



# **Atlas Tile Calorimeter Data Quality Assessment During the LHC LS1**

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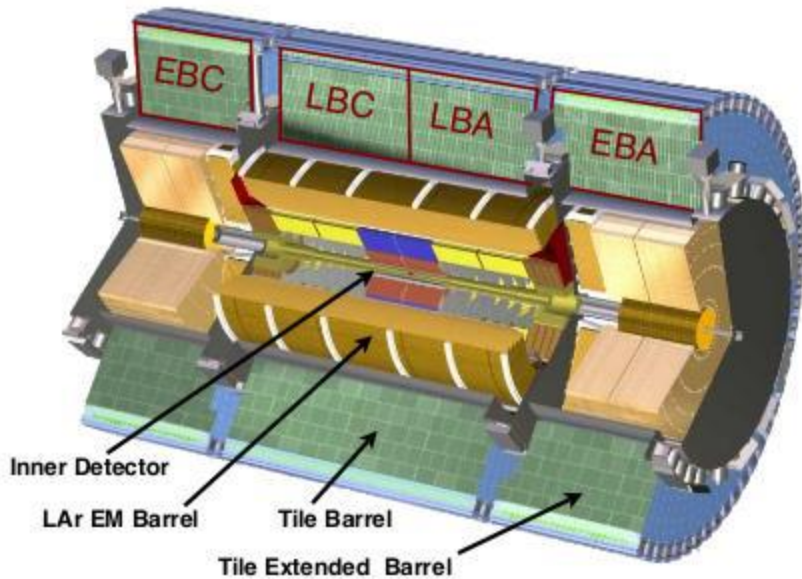
**Physics in the LHC era, Tbilisi, Georgia**

**17-th of October, 2013**

# Outline

- **ATLAS Tile Calorimeter**
- **Signal from Calorimeter**
- **Calibration systems**
- **Organization of LS1 activities**
- **Role of DQ Leader in LS1**
- **Standalone Calibrations**
- **Consolidated modules**
- **Verification of consolidations and re-openings**
- **Summary**

# ATLAS Tile Calorimeter



- Diameter: 8.5 m
- Length= 12 m
- Weight: 2900 T
- Total thickness of  $7.4\lambda_{\text{int}}$  at  $\eta=0$

## Design goals:

- large dynamic range (detect low signal from muons up to high signals from jets at TeV scale)
- energy linearity  $\sim 2\%$  for high  $p_T$  jets up to few TeV

• 3 cylinders with coverage:  $|\eta| < 1.7$ )

• Sampling calorimeter: Fe/scintillator: 4:1

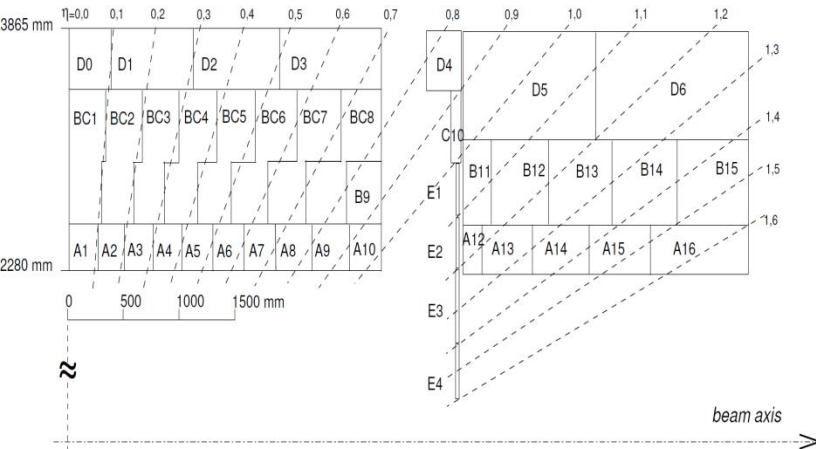
• Double PMT readout via WLS fibers (5000 cells  $\rightarrow$  10k channels)

• Aim for jet energy resolution:  $\Delta E/E = 50\% / \sqrt{E} \oplus 3\%$

# ATLAS Tile Calorimeter

## Principle of TileCal:

Measure light produced by charged particles in plastic scintillator.  
 scint. light from tiles collected by WLS fibers and delivered to photomultipliers (PMTs)



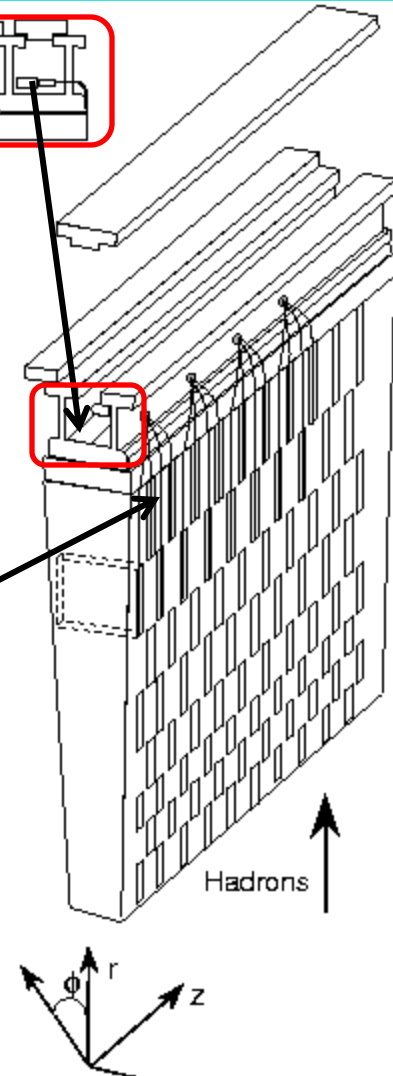
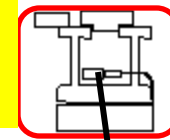
scintillator tile

