Charge Injection System (CIS) Update Tile Week

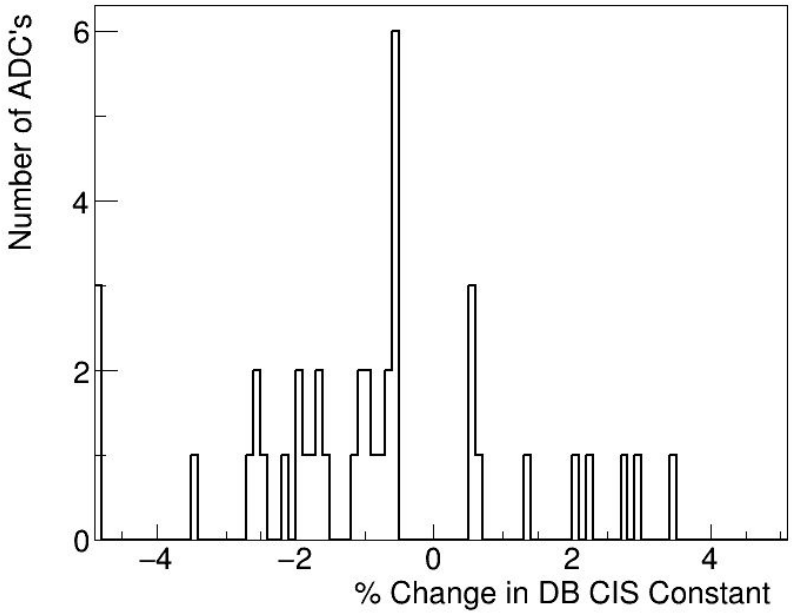
Peter Camporeale, Jacky Li
The University of Chicago
October 6, 2022

Overview

1. **Run selection:** One bad timing plot, 12 good runs from September 1 - October 1, 2022
2. **Global performance:** Little deviation in CIS constant over time with low RMS
3. **Specific Channels:** LBC52 Channel 34 response at beginning of September is random, LBA01 has runs with zero response
4. **General Comments**: Priorities for updating TUCS functionalities? Comments on ongoing work.

Summary

- CIS runs from September 1 - October
  - Database will be updated October 10
- 41 channels in update
- 14 Good (>1 successful calibration)
- 3 >5% change
- 11 Masked
- 16 Affected



Half-gain in LBC52 Low Gain Channel

Run Selection

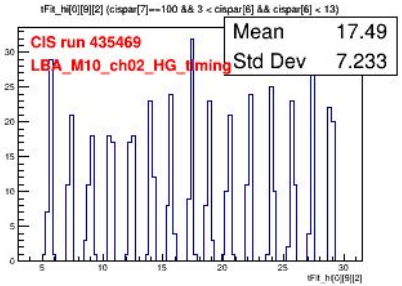
Runs:

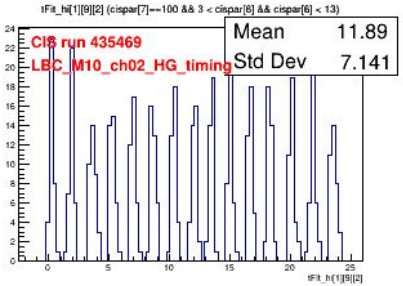
- **Date range:** September 1 - October 1,2022
- **Runs excluded (1):** 435469
- **Runs used (12):**, 433072, 433116, 433430, 433655, 433937, 434229, 434572, 434584, 435091, 435269, 435290, 435722

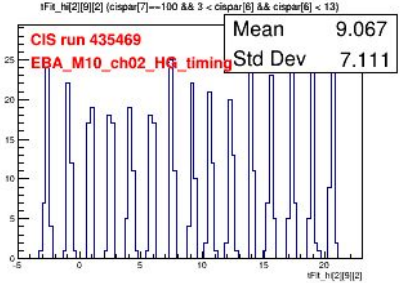
Reasons:

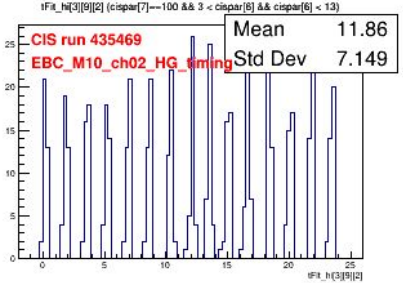
- Timing plot for LBC in run 435469 includes sampling pulse at large time
- No other systematic outliers in the plots of individual channels

Excluded Run Timing: 435469

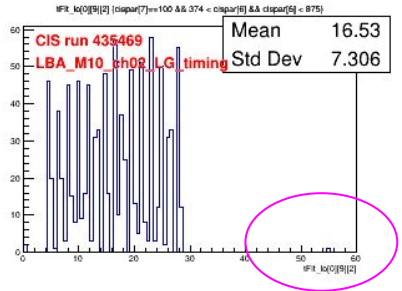


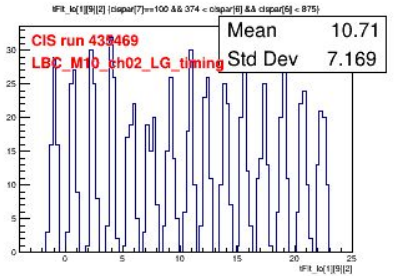


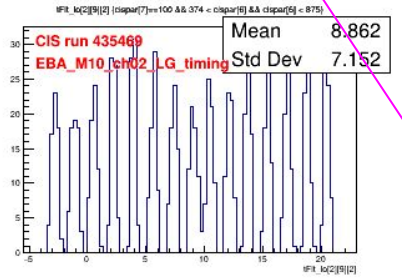


