Tile Week: Charge Injection System (CIS) Update

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Introduction

- This month's calibration updates few channels, most of which are known Bad CIS channels. There are few major problems
- We have updated documentation, streamlined the calibration macro, and added to existing Tucs/cis scripts

Summary

Channels in Update	28
Good (>1 Successful Calibration)	3
>5% Change	7
Masked	12
Affected	13

Table: Summary of channels included in the update. Runs are taken from the period 1 May 2023 - 12 June 2023. There are 7 channels with greater than 0.5% change, the usual update threshold we use.

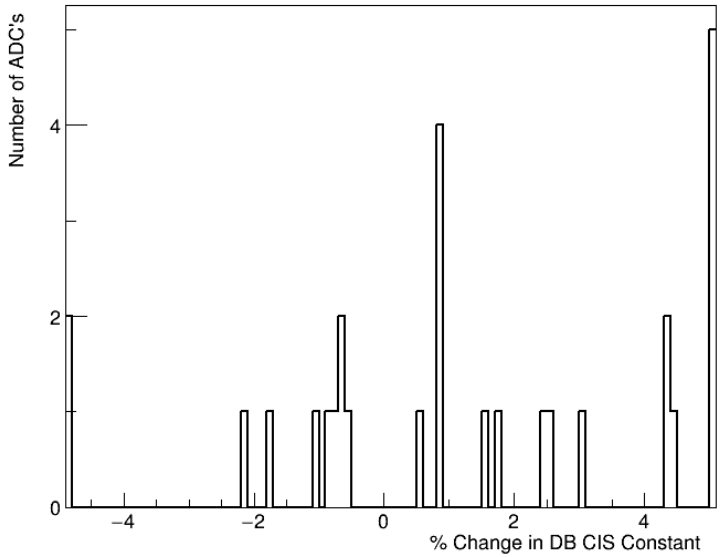


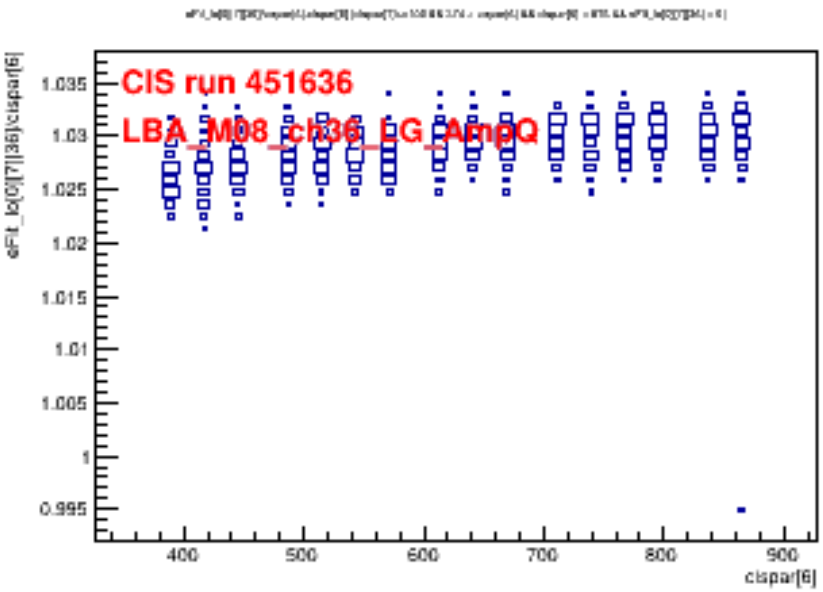
Figure: Distribution of CIS constants for the entire detector. The histogram omits channels for which change is less than 0.5% since the last update.