WLS fibers

readout electronics,  
 PMTs are housed  
 here

PMT

Double  
 readout

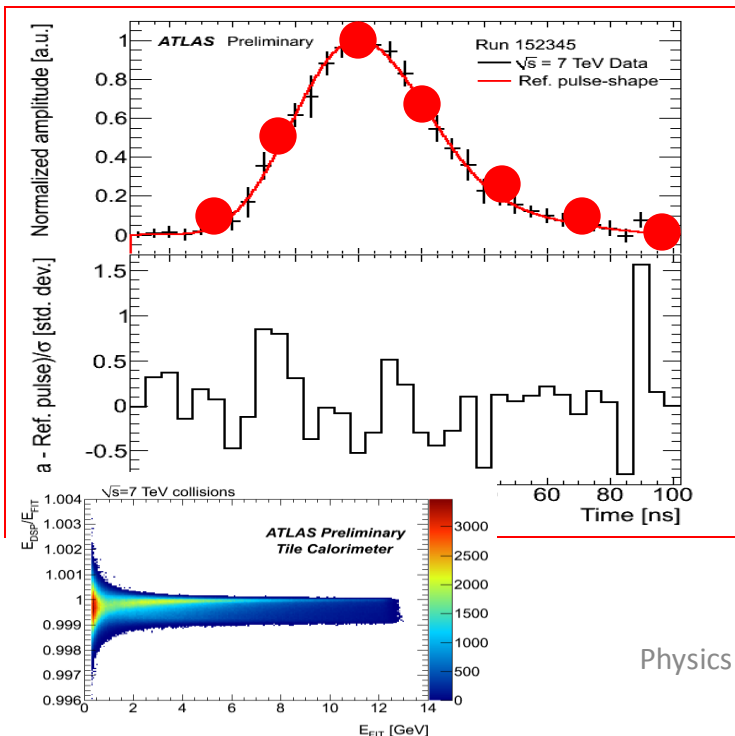
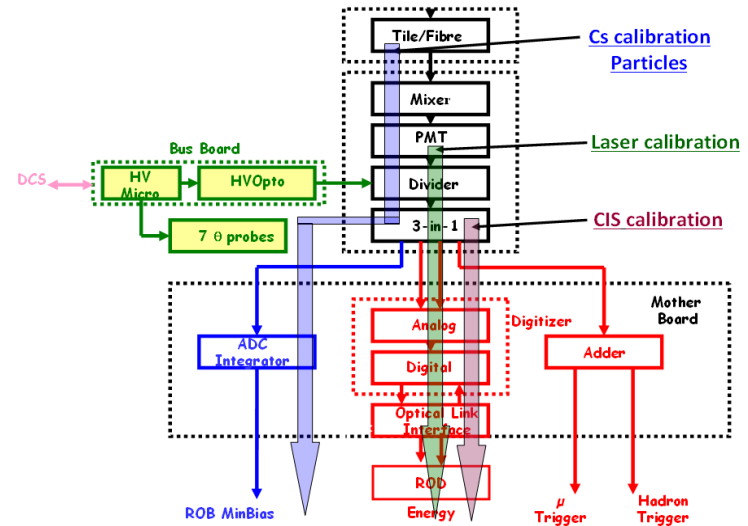


- Tile readout is grouped into projective geometry cells. each cell readout by 2 PMTs except of special cells
- 3 longitudinal layers
- Granularity  $\Delta\eta \times \Delta\phi = 0.1 \times 0.1$  ( $0.2 \times 0.1$  in 3rd layer)

# Signal from calorimeter

- Light signal converted into electrical pulse in PMTs
- Digital readout path:
  - shaping → pulse shape → sampled every 25 ns → energy reconstruction in RODs
  - two gains (ratio 64:1) to cover the required dynamic range (HG: up to ~12 GeV, LG: ~12 - 800 GeV)
  - used for physics, laser and CIS

Calibration schema in Tile Calorimeter



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

# Calibration systems

Tilecal includes 4 calibration systems: Cesium, laser, CIS, integrators;

Type of calibration runs:

**Ped (Pedestal):**

→ used to monitor electronics noise without a signal.  
(Bigain run – LG+HG)

