Charge Injection System (CIS) Update

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Introduction

- For this update, we have picked out the channels that we feel to be recalibrated, as well as suggest some channels that we believe will need to changed from Good/Bad CIS respectively.

Summary

Channels in Update	26
Good (>1 Successful Calibration)	1
>5% Change	2
Masked	10
Affected	15

Table: Summary of channels included in the update. Runs are taken from the period 1 July 2023 - 31 July 2023. There are 2 channels with greater than 0.5% change, the usual update threshold we use.

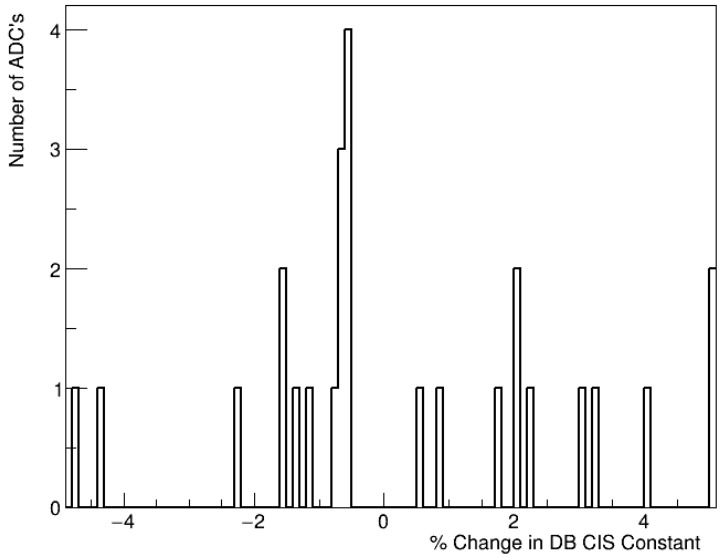


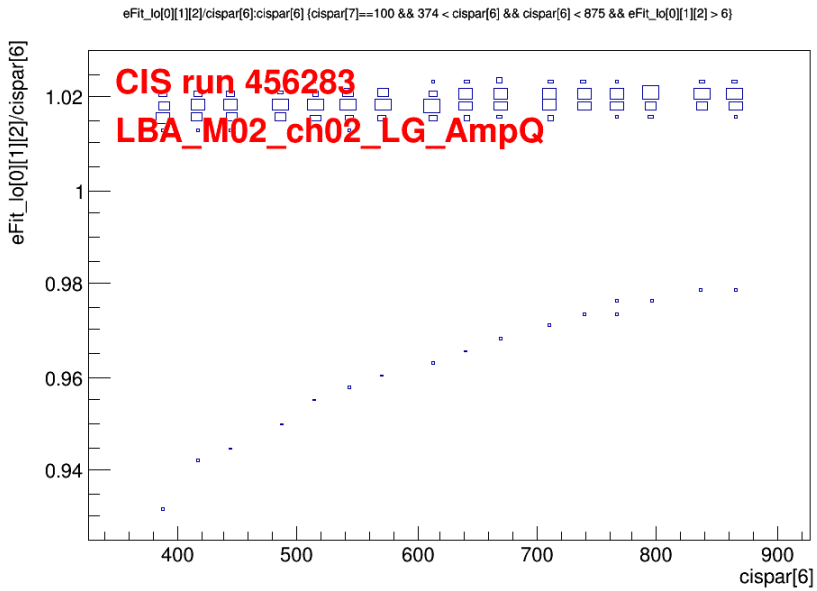
Figure: Distribution of CIS constants for the entire detector. The histogram omits channels for which change is less than 0.5% since the last update.

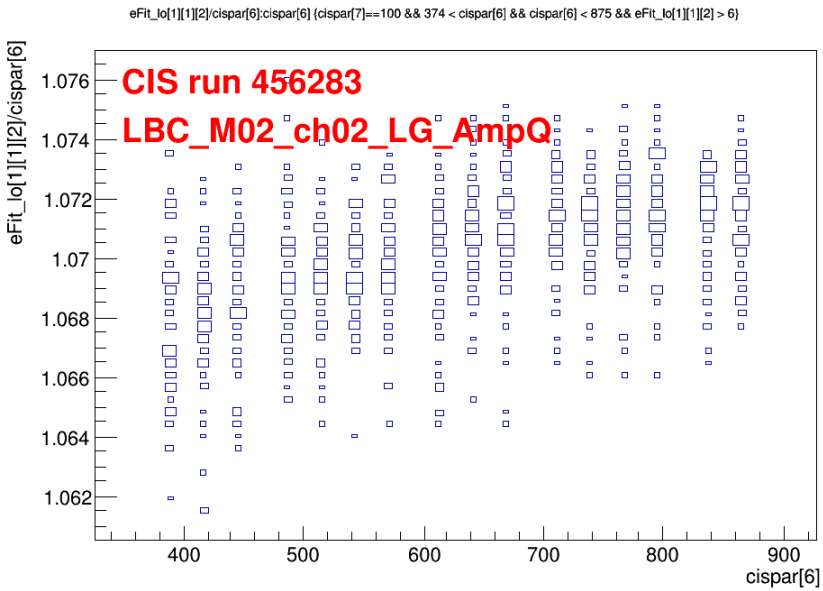
Run Selection

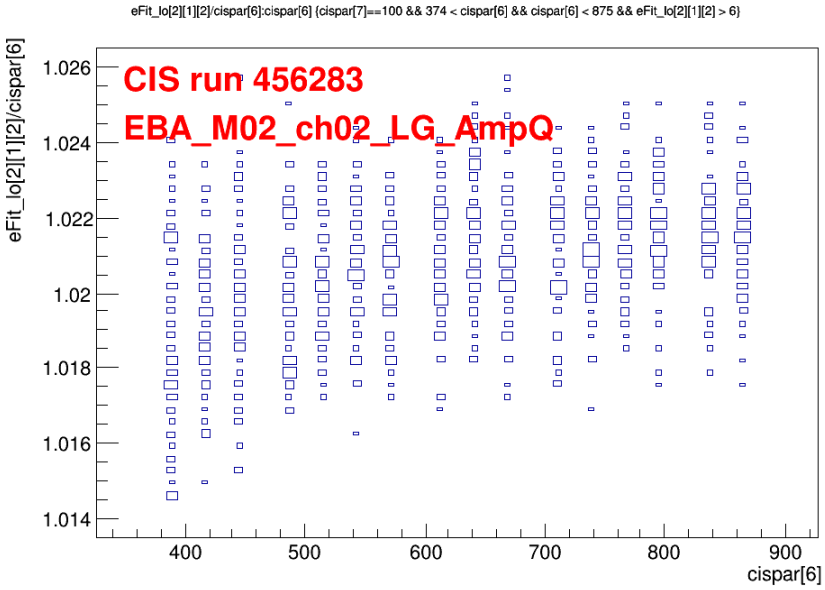
Date Range	07 July 2023 - 6 August 2023
Runs Included	456051 456292 456508 456645 456885 457083 457543 457650
Runs Excluded	456283[a] 457332[a]

