LAr/Tile/Lvl1/Trigger shutdown & commissioning

by Denis Oliveira Damazio
Brookhaven National Laboratory
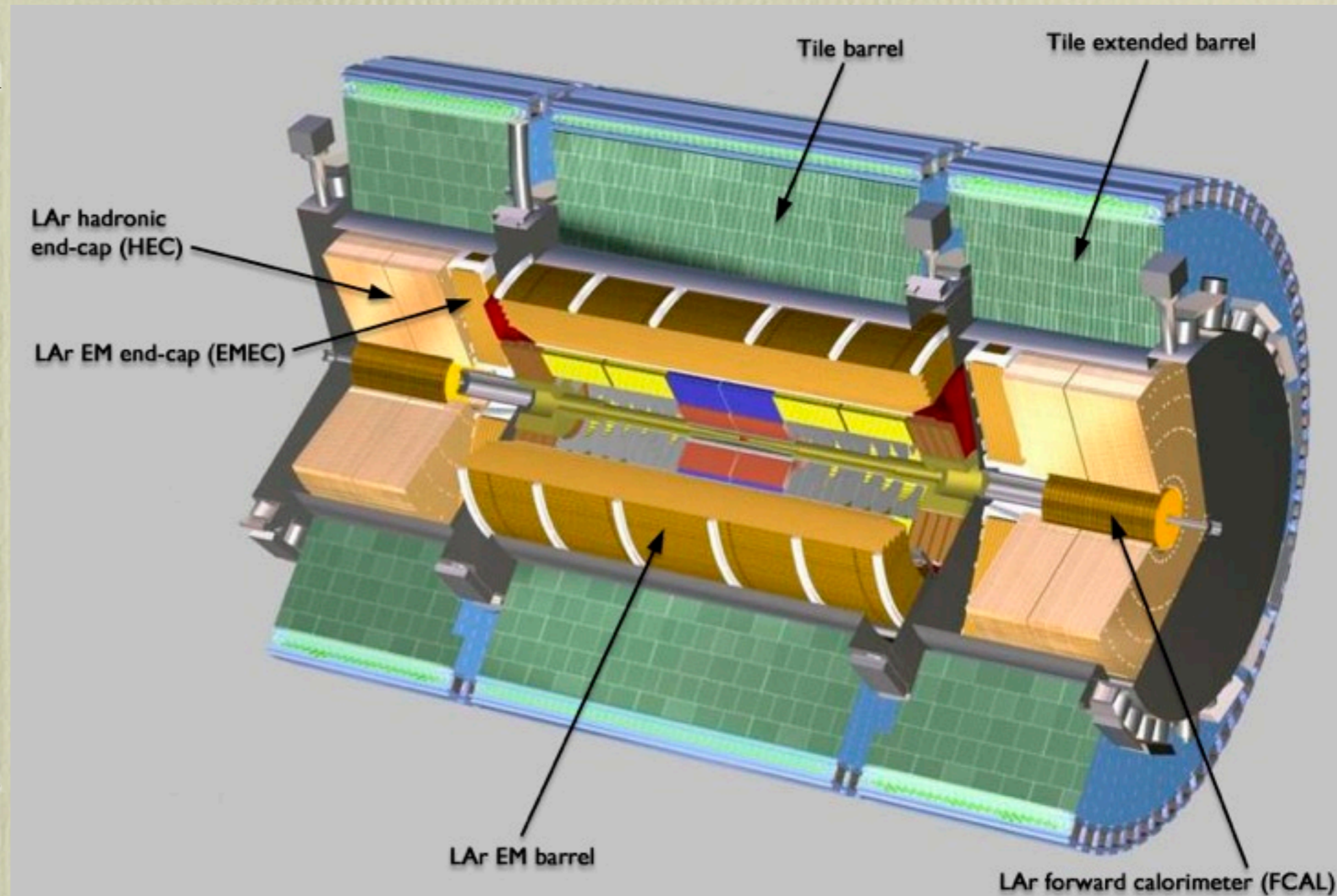
with plots from lots of people
(I may have not put all names!)

Topics

- Introduction about our calorimeter.

- LAr commissioning and shutdown activities.

- Tile commissioning and shutdown activities.

- LVL1 commissioning and shutdown activities.

- HLT experience during this whole period

  - Dealing with Bad Channels.

  - Data corruption.

  - Time performance.

  - A few plots on Physics Performance.

Wednesday, April 15, 2009

Our Calorimeter

- The EM section uses lead absorbers and liquid argon as active medium. High-Voltage allows for charge collection. Full coverage up to eta=3.2. (complemented with FCal up to 4.9).

- In the Hadronic EndCaps copper is the absorber with liquid argon as active medium.

- Hadronic calorimetry at lower pseudorapidity (<1.7) done by iron plates absorbers and scintillating tiles (Tile Calorimeter). Light collected by fibers attached to photomultipliers.

Tile barrel

Tile extended barrel

LAr hadronic end-cap (HEC)

LAr EM end-cap (EMEC)

LAr EM barrel

LAr forward calorimeter (FCAL)

Marco Delmastro

Our Calorimeter

- Cells defined by the electrodes around lead plates. The detector can be modeled as a capacitor.
- The Detector pulse from each cell is shaped and sampled at the front-end.
- Calibration system can mock up the detector pulse : calibration procedure compensates.
- The "analog version" of the shaped pulses is fed directly to the L1.
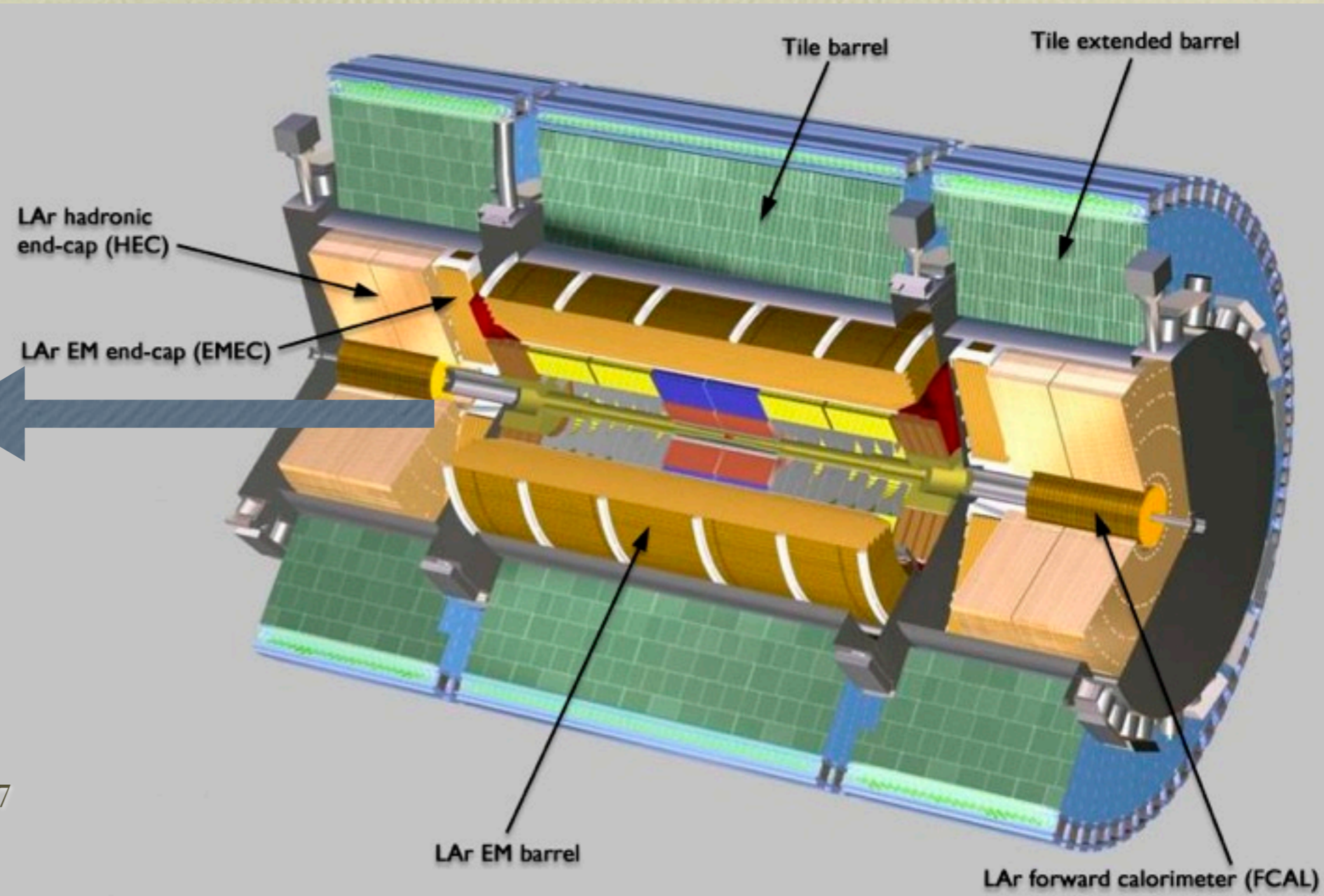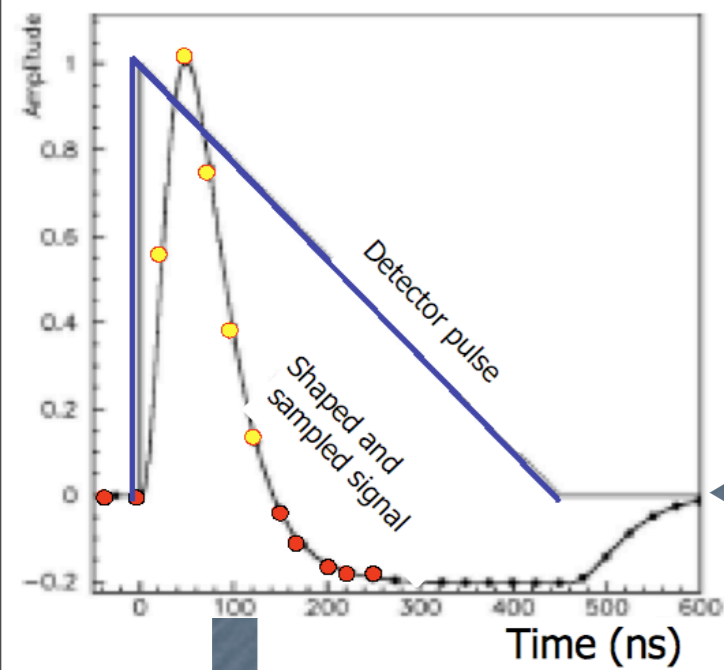

4

Denis Oliveira Damazio (BNL)
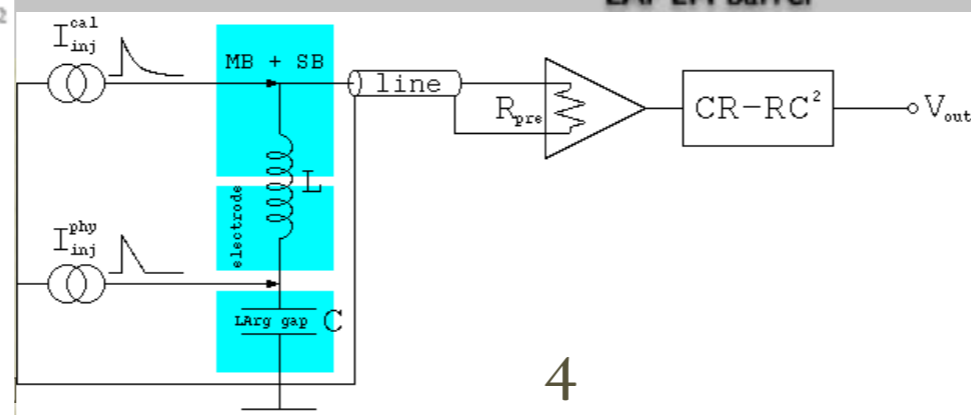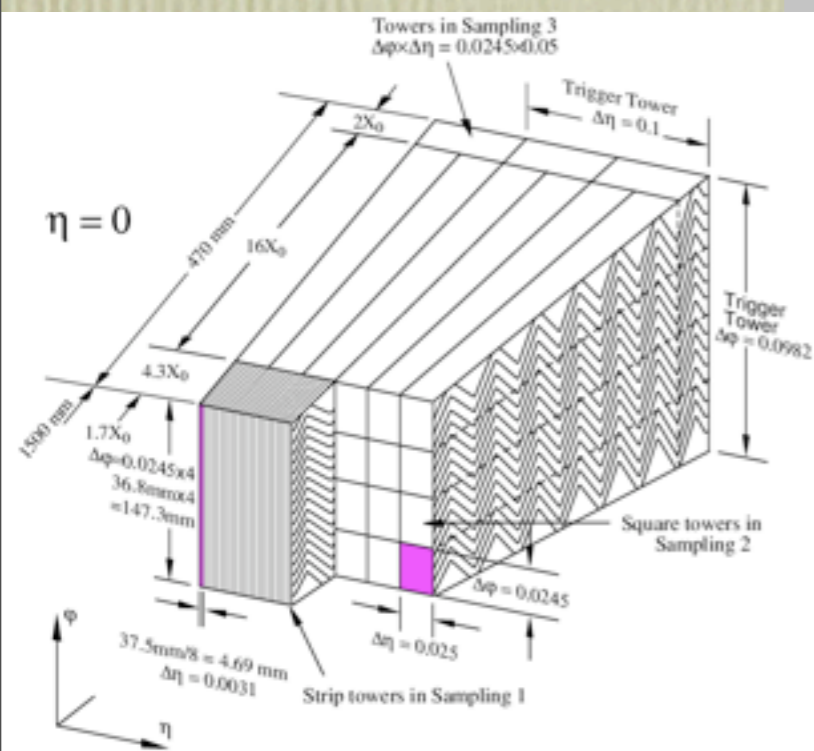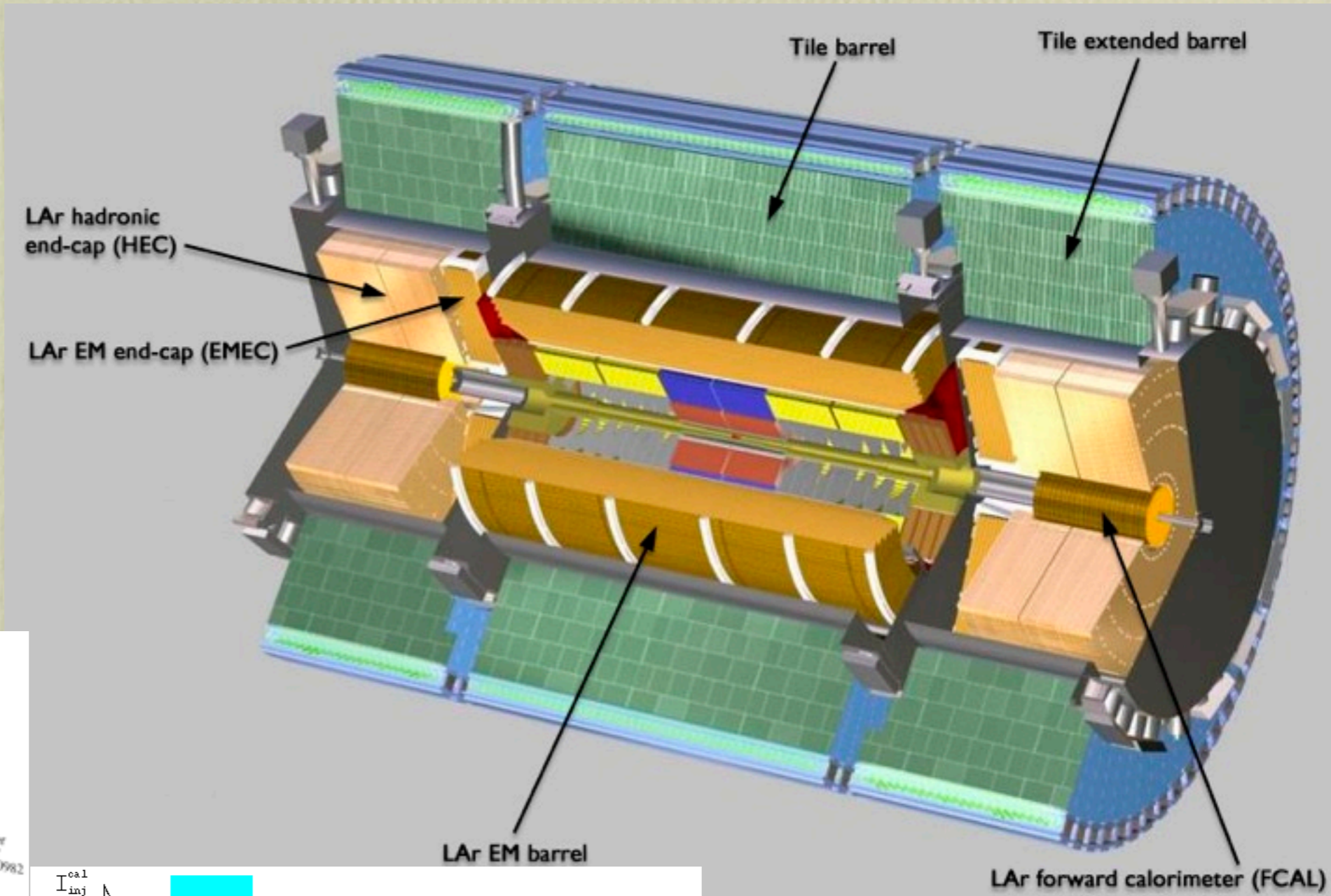
Our Calorimeter

Optimal filter technique

Energy :
$$E = \sum_{i=1}^{N} \underline{a_i}(s_i - \underline{ped})$$

Peaking time:
$$E\tau = \sum_{i=1}^{N} \underline{b_i}(s_i - \underline{ped})$$

Quality factor :
$$\chi^2 = \sum_{i=1}^{N}(s_i - \underline{ped} - E(\underline{g_i} - \tau \underline{g_i'}))^2$$


Since 2007

- For the events accepted by the L1, the samples are processed by the Digital Signal Processors in USA15 (optimum filtering - designed removed pile-up effects). These are the readout-drivers. They calculate energy, time and quality factor for the LAr energies.
- Optimum Filter idea in one line : "Let me know your best estimate of a pulse shape : based on this and on a detector pulse, I tell the energy, time and a quality factor" : Main reason for 32 samples runs.