**CIS (Charge Injection Scan):**

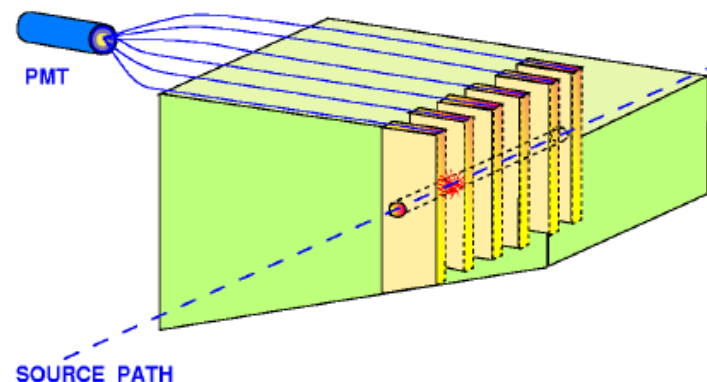
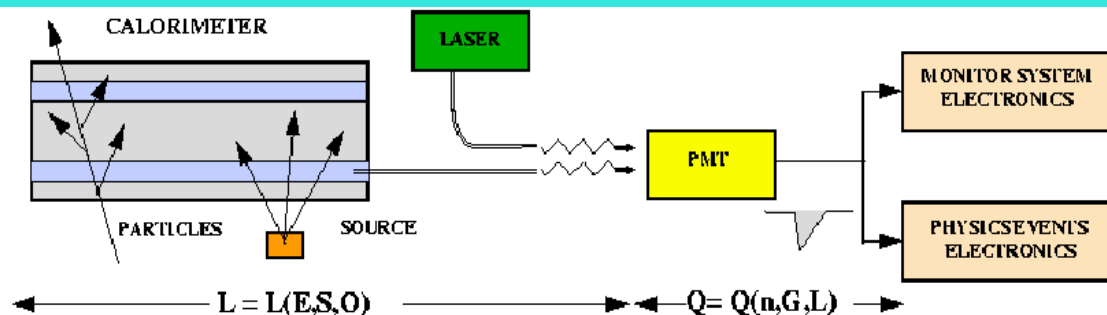
→ yields the count/pC conversion for each channel  
→ scans the entire range of the tilecal electronics (Bigain run – LG+HG)

**MonoCIS:**

→ A constant charge is injected to monitor electronics stability. (Mogain run)

**Laser:**

→ Laser light is injected into the laser fibers to make sure there are no dead PMTs/fibers and to calculate PMT gain and timing. Special calibration laser runs to monitor PMT linearity. (Monogain run)



# Organization of LS1 activities

## Tile LS1 Operations and Maintenance team:

**Run Coordinator**

**DQ Leader**

**Maintenance coordinators**

**Deputy Run Coordinator**

**DQ Validator**

**Maintenance team**

# Role of DQ Leader in LS1

- Retrieve the latest set of modules to inspect from the maintenance team
  - Receive a list from the Run Coordinator
  - Any module that have been checked for DVS and that might have an older or no DQ status on the Web Interface
- Assign the DQV the modules to check in the calibration runs :  
<http://tcws.web.cern.ch/tcws/dashboard/current/showRunList.php>
- Use the DQV report to assess and fill out the DQ portion on the [TileLS1Stats](https://tilecal.web.cern.ch/tilecal/TileLS1Status/current/index.php) page:  
<https://tilecal.web.cern.ch/tilecal/TileLS1Status/current/index.php>
- Report status during the maintenance meetings and give a full report during the TileCal Operation and Maintenance Weekly meetings.
- Flag modules as **Good/Average/Bad**
  - Average** =1 bad channel
  - Bad** = 2 or more bad channels
- Meet with maintenance team/Run Coordinator to pay attention to any DQ problems in consolidated modules
- Any DQ checks requested by DQ coordinator/RC/maintenance/etc....



# Standalone calibrations

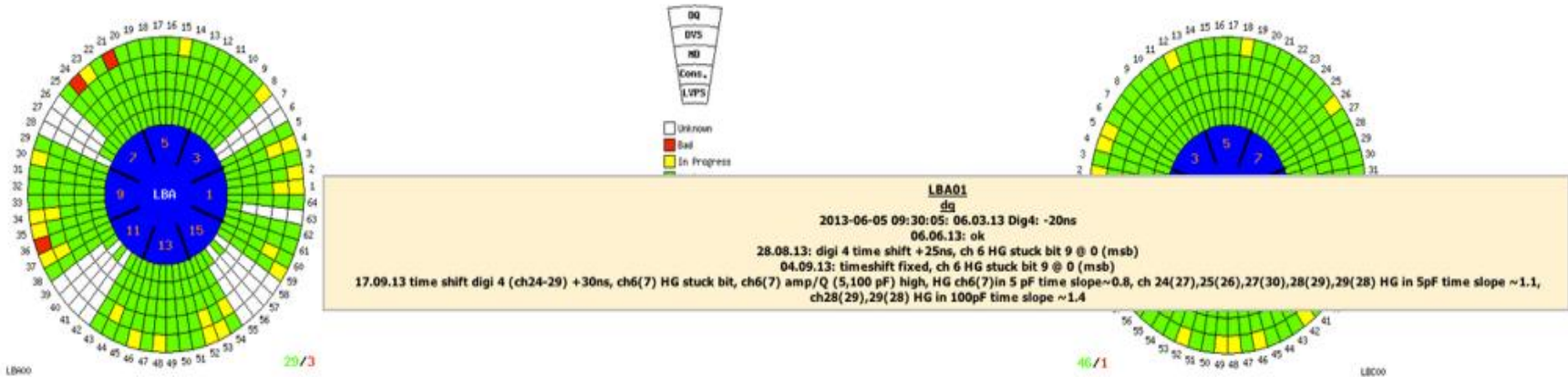
## Standalone calibration runs:

- Laser LG, laser HG, pedestal, CIS mono, CIS scan
- taken ~ twice per week
- goal: check newly consolidated modules + periodically re-check previously consolidated modules (sometimes new problems appear!)
- results summarized in the web-interface