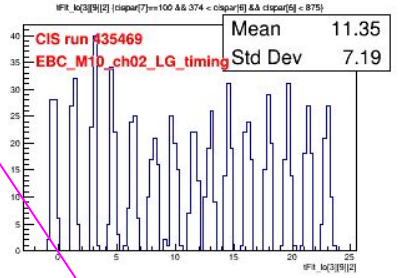


High gain





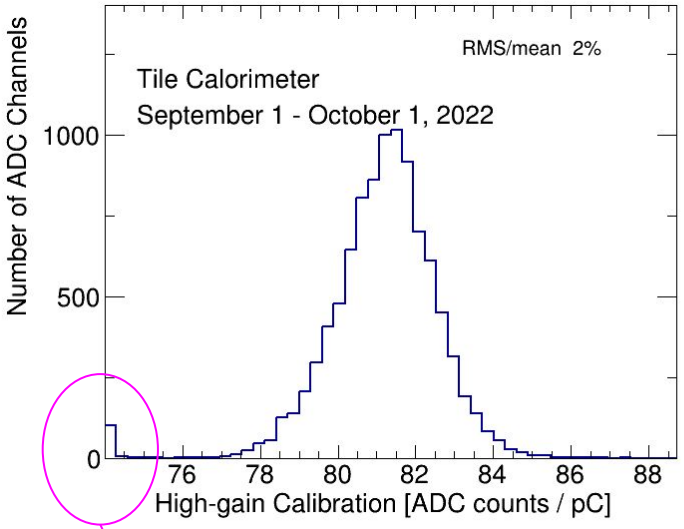




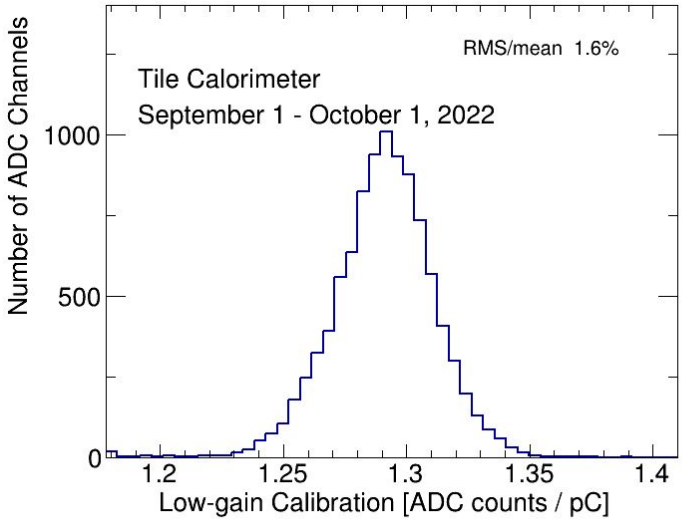
Low gain

Outlier in charge pulse sampling time only in LG

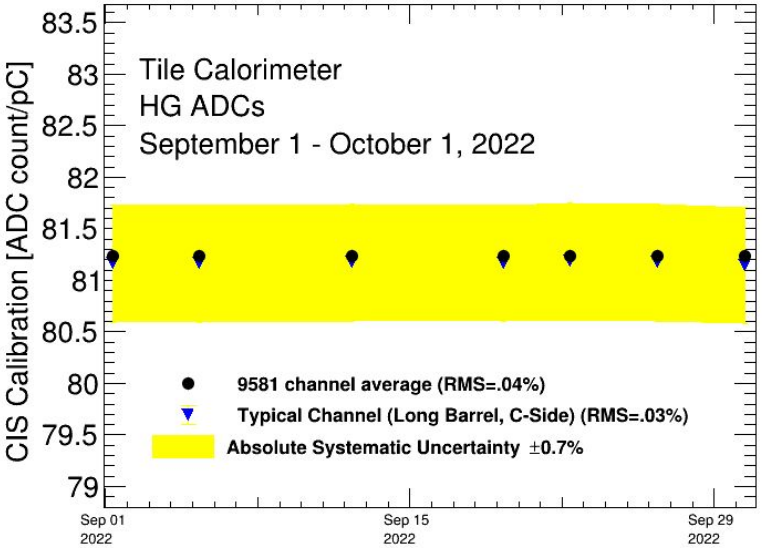
CIS Constant Distributions

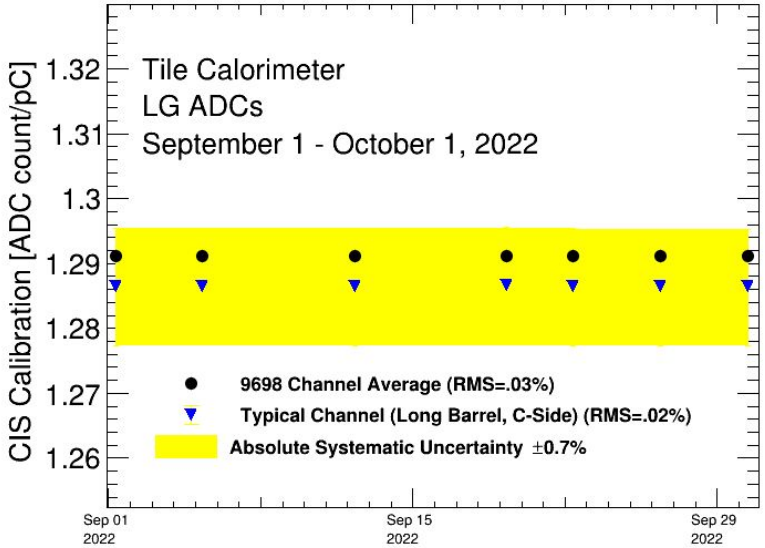


From LBA14 (demonstrator)

