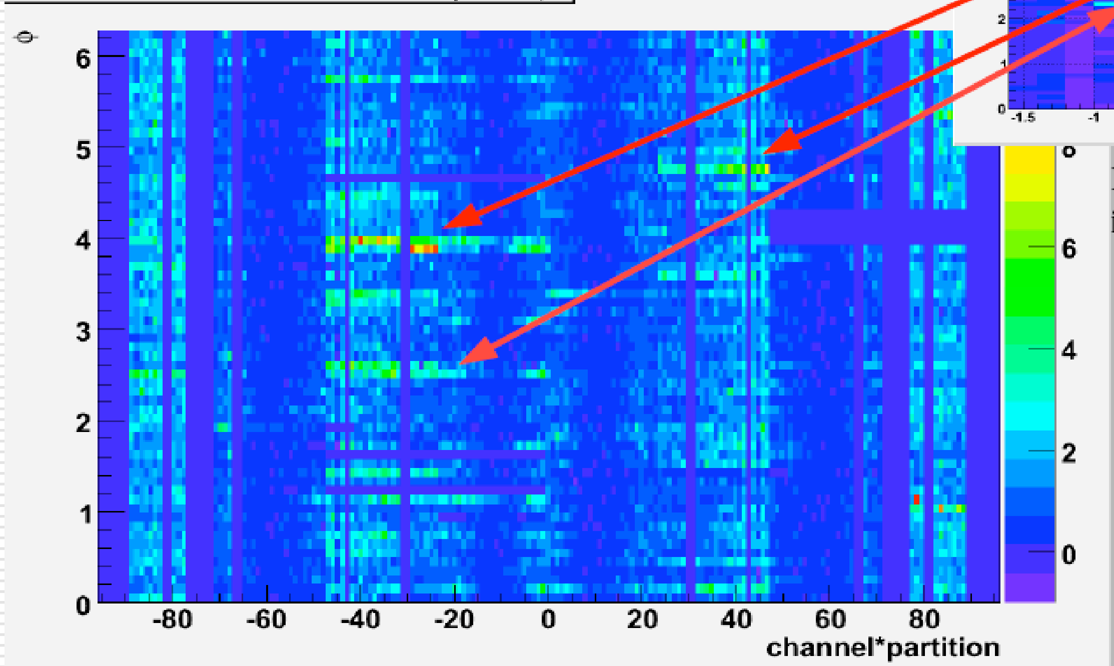


W-shape vs η reflects on the nr of topoclusters vs η!

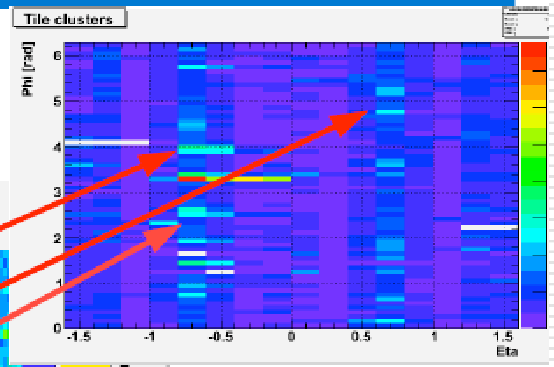
Investigating the non-Gaussian noise in TileCal

Kurtosis and Fake Cluster

We can map the noise clusters to the Kurtosis of the Raw Channel noise. Note we see good agreement for diffuse noise, but not for mis-calibration (LBC34) (which is expected given that it is noisier due to a larger flat factor applied by Cs)



Map of the kurtosis as a function of the eta and phi.