# Standalone calibrations

## Standalone calibration runs:

- Laser LG, Laser HG, pedestal, CIS mono, CIS scan



- results summarized in the Tile LS1 Maintenance status web interface:  
<https://tilecal.web.cern.ch/tilecal/TileLS1Status/current/index.php>

# Schedule of LS1 activities

In September of 2013 several maintenance activities at P1: **cooling, network interventions, DCS upgrade**

- **Tile was off for most of the time**
- **TDAQ infrastructure not available for 3 weeks**
- **maintenance team kept working, however we could not run the usual verifications (DVS tests and calibrations)**

# Consolidated modules:

- **LBA: 01,02,03,04,05,08-25, 29-38, 43-54, 59-62, 64**
- **LBC: 01-38, 41-56, 59-64**
- **EBA: 01, 02, 9-11, 14, 15, 16-22,  
33,35, 37, 38, 49,59,60, 61, 62,64**
- **One set of calibration runs over September- 04.09.13  
Runs: 223097 -223101**

# EBA consolidated modules checked in the calibration Runs (223097-223101) taken at 4.09.2013

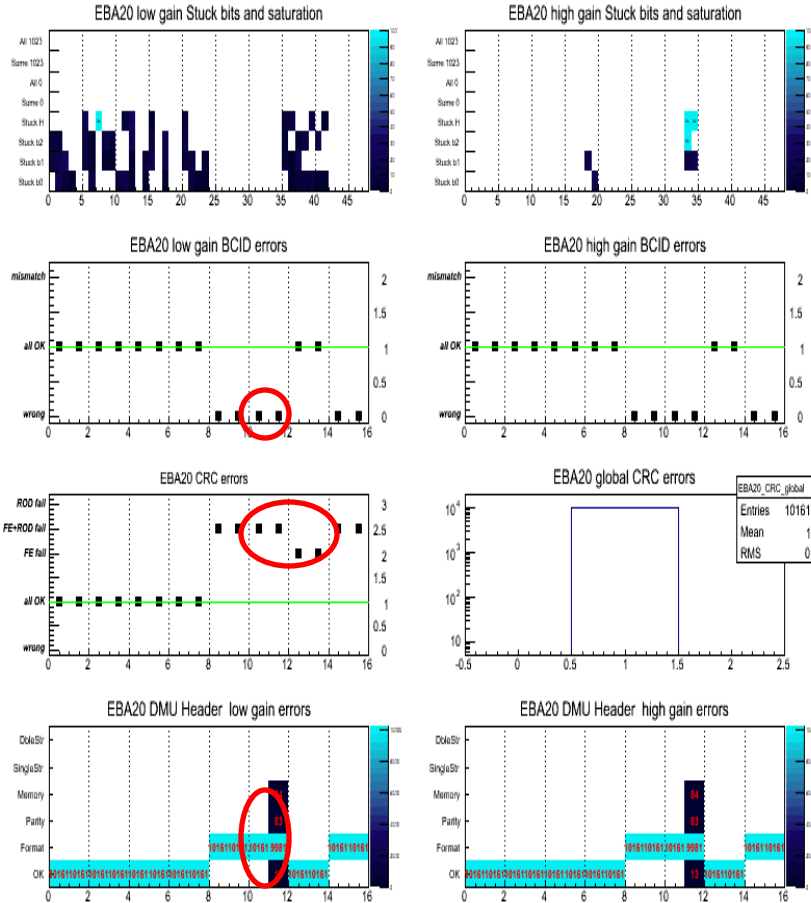
	MonoCIS	CIS	Pedestal	Laser LG	Laser HG	Comments
EBA09 30.08.13	OK	OK	OK	OK	OK	
EBA10 29.08.13	OK	OK	OK	OK	OK	
EBA11 21.08.13	OK	OK	OK	OK	OK	
EBA14 26.08.13	OK	OK	OK	OK	OK	ch 0(1), ch 1(2) Ampl, RMS high
EBA16 28.08.13	ch31 (29) amp, RMS amp high	LG Amp/Q ch31(29) (5,100pF) >1.5	OK	OK	OK	02.09.13 ch 31 CIS response 180%
EBA17 30.08.13	ch20-23 (21-24) time shift > 5 ns	OK	OK	OK	OK	to update digit timing
EBA18 21.08.13	OK	OK	OK	OK	OK	
EBA19 27.08.13	OK	OK	ch 32(30) RMS Noise LF,HF>1.2	OK	OK	02.09.13 ch32 (30) LG noise ~1.3, correlation in MB 1, 2 ~ 0.6-0.8. update: the noise and correlations for ch 32 is worse than before the consolidation.
EBA20 05.08.13						See next slide
EBA21 20.08.13	OK	OK	OK	OK	OK	