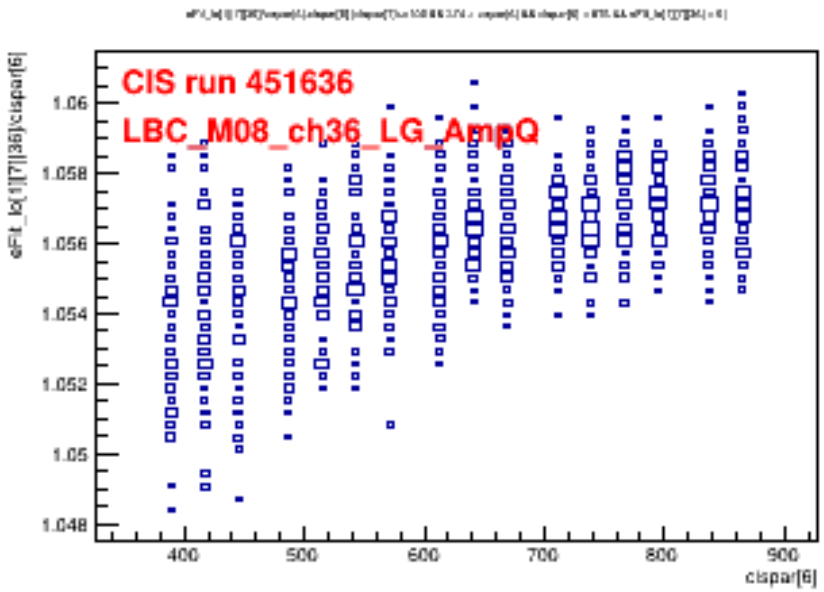
Run Selection

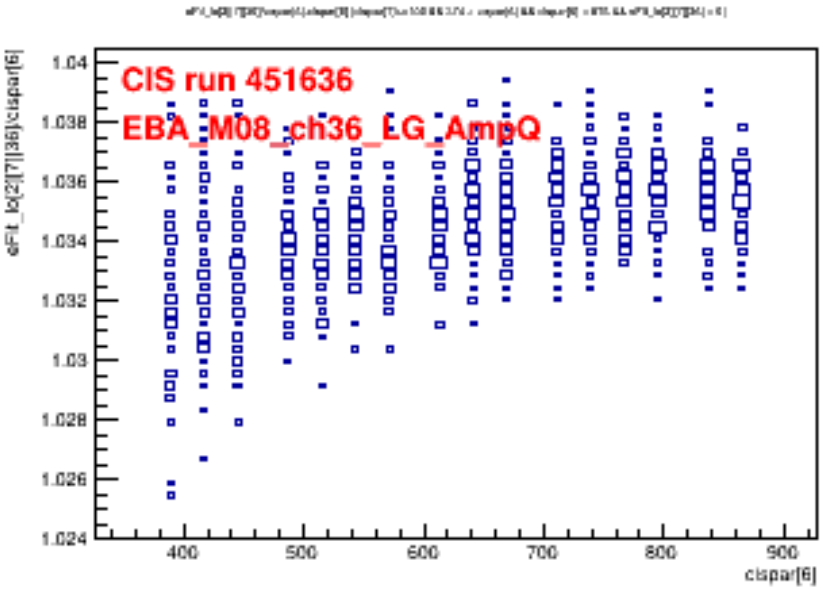
Date Range	1 May 2023 - 12 June 2023
Runs Included	451195 451483 451772 452058 452062 452248 452747 452822 453018 453147 453263 453591 453841 454106
Runs Excluded	451636[a] 451756[b] 452600[c]

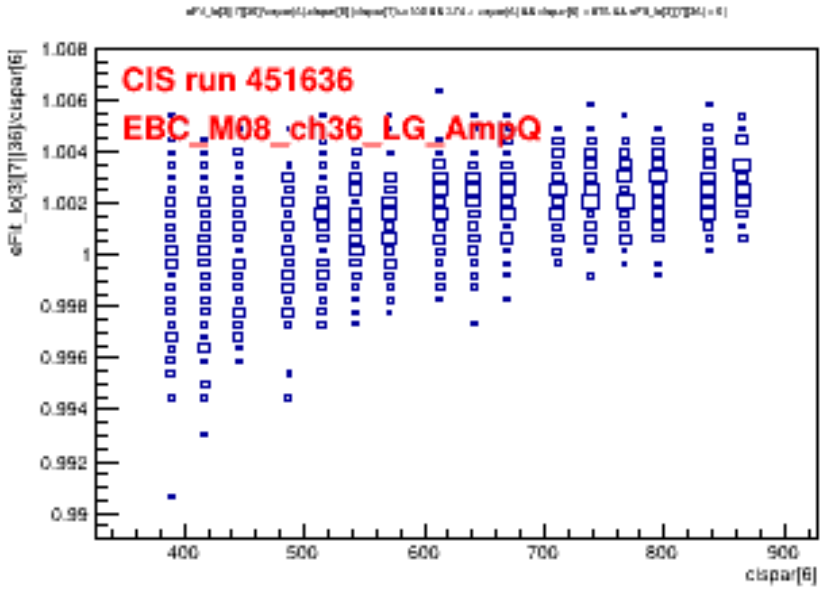
- a,b,c: Bad amplitude-charge ratio in LBA (one such example is shown on the next slide)

Run Selection: Run 451636 AmpQ Ratio (a)









CIS Constant Distributions

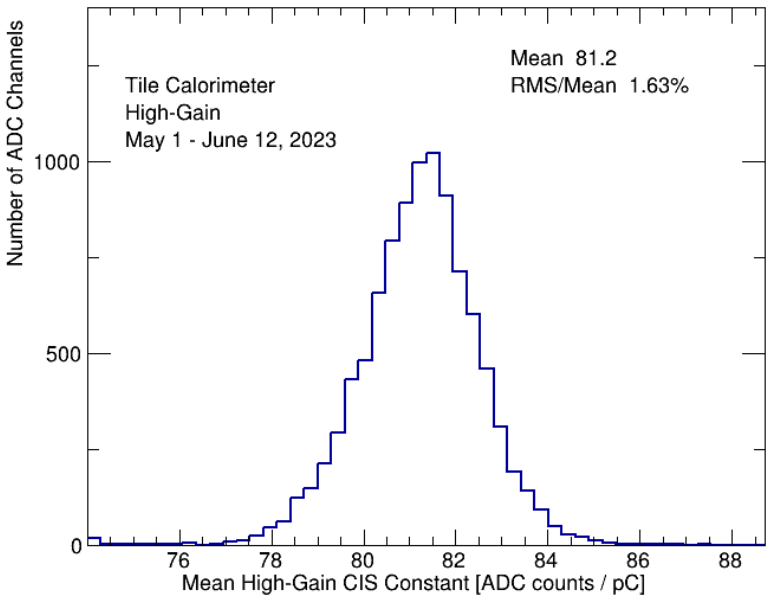


Figure: Distribution of Mean HG CIS constants for calibration runs in May/June 2023

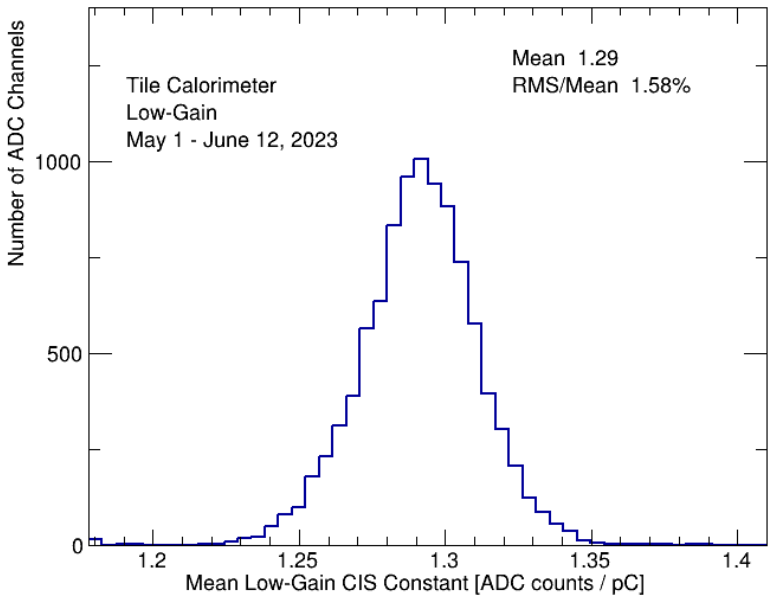


Figure: Distribution of Mean LG CIS constants for calibration runs in May/June 2023