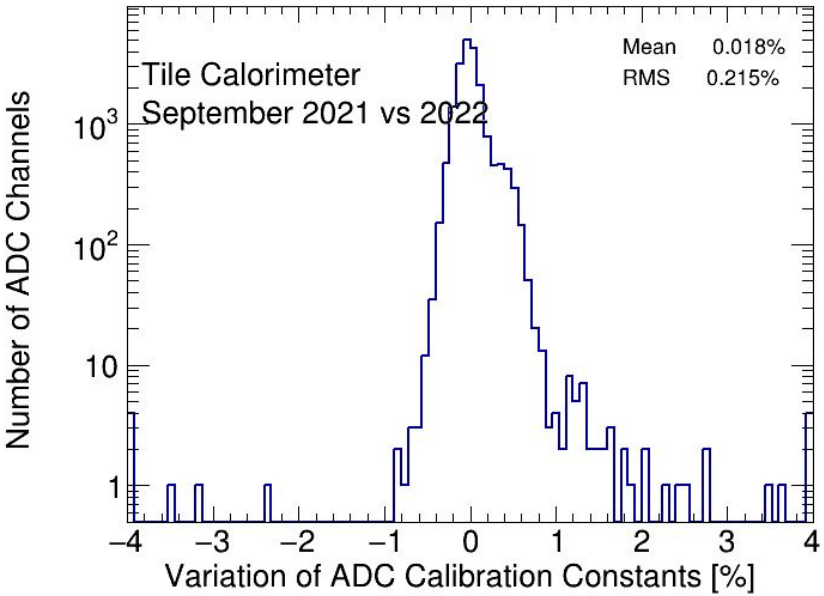


Detector Time Stability



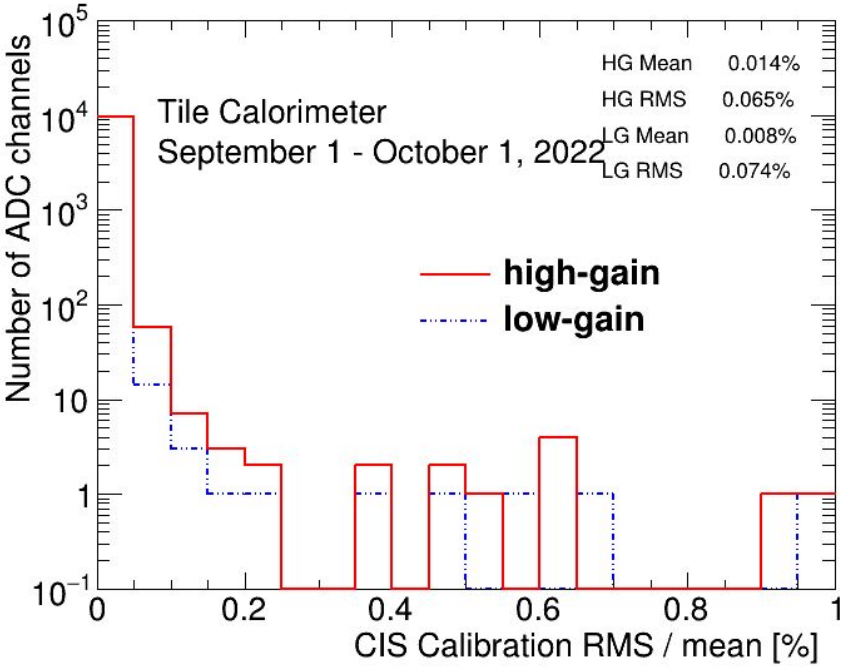


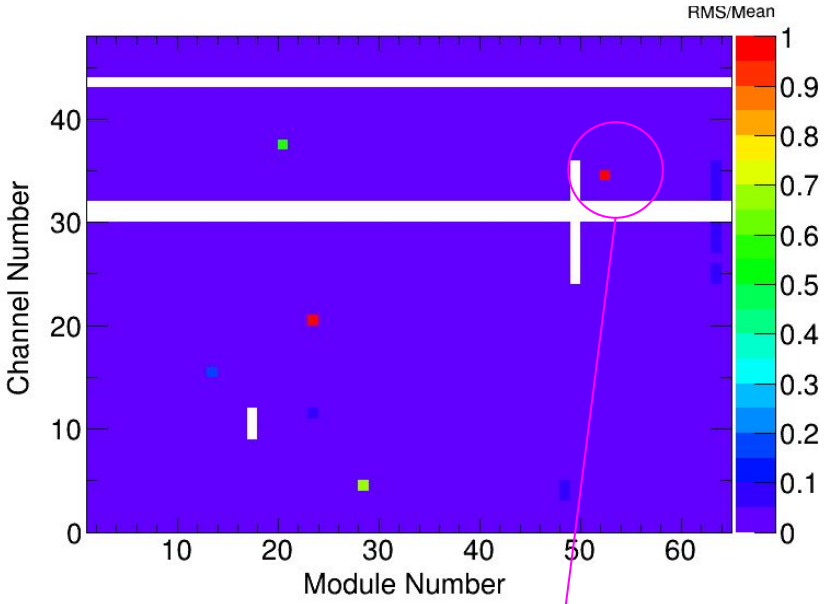
CIS Constant Long-Term Stability: 2021 vs 2022