# EBA20 module

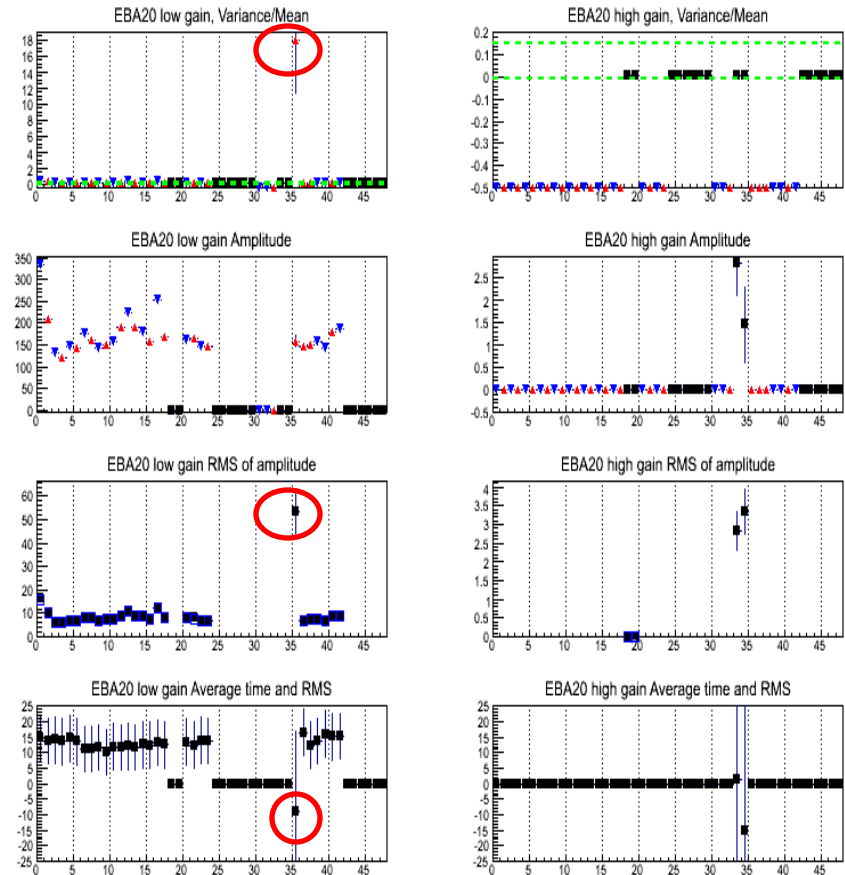
	<b>MonoCIS</b>	<b>CIS</b>	<b>Pedestal</b>	<b>Laser LG</b>	<b>Laser HG</b>	<b>Comments</b>
<b>EBA20 5.08.13</b>	LG,HG BCID DMU 11,12 wrong ; CRC errors: DMU11,12 (PMT 29,30,33,34) - FE+ROD fall; DMU 13,14 (PMT 37,38,44,41,42,43) -FE fall: DMU 11,12 Header errors ( format ~ 100%), LG RMS noise ch35 >100 (LF,HF)	LG RMS noise LF ch35(34)>160, HG RMS noise LF ch35(34)>400; LG,HG BCID DMU 11 wrong, CRC errors <;1 all DMU, Global CRC <;1; LG,HG DMU11,12, Header errors (format ~100%), LG, HG Amp/Q 5,100 pF ch30(33), ch 31(29)=0	LG,HG, BCID DMU 11 wrong; CRC errors: all DMU <1, Global CRC <1; LG,HG DMU 11,12 Header error (format ~ 100%); LG,HG pedestal value ch 35 > 100; LG,HG RMS noise ch 35 > 100 (LF), LG RMS noise ch35>120 (HF), HG RMS noise ch35 > 50 (HF)	CRC errors: DMU 11(PMT 29,30,33),DMU1 2(PMT 34)- FE+ROD fall,DMU13 (PMT 37,38,44),DMU1 4 (PMT 41,42,43)- FE fall; DMU 11,12 Header errors (format ~ 100%); LG variance/Amp ch 35(34) >18, RMS of amp ch35(34)>50, Timing shift ch 35 ~ -20ns, ch 30-32 ( 33,29,30) ~ - 15ns; ampl ch30-32 (33,29,30)=0	BCID DMU 11 wrong; CRC errors: DMU 11,12-FE+ROD fall, DMU 13,14 -FE fall; DMU 11,12 Header errors ( format ~100%); variance/mean ch30-32<-0.4, ch35 >1; Amp ch30-32=0, ch35(34)>1.5; Time shift ch30-32,35 ~ -15 ns, RMS noise ch35 >100 (LF)	Replace Digit 3