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Cosmic in LAr

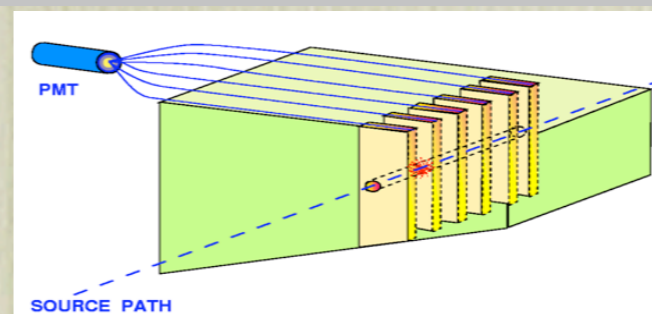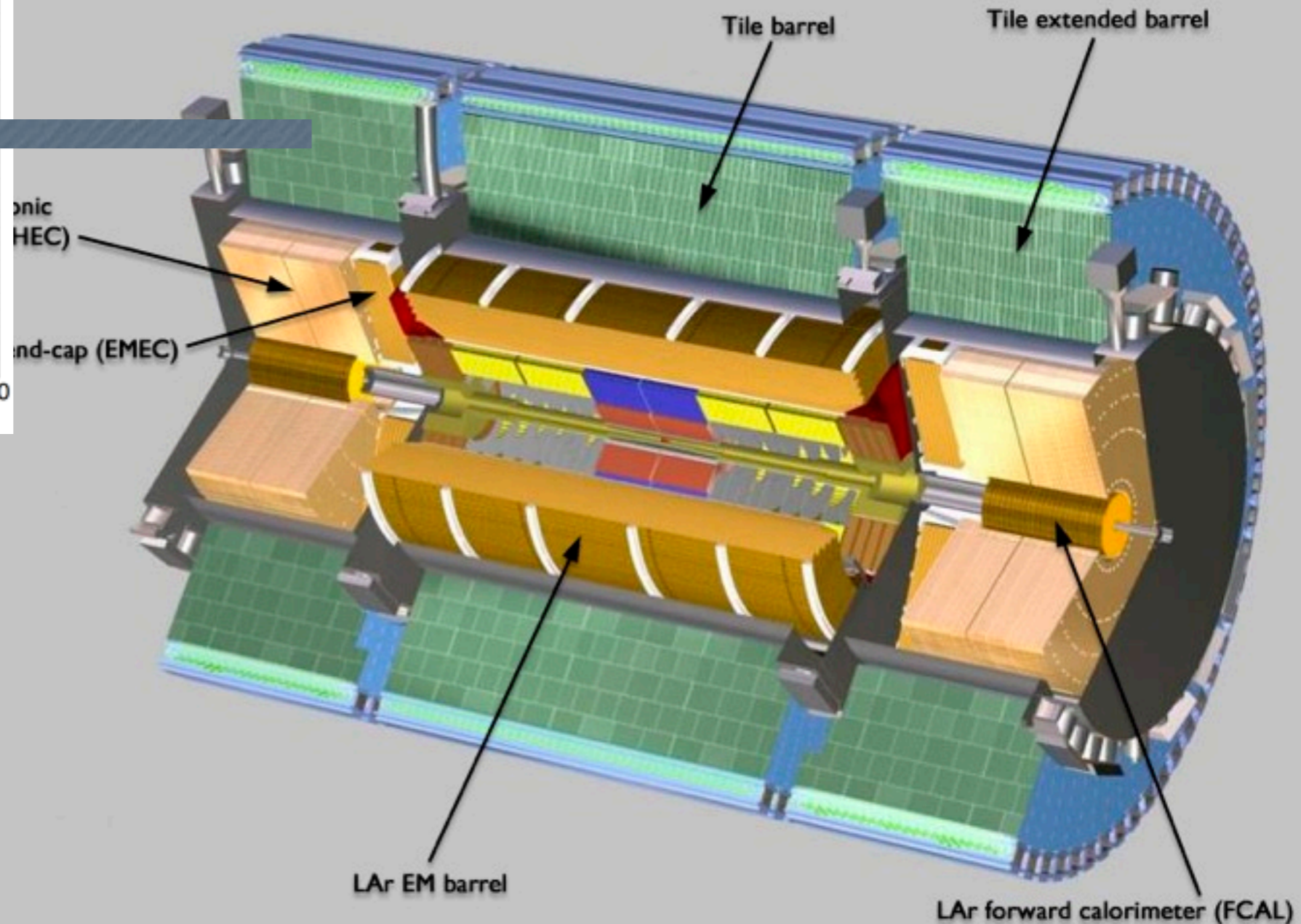- Using cosmics it is possible to evaluate the pulse shapes.

- Pulse shapes similar to real ones : increase of precision on energy measure.

- Most Probable Value (MPV) displays a feature proportional to the length of the LAr 2$\underline{nd}$ layer cells (longest one).

Giulio Usai, Arantxa, Alberto Valero
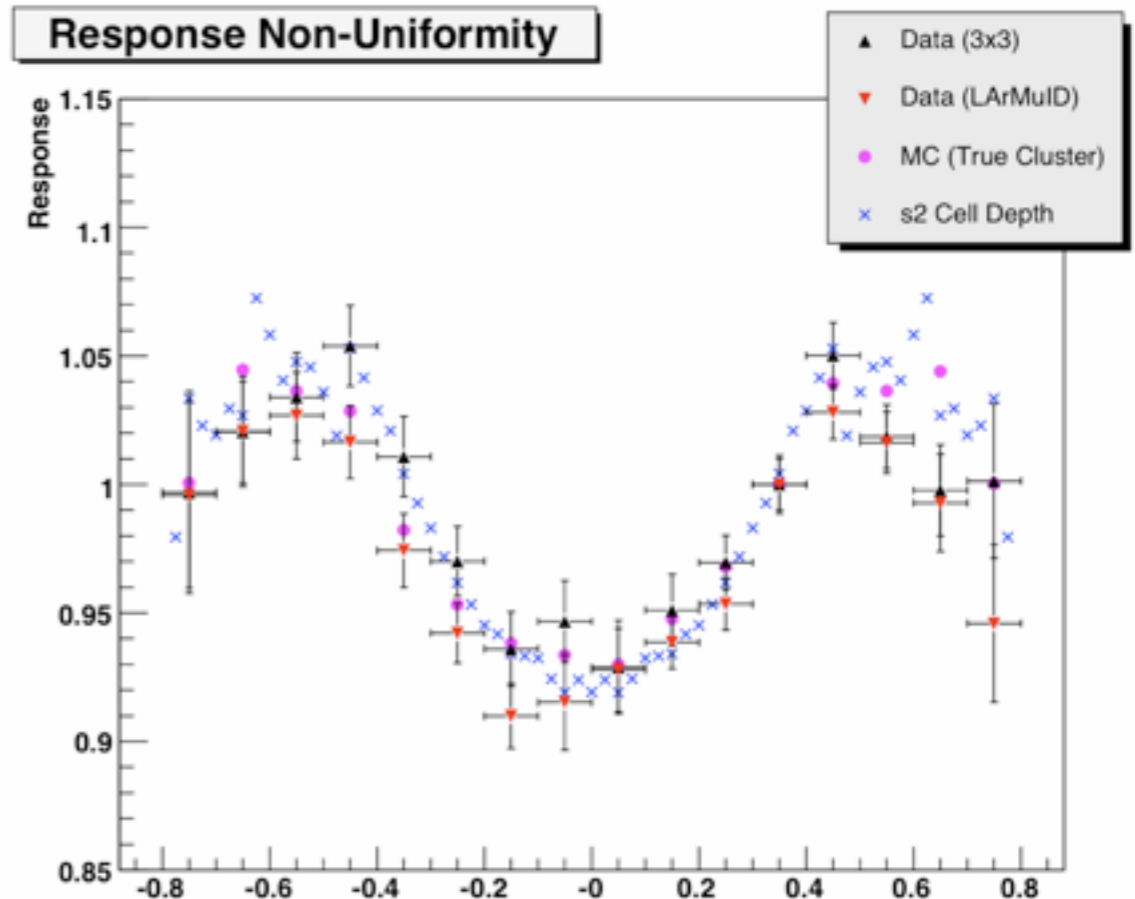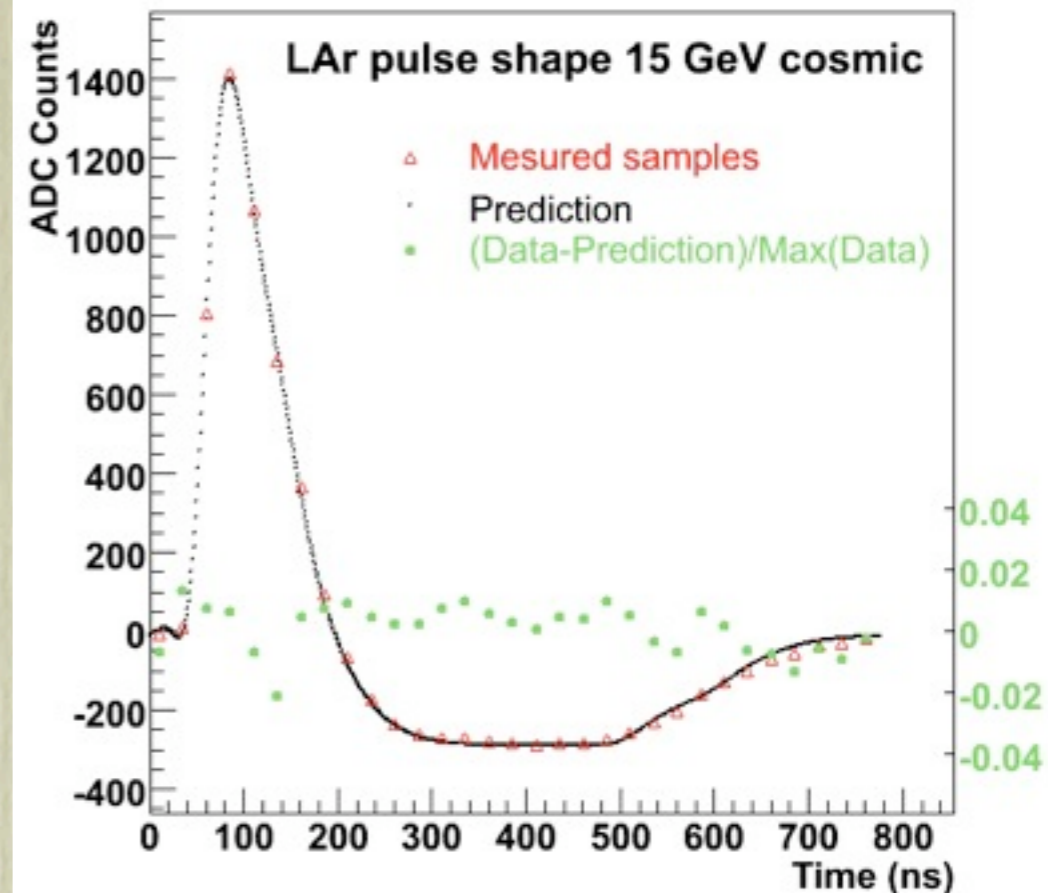
Our Calorimeter
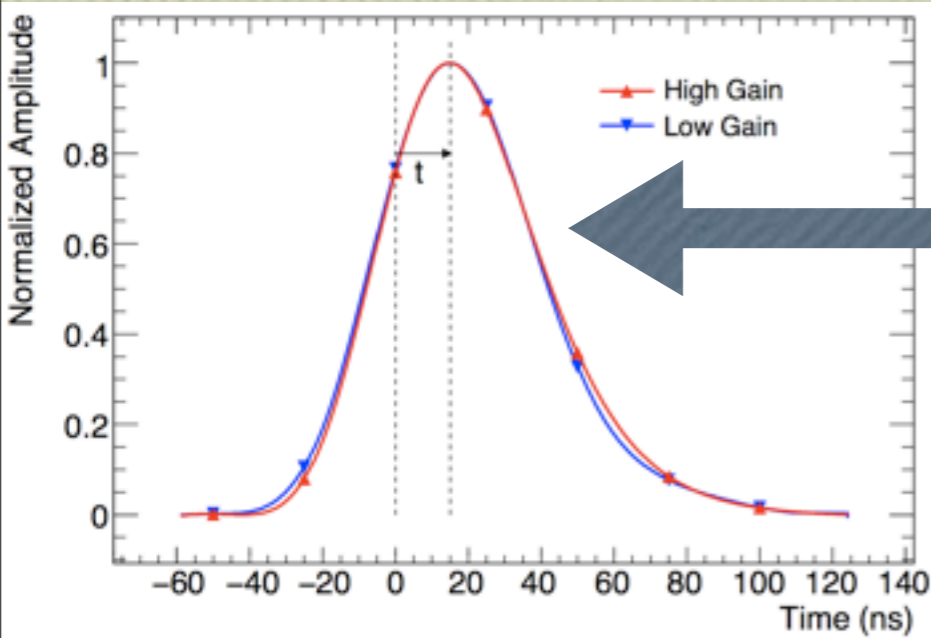
- Light collected by scintillating plates (or from laser calibration system) input to photomultipliers (PMT).

- Pulse much faster than liquid argon ionization pulse.

- Actually, in this case, the shaper enlarges the signal.

- Energy calculation similar to LAr : optimum filter running in DSPs. Knowledge of pulse shapes fundamental!!!

Tile barrel   Tile extended barrel

onic (HEC)

end-cap (EMEC)

LAr EM barrel

LAr forward calorimeter (FCAL)

PMT

SOURCE PATH

Scintillating Tiles

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Tile In Cosmics
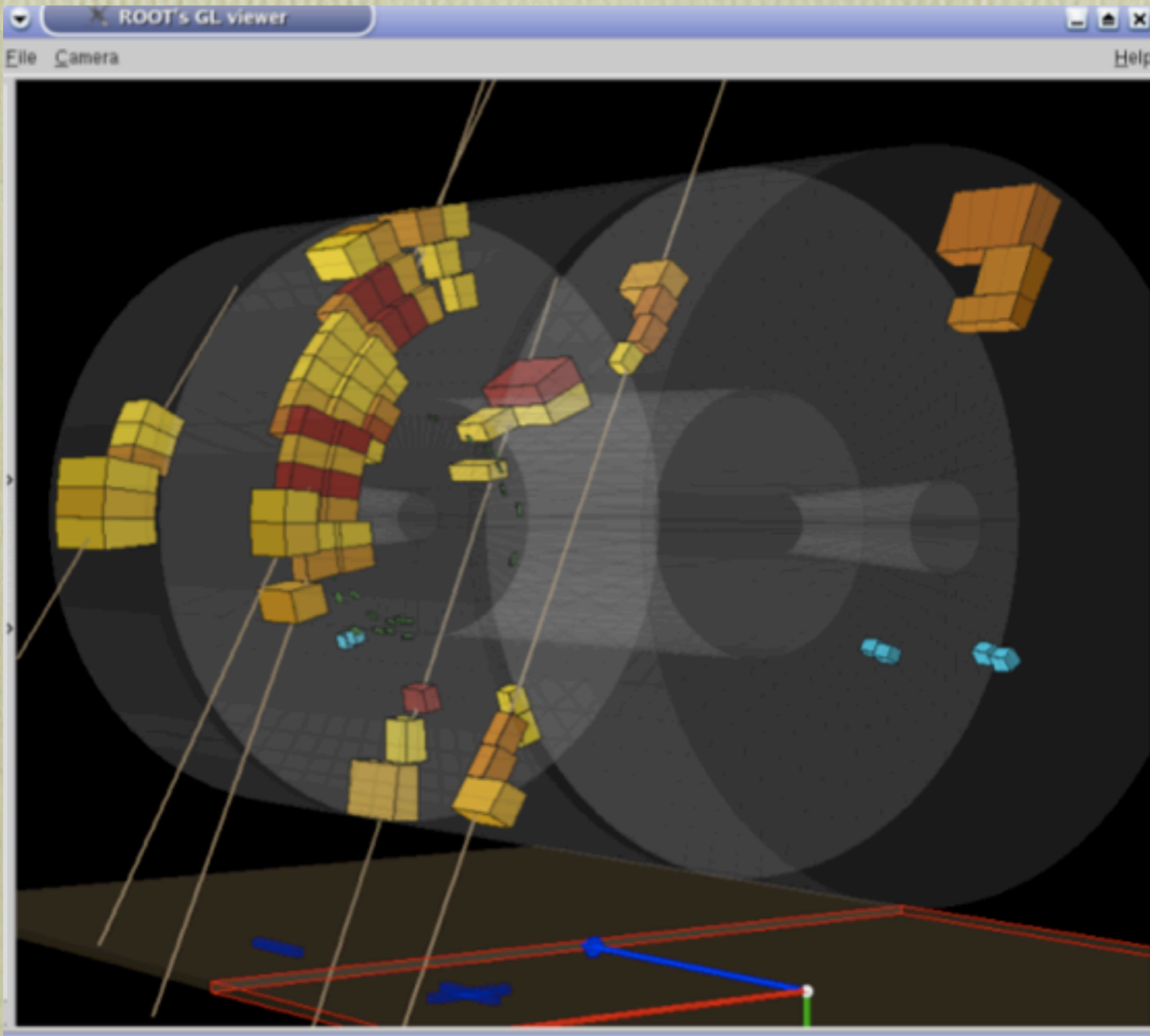
- In order to better measure the energy deposited in TileCal by Cosmic Rays, it is important to select good "track in Calo".