Module	Change (%)
EBC_m16_c39_highgain	+5.82
LBC_m59_c24_highgain	-6.51
LBC_m59_c25_lowgain	-5.74
LBC_m59_c26_highgain	-9.23
LBC_m59_c27_highgain	-4.80

CIS Constant RMS/Mean





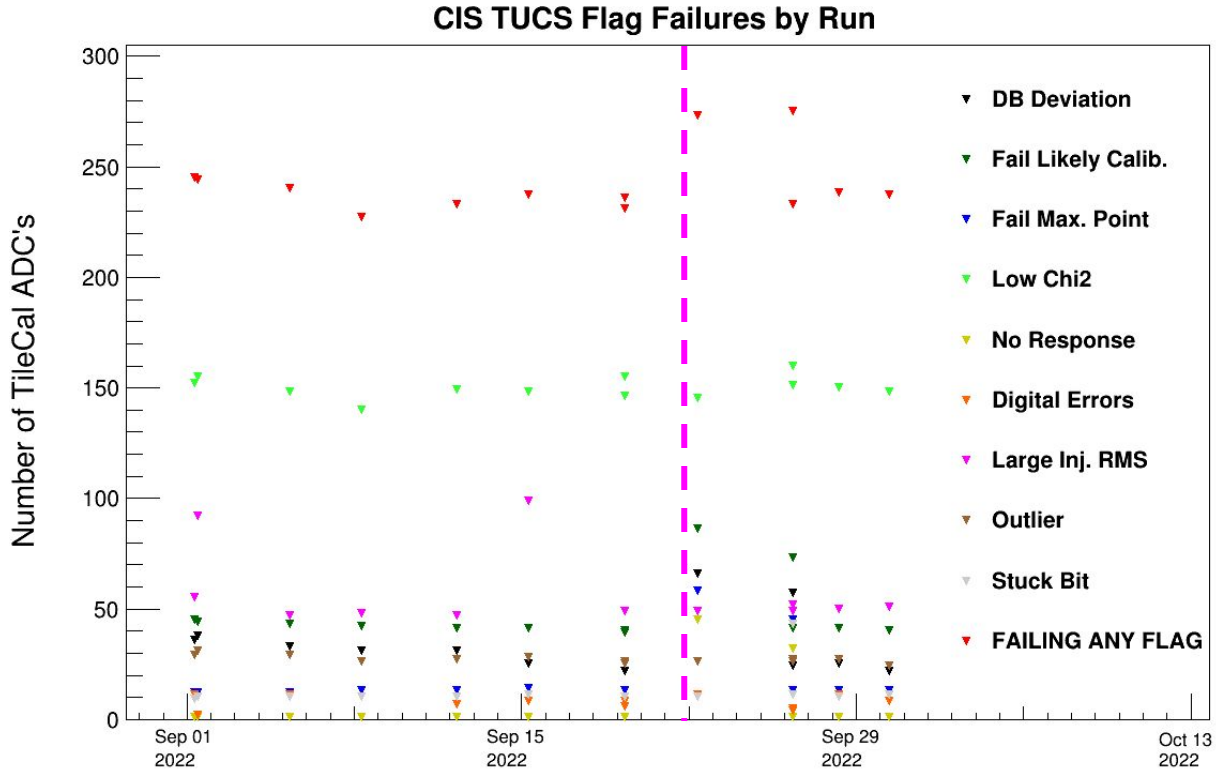
List of high RMS/mean channels identified given on next slide