# EBA20 module

## monoCIS – Run 223097



## Laser LG – Run 223100

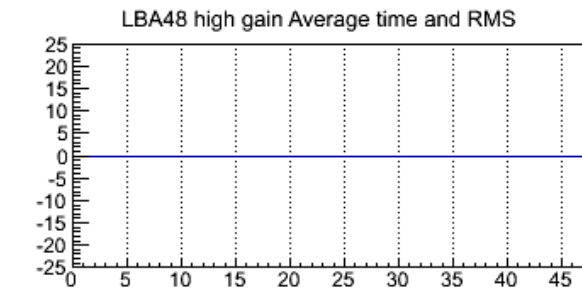
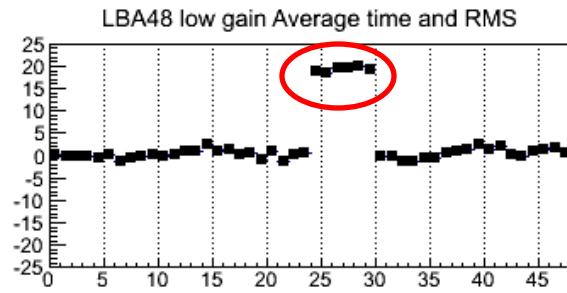
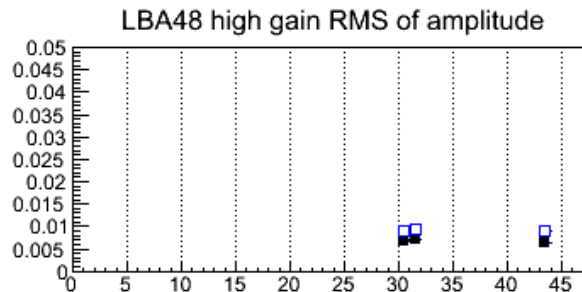
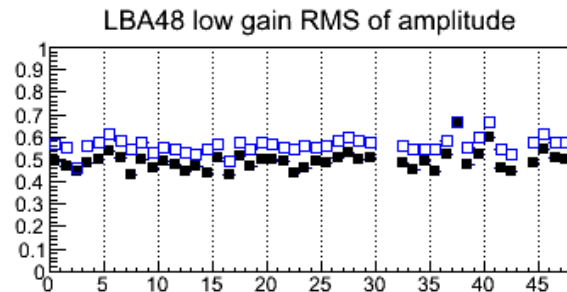
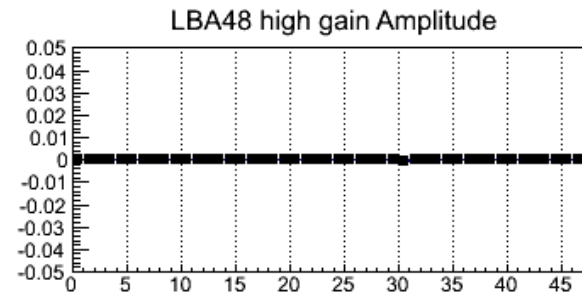
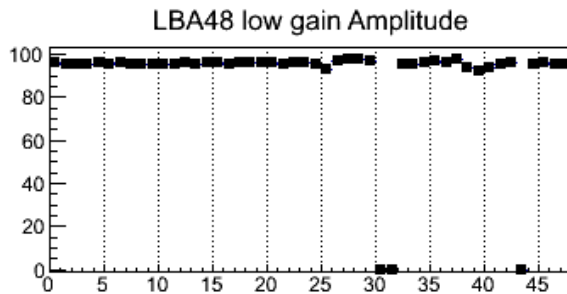


# Changes of DQ status in Consolidated Modules

Old DQ status	Current DQ status	Comments
LBC62	LBC62	10.09.13: L1Trigger tower 1 dead. Set flag to red
LBC52	LBC52	10.09.13: L1 trigger: tower 1 half-gain. Set flag to yellow
EBA16	EBA16	09.09.13: L1Trigger: looks like a muon output swap
EBA20	EBA20	12.09.13:LG,HG DMU11,(PMT29,30,33) DMU12(PMT 34)errors: BCID, CRC; DMU 13(PMT 37,38,44)14(PMT41,42,43) CRC errors; ch35(34) noisy; Timing shift: ch35(34), ch30-32(33,29,30)
LBA48	LBA48	17.0913: LG Average Time and RMS digi 4 (ch24÷29) shift +20ns
LBA59	LBA59	17.0913: LG Average Time and RMS digi 4 (ch24÷29) +20ns; ch27 LG Time offset 100pF above threshold, LG ch29 Time slope in 100pF <-0.2
LBC34	LBC34	19.09.13: LG CRC errors DMU 4,5,7 Rod fall, all other DMUs errors FE_Rod fall; LG&HG All DMU FORMAT errors 100%; HG Time slope 100pF all ch <1



# Run223097 (monoCIS) Time shifts



# Reopened Super Drawers, September 2013

Super-Drawer DQ status	Super-Drawer Issues/Comments/Notes	Date	Comments
LBC62	"dead" tower 1 in trigger.	Sep 23 , 2013	
LBC42	PMT5 with no response do Laser (LG and HG) PMTs 26 and 39 with HV instability	Sep 23, 2013	
LBA36	opened because half drawer dead for CIS and Laser. Power connector well not connected. fixed	Sep 19 , 2013	
EBA16	Reopened to swap Calo/Muon trigger cables.	Sep 13 , 2013	
LBA04	Reopened due to problems seen in DVS and DQ with PMT43.	Sep 13 , 2013	
LBA24	Reopened for following reason: DMU 13 parity error 5-95% events ch 39, 40, 41 (PMT 40,41,42) laser response +5-10% in same DMU 14 priority: high replace digitizer for DMUs 13-14 Corresponding digitizer#2 was replaced.	Sep 10 , 2013	
EBA14	Shielding for PMTs 37-38 (D6 noise)	Sep 12, 2013	
LBA21	Reopened for following reasons: ch19 (20) - very small amplitude and time shifted by +30 ns in laser ch32 (31) - gain switch failure	Sep 8, 2013	
LBA22	Reopened because PMT45 was dead for Laser.	Sep 4, 2013	After the repair was checked in calibration runs taken at 04.09.13. Everything was OK.