- Using different methods (like Hough Transform) for that.

- The obtained energy deposition fits much better the Landau expected distribution.

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LAr coming back to power

- Low-Voltage : Decided to perform new retrofitting campaign. Coming back slowly. This week barrel should be finished. Missing EndCap-C.

- High-Voltage : Slowly being brought on. Should allow to see first cosmics in the calo slice week soon.

- Many noisy cells identified during this period are being addressed during shutdown.

- Noise burst events dominated runs without high voltage (no physics). Most of december runs.

- These problems are isolated to specific problems in the front-end electronics : being addressed now.
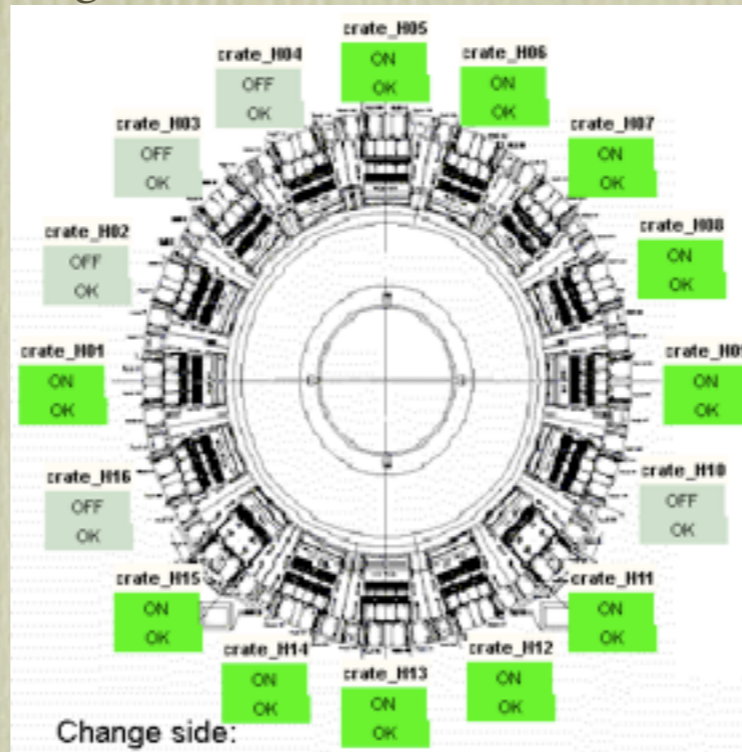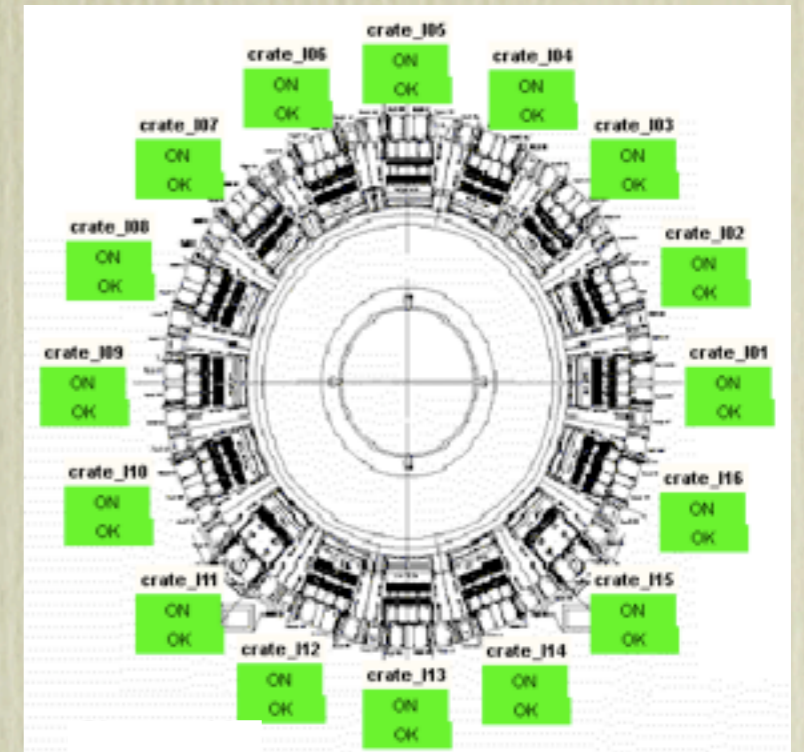
Increasing coverage in the following weeks. Online software and infrastructure being prepared for "slice week" (next week!!!)

Automatic Calibration procedure being constantly exercised. Pulse injection directly into calorimeter plates and pedestal runs.

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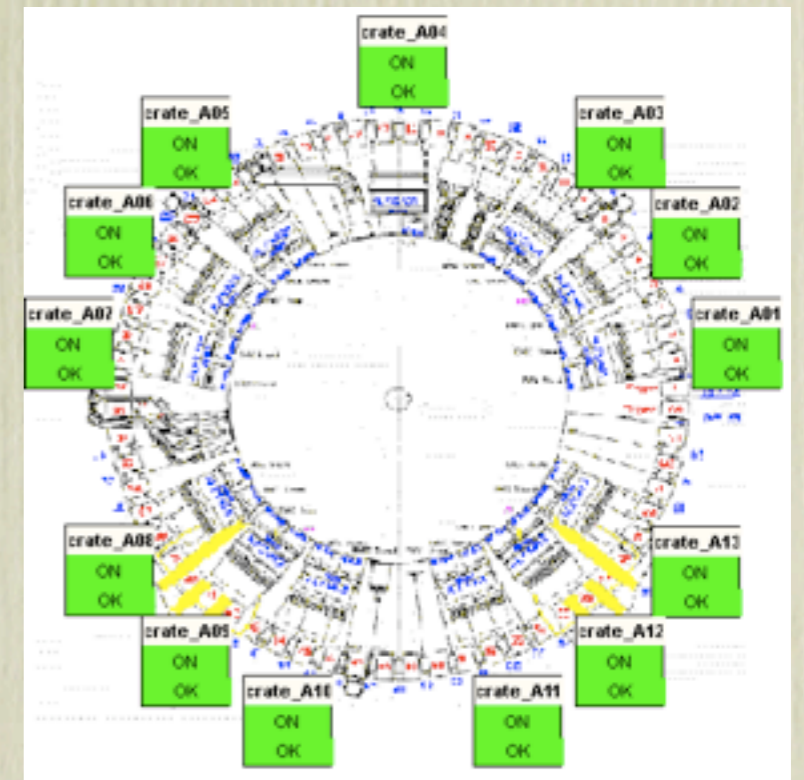
Tile Commissioning

- TileCal started a repair campaign to address many issues found during the ATLAS cosmic/first beam run last year. Also trying to model expected behavior of the detector based on past experience.

- A small amount of modules producing corrupted data too often (see ahead). No protection for the HLT. Being fixed.

- TileCal concentrating now in calibration exercises and developments in the DSP to guaranty good reconstructed energy performance.

example LBC

Fixes during this shutdown
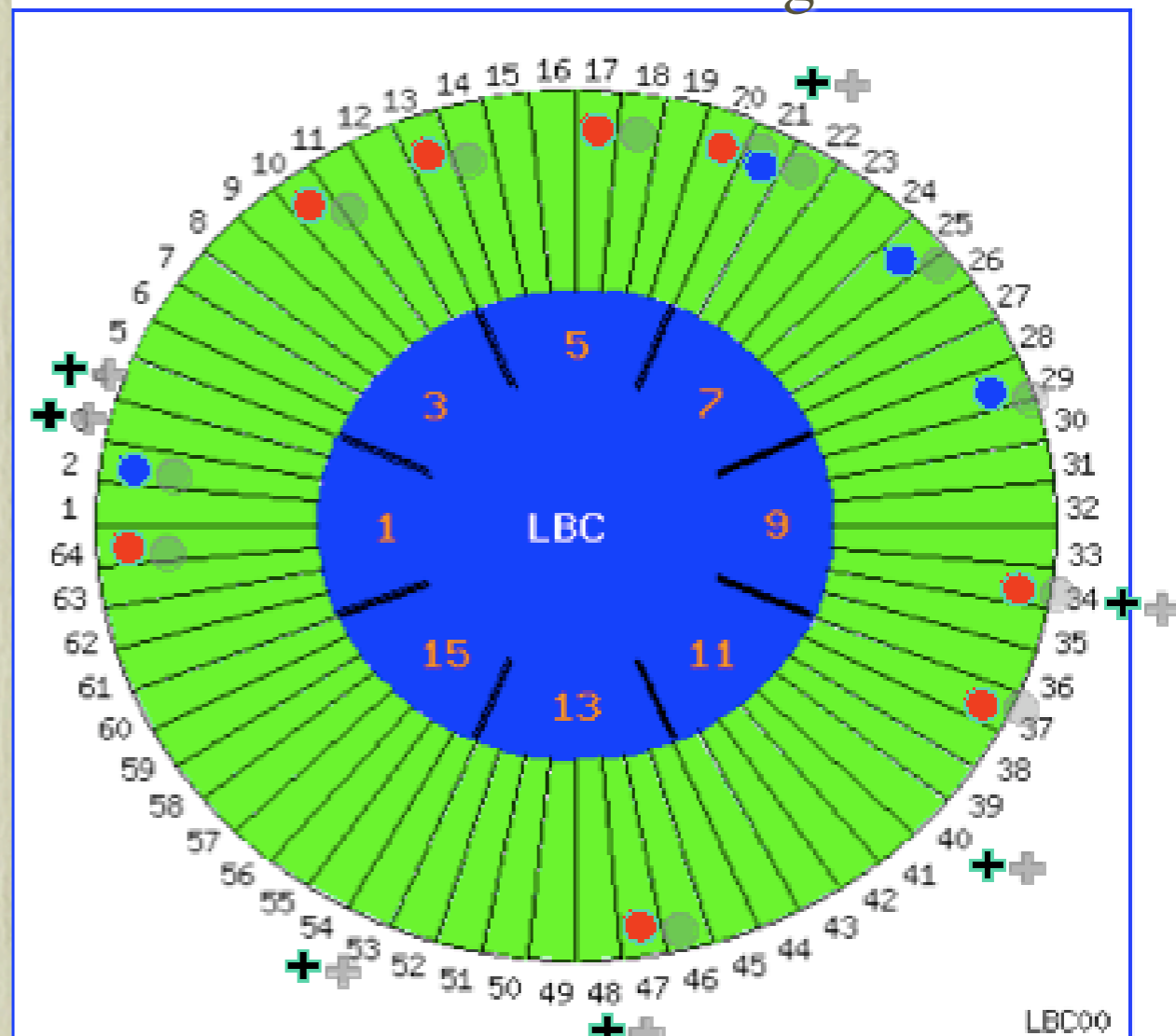
Major repair
Medium repair
LVPS

Cesium : PMT High Voltage

Laser : Pulse time

DANGER
LASER BEAM

Charge Injection : Linearity, possibility to emulate physics patterns like jets.

Tau Workshop Copenhagen

Just to give you a feeling

LAr Front-End Crates
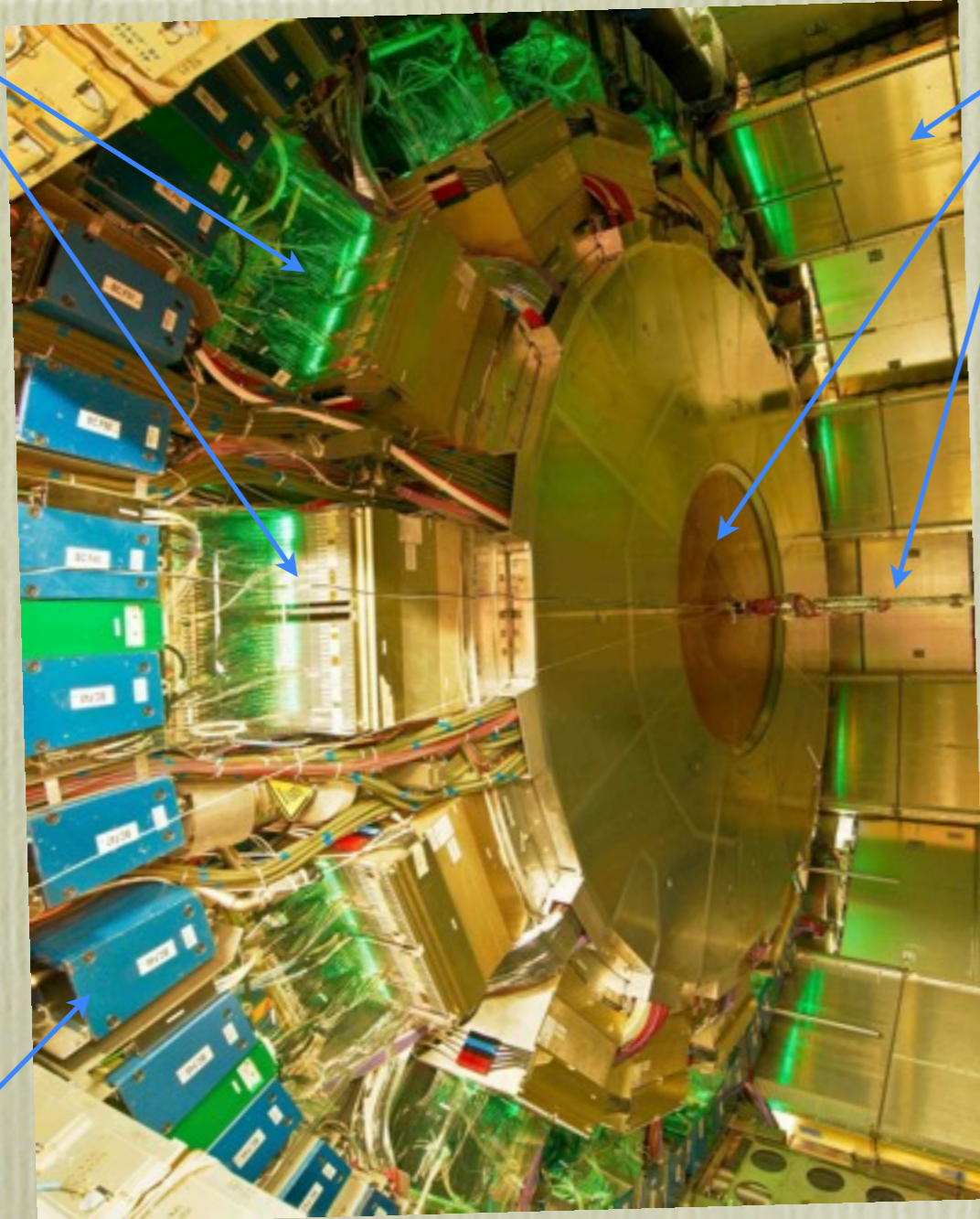
Muon Chambers

Inner Detector enclosure

Beam pipe

TileCal drawers insertion point

- Very beautiful picture. Barrel Calo, before close up of endCaps.

- Taken during close up picture before first beams last year.

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ATLAS Trigger System

- For Calo, L1 decision is performed by checking analog pulses from LAr and Tile.

- ROBs hold data to serve the L2 farm. In case of a L2 accept, data is requested to be sent to the Event Builder.