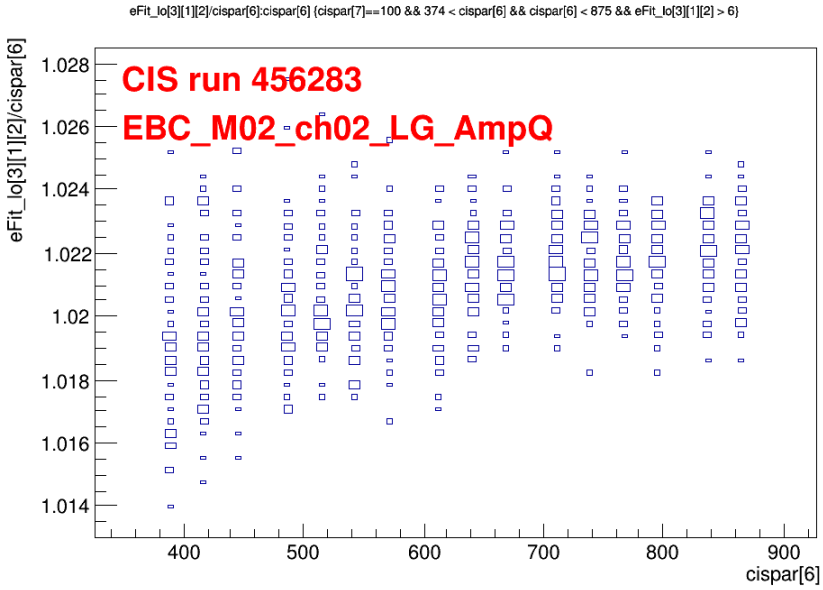
- a: Bad amplitude-charge ratio observed in LBA (example shown in next slide)

Run Selection: Run 456283 AmpQ Ratio (a)

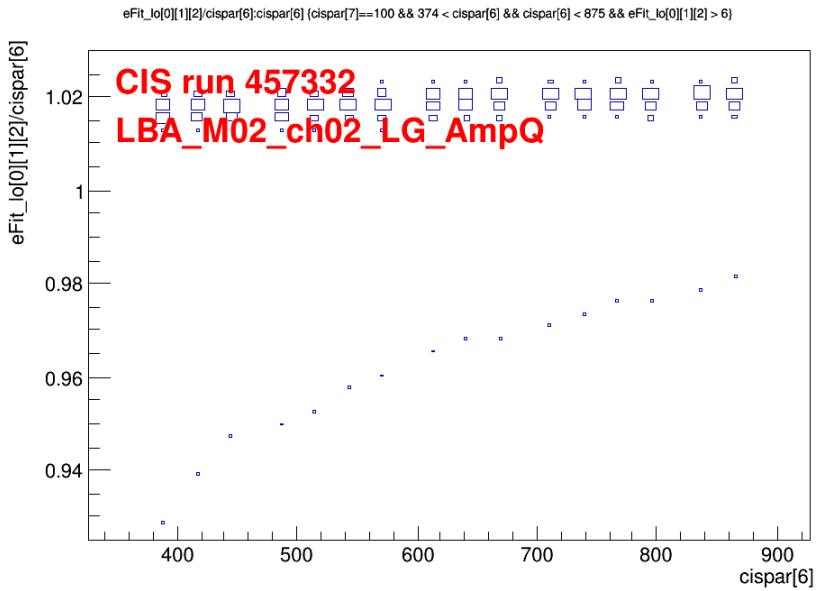


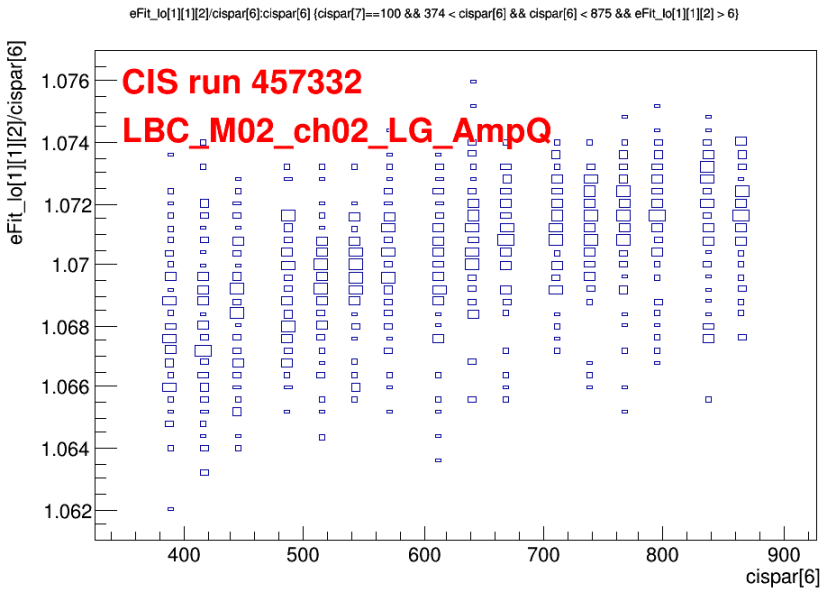


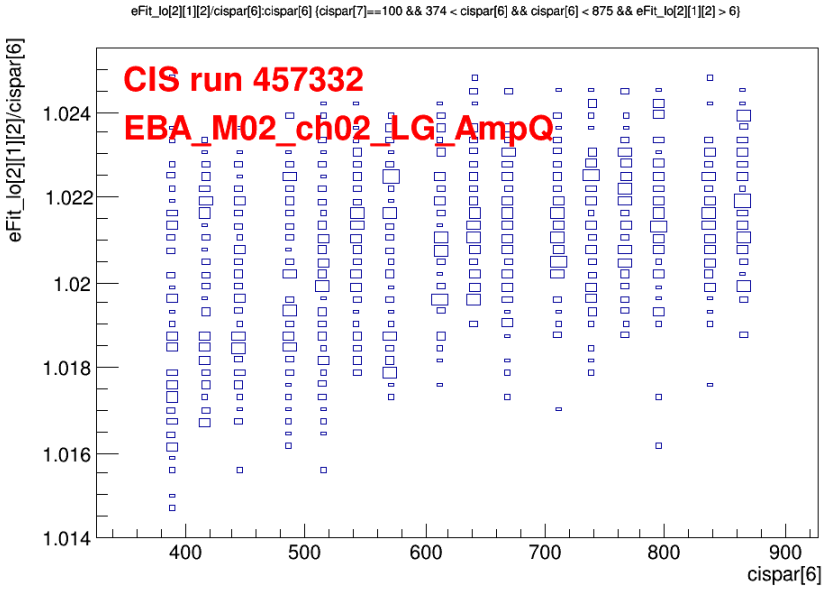


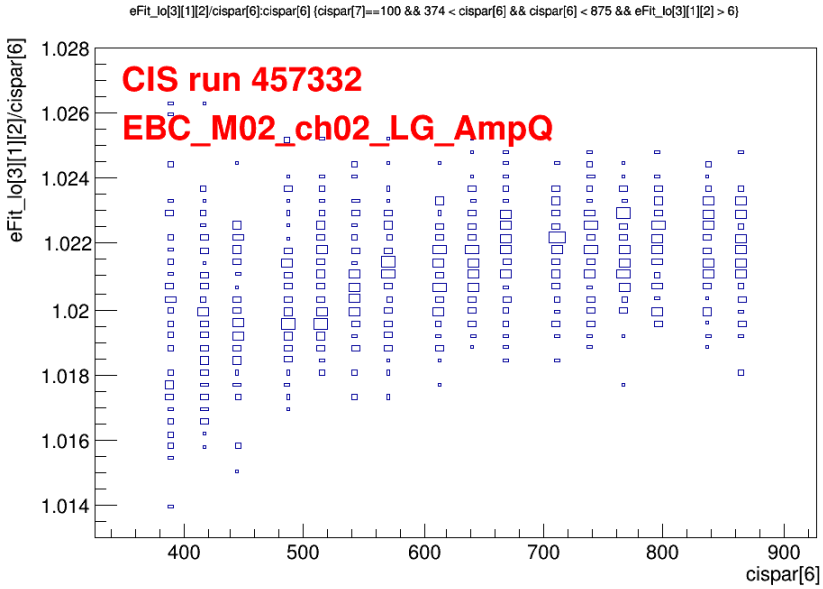


Run Selection: Run 457332 AmpQ Ratio (a)