Monthly Stability

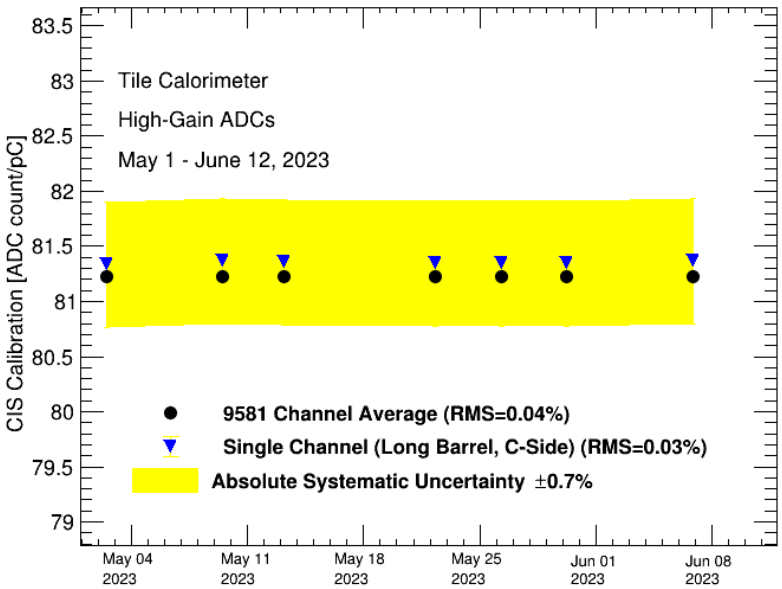


Figure: May/June stability of CIS constant in TileCal compared to a single channel (HG)

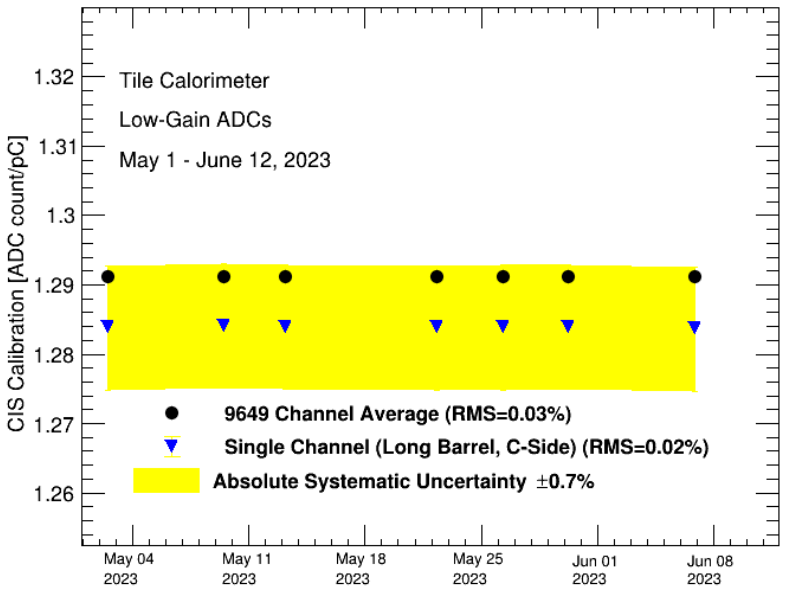


Figure: May/June stability of CIS constant in TileCal compared to a single channel (LG)

Detector History

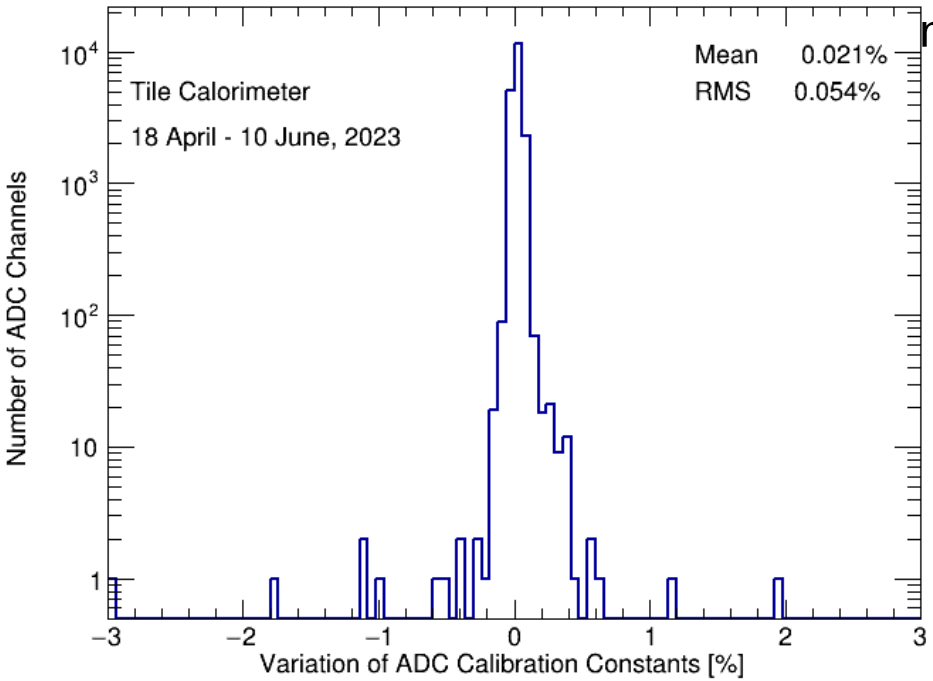


Figure: Change in CIS constants by channel from beginning of May to middle of June 2023

- Here, we list the (non-flagged) channels that underwent a drift of greater than 3% between runs 451195 and . These correspond the overflow bins in the histogram.
- Only largely problematic module is **EBC30 C11 LG**