Map of fake clusters induced by noise

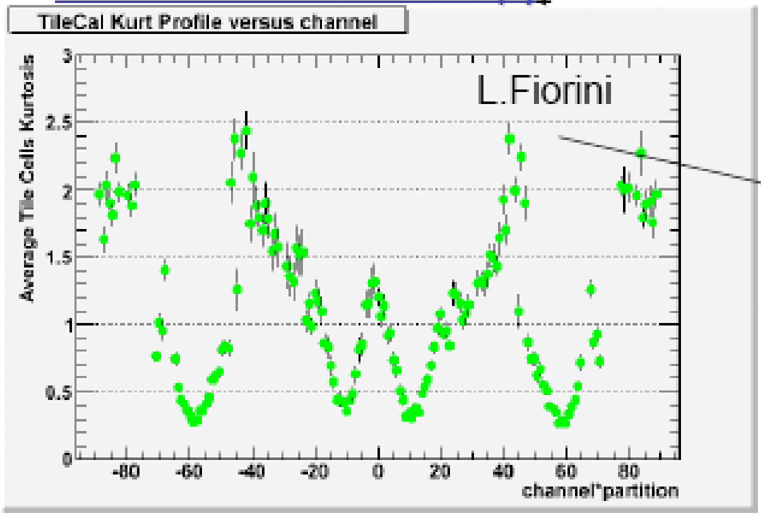
ExKurt = 0)

The fake topoclusters are related to the non-Gaussian behavior !

L.Fiorini, B.Martin

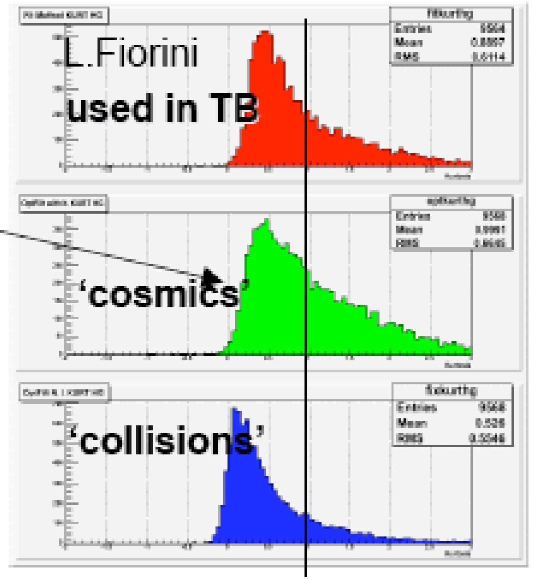
Investigating (cont…)

Kurtosis of noise vs |η|



follows η

Kurtosis for all channels



42% with kurt>1

17% with kurt>1

The kurtosis of the noise distribution follows the same pattern as the RMS/σ shown before, so the non-Gaussian lepto-kurtic behavior correlates with high RMS/σ.

The kurtosis (and the noise) estimation depends on the signal reconstruction method. The one used in the cosmics reconstruction (OF with Iterations,green) gives many more lepto-kurtic cases than the one to use with beam (OF with knowledge of phase, blue)

This is to say that the %-age of non-Gaussian cases depends on the signal reconstruction method.

Reasons of TileCal non-Gaussian noise ?

- The average level of noise in TileCal as described by the Gaussian σ is within the requirements.
  - The average of 35 MeV per cell gives for a R=0.7 cone ~ 800 MeV.
- As the RMS/σ plot shows, the noise distributions show tails that are more pronounced in $|\eta|$ regions that correspond to channels close to the power distribution points in the SuperDrawers.
  - This a known feature which was even improved during the commissioning with filters, but there is still a residual effect.

•We plan to investigate further the relation (how often) of the non-Gaussian shape and any correlated noise.

- • Coherent noise studies for few superdrawers in the past.

•Some correlated noise cases were improved during maintenance.