CIS Constant Distributions

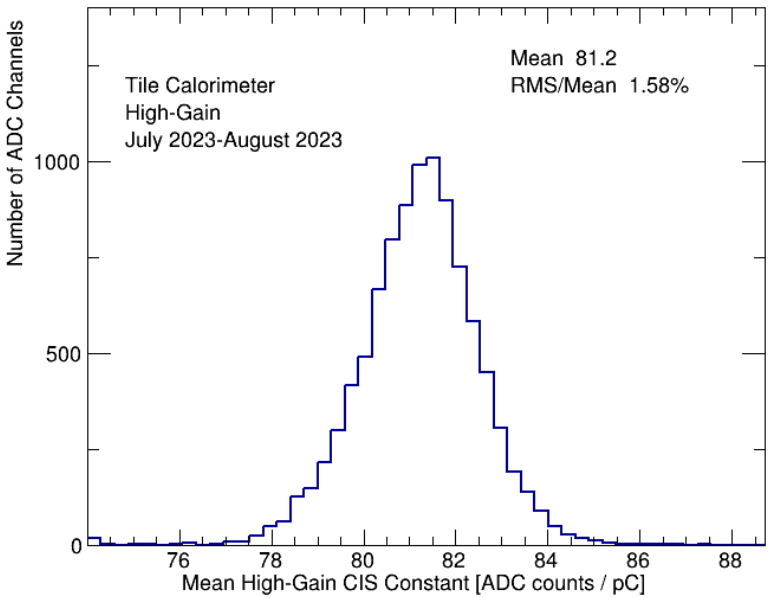


Figure: Distribution of Mean HG CIS constants for calibration runs in July 2023

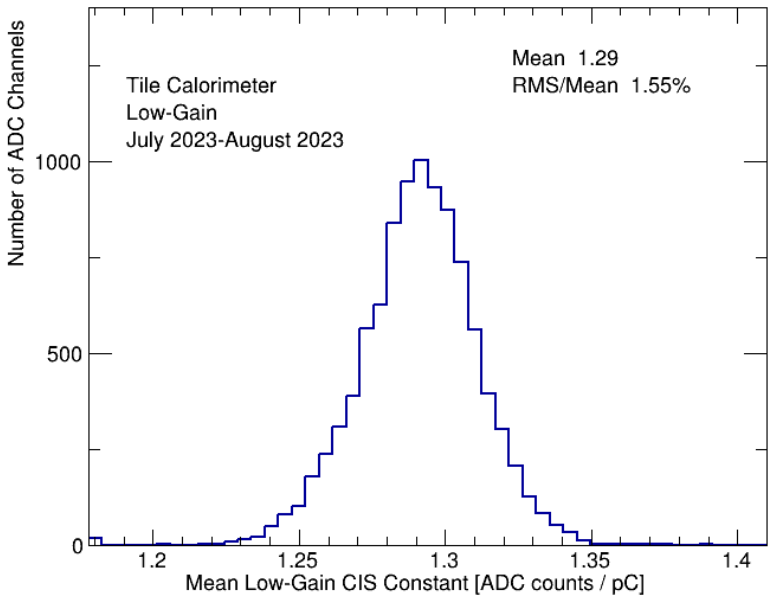


Figure: Distribution of Mean LG CIS constants for calibration runs in July 2023

Detector History

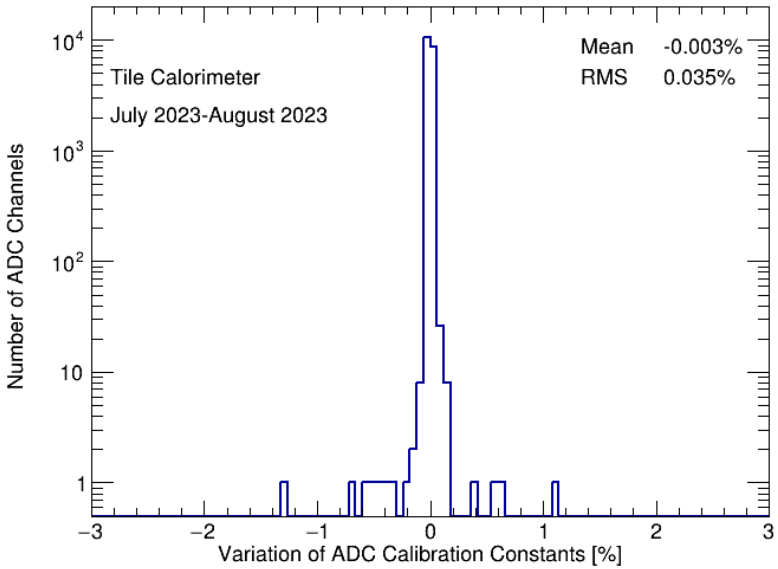


Figure: Change in CIS constants by channel from beginning to end of June 2023, non-flagged channels only

- As is visible in the figure, there are no overflow or underflow bins and thus no non-flagged modules to recalibrate.
- However some flagged channels need to be recalibrated and will be shown on a later slide.

RMS Distributions

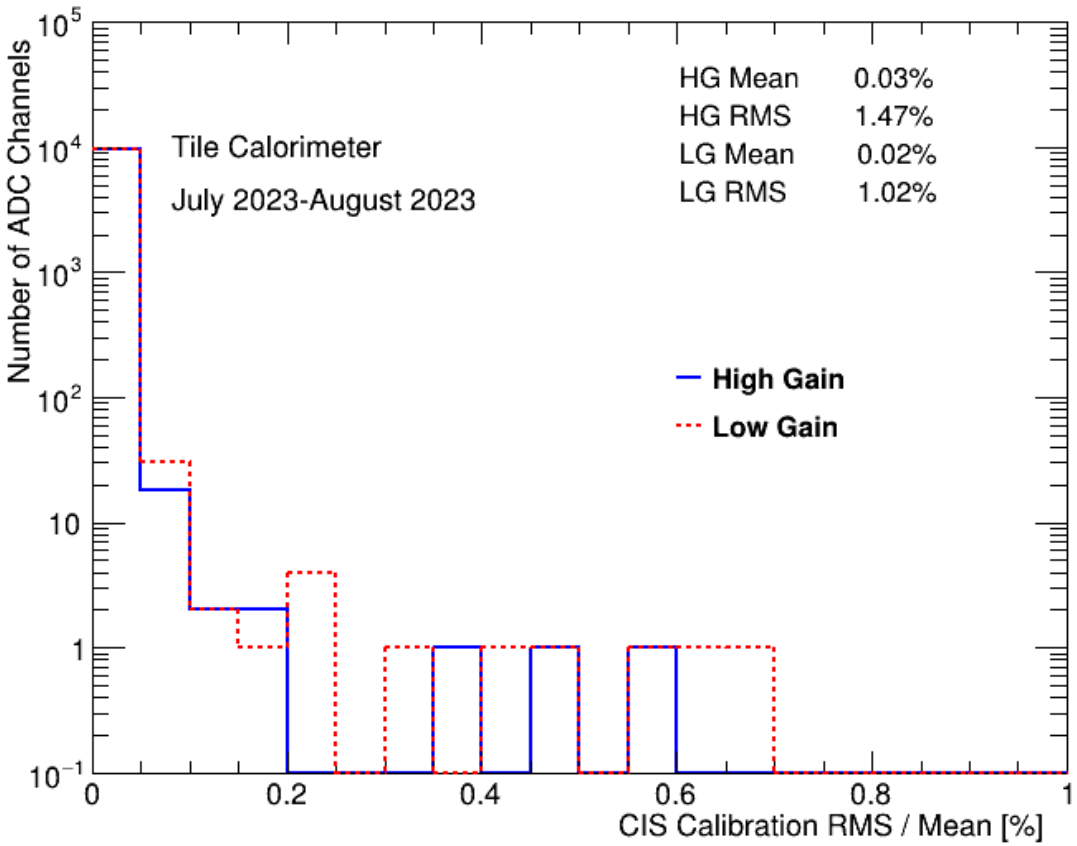


Figure: RMS/Mean distribution of CIS constant.