# Newly consolidated EBA modules – Sept ÷ Oct, 2013

Super-Drawer	Super-Drawer Issues/Comments/Notes	Date	Comments
EBA64	Standard reinforcement done. Plus 4 3in1 cards and 2 active dividers installed and connectors on the 3in1 adder cables for PMT#37 and 38 (D6 RL cells) screening (shielding) copper tapes added.	9 Sep, 2013	
EBA01	Drawer extracted from back side for consolidation.	10 Sep, 2013	
EBA02	Digitizer #8 changed due to stuck bit problem.	10 Sep, 2013	
EBA62	PMTs 1, 2, 13, and 14 removed for modification. Integrator gains changed for all four PMTs and active dividers installed in PMTs 1 and 2.	10 Sep, 2013	
EBA37	Removed PMTs 1, 2, 13, 14. Installed active dividers for PMTs 1, 2 and inserted new 3-in-1 cards with modified gains for 13, 14. Then reinstalled PMT blocks.	17 Sep, 2013	
EBA49	Replaced digiter: Looking at PMT 29's issues, noticed a StuckBit issues in collaboration with DQ	20 Sep, 2013	
EBA38	Consolidation started.	20 Sep, 2013	DVS tests ok, but: ch #3 high gain noise 6.45 ADC counts
EBA59	Consolidation started.	20 Sep, 2013	DVS tests passed, but integrator test failed
EBA60	PMTs 1, 2, 13, 14 removed to install new active dividers (1, 2) and 3-1 cards with modified gains (all). Then, PMTs reinserted. Digitizer #7 was replaced	30 Sep, 2013	
EBA61	PMTs 1, 2, 13, 14 removed and modified 3-in-1 cards installed. Active dividers added for PMTs 1 and 2. The 3-in-1 card was changed for PMT17 to solve the initial issue.	11 Oct, 2013	
EBA35	PMTs 1, 2, 13, 14 removed to install new active dividers (1, 2) and 3-1 cards with modified gains (all). Then, PMTs reinserted. Replaced mezzanine card	8 Oct, 2013	

# Newly consolidated EBA modules – Sept ÷ Oct, 2013

<b>Super-Drawer</b>	<b>Super-Drawer Issues/Comments/Notes</b>	<b>Date</b>	<b>Comments</b>
<b>EBA15</b>	<b>PMTs 13, 14 and 19, 20 had modified 3-in-1 cards installed, 19 and 20 also active dividers</b>	<b>11 oct, 2013</b>	
<b>EBA33</b>	<b>PMT 37 and 38 trigger cables shielded. PMTs 1,2,13,14 underwent 3-in1 card replacement, modified gain 3-in-1 cards installed</b>	<b>11 oct, 2013</b>	

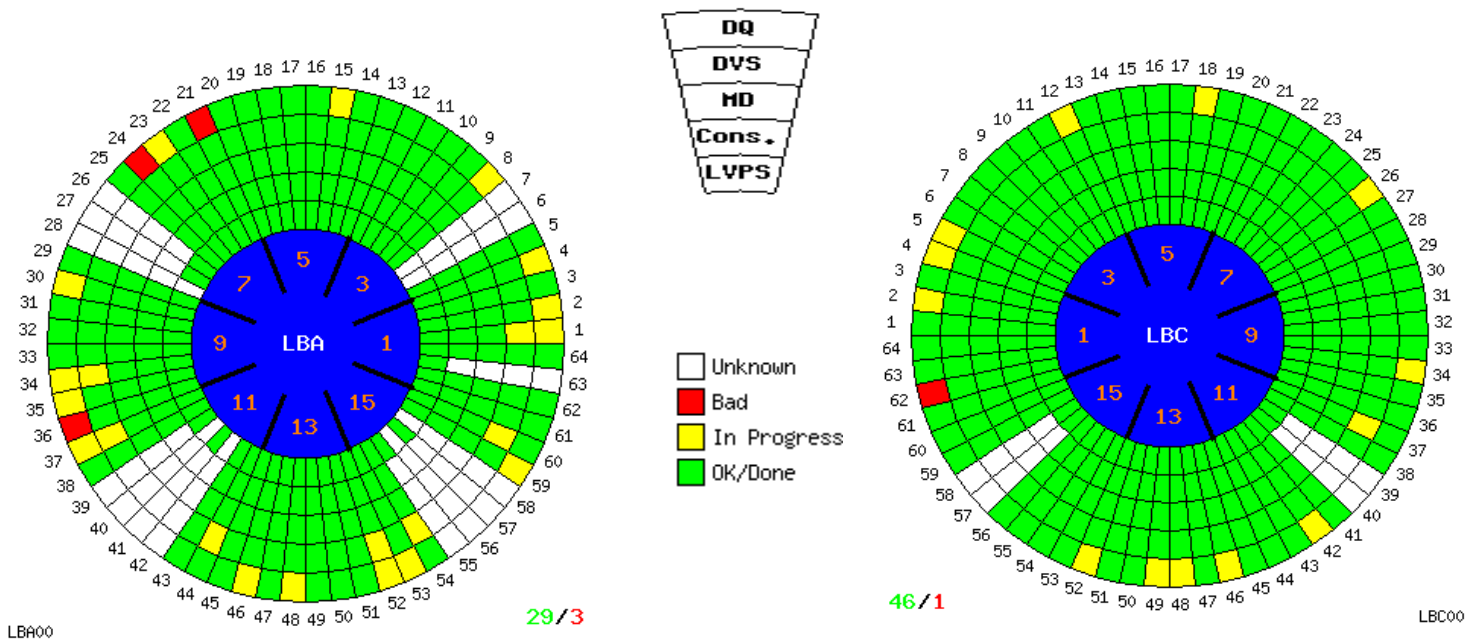
# Reopened Super Drawers May ÷ August 2013