- Each built event is processed by the Event Filter farm nodes. Finally, data is recorded into tape.
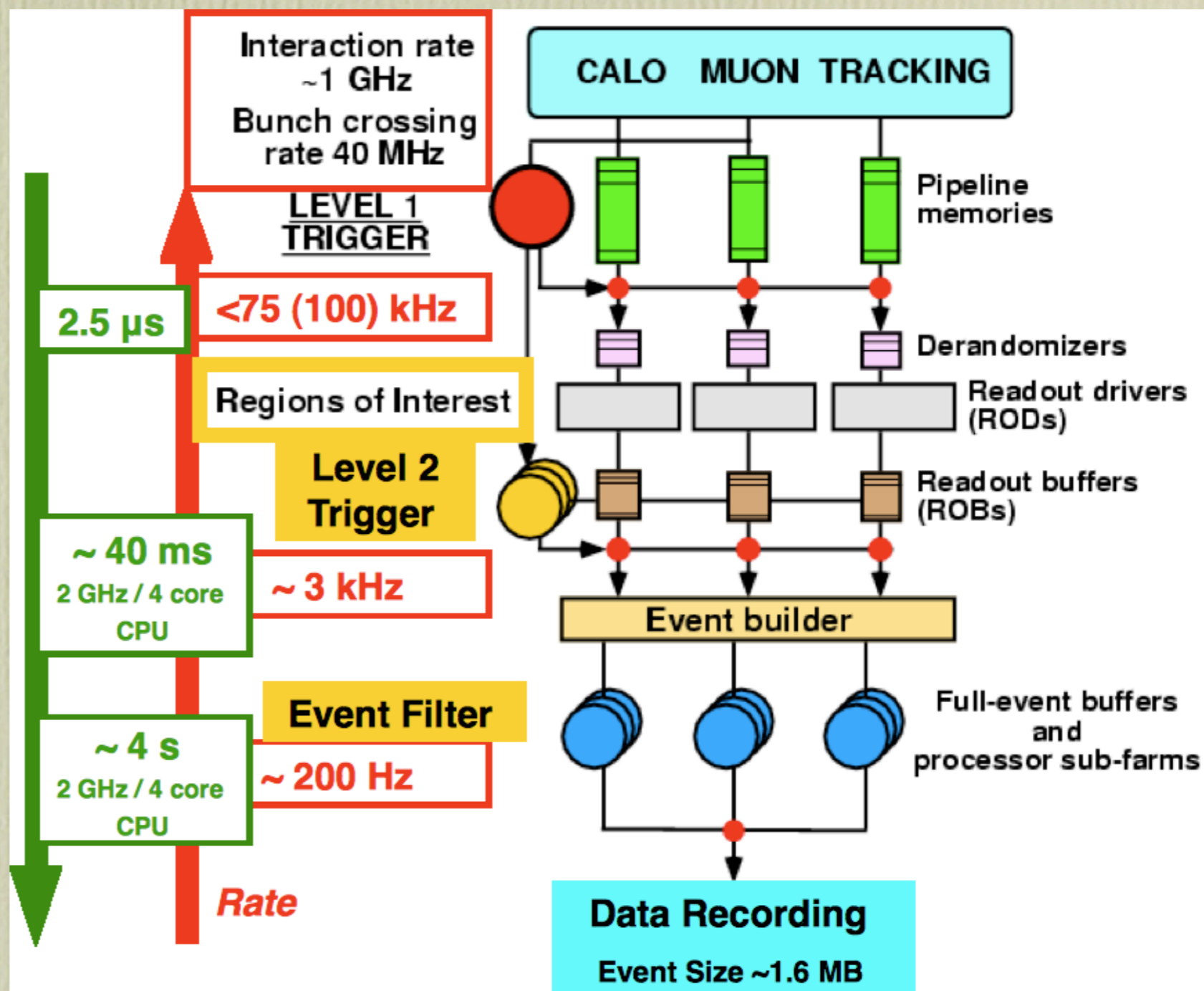
During commissioning size varies a lot. Up to 10 MBs when LAr in transparent 32 samples mode

Wednesday, April 15, 2009

Werner Wiedenmann

Trigger farms being used

Cosmic events recorded and processed by ATLAS since Sep 13, 2008

- Sum of RPC, TGC, MBTS L1 Triggers
- RPC Triggers (L1)
- Bottom 'Downward' RPC Triggers (L1)
- TGC Triggers (L1)
- Min. Bias Scint. Triggers (L1)
- Calorimeter Triggers (L1)
- Inner Detector Track Trigger (L2)
- EM Calorimeter Triggers (L1)

216 million events

Several hundred million cosmic events taken in various detector configurations before the first LHC beams.
Last updated: Mon Oct 27 16:04:45 2008

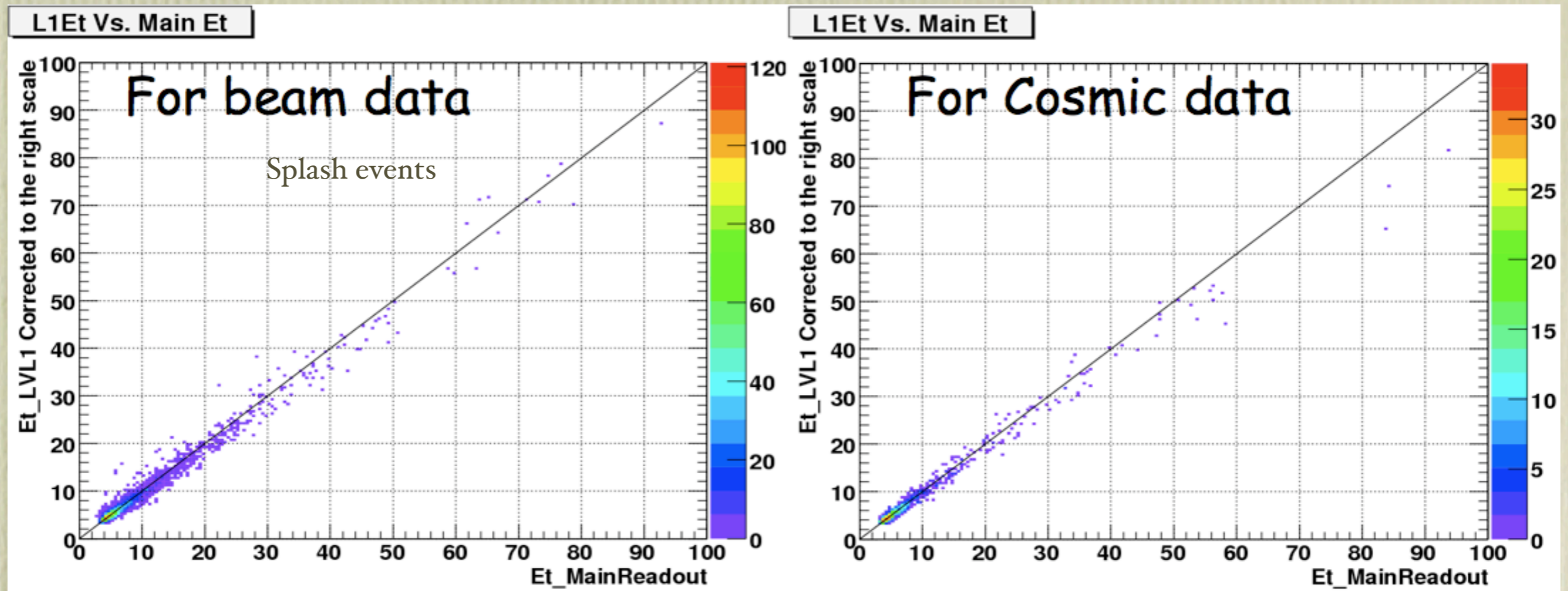Number of events (in million) vs Days passed since Sep 13, 0:00

- About 35% of the final system is already in place.

- Many of the racks will be L2 or EF.

- Calo trigger was one of the smaller parts of the calo exercise last year.

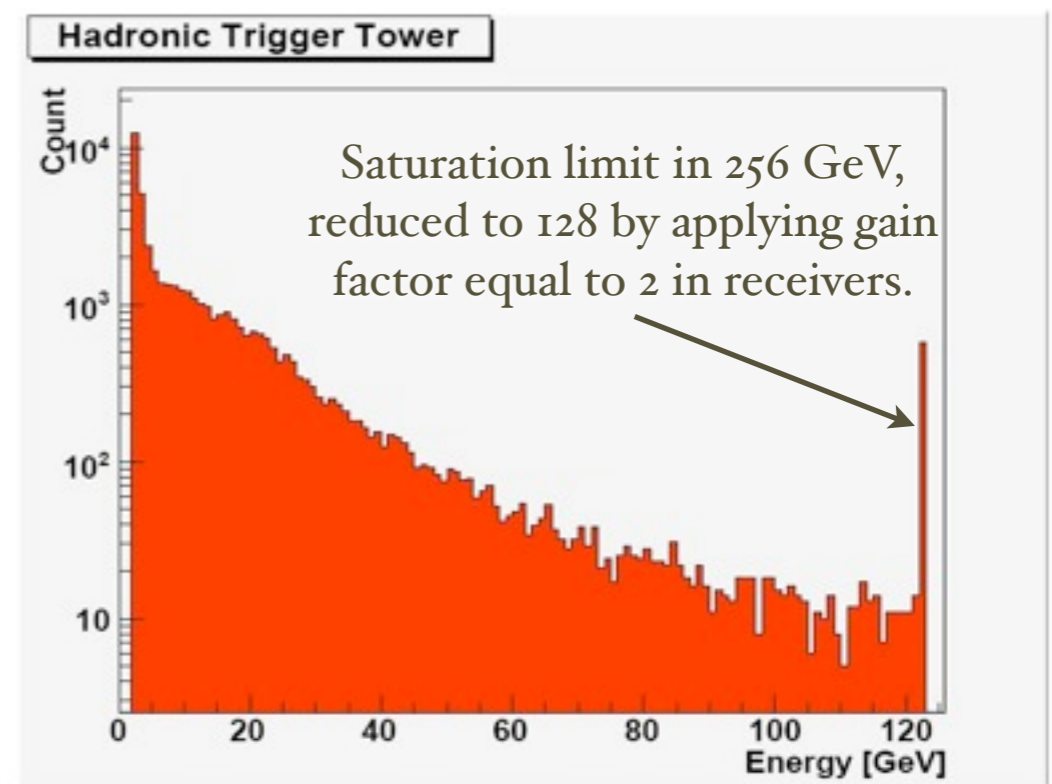- L2 used to improve selection of golden tracks for alignment.

LFS nodes

UPS for CFS

XPUS

CFS nodes

SDX1 | 2nd floor | Rows 3 & 2

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Lvl 1 - Calo results

Chaouki Boulahouache
and Stephen Hillier

L1Et Vs. Main Et

For beam data

Splash events

L1Et Vs. Main Et

For Cosmic data

- Lvl1 also performed some hardware fixes during shutdown.

- Lvl 1 friends trying to compare the main readout energy versus the reconstructed energy.

- Difficulties arise from noise cells (must be identified and masked).

- Timing synchronization of the pulses from different layers is a key point for the Lvl 1 processing.

- Bunch cross identification activities going on.

Hadronic Trigger Tower

Saturation limit in 256 GeV, reduced to 128 by applying gain factor equal to 2 in receivers.

[L)

Stephen Hillier

Nice Cosmic Views!

- Again, just to give you a feeling, we got some very nice LVL1 triggered events.

- All detectors seem to see them.

- Interesting to check alignment.

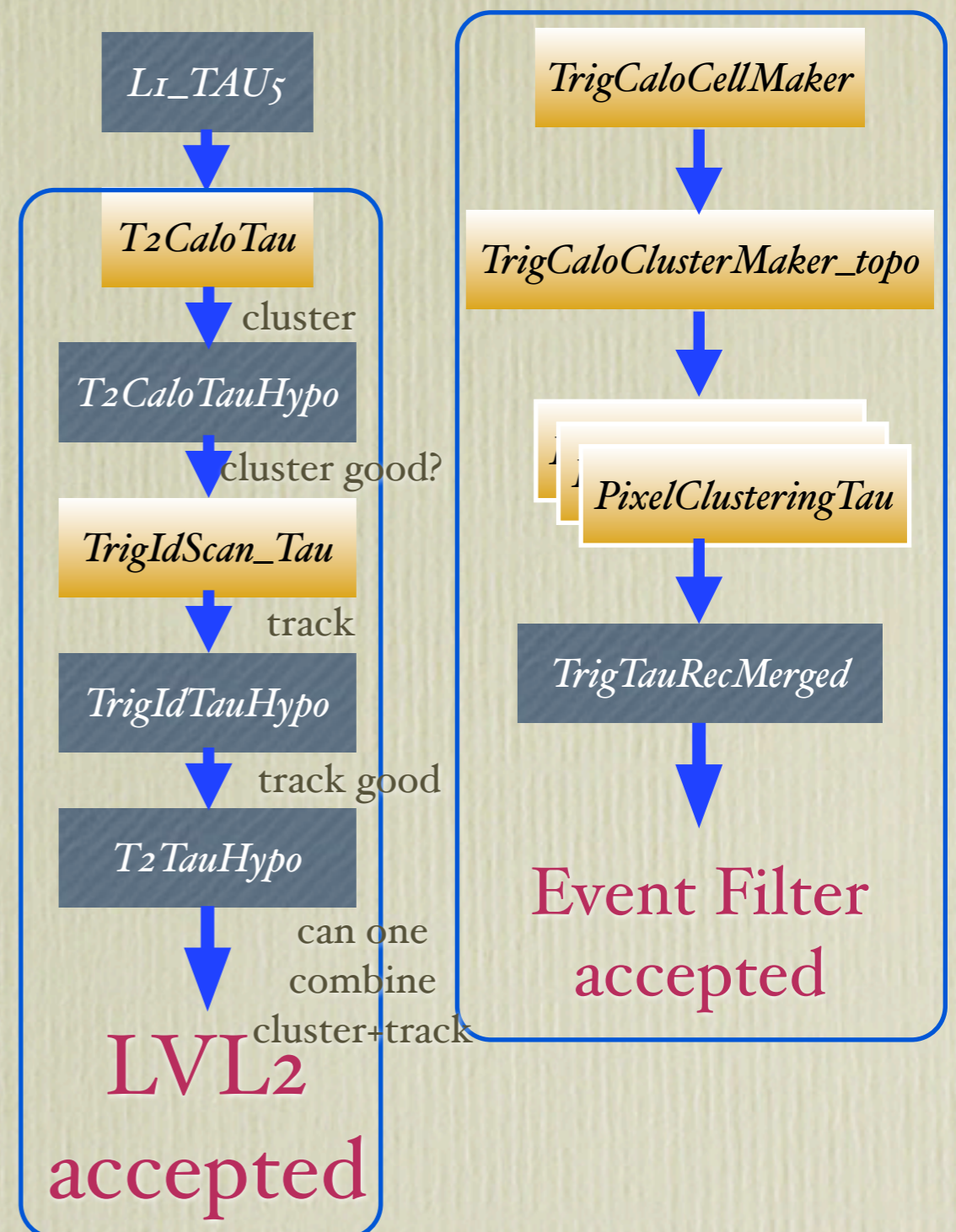- There are a few plots with magnetic field too... Nice to see the tracks bending.
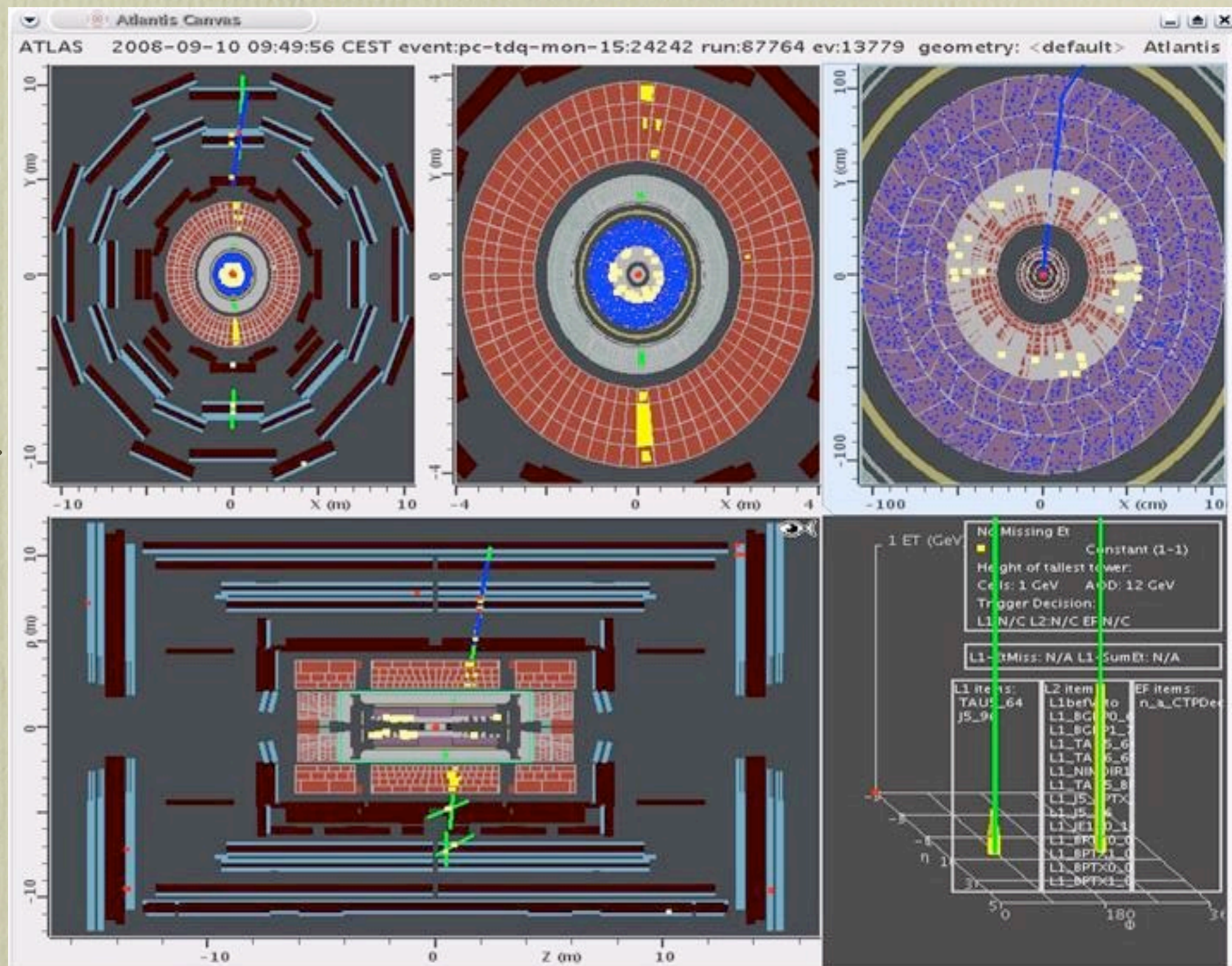
From Detector to HLT

- The trigger is composed of chains of algorithms.

- There are feature extraction algorithms (yellow) and hypothesis (perform cuts - gray).

- Different Hypo algorithms may need input from the same FEX. Caching.

- Caching of data preparation layer widely used for the HLT Calorimeter algorithms.

- EF uses a lot of the offline code. For instance, EFCalo uses topo clusters.

- That demanded a lot of effort to adapt the software that provides data to the cluster building.

L1_TAU5

T2CaloTau
cluster

T2CaloTauHypo
cluster good?