(Note: There is some overflow beyond RMS/mean = 1)

CIS Constant RMS/Mean

Very High	Very High (continued)
EBA_m61_c15_highgain	LBC_m16_c29_highgain
EBA_m07_c31_lowgain	LBC_m43_c25_highgain
EBA_m61_c15_lowgain	LBC_m46_c04_highgain
EBA_m22_c16_lowgain	LBC_m52_c18_highgain
LBA_m01_c06_highgain	LBC_m23_c20_lowgain
LBA_m62_c36_highgain	LBC_m52_c34_lowgain
LBA_m64_c29_highgain	
LBA_m01_06_lowgain	

CIS TUCS Quality Flags

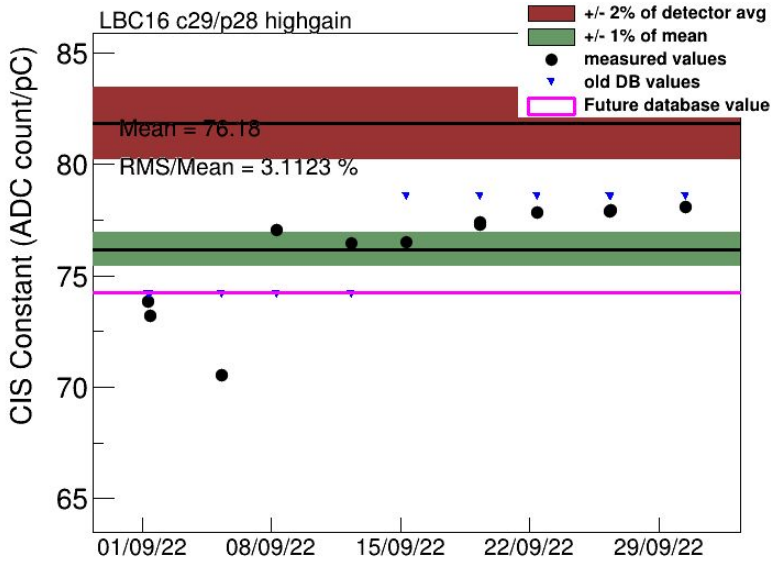


Return of LHC beam on 22.9 likely caused some heightened short-term instability for CIS?

Interesting Channel Behaviour

High Deviation from DB Mean (3)

	OLD	NEW	CHANGE
• LBC_m16_c29_highgain	78.52	74.23	-5.46%
• LBC_m47_c35_lowgain	1.17	0.65	-44.8%
• LBC_m52_c18_highgain	103.50	94.0	-9.19%