TUCS Quality Flags

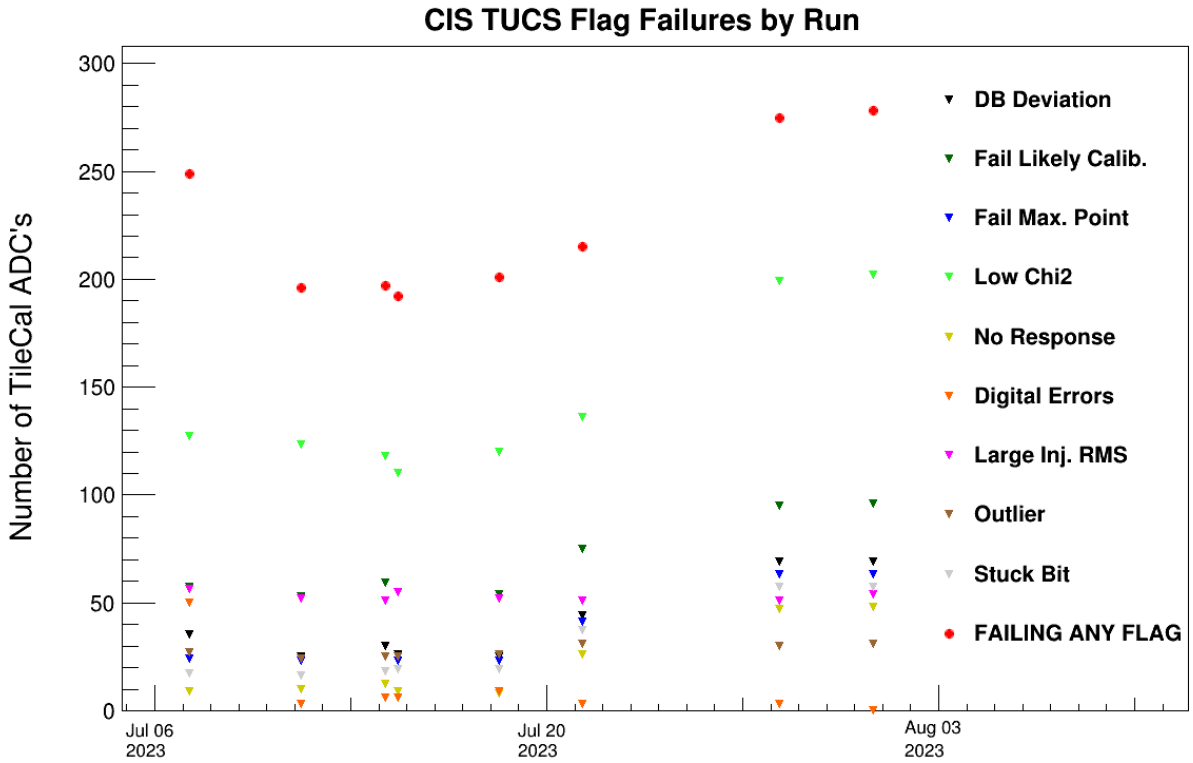


Figure: TUCS quality flags for all runs included in CIS constant update this month

Channels to Recalibrate

Module	Channel	Gain	Recalibrate From Date
EBA40	35	H	18/07
EBC38	05	H	21/07
LBC57	06	H	18/07

Channels to Recalibrate

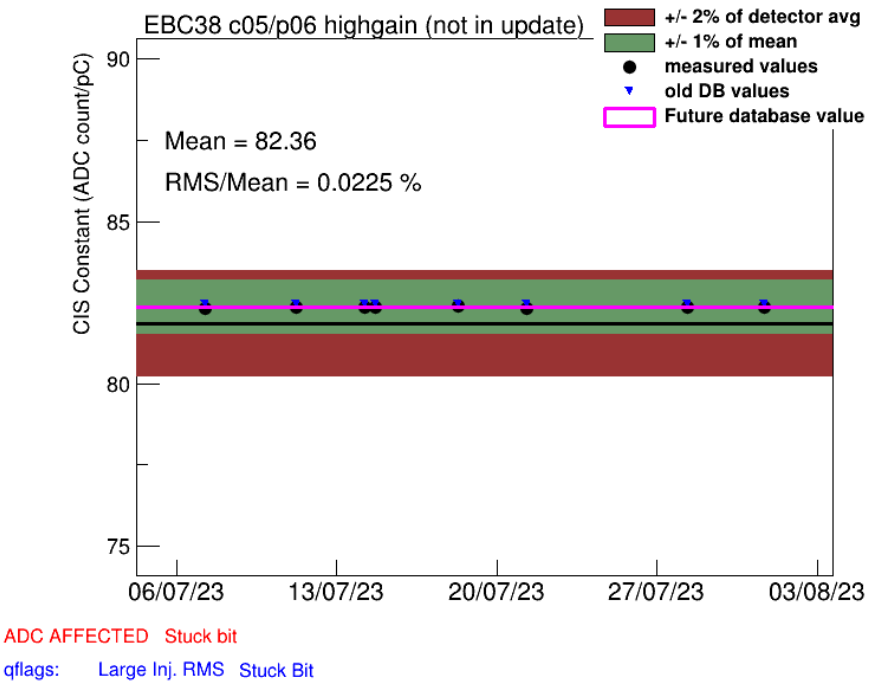


Figure: Recalibrate from 21/07

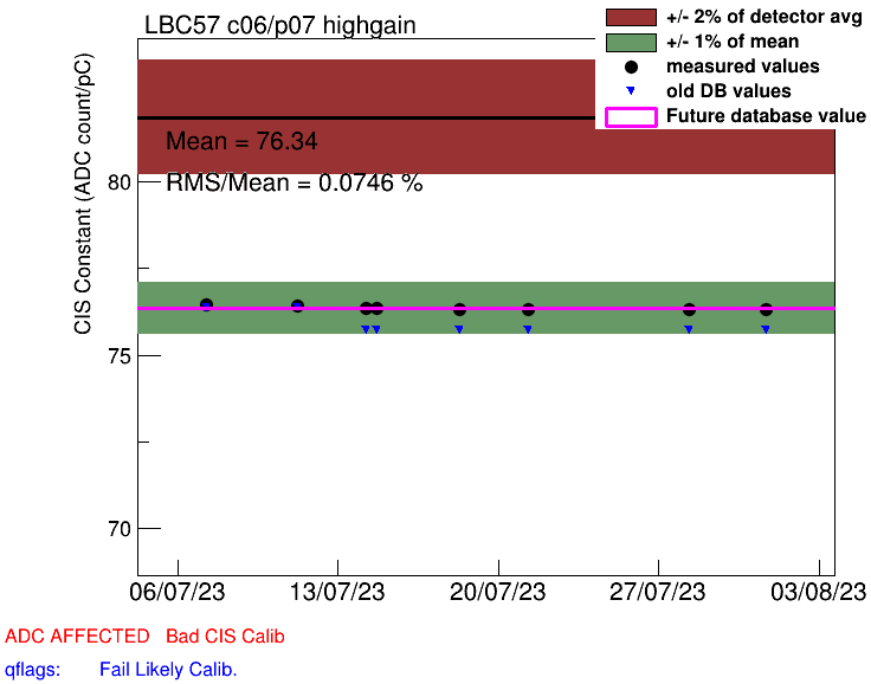


Figure: Recalibrate from 17/07

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Flag Changes

Module	Channel	Gain	Change Flag To
EBA12	36	H	Bad CIS
EBA40	35	H	Good CIS
LBA02	06	H	Good CIS
LBA42	07	H	Good CIS
LBA52	01	H	Good CIS
LBA58	25	H	Bad CIS
LBC20	37	H	Good CIS
LBC44	34	L	Good CIS
LBC63	45	H	Good CIS