TrigIdScan_Tau
track

TrigIdTauHypo
track good

T2TauHypo
can one combine cluster+track

LVL2 accepted

TrigCaloCellMaker

TrigCaloClusterMaker_topo

PixelClusteringTau

TrigTauRecMerged
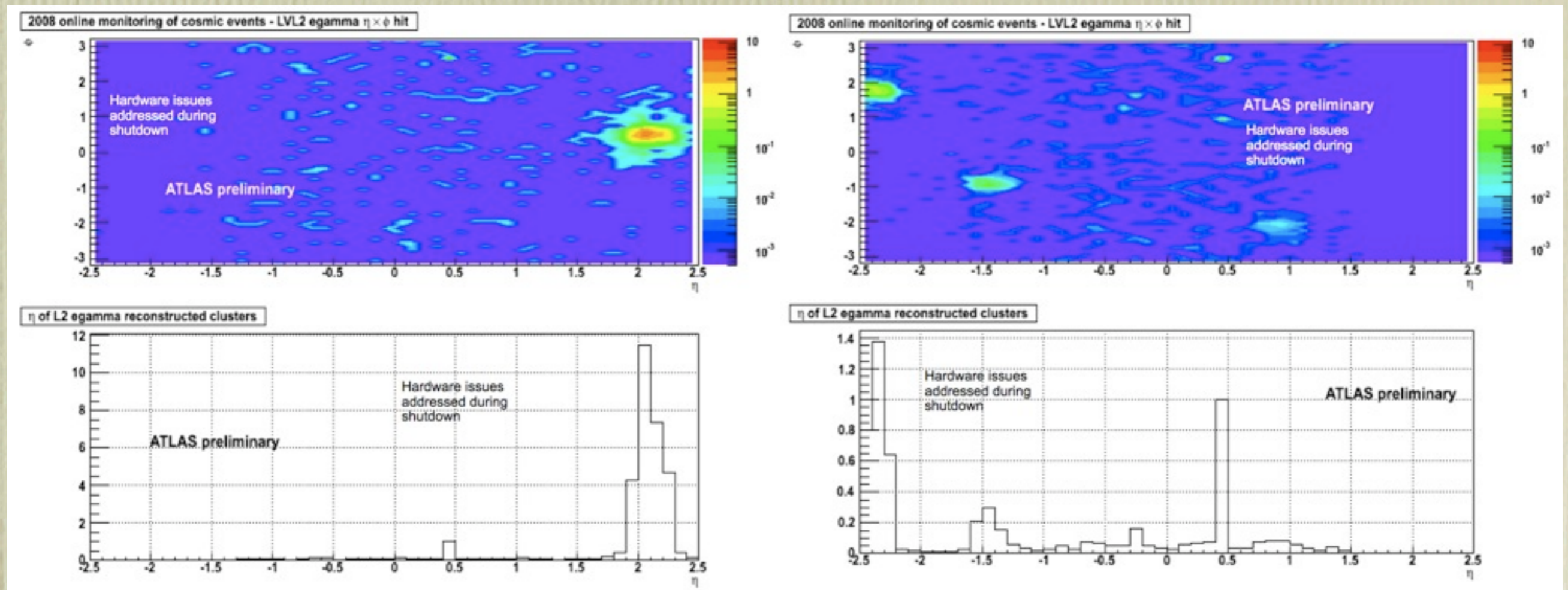
Event Filter accepted

HLT Calo Data Preparation Layer

- The same data preparation layer feeds up Lvl2 and Event Filter algorithms with calorimeter cells.

- Since M5 a full slice (egamma - without track - at that time) operating.

- Other slices integrated step-by-step.

- Caching of results make one slice speed up the others.

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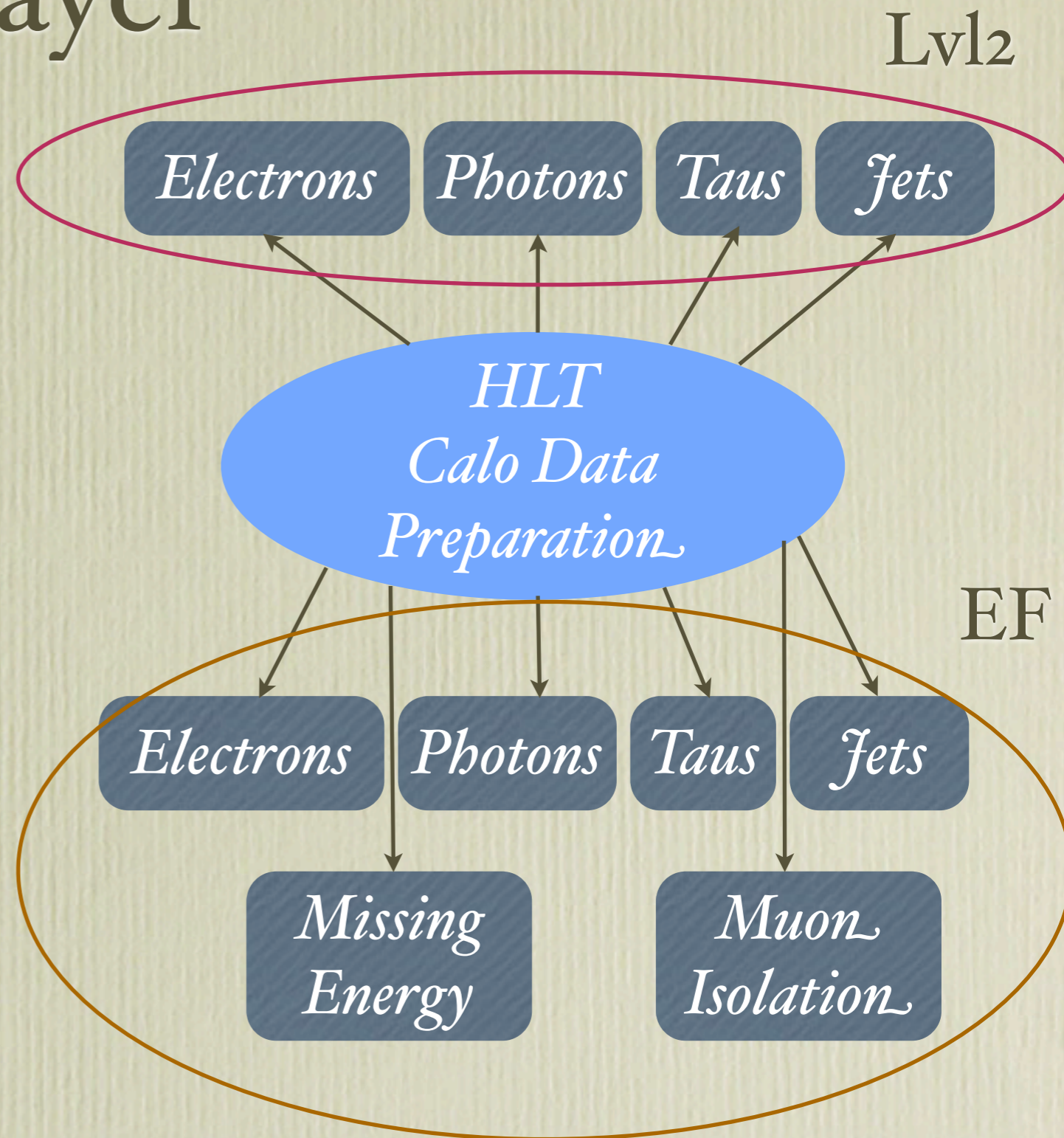
Noise in the Calorimeter

Prescale factor of 2000 : signature at 2 Hz   No Prescale but masked bad TT at L1 : signature at 2 Hz

- Plots obtained from the online Trigger monitoring system, recorded at the end of the run. Electron/photon algorithm eta/phi hit map.

- L1 operating far below its operating range. Hot spots appear no matter what.

- Hot cells from the detector addressed during shutdown period. New runs being taken to check the fixes. Specially interesting, Calo Slice Week.

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Masking via text file

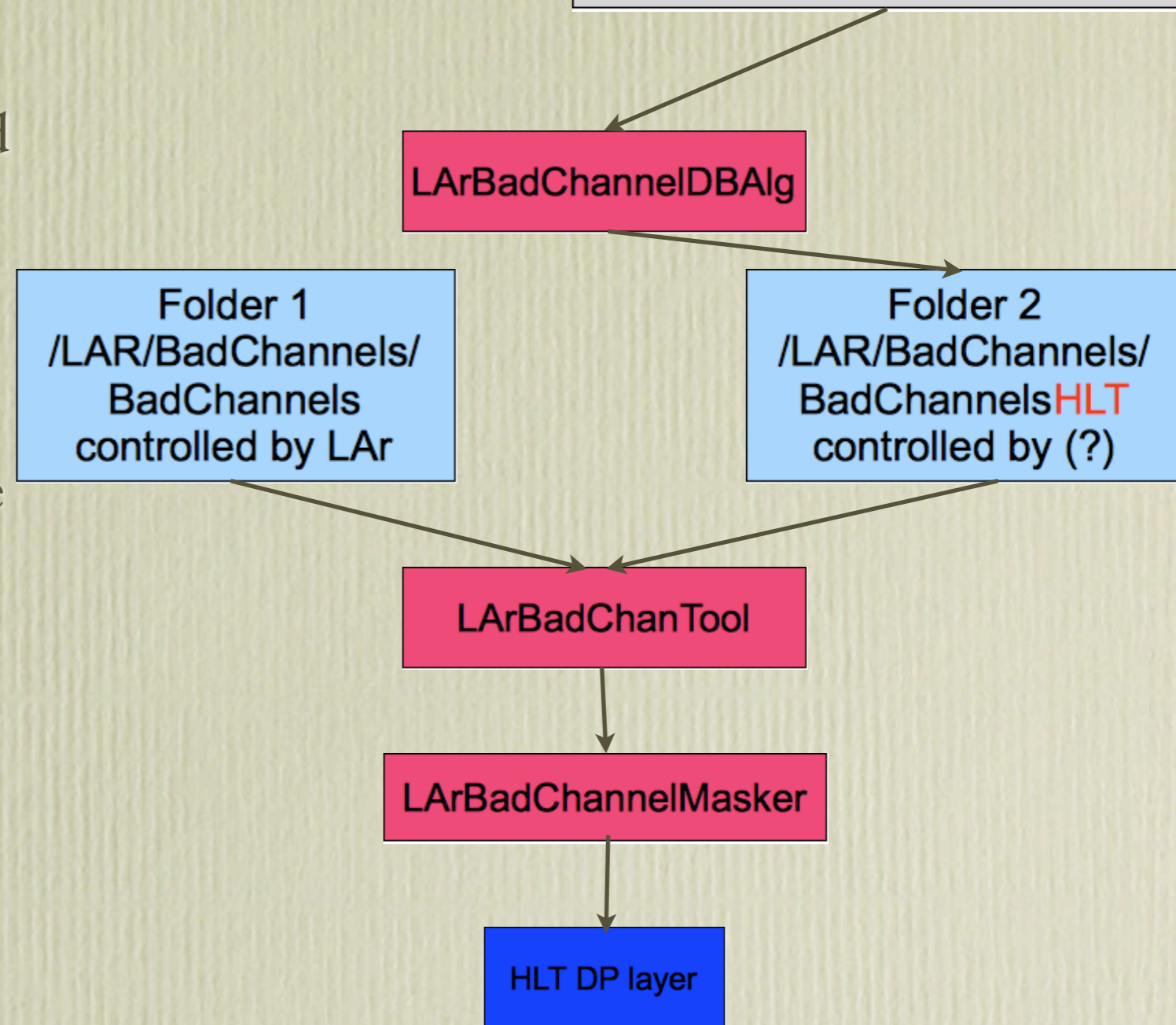| #barrel_ec	pos_neg	FT	Slot	Chan.	CalibLine	Status
0	1	4	12	64	0	deadCalib	
0	1	4	12	65	0	deadCalib	
0	1	4	12	66	0	deadCalib	
0	1	4	12	67	0	deadCalib	
0	1	13	12	64	0	deadCalib	
0	1	13	12	65	0	deadCalib	
0	1	13	12	66	0	deadCalib	
0	1	13	12	67	0	deadCalib	

Base work by Ted Todorov and Ryan Taylor to introduce this into HLT

- For LAr it is possible to use a second folder of the cool DB to provide information on newly bad channels. This is necessary if one may want a shifter to update DB.

- Similar case for Tile.

- Working in ways to easily find the addresses of the cells to be masked via monitoring.

- Where to store this information?! What other conditions are necessary?! Check next week's Detector Conditions Workshop. Some discussion already here for HLT Calo Twikis :

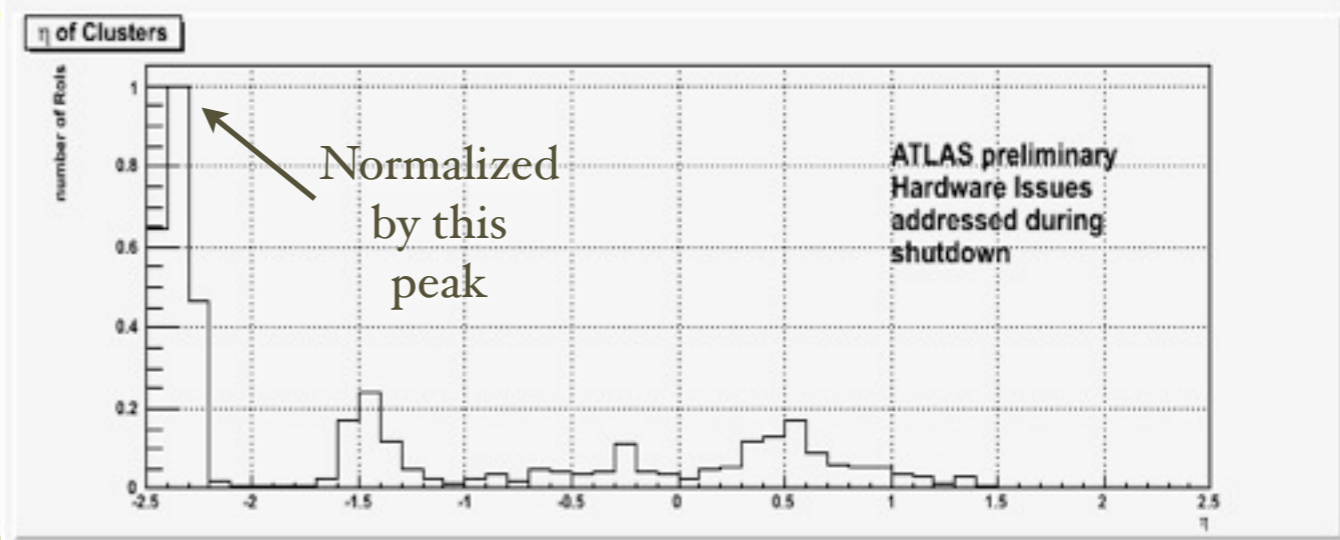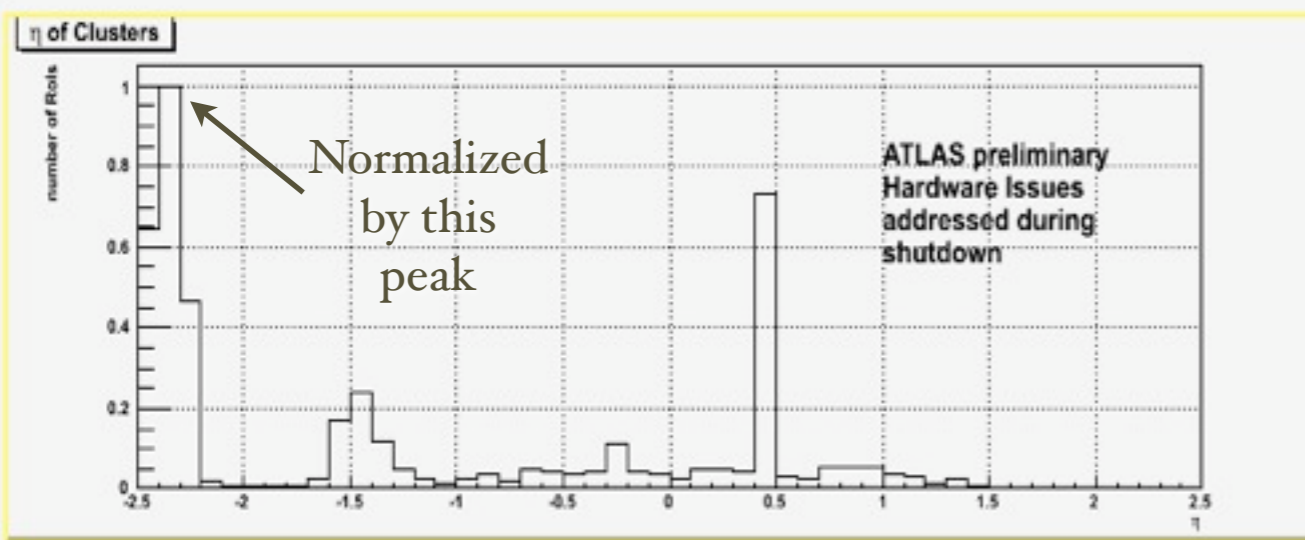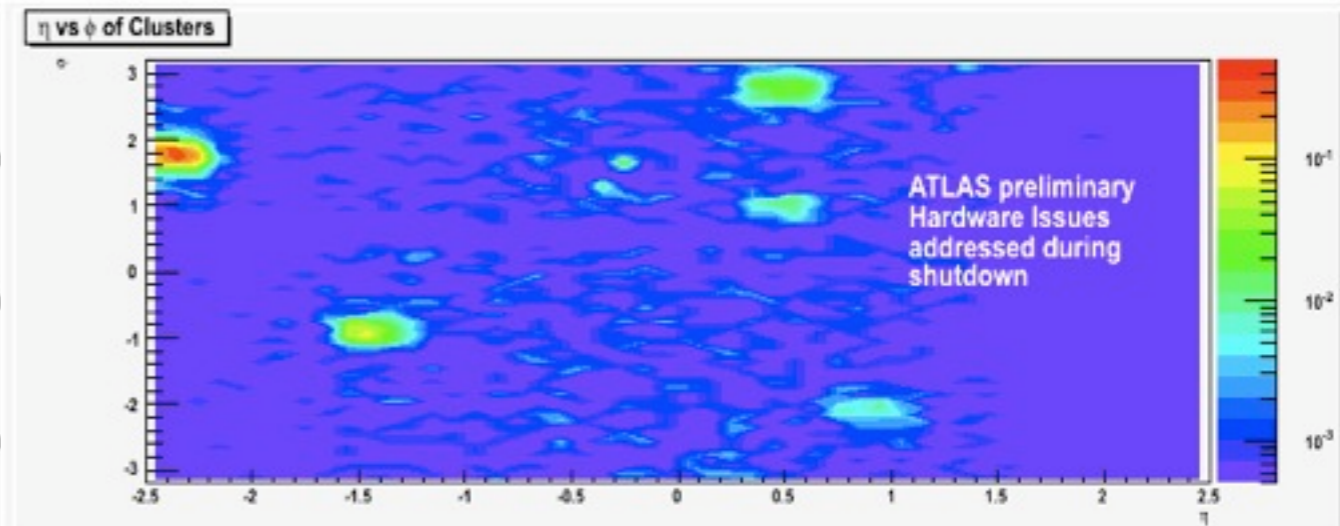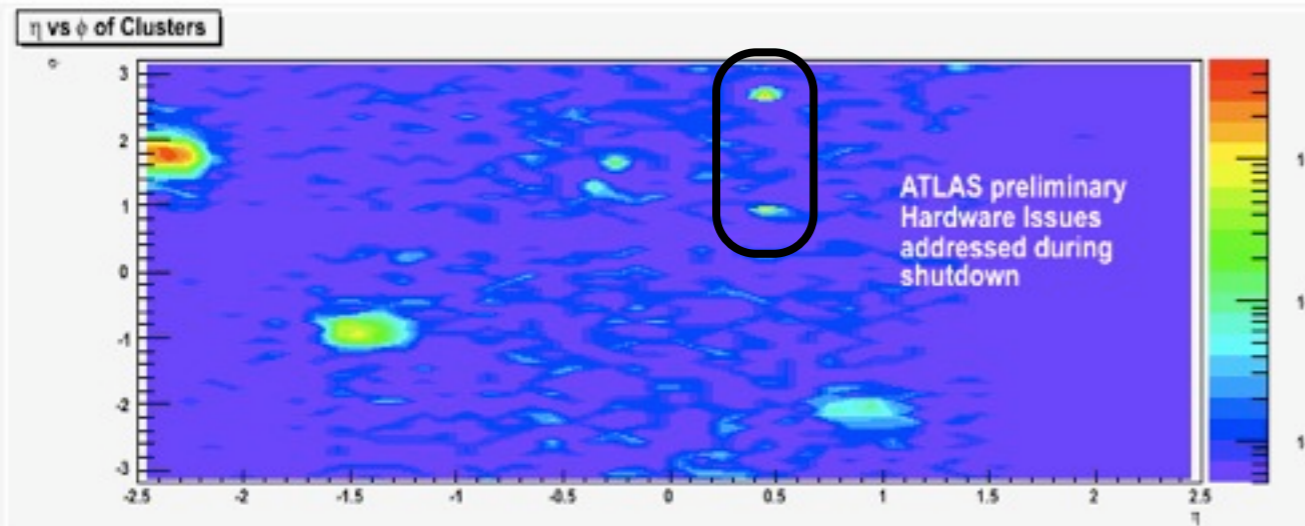https://twiki.cern.ch/twiki/bin/view/Atlas/HLTCaloConditions