How to treat the non-Gaussian behavior

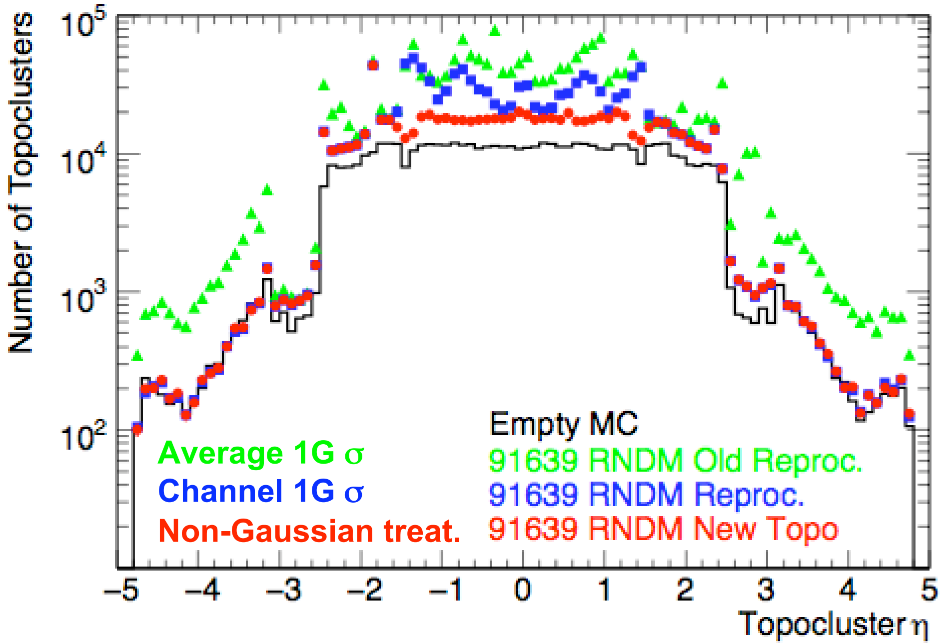
- For the real data:
  - Include in the condDB the description with two Gaussians' parameters.
  - Develop a pdf to treat channel-by-channel the non-Gaussianity and use an "effective" σ instead of a single Gaussian σ.
  - With no change to topoclusters code, this new σ is used to compare with cell E.
    - The effective sigma is defined from the pdf as the point of the 68.3% CL.
  - NOW IN VALIDATION PHASE, expected in July!
- For the simulated data:
  - Fold in the channels the non-Gaussian description
  - Do the same steps as above
  - WILL BE READY FEW MONTHS LATER

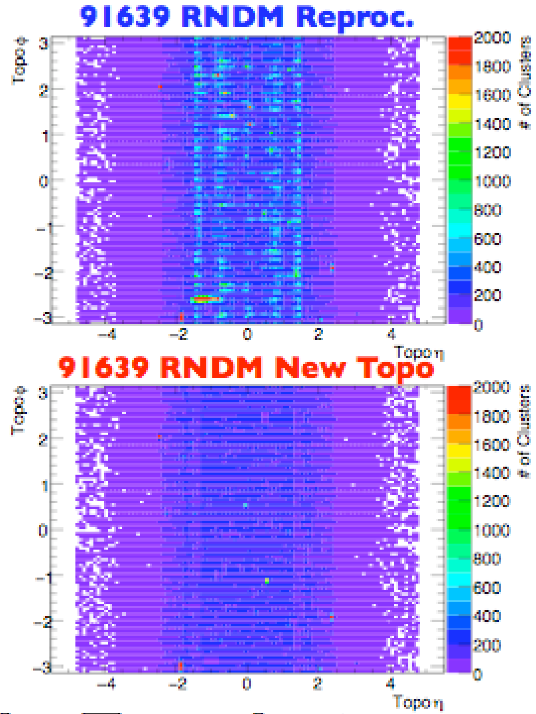
A.Artamonov

Will it help? (with another approach wrt p15)