Detector History: EBC30 C11 LG

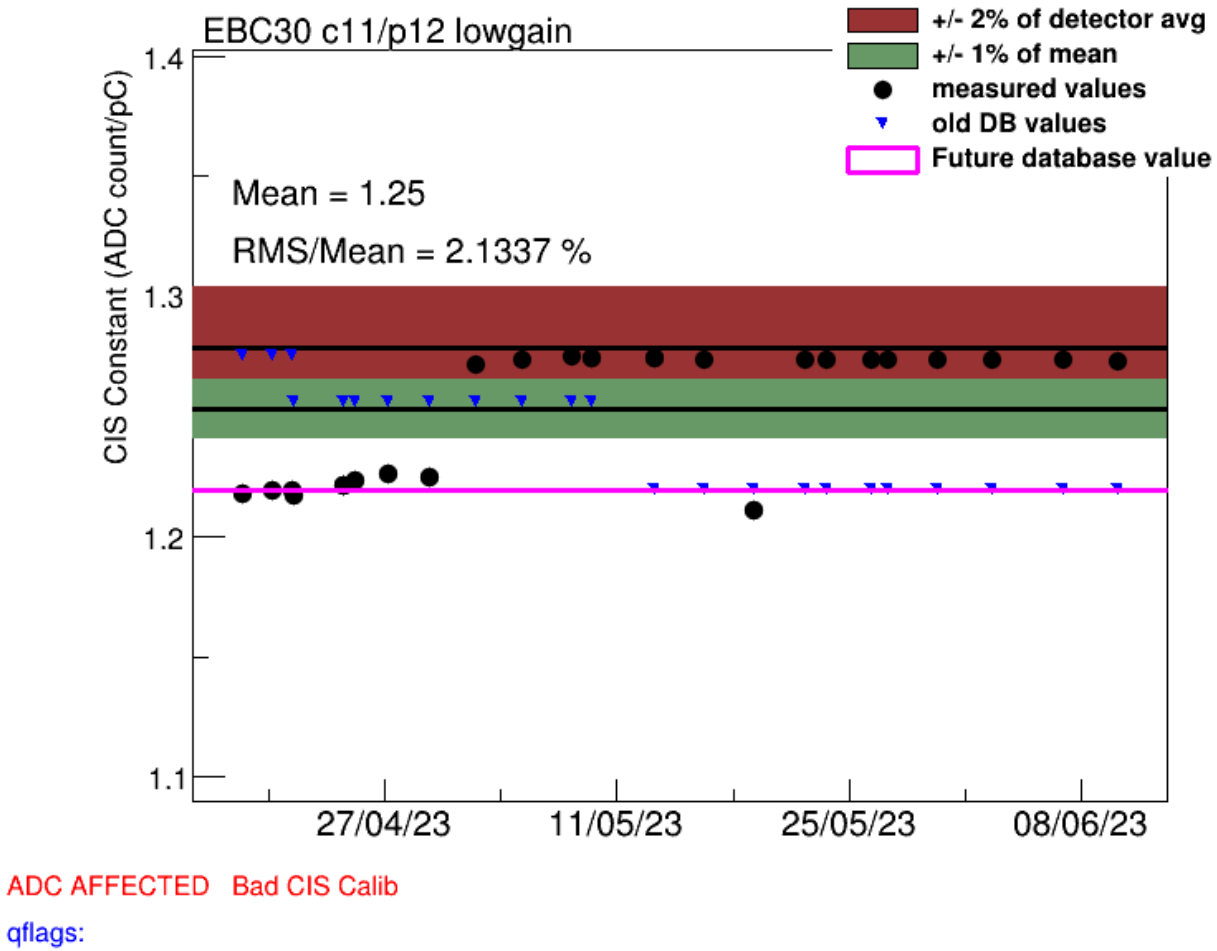


Figure: Recovered CIS since this month

RMS Distributions

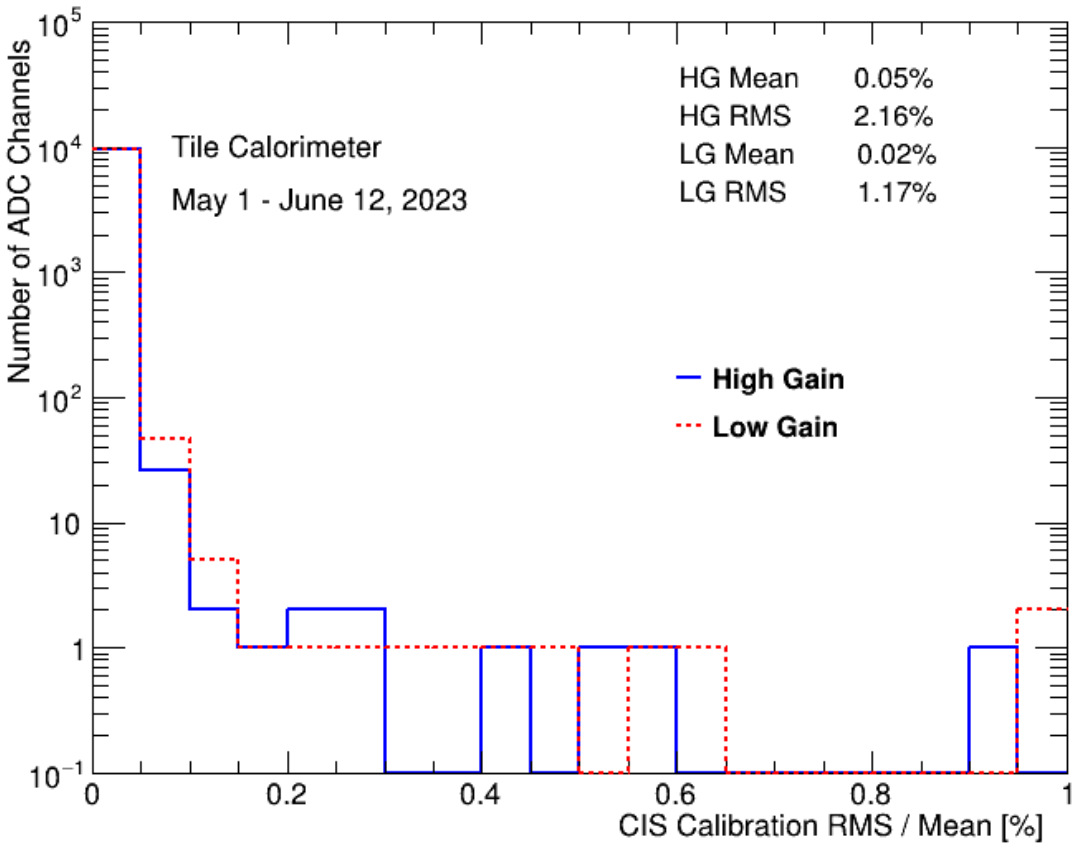


Figure: RMS/Mean distribution of CIS constant.