LArBadChannelDBAlg

Folder 1
/LAR/BadChannels/
BadChannels
controlled by LAr

Folder 2
/LAR/BadChannels/
BadChannelsHLT
controlled by (?)

LArBadChanTool

LArBadChannelMasker

HLT DP layer

Wednesday, April 15, 2009

Masking of bad detector cells
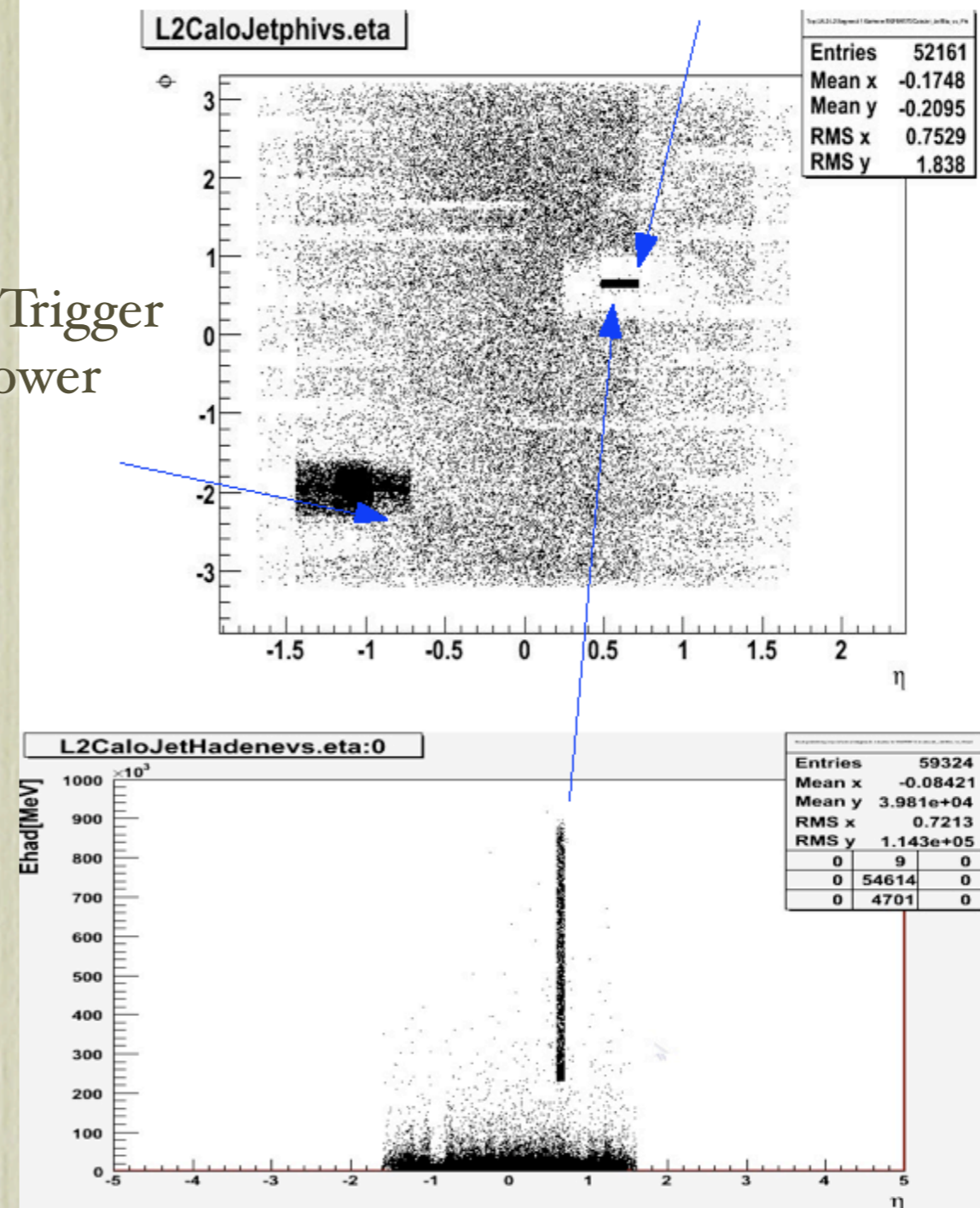
Not Masked

Masked

- Reprocessing the full run. Removing the hot cells from the HLT would avoid that these cells contribute to build a cluster energy.

- This would reduce the number of LvL2 accepts. And would also protect the EF.

- To solve the problem at the Lvl1, we have to set the gains from the front-end to Lvl1 system to zero for bad cells.

Corrupted Data from Tile

- Problem appearing even when masking applied. Occasional corrupted information.

- Worst part of it : seems like physics : 300 GeV peaks. Easy to spot in CR. Not as easy in real life (?).

- Recently fixed by checking a Data Quality block from the ROD inputFPGA.

Hot cell sucks all the LVL2 Jet findings on any region that touches it

Hot Trigger Tower

L2CaloJetphivs.eta

Entries	52161
Mean x	-0.1748
Mean y	-0.2095
RMS x	0.7529
RMS y	1.838

L2CaloJetHadenevs.eta:0

Entries	59324
Mean x	-0.08421
Mean y	3.981e+04
RMS x	0.7213
RMS y	1.143e+05

0	9	0
0	54614	0
0	4701	0

Global Time Performance

- Most of the time, the HLT will be rejecting events. Physics menu (full 10^{31}) used.

- Different algorithms need different processing times.

- May also need different amounts of data.

- System built with enough buffering to allow for a few events taking longer time.
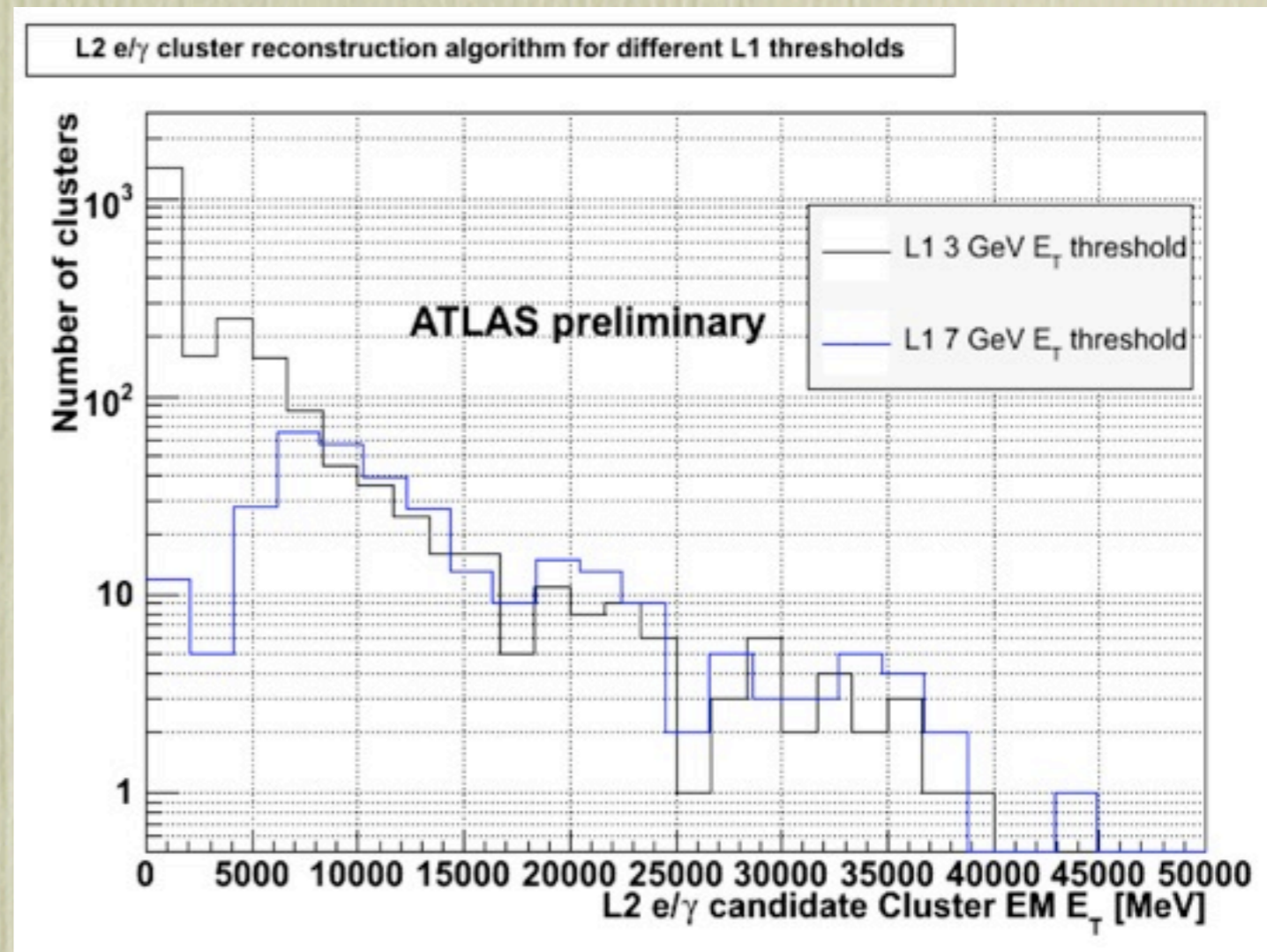
- Some algorithms getting more complexity => Keep an eye on time.

- In general calorimeter algorithms help each other with caching. In general Calo algorithms do not represent a problem (except some full calo, like TileMuId).