Topocluster η, η-φ

H. Okawa





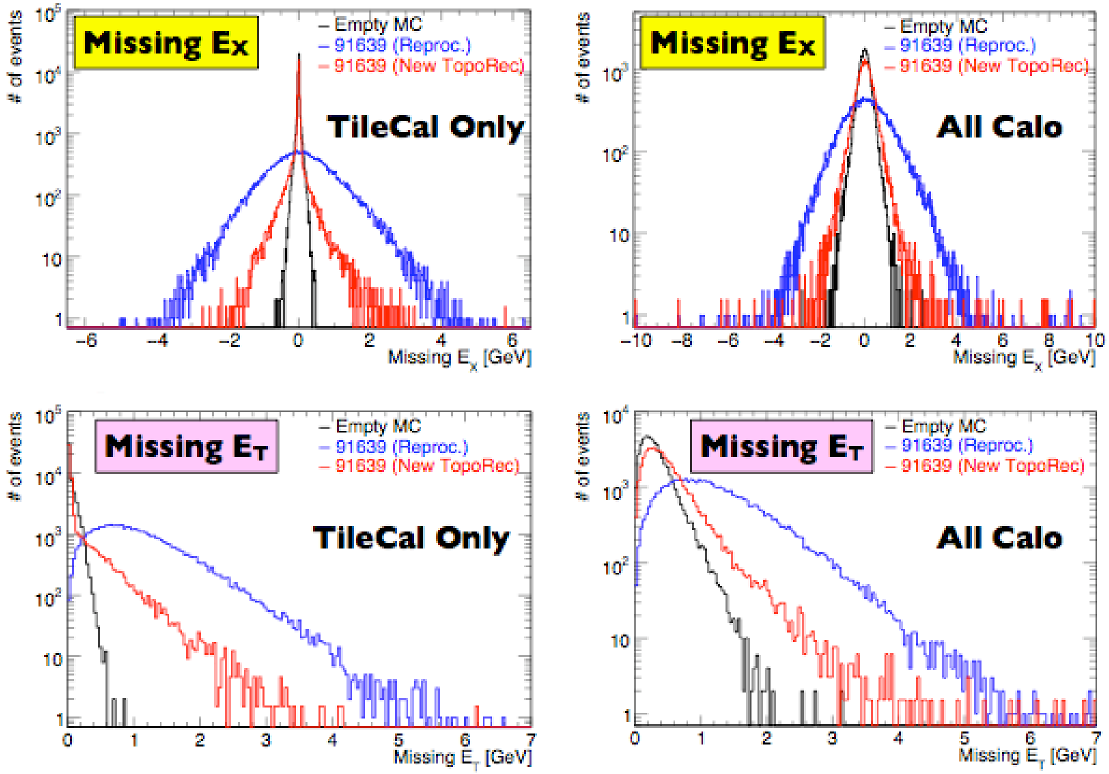
- **The "2 W's" shape is observed in the Topocluster η distribution as well** (expected from the η-dependence of non-Gaussian noise)

- **Such feature is removed with non-Gaussian treatment**

Will it help? (with another approach wrt p15)

Missing Ex, ET (MET_Topo)

H. Okawa



	MEX RMS [GeV]	MEX Mean [GeV]
TileCal Only	0.957 0.233 0.063	0.077 -7e-3 -2e-4
All Calo	1.111 0.553 0.284	0.118 0.021 8e-4

Channel 1G σ
Non-Gaussian treat.

	MET RMS [GeV]	MET Mean [GeV]
TileCal Only	0.70 0.31 0.071	1.09 0.15 0.055
All Calo	0.914 0.609 0.232	1.24 0.514 0.328

- There used to be a big discrepancy in MET_Topo performance
- Core shape is now pretty consistent in the updated reconstruction (remainig tail may be removed by using the Q-Factor)

Gives confidence to be on the right path, have to use it in MC!