Super-Drawer, Old DQ Status	Super-Drawer Issues/Comments/Notes	Date	Comments, Current DQ status
LBC07	All 6 channels on MB#2 had high RMS noise level for low frequency	Aug 20, 2013	OK
LBC33	Reopened du to digitizer 8: digital errors, LG amp RMS affected	Aug 14, 2013	OK
LBC11	Reopened du to: ch 45 (PMT 48): stuck bit on (bit4) HG CIS, 6x noise (ped/laser HG)correlated noise HG 0.4 inner half SD	Aug 13, 2013	19.09.13: lg Average time and RMS ch19 ÷23 +8ns
LBC15	Was reopened to replace the mezzanine card (due to problems communicating with all motherboards)	Aug 6, 2013	OK
LBC23	oscillations with 5 V sense line,	Jun 28, 2013	19.09.13: Digi 4 (ch 24-28) 5.9 ns
LBA37	light leak in PMT 2 (HV on)	May 27, 2013	06.06.13: Laser LG: chs 1(2),19(20) Amp=0. 17.06.13: Laser LG/HG: ch1(2) Amp=0 05.07.13: INFO: for PMT2 from laser: It has very low response wrt the rest since 2010 at least! Most probably what the intg sees is not light leak. 07.07.13 ch1/PMT2 no response to Laser 28.08.13: ch 1/19: response to laser is low (7/3% wrt mean response) but not 0! ch19 cis response 110% 17.09.13: Laser LG Digi 1,2 (ch 36-47) time shift 10ns.

# Overall progress- LBA+LBC

	Good DQ	DQ Problems	Bad DQ	Unchecked
Current	79	27	4	18

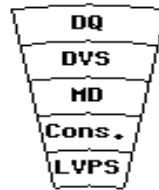
Outermost circle is for Data Quality



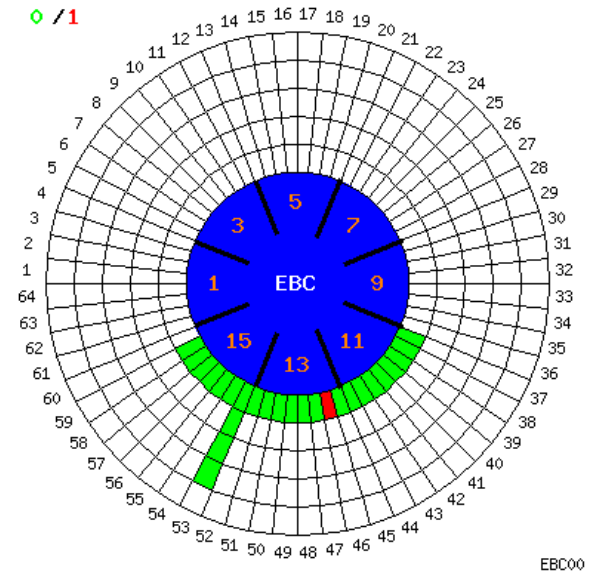
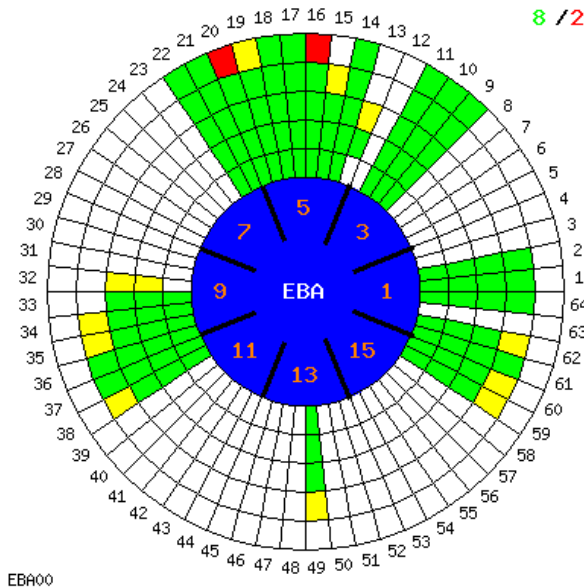
# Overall progress- EBA+EBC

	Good DQ	DQ Problems	Bad DQ	Unchecked
<b>Current</b>	<b>8</b>	<b>1</b>	<b>2</b>	<b>117</b>

Outermost circle is for Data Quality



- Unknown
- Bad
- In Progress
- OK/Done



# Summary

- During LS1 Tile Calorimeter Data Quality (DQ) Leader (shift – 4 weeks) and DQ Validator (shift 1÷2 weeks) are analyzing the calibration runs ( Pedestal, CIS, monoCIS, Laser LG, Laser HG) and any DQ checks requested by DQ coordinator/RC/maintenance/etc..
- In calibration runs taken at September of 2013 have been analyzed all consolidated modules (LBA ,LBC and EBA – **only consolidated before 04.09.13**)
- Changed DQ status of some modules at Tile LS1 Maintenance status web interface:
  - LBA48, LBA59, LBC34,LBC52 : from green → yellow
  - LBC62, EBA20 : from green → red
- Productive joint work (collaboration) of Run Coordinator, maintenance and DQ teams ( meetings, discussions) have been carried out.



**Thanks for attention !**

# Back -up