Flag Changes: To Good CIS

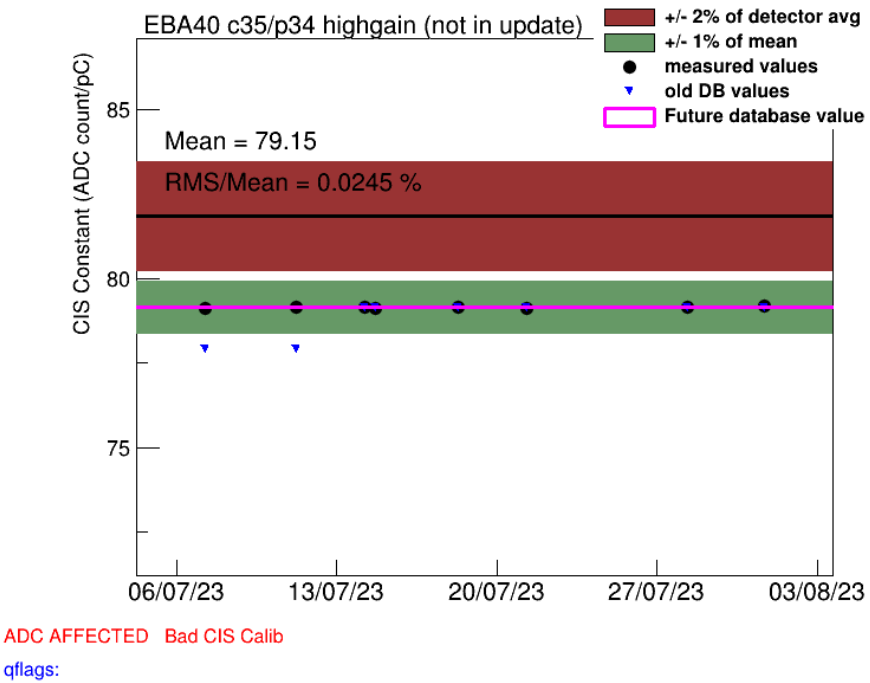


Figure: Good CIS in EBA40 Channel 35 HG

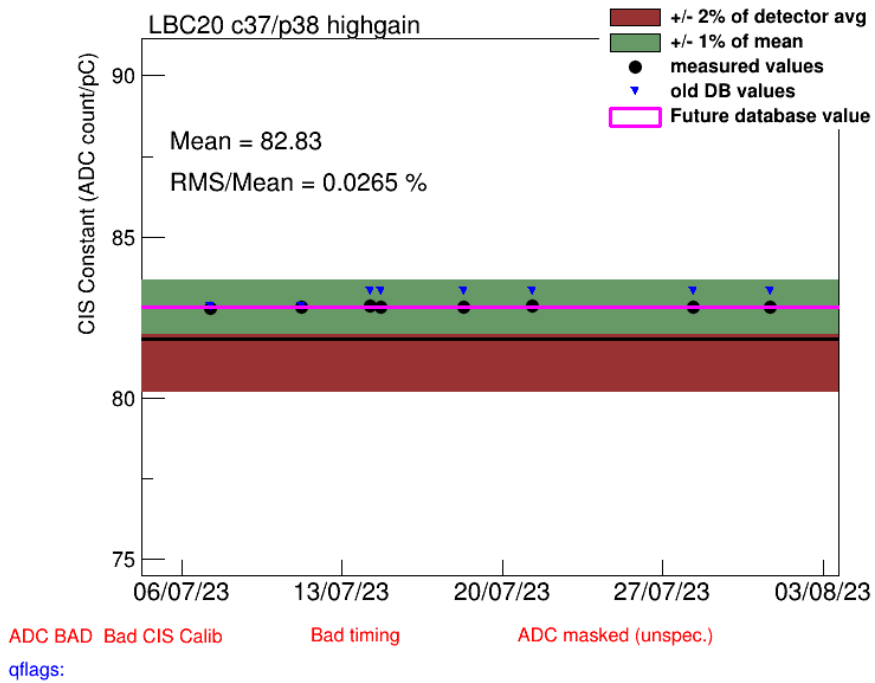


Figure: Good CIS in LBC20 Channel 37 HG

- Both these channels have normal pulse shapes, and the channels with flag changes to Good CIS are similar.

Flag Changes: To Bad CIS

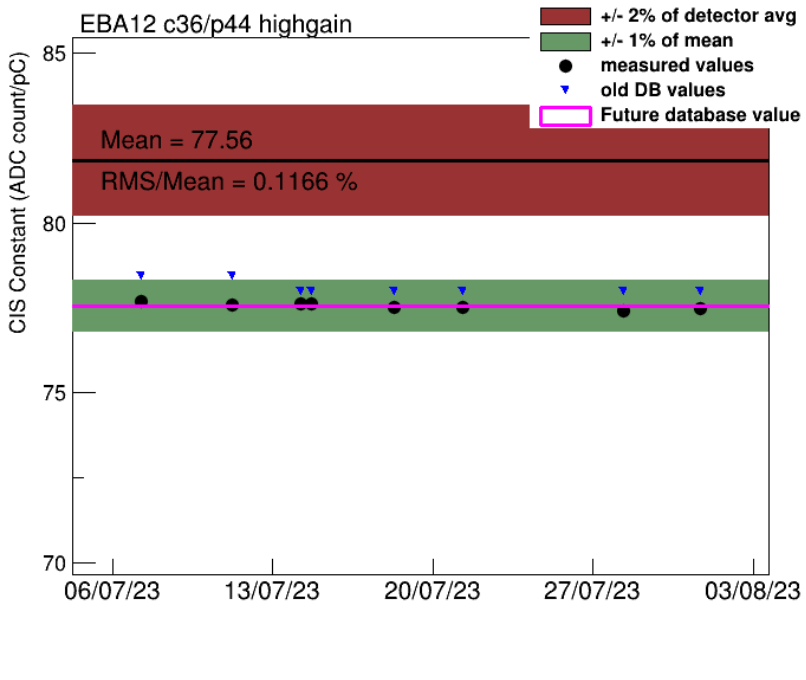


Figure: Bad CIS in EBA12 Channel 36 HG (drifting)

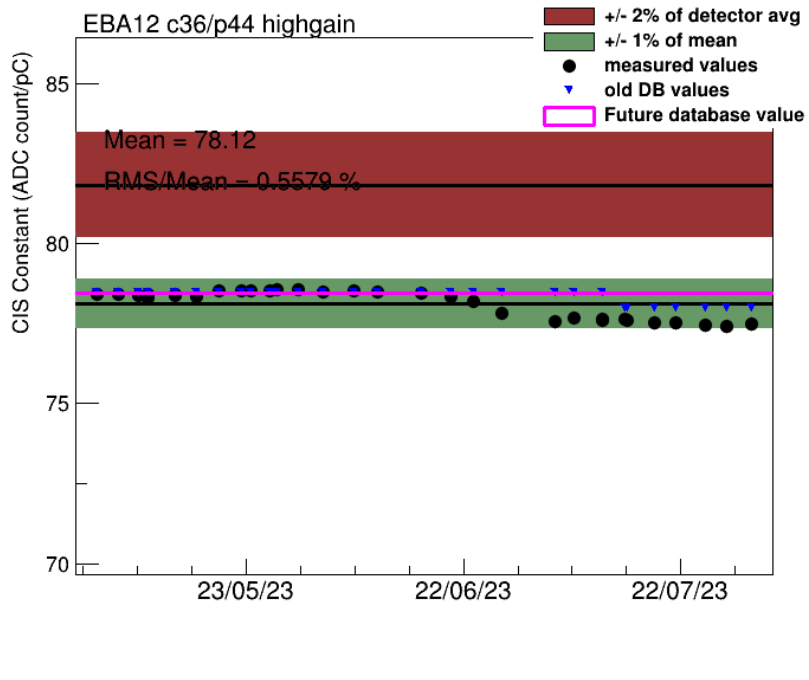


Figure: EBA12 Channel 36 HG 4 month graph

- EBA12 Channel 36 is drifting signifigantly, as seen in the long plot.