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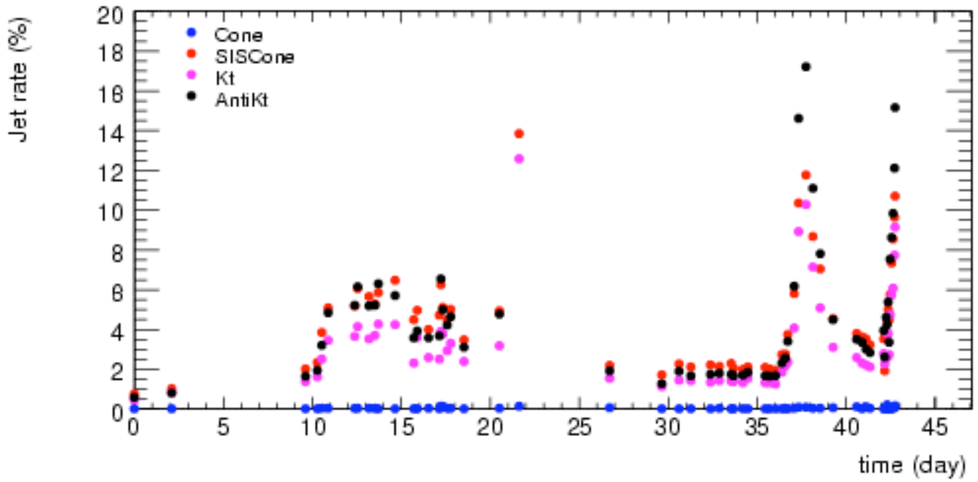
Stability in time -1

Pedestal level in Larg vs time affects the nr of jets above a certain threshold.

N.Makovec

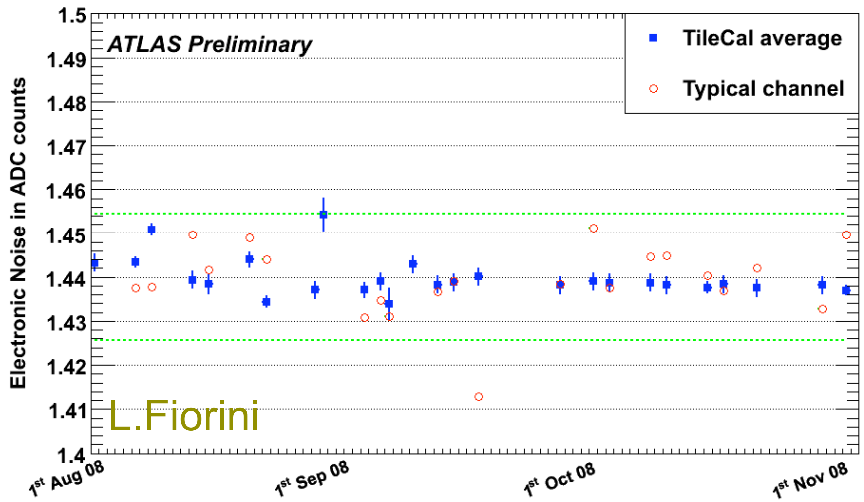


The fraction of events with at least one jet with Et>7GeV varies with time.
It is correlated with the pedestal shift in the LAr barrel

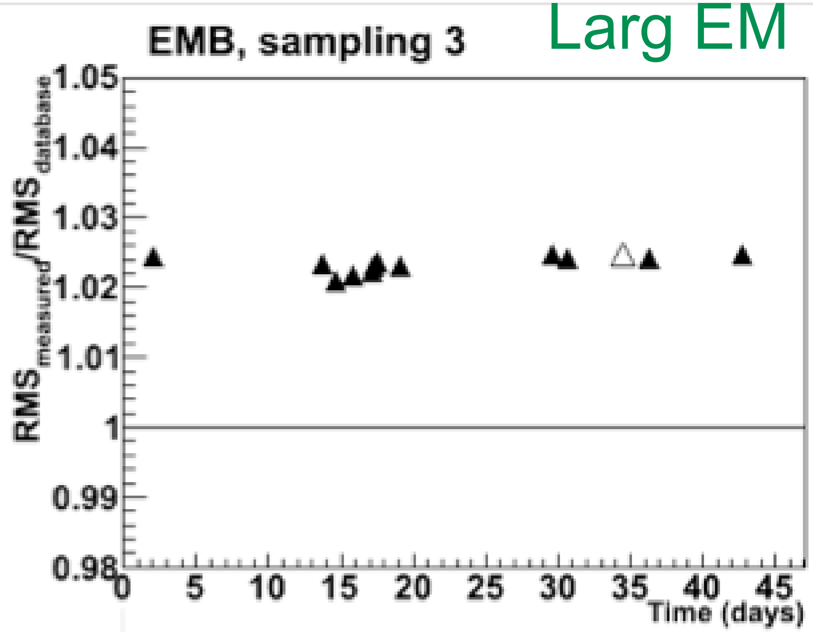
-Pedestal level increasing E_{jet} here.