TUCS Quality Flags

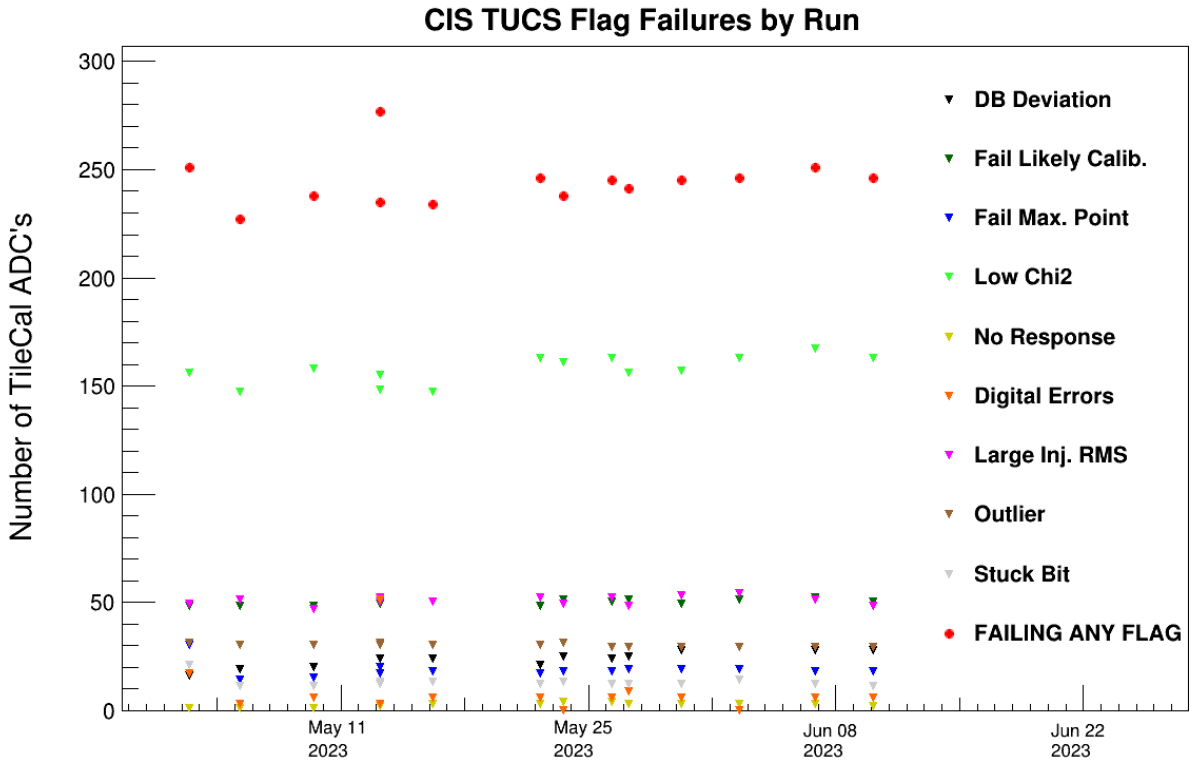


Figure: TUCS quality flags for all runs included in CIS constant update this month

Channels to Recalibrate

Module	Channel	Gain	Recalibrate From Date
EBA49	00	H	1/6
LBA37	21	H	7/5

Channels to Recalibrate

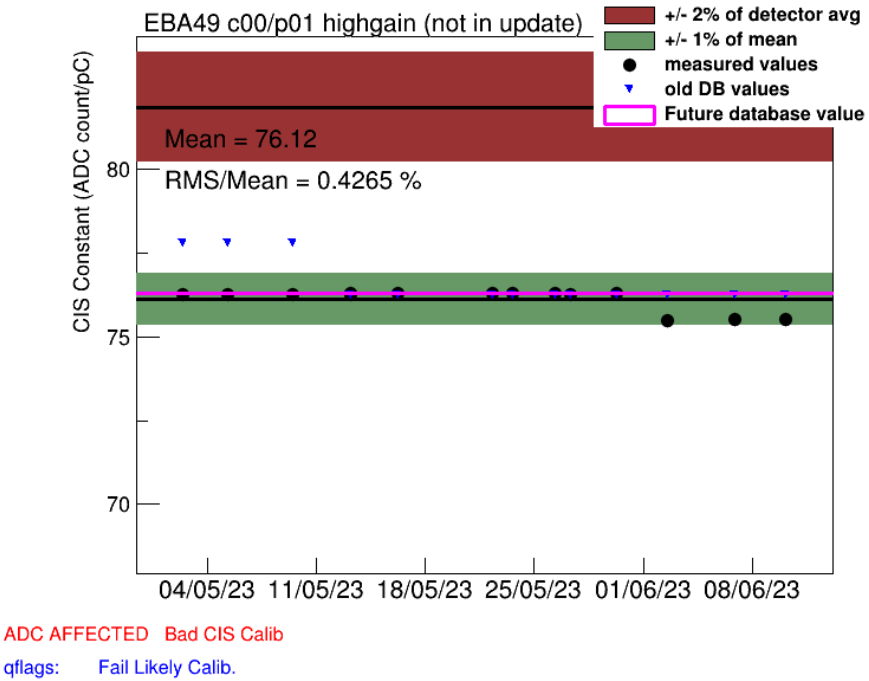


Figure: Recalibrate from 1/6.