LVL2PU Rejected Event Total Processing Time

Entries	7.929809e+08
Mean	38.18
RMS	40.07

Level-2 rejected events

Processing Time for Rejected events

Entries	2358731
Mean	125.1
RMS	164.8

Event Filter rejected events
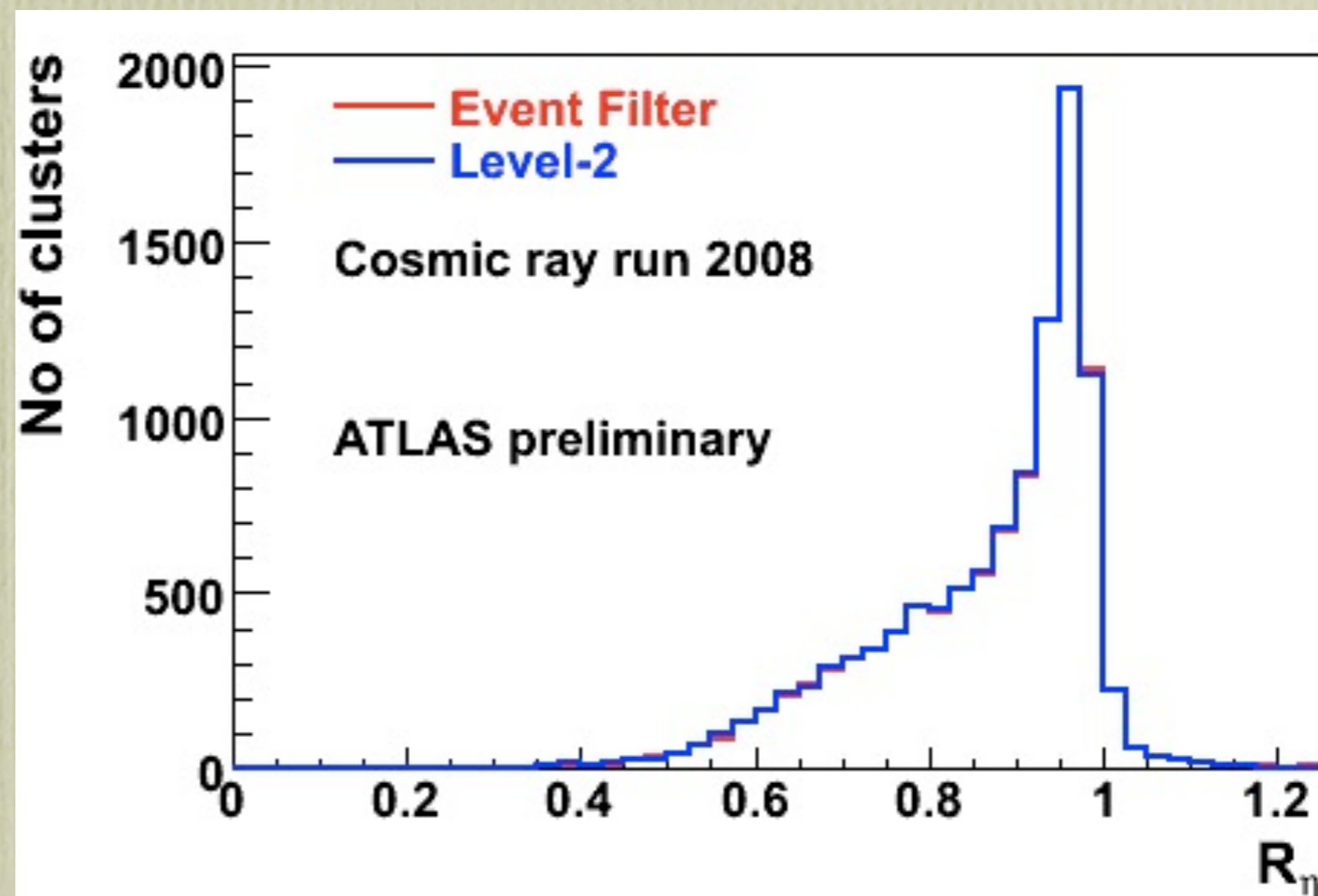
Wednesday, April 15, 2009
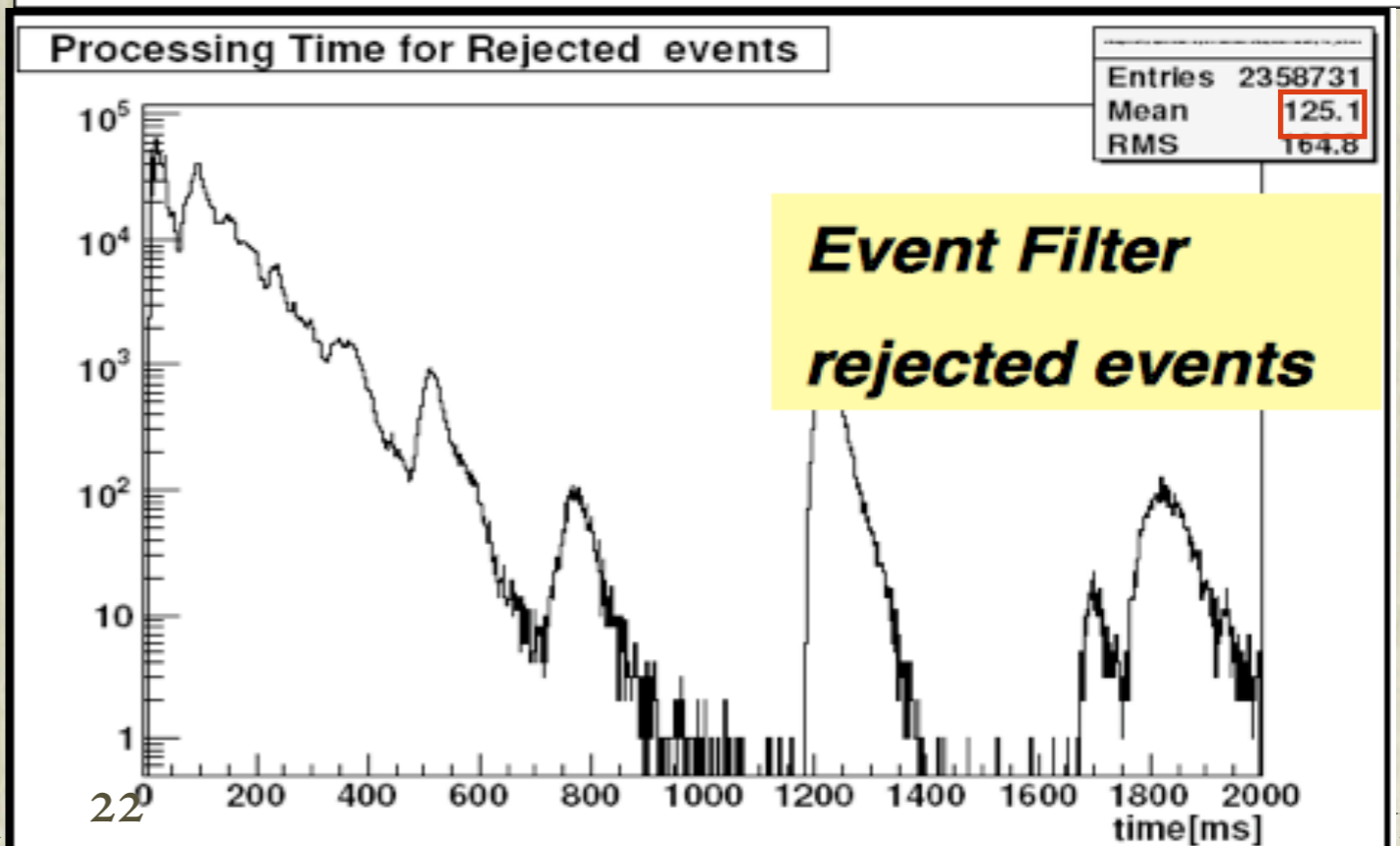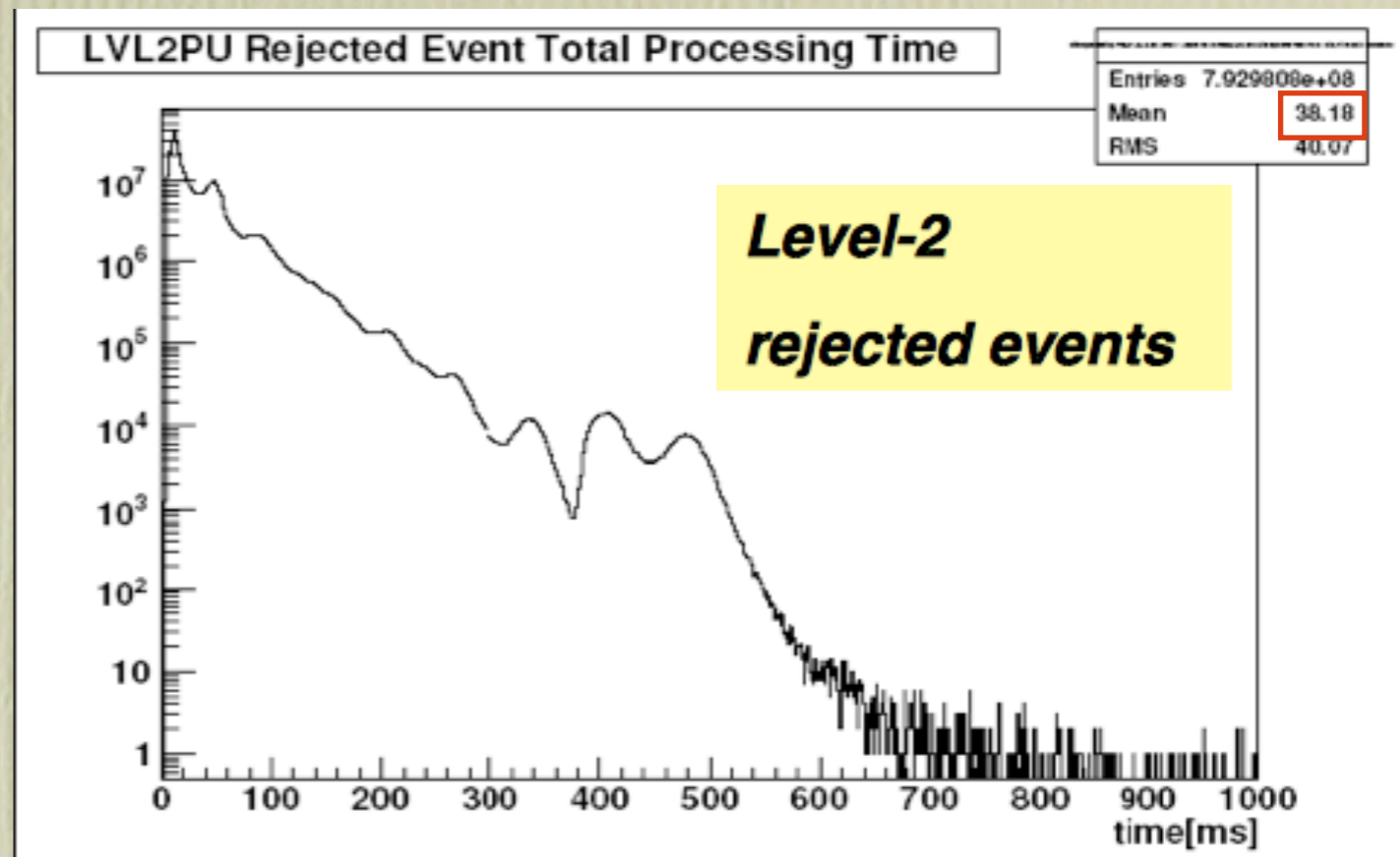
Monitoring different hypothesis

- Et monitoring at the Lvl2 based on different Lvl1 starting triggers.

- A higher Lvl1 threshold takes us away from the noise baseline.

- The number of fake clusters is seriously reduced. We start to do physics ;-)

L2 e/γ cluster reconstruction algorithm for different L1 thresholds

ATLAS preliminary

L1 3 GeV E_T threshold
L1 7 GeV E_T threshold

Number of clusters

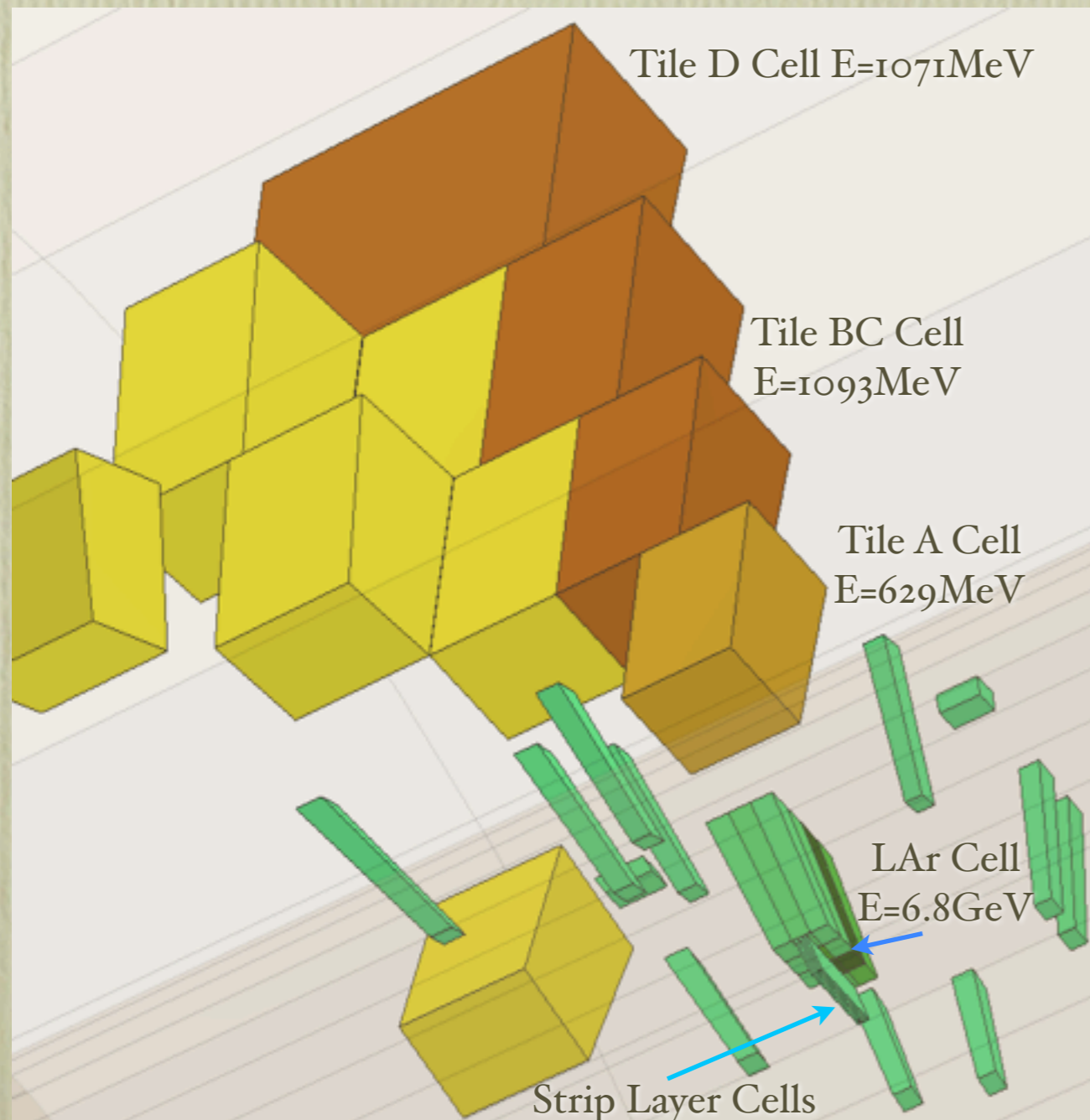L2 e/γ candidate Cluster EM E_T [MeV]

Egamma Slice

- Egamma is comparing the results of the LVL2 with those from the EF.

- EF is very based on the offline, so, the comparison is particularly important.

Confinement variable : E3x7/E7x7

Wednesday, April 15, 2009

A 3D plot

Tile D Cell E=1071MeV

Tile BC Cell
E=1093MeV

Tile A Cell
E=629MeV

LAr Cell
E=6.8GeV

Strip Layer Cells

- The cells from a few events can be dumped from the LVL2 trigger (egamma and taus), showing a Region of Interest.

- Events with energy depositions in Tile and LAr are particularly interesting : one detector helps to check the other!

Wednesday, April 15, 2009

Fundamental Topic : Online Monitoring

- Cross-correlating detector plots with LVL1 and detector plots, one can quickly isolate sources of issues.

- I believe that working in an integrated online monitoring with detectors, Lvl1 and different HLT slices is a key topic for the next months.

- Also, only the detector knows about its cabling fundamental information for masking!
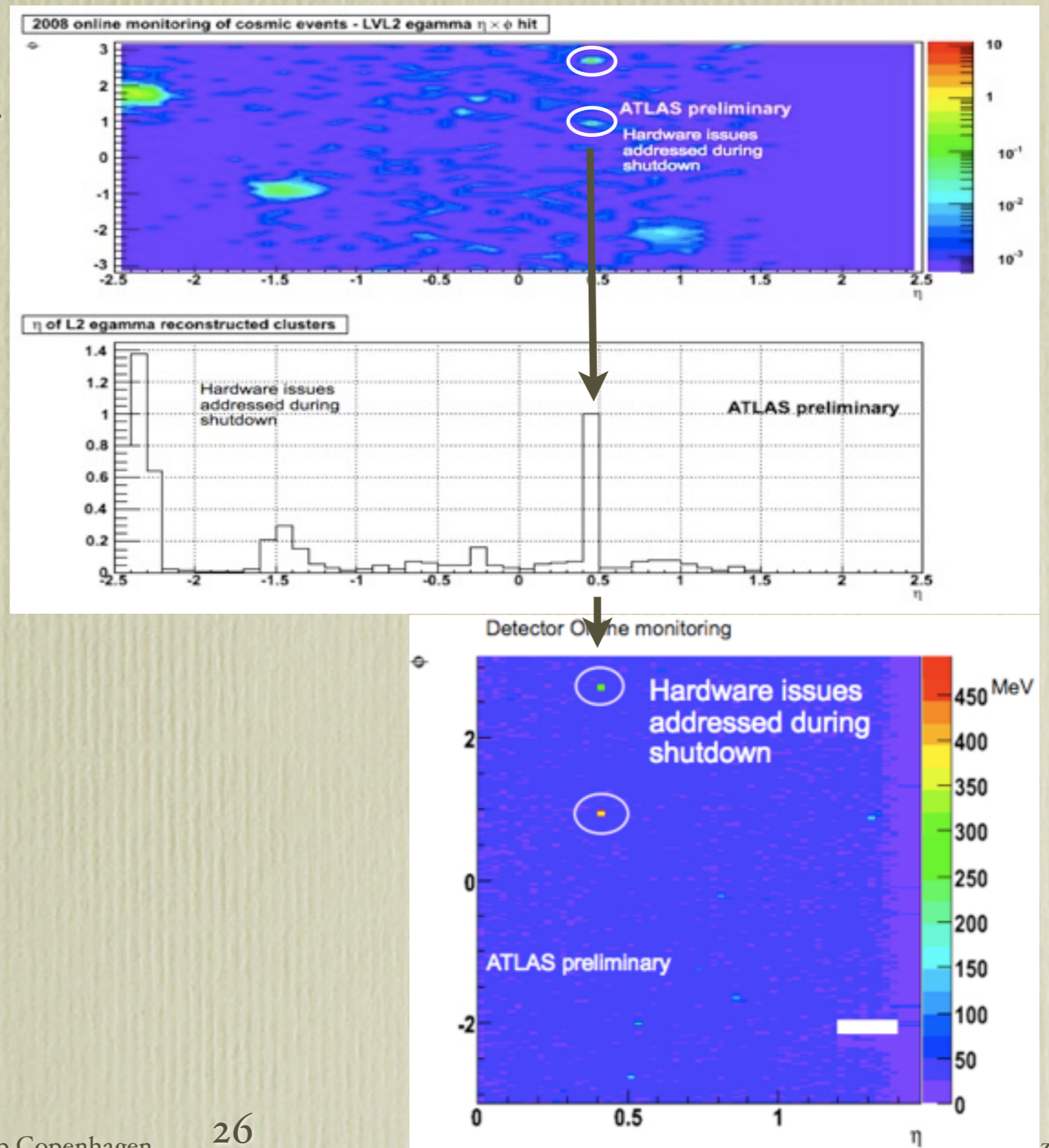
Tier Zero Monitoring
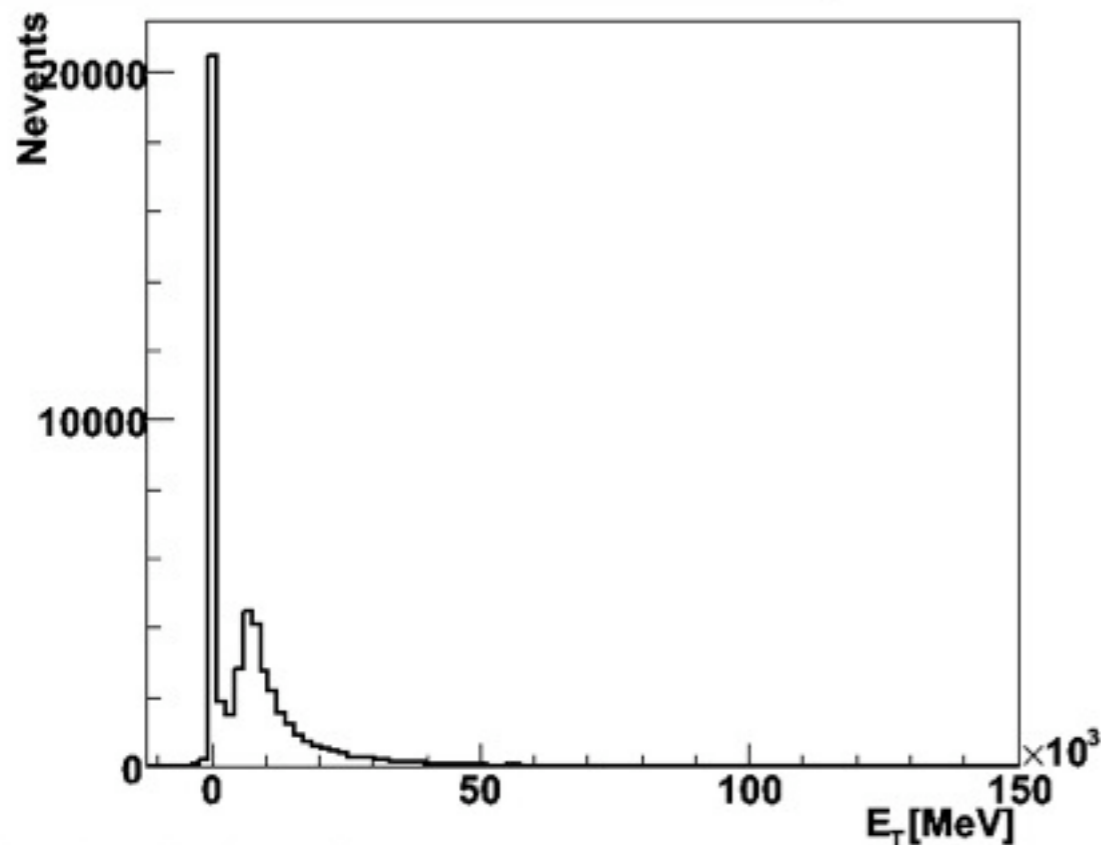
- tauSlice: **Red**
  - Dump: **Red**
    - EFTau: **Red**
    - L1RoI: **Green**
    - T2CaloTau: **Green**
    - T2IDTau: **Red**
    - T2TauFinal: **Green**
  - tauNoCut: **Red**
    - EFTau: **Red**
    - L1RoI: **Green**
    - RelativeEfficiency: **Green**
    - T2CaloTau: **Green**
    - T2IDTau: **Red**
    - T2TauFinal: **Green**