Should be OK with DB updates daily from pedestal runs.

Stability in time -2



TileCal



Larg EM

Toggle Drawer Containing Thumbnail And Content Views S$_{measured}$ and RMS$_{database}$:

fair agreement below 5%

↳ Differencies probably linked to a change of the default phase in the energy computation

↳ More pronounced in the samplings 2 and 3 of the EM calorimeters

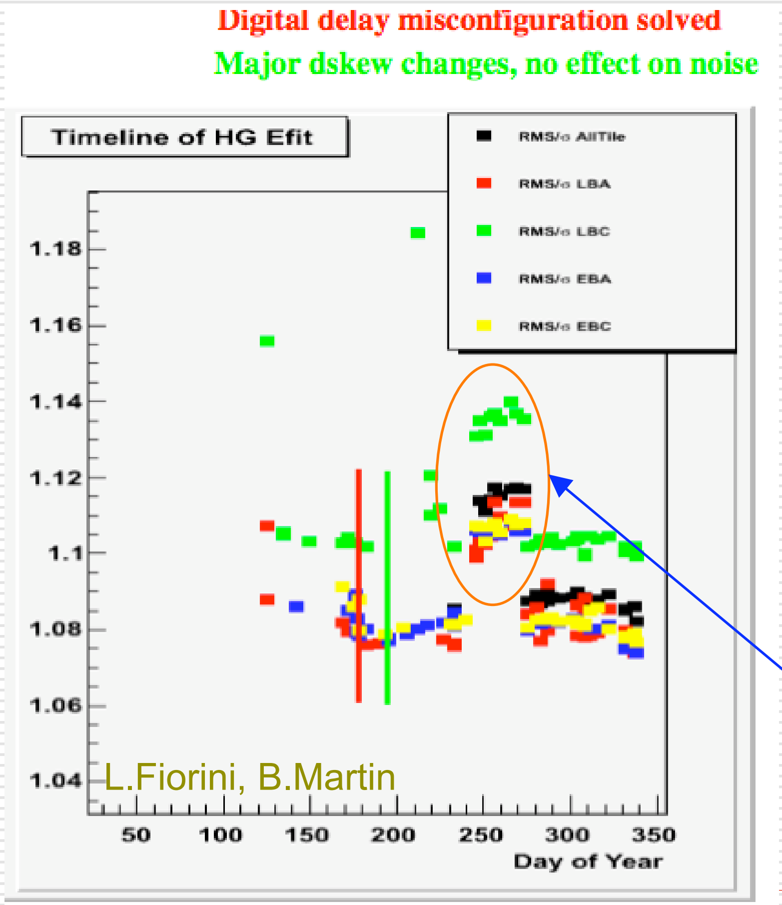
➔ Stable with time but systematically biased

t_0 = run 87764 (10th of September)

E.Petit

Stability in time -3

RMS/σ vs time



TileCal plot that indicates that the non-Gaussianity is reasonably stable with time.

- Still to study if it is really OK!

April to September 08

(Different reconstruction conditions, Not to discuss now.)

Overall Calorimeters Quality

Detector status (TileCal)

- We have 2 months with the calorimeter closed.
- There are 22 cells unavailable due to a LVPS (concentrated in $\Delta\phi$=0.1 and 1/2 barrel part in η)
  - Between 3 and 5 cells masked in the reconstruction mainly due to intermittent data corruption problems.
- The maintenance brought the calorimeter to a very good status in the FE.
  - But we lost one LVPS after closure.

Reminder: A TileCal cell has 2 r/o channels.