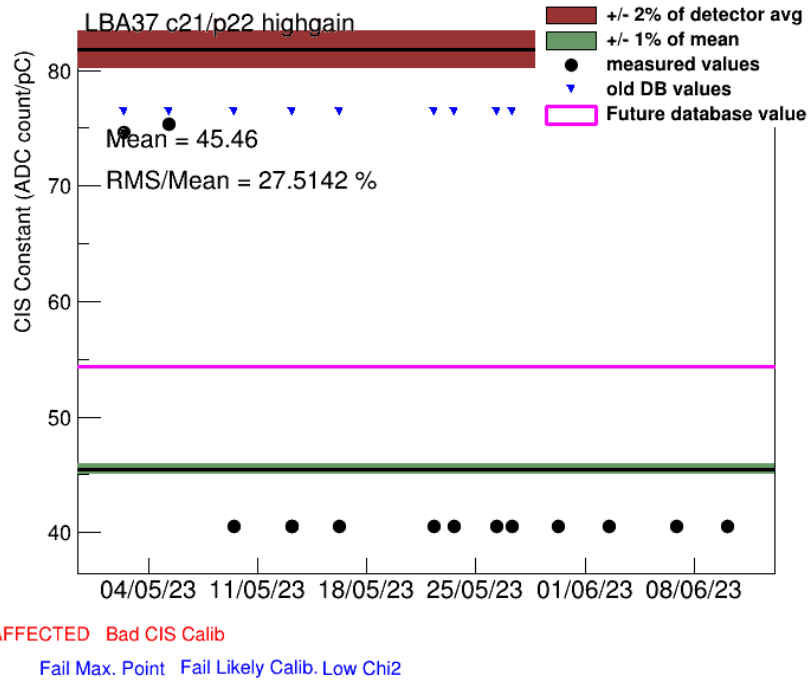
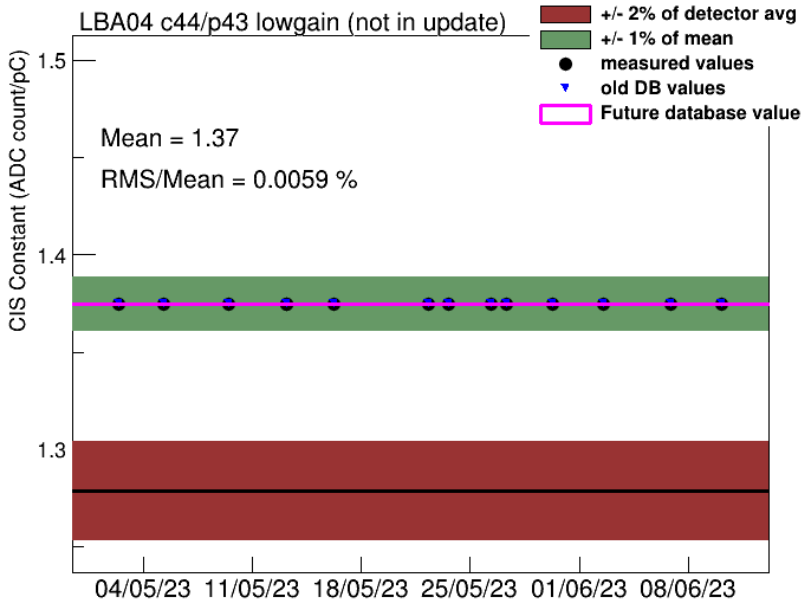


Figure: Recalibrate from 7/5. Known in DQ to have Amp/Q about 0.5

Flag Changes

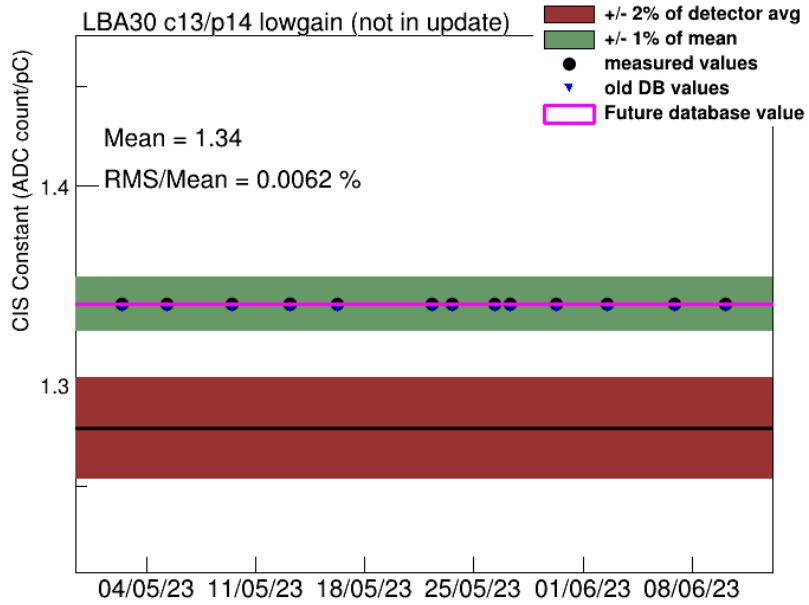
Module	Channel	Gain	Change Flag To
EBC15*	16	H	Bad CIS
EBC55*	01	H	Bad CIS
LBA04	44	H/L	Good CIS
LBA30	13	L	Good CIS
LBC35*	45	H/L	Bad CIS
LBC44	34	H	Bad CIS

Flag Changes: To Good CIS



ADC AFFECTED Bad CIS Calib

qflags:

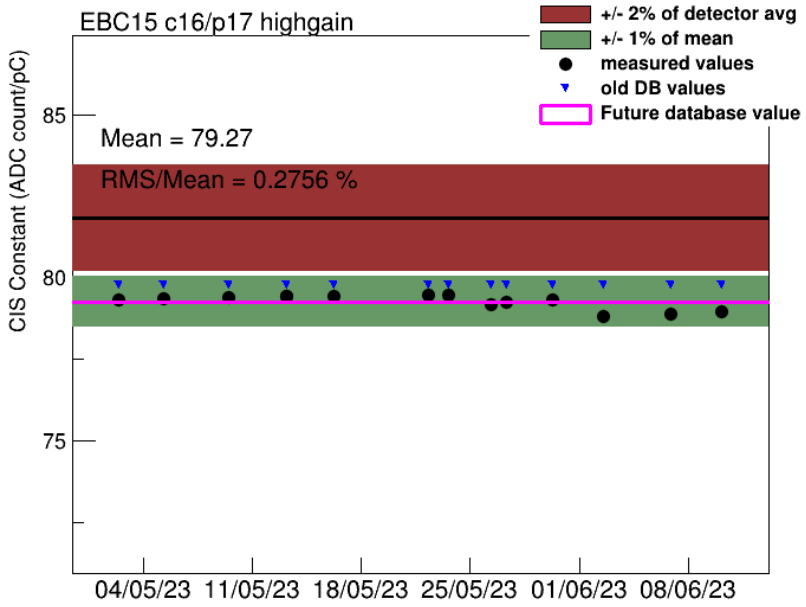


ADC AFFECTED Bad CIS Calib

qflags:

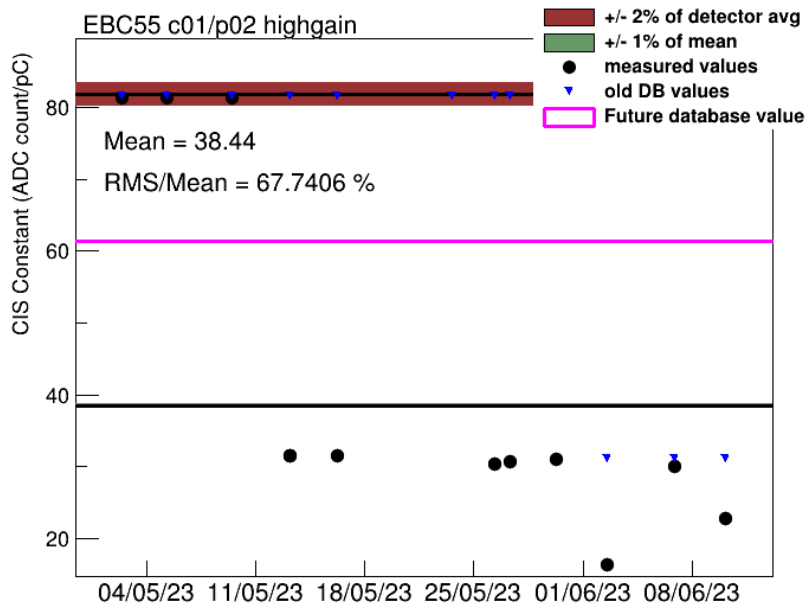
- In these two channels, the pulse shape looks normal

Flag Changes: To Bad CIS



ADC AFFECTED Bad Las Calib

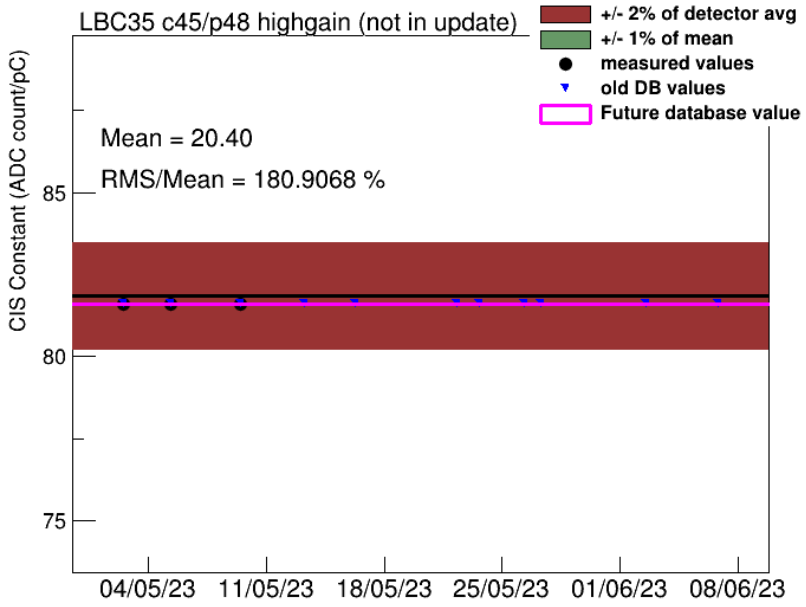
qflags:



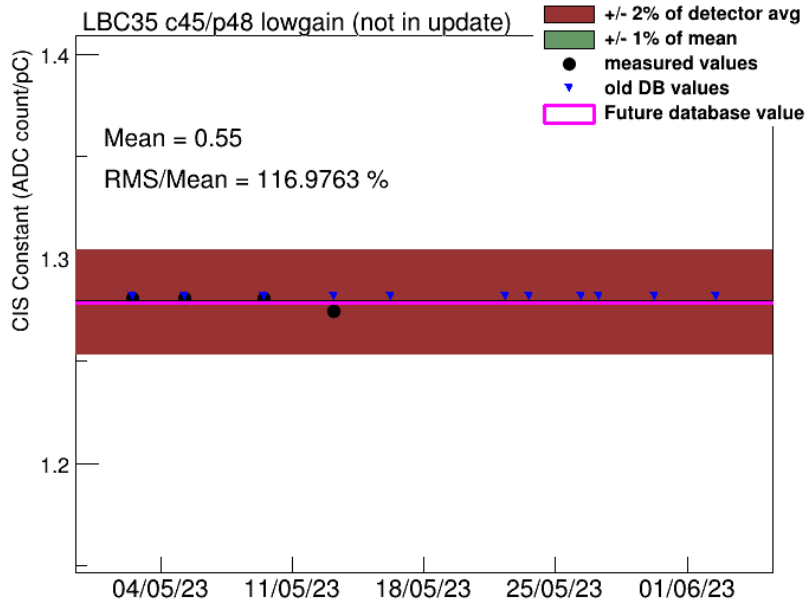
qflags: Fail Max. Point Fail Likely Calib. Large Inj. RMS Low Chi2

- EBC55 channel 1 has bad pulse shape; timing, amplitude-over-charge, pulse shape all look good for EBC15

Flag Changes: To Bad CIS



qflags: Fail Max. Point Fail Likely Calib. Low Chi2 Stuck Bit



qflags: Fail Max. Point Fail Likely Calib. Stuck Bit

- No pulse seen in June runs. Known issue in DQ.