Falg Changes: To Bad CIS

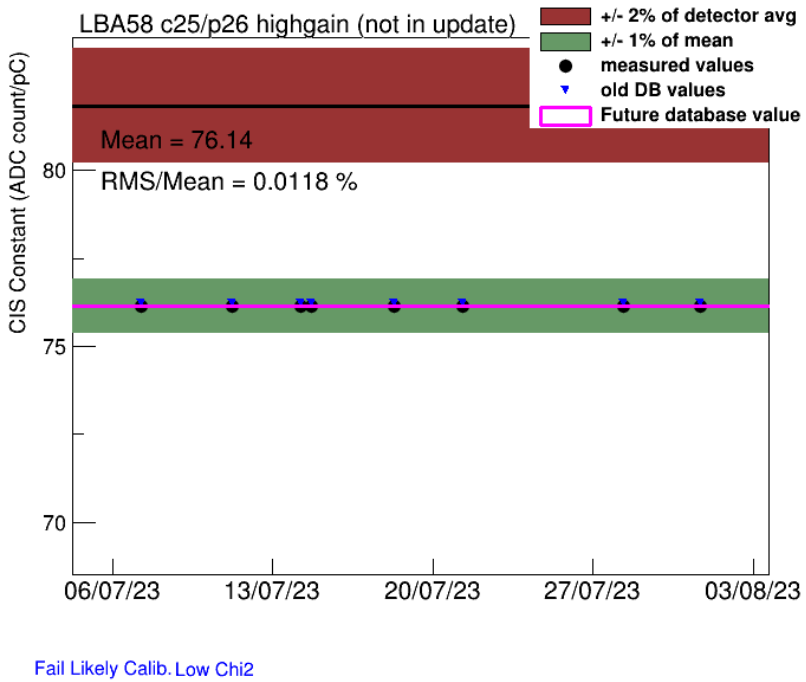


Figure: Bad CIS in LBA58 Channel 25 HG (far from detector average)

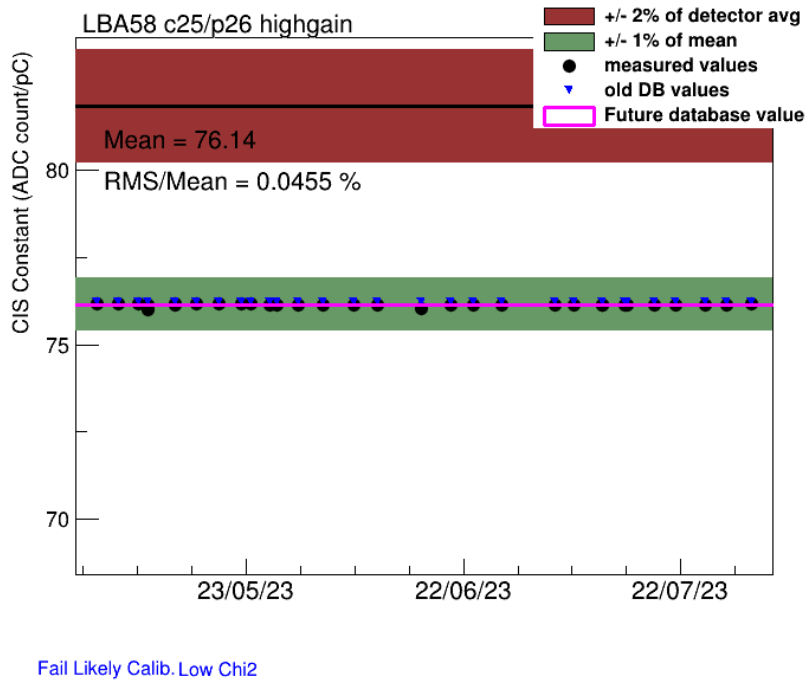


Figure: Bad CIS in LBA58 Channel 25 HG 4 month graph

- LBA58 Channel 25 is stable, but too far from detector average.

Channels with $> 5\%$ Change

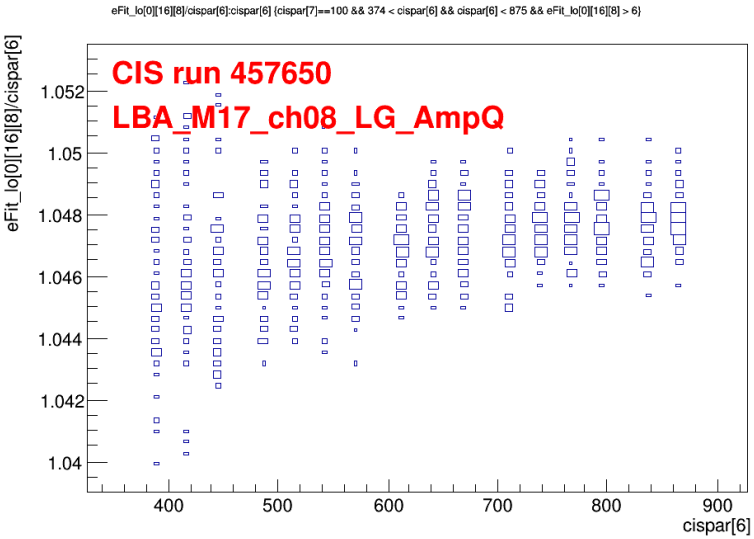
Channel	Old DB Value	New DB Value	Change	Status
EBC m61 c08 lowgain	0.93	1.01	9.0%	Bad CIS
LBC m47 c35 lowgain	1.07	1.2	12.8%	Bad CIS

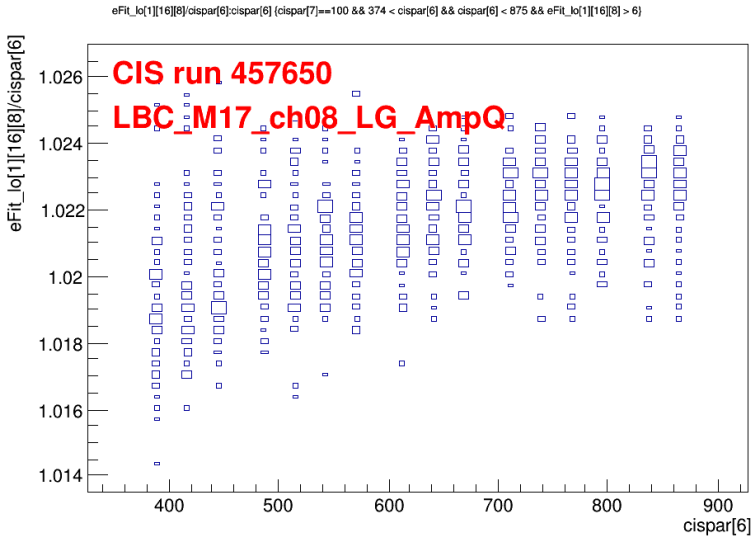
- These are all known Bad CIS channels which tend to have large variations in their calibration constants from month to month.