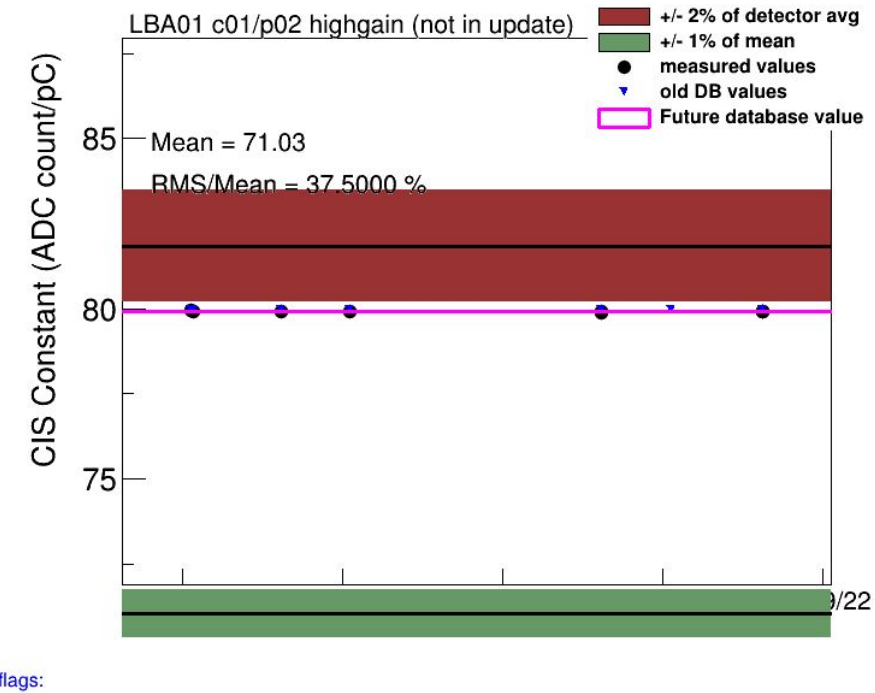
ADC AFFECTED Bad CIS Calib

qflags:

- All channels listed above besides are “ADC masked” anyways (apart from highlighted)
- LBC_m16_c29 is ADC affected; last month, CIS constant increased by >5%, now it has decreased again by roughly the same amount. Affected → Masked?

No Response in LBA 01 in mid-September

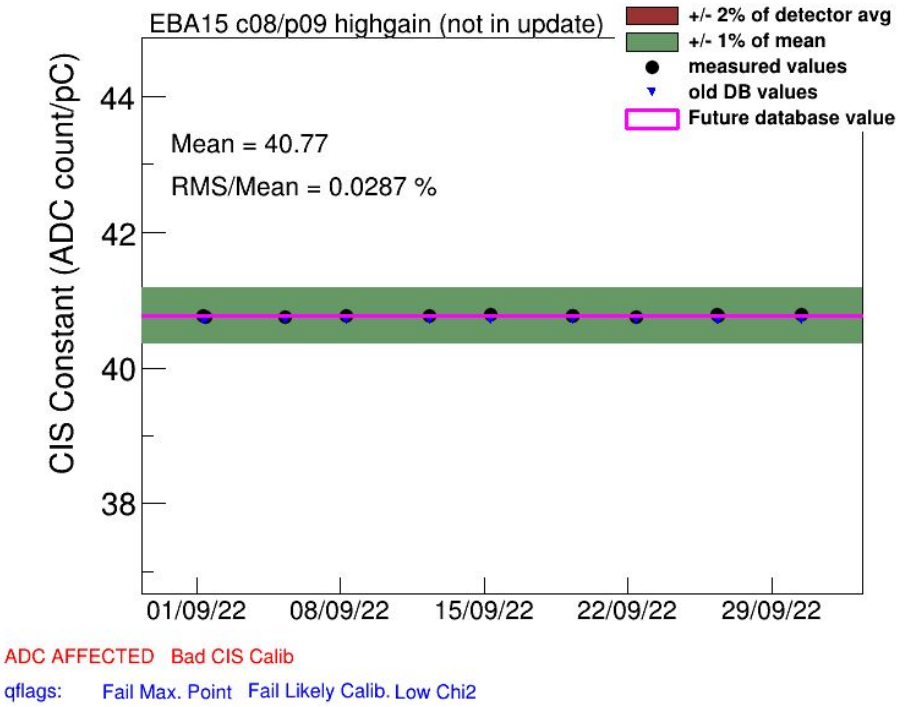
- Database value will not change
- Reason for no response in some of the runs of LBA01?