L2 TrigCaloCluster Eta vs Phi
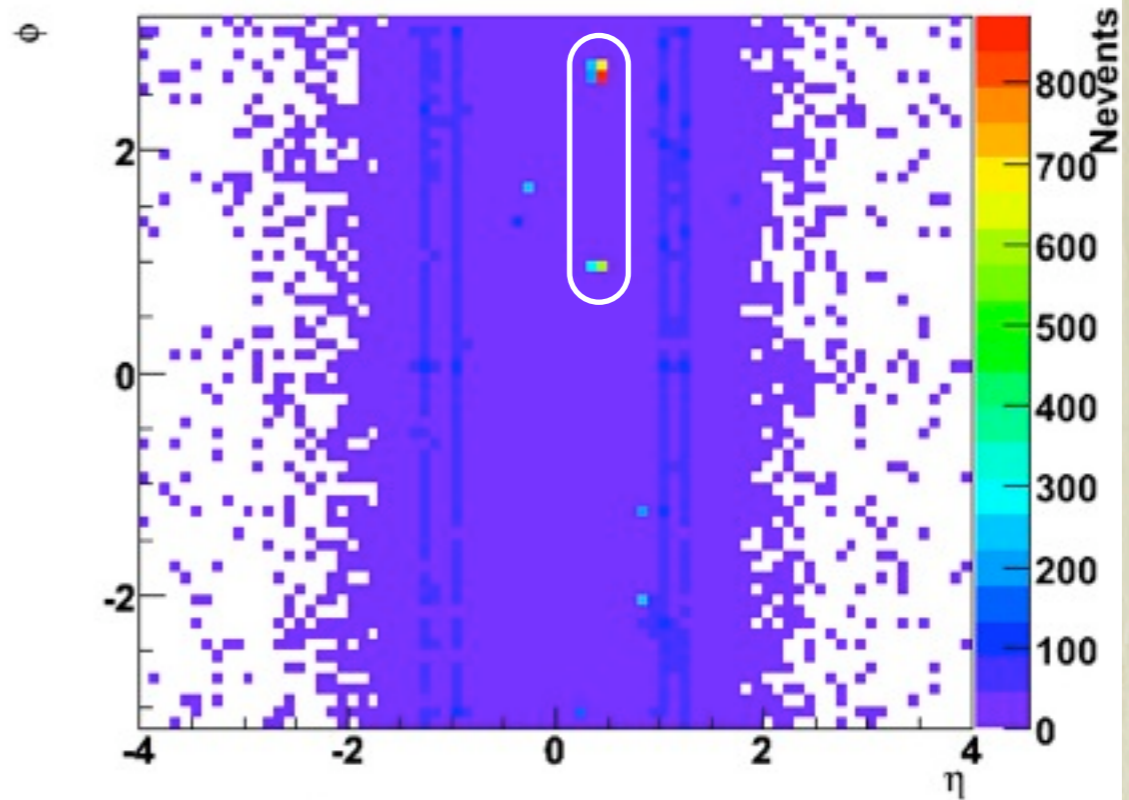
Run 90345, 1/physics_L1Calo
/HLT/tauSlice/tauNoCut/T2CaloTau/hEtaVsPhi

L2 TrigCaloCluster, E_T in narrow cone

Run 90345, 1/physics_L1Calo
/HLT/tauSlice/tauNoCut/T2CaloTau/hEtRawNar

- Slices must provide tests on the monitoring histograms and a good/bad flag for each run.

- Plots from the reprocessing for the HLT Tau Slice.

Denis Oliveira Damazio (BNL)

Wednesday, April 15, 2009

Kind of photo we want to see by october!!!

Splash Events
on September 10th,
2008

Happy people on the
control room!!
And, I hope soon,
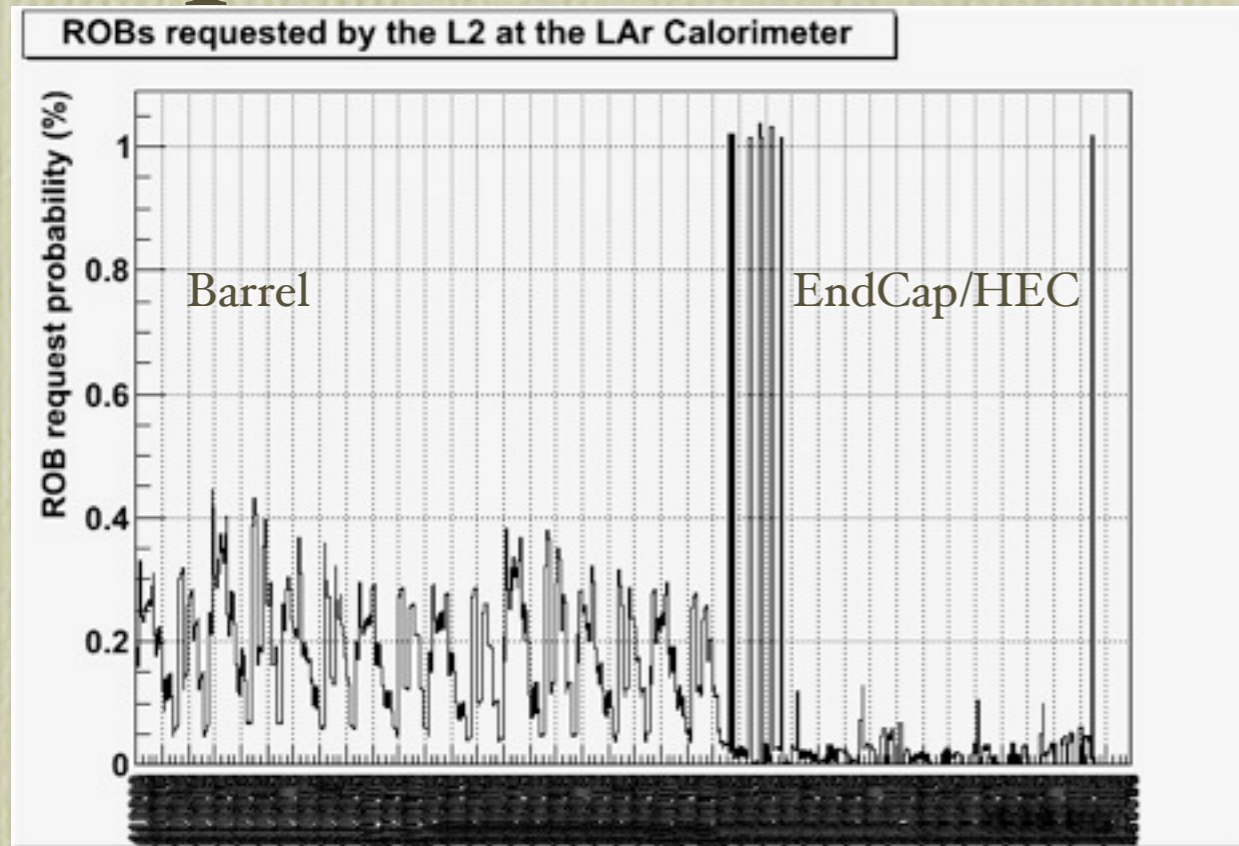all over the world!

<-- Beam 1 (A)

Summary

- Lots of hardware issues found in the runs taken since 2007. They were specially addressed during this shutdown period. Sub-Detector coming back to life!

- Detector groups trying to understand calorimeter performance. Calibration and cosmic runs being taken.

- Monitoring HLT, Lvl1 and detector seems to be the key to identify problems (and cure them!).

- Calo Weeks starting next week! Join the team, take shifts in the different calos, in Lvl1 and in the HLT table : be there when LHC start up!

Wednesday, April 15, 2009

More information

- Links to different slides about detector or trigger commissioning.

- LAr shutdown period activities (Katherine Copic) : http://indico.cern.ch/getFile.py/access?contribId=8&sessionId=17&resId=0&materialId=slides&confId=47254

- Tile Commissioning (Giulio Usai) : http://indico.cern.ch/materialDisplay.py?contribId=9&sessionId=17&materialId=slides&confId=47254

- HLT Calorimeter Twiki : https://twiki.cern.ch/twiki/bin/view/Atlas/WebHome?topic=TrigT2Calo.

- CHEP talks on HLT :

  - Werner Wiedenmann : http://indico.cern.ch/contributionDisplay.py?contribId=150&sessionId=57&confId=35523.

  - Alessandro Di Mattia : http://indico.cern.ch/contributionDisplay.py?contribId=94&sessionId=57&confId=35523.

- Next Week HLT/Detector Conditions Workshop : http://indico.cern.ch/conferenceDisplay.py?confId=44741.

BackUp

ROB requested in the presence of hot Lvl1 elements
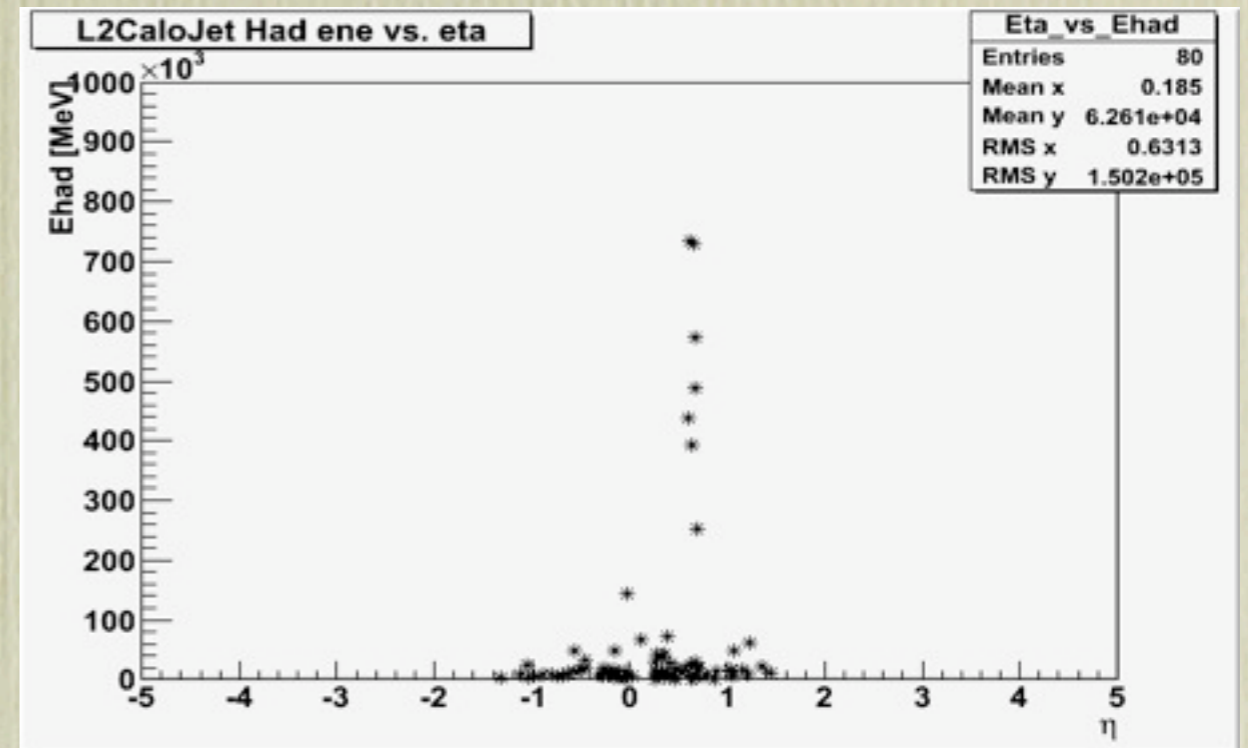

Barrel   EndCap/HEC

Prescale factor of 2000
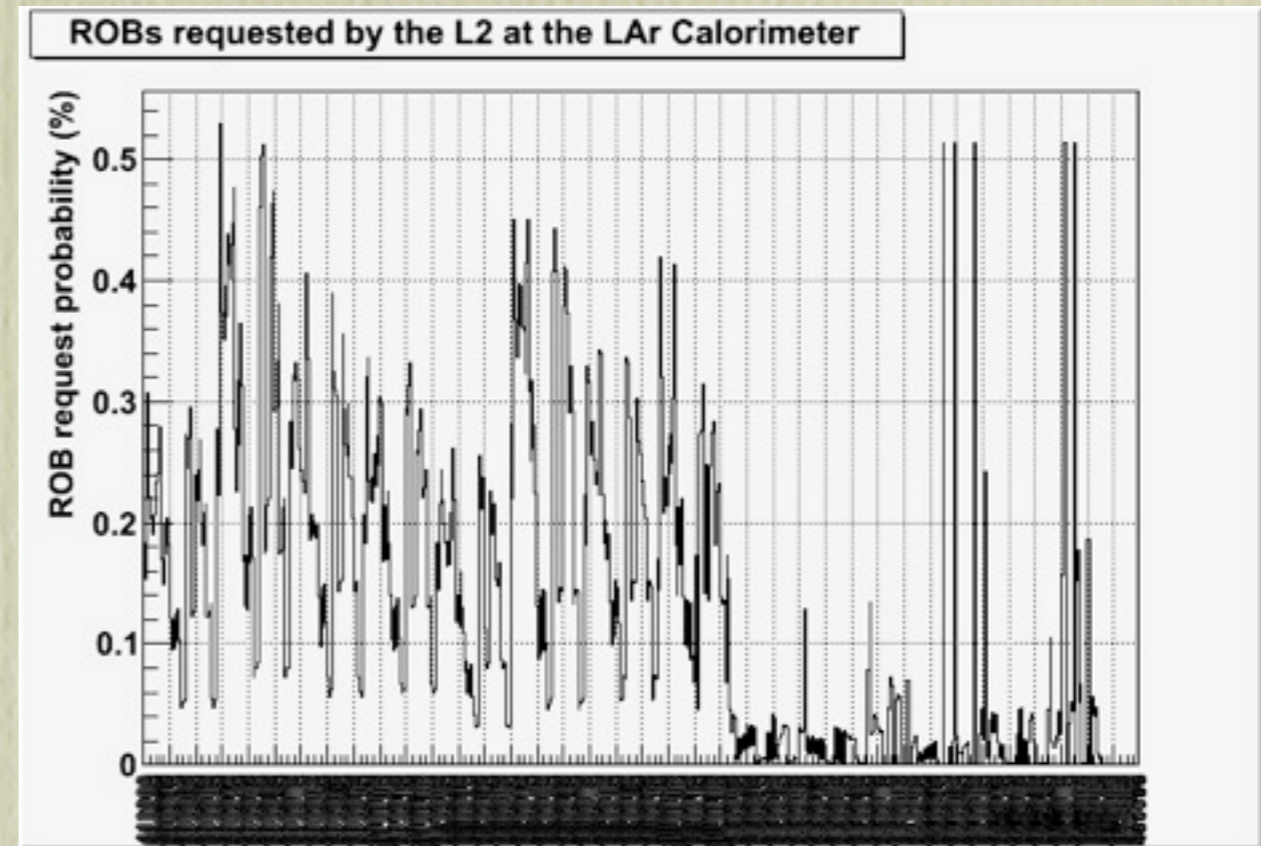
No Prescale but masked

- These are the ROB addresses. See that before the masking, even with huge prescale, a few ROBs are being requested much more than others.

- This can eventually block the full data acquisition system : No physics!

- Checking the address map, these too noisy TT correspond to the different layers on exactly the same region around eta=2.2, phi=0.9.

Wednesday, April 15, 2009

Problem recently fixed

- A fragment produced inside the ROD (but not by the Tile DSPs) provide information on data corruption.

- It comes from the input FPGA. The fragment is just copied (but not interpreted) by the DSP.

- Recently a correction was applied to the bytestream conversion, allowing to avoid these issues by checking this data quality fragment.

- It would be nice to re-run some of these tests in a reprocessing with re-run of the HLT to check for such problems.

Before fix

After fix