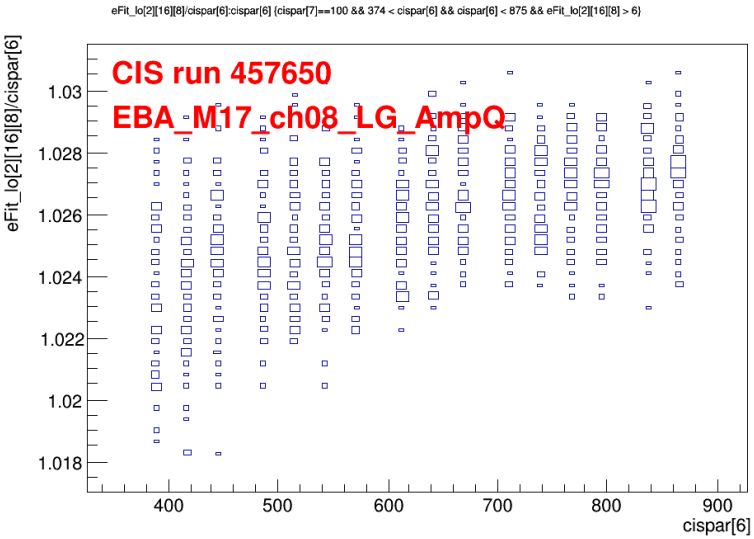
Masked/Affected Channel List

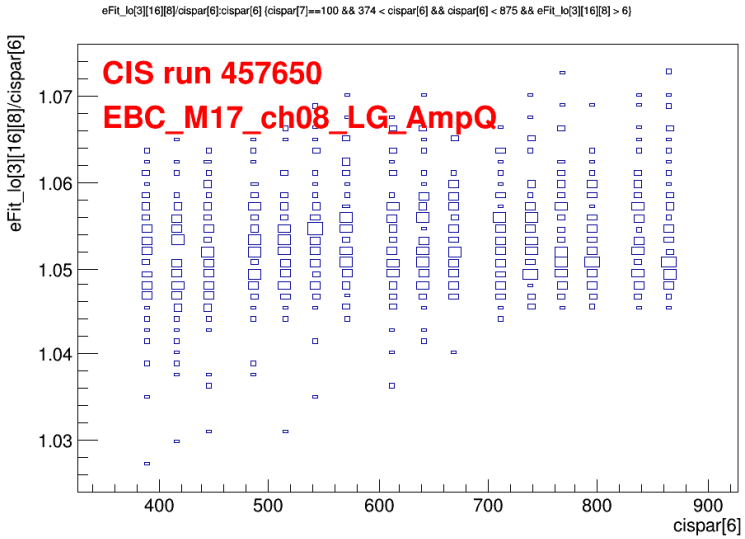
Masked (10)
EBC20 c10/p11 lowgain
EBC22 c16/p17 lowgain
LBC43 c24/p27 highgain
LBC47 c35/p34 lowgain
LBC08 c03/p04 lowgain
LBC52 c18/p19 highgain
LBC13 c15/p16 lowgain
LBC20 c37/p38 highgain
LBC23 c20/p21 lowgain
LBC28 c04/p05 lowgain
Affeted (15)
EBC61 c08/p09 lowgain
EBC23 c03/p04 highgain
LBC44 c12/p13 highgain
LBC46 c04/p05 highgain
LBC10 c37/p38 highgain
LBC57 c06/p07 highgain
LBC16 c29/p28 highgain
LBC20 c37/p38 lowgain
LBC62 c08/p09 highgain
EBA42 c30/p33 highgain
EBA49 c00/p01 highgain
EBA50 c31/p29 highgain
EBA50 c20/p21 highgain
EBA13 c04/p05 lowgain
LBA64 c29/p28 highgain