Detector status (Larg)

- 5 OTx are dead now (out of 1600 in total)
  - OTx is the optical transmitter sending off the serialized data of one FEB to the ROD.
  - There is ONLY 1 per FEB (TileCal has two per SD)
- One LVPS having lost the redundant mode (after a power outage).
  - Total LVPS: 2x16 in Barrel, 2x13 in Endcap
- Apart from the above, very few hopeless channels in the DB.

Issues and stability

- Tile has done one FE full refurbishment campaign (07-08) and one maintenance campaign.
  - In the 08 stable period we started from 0.4% dead cells and we finished with ~2%. We lost 2 LVPS and 2 FE SDs.
  - Now studying long-term reliability based on the repairs data.
- Larg has done a LVPS refurbishment campaign in 07-08 (except the C29 case).
  - The LVPS have build-in redundancy. There was no failures until recently, now 1 LVPS in redundant mode.
- Larg new problem in 09 are the OTx failures, which is being studied now (it is a cause of Single Point Failure) and happens at ~1/week.
  - Problem appeared in 08 (with 8 failures) and in 09 there are 5 failed already.

Types of problems: for the channel status in DB

(see wiki for more details)

LAr Bad Channel bits

- deadCalib (601)
- deadPhys (34)
- deadReadout (4)
- almostDead(0)
- distorted (320)
- highNoiseHG (22)
- highNoiseMG (0)
- highNoiseLG (0)
- lowNoiseHG (191)
- lowNoiseMG(0)
- lowNoiseLG(0)
- unstableNoiseHG (0)
- unstableNoiseMG (0)
- unstableNoiseLG (0)
- peculiarCalibrationLine (32)
- short (4)
- unstable (106)
- sporadicBurstNoise (295)
- problematicForUnknownReason (0)

Tile Bad Channel bits

AdcDead	NoHV
VeryLargeHfNoise	WrongHV
NoData	NoLaser
WrongDspConfig	BadLaser
SevereStuckBit	NoCesium
StuckBit	BadCesium
DataCorruption	NoTiming
LargeHfNoise	BadTiming
CorrelatedNoise	TrigNoGain
LargeLfNoise	TrigHalfGain
NoCis	TrigNoisy
BadCis	IgnoredInDsp
NoPmt	IgnoredInHlt
SevereDataCorruption	DisableForL1

Calo Bad Channel Bit

- Dead
- Noisy
- Affected (any bit set)

not fully up-to-date for this year implementation…

Types of problems (Tile)

- All channel problems (from data and CAF, static and intermittent) enter in coolDB.
  - No response to particles
  - Dead channels for calibration (really are low quality channels)
  - High levels of noise
  - Data corruption, bit stuck
  - Masking is used only for dead, high %-age of data corruption, high order stuck bit, very high HFN.
- Dynamic masking is also used for the data corruption cases (happen in some events), checks the quality fragment.
- With 2 channels/cell, if:
  - One channels is “masked”, the other’s E is doubled.
  - If both are “masked” the E_cell is 1. MeV.
- The HLT uses the same DB and also (almost) the same dynamic masking.
- Other handles? Some quantities that are in the TileCell (not the CaloCell) and are accessibe in DPD/AOD, e.g. Q-factor/channel, PMT(E,t) asymmetry.
  - In a different container digits are available (currently perf DPDs in cosmics contain them)
- More problems? If the BE has not filled the fragment correctly so that it looks good….
  - Or corrupted fragment, disregard !
- On the aftermath? Mark in EventInfo…. (not exploited yet).

Last…

- A lot of progress in understanding real data and their treatment.
- Still issues to work on:
  - Noise description in data and Monte-Carlo
  - DQ is in good state, need to have fast reactions to its results for the reconstruction.
  - Be alert for the detector reliability issues!
- We are now in a cosmics run, will consolidate more the issues of the previous pages.
- THANKS A LOT TO ALL COLLEAGUES WHO PROVIDED MATERIAL AND INTERACTED WITH US!