Channels with $> 5\%$ Change

Channel	Old DB Value	New DB Value	Change	Status
EBC m20 c10 lowgain	1.15	1.25	7.8	Bad CIS
EBC m55 c01 highgain	30.94	61.41	98.5	Bad CIS
EBC m61 c08 lowgain	0.65	0.71	8.9	Bad CIS
LBA m37 c21 highgain	76.33	54.33	-28.8	Bad CIS
LBC m08 c03 lowgain	0.63	1.02	60.8	Bad CIS
LBC m43 c24 highgain	76.67	80.6	5.1	Bad CIS
LBC m52 c18 highgain	102.68	97.31	-5.2	Bad CIS

- All of these channels are known Bad CIS channels, and the calibration value changes from month run to run

Masked/Affected Channel List

Masked (12)
LBC20 c37/p38 highgain
LBC28 c04/p05 lowgain
LBC43 c24/p27 highgain
LBC47 c35/p34 lowgain
LBC52 c18/p19 highgain
LBA62 c26/p25 highgain
LBA35 c08/p09 highgain
LBA38 c46/p47 lowgain
LBA02 c06/p07 lowgain
LBA02 c06/p07 highgain
EBC56 c41/p41 lowgain
EBC16 c11/p12 lowgain
EBC16 c11/p12 highgain
EBC20 c10/p11 lowgain
EBC22 c16/p17 lowgain
EBA07 c31/p29 lowgain
LBC08 c03/p04 lowgain
LBC19 c26/p25 highgain
LBC23 c20/p21 lowgain

Affeted (13)
LBC20 c37/p38 lowgain
LBC44 c12/p13 highgain
LBC62 c08/p09 highgain
LBC46 c04/p05 highgain
LBC10 c37/p38 highgain
LBC57 c06/p07 highgain
LBA06 c40/p41 highgain
LBA51 c12/p13 highgain
LBA52 c01/p02 lowgain
LBA64 c29/p28 highgain
LBA45 c06/p07 highgain
EBC01 c21/p22 highgain
EBC46 c07/p08 lowgain
EBC13 c03/p04 lowgain
EBC23 c36/p44 highgain
EBC30 c11/p12 lowgain
EBC30 c11/p12 highgain
EBC34 c41/p41 lowgain
EBA55 c22/p23 highgain
EBA16 c17/p18 highgain
EBA40 c35/p34 highgain
EBA42 c30/p33 highgain
EBA49 c00/p01 highgain
EBA50 c20/p21 highgain
EBC15 c16/p17 highgain
EBC61 c08/p09 lowgain
LBA37 c21/p22 highgain
LBA03 c17/p18 lowgain
LBC16 c29/p28 highgain

Flag Changes: Investigation

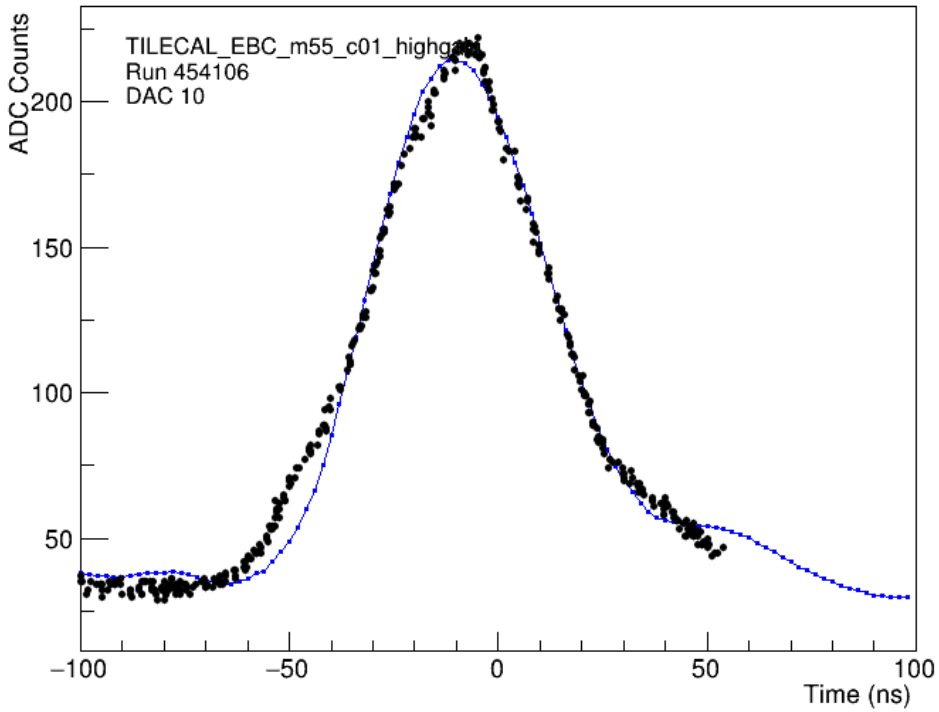


Figure: EBC55 bad pulse shape

TUCS Flags Description

Figure 19: Descriptions of each CIS TUCS quality flag

Flag	Location	Passed If...
No Response	qflag bit 1	At least one successful injection readout
Fail Likely Calib.	qflag bit 3	CIS constant within 6.23% of detector-wide mean
Fail Max. Point	qflag bit 4	≥ 1 point in fit range > 600 ADC counts
Large Injection RMS	qflag bit 5	RMS of all fixed-charge injections in fit range < 5
Digital Errors	qflag bit 6	All digital error checks passed
Low Chi2	qflag bit 7	Linear fit $\chi^2 > 2 \times 10^{-6}$
Edge Sample	qflag bit 8	No events in fit range w/ 1st or 7th sample as max
Next to Edge Sample	qflag bit 9	No events in fit range w/ 2nd or 6th sample as max
Stuck Bit	qflag bit 10	No stuck bits in readout chain detected
Unstable	TUCS	ADC CIS const. RMS/Mean < 0.39%
Mean Deviation	TUCS	CIS constant within 5% of ADC time period avg.
Default Calibration	TUCS	Default CIS constant not used in database
Outlier	TUCS	CIS const. < 6 and > 15% away from det. avg.
DB Deviation	TUCS	Measured and database const. differ by < 1%