Problems with AmpQ ratio: Run 457650, EBC17/C08/LG

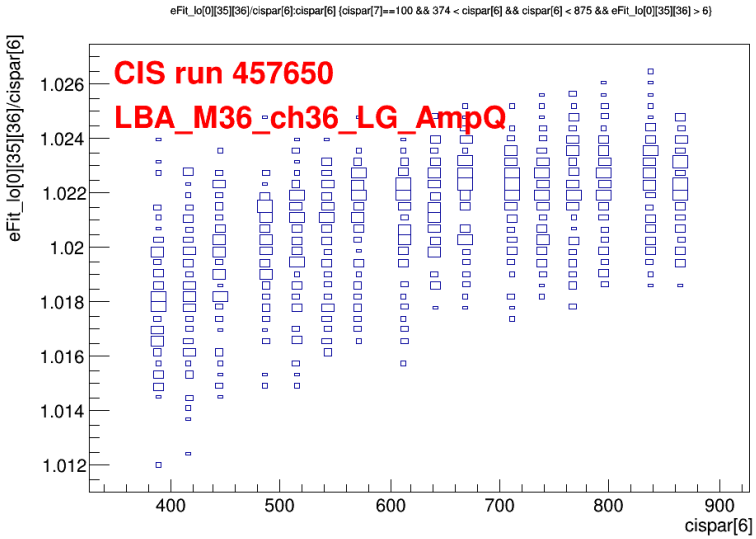


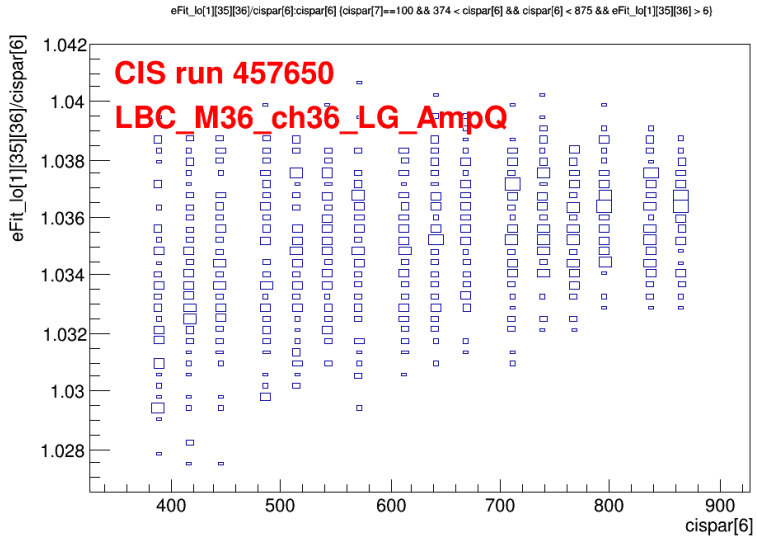


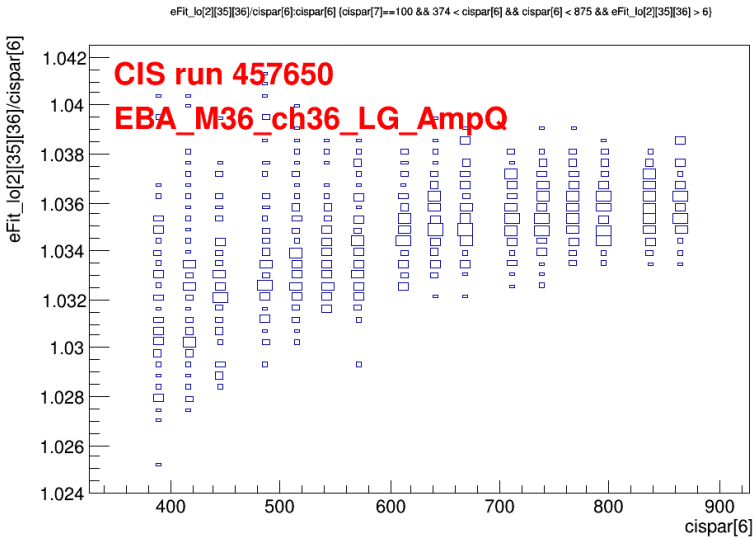


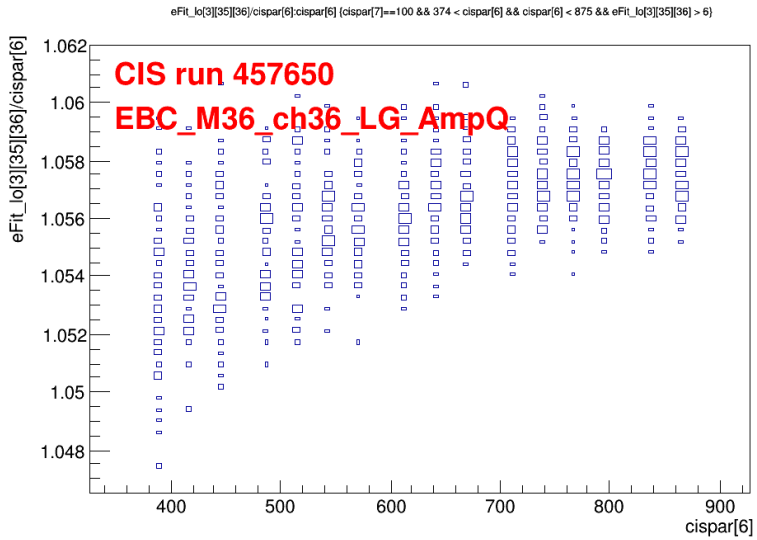


Problems with AmpQ ratio: Run 457650, EBC36/C36/LG

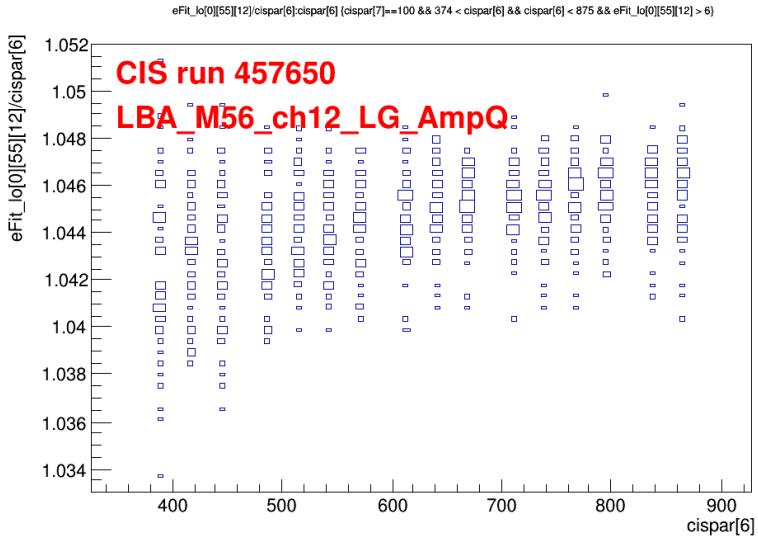


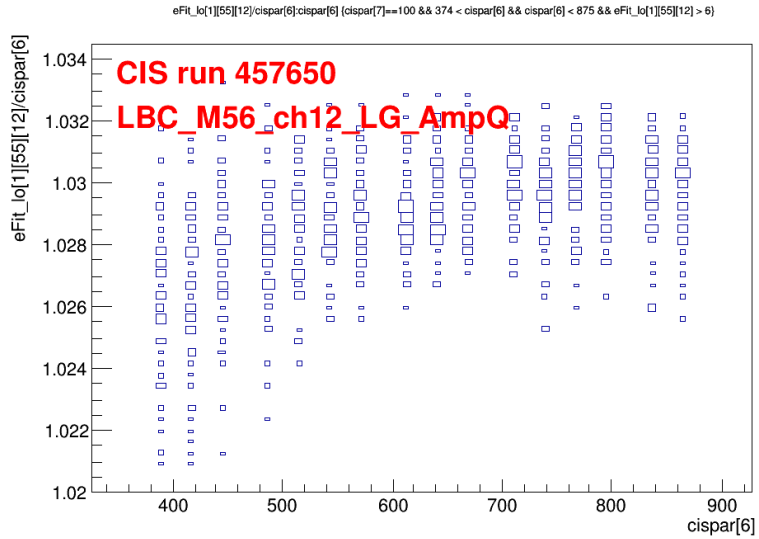


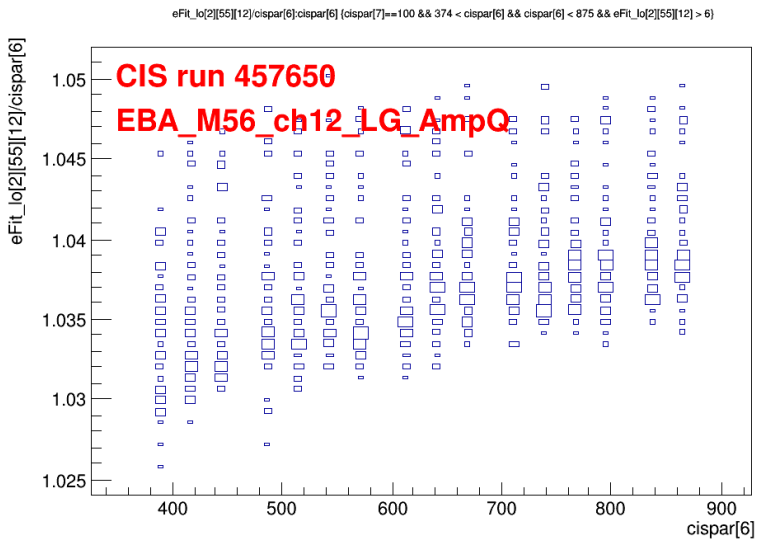


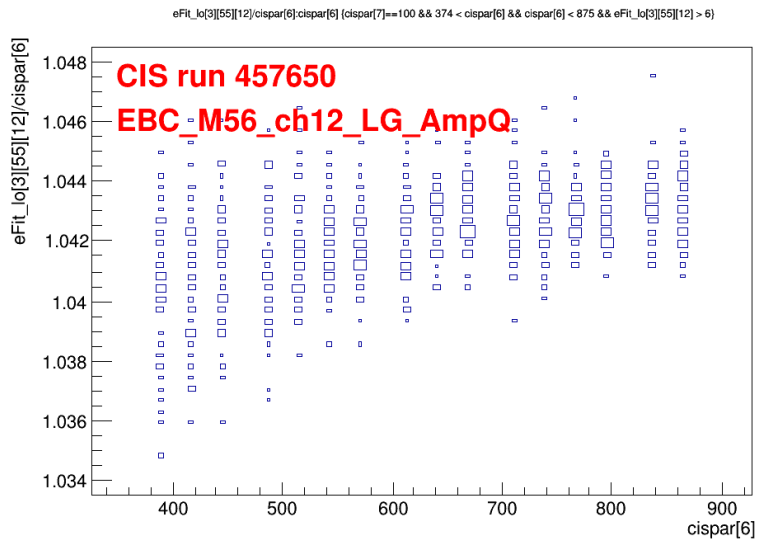


Problems with AmpQ ratio: Run 457650, EBA56/C12/LG









TUCS Quality Flag Descriptions

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%