Half Gain Channels

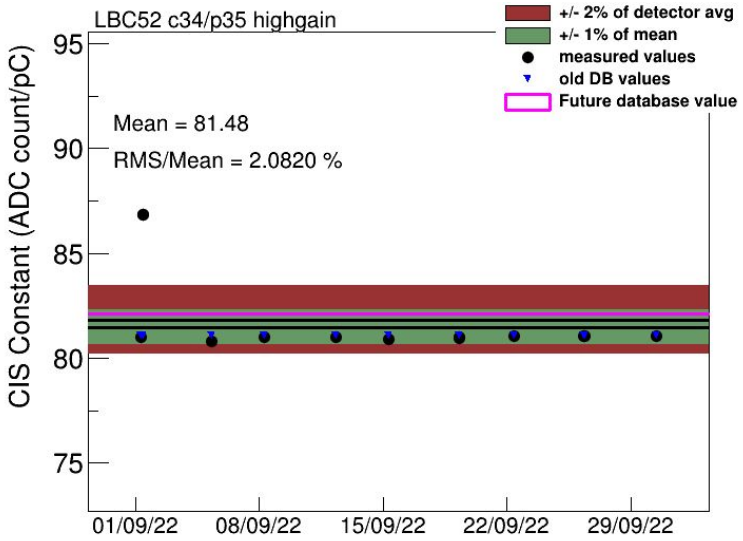
- EBA_m15_c08_highgain
- EBA_m16_c00_highgain
- EBA_m36_c15_highgain
- EBA_m42_c30_highgain
- EBA_m48_c31_lowgain
- EBC_m09_c40_highgain
- EBC_m21_c36_lowgain
- LBC_m08_c03_lowgain
- LBC_m19_c22_lowgain

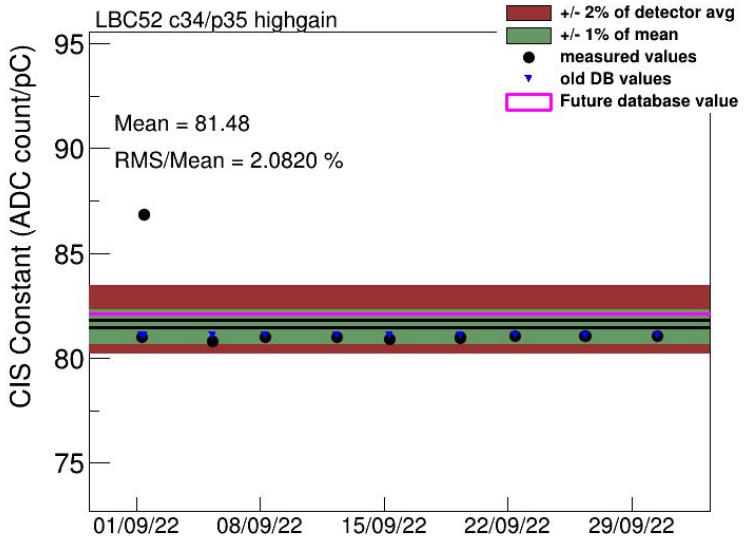
Affected
Masked



LBC 52 Channel 34

- Bad runs at the beginning of the month shift the constant (but not far enough away from the database value to be marked as bad)
- In both HG and LG, only in this channel



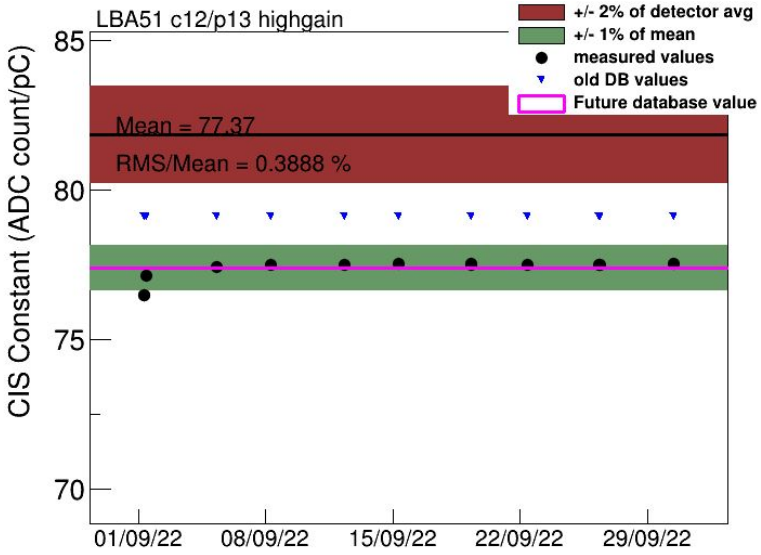


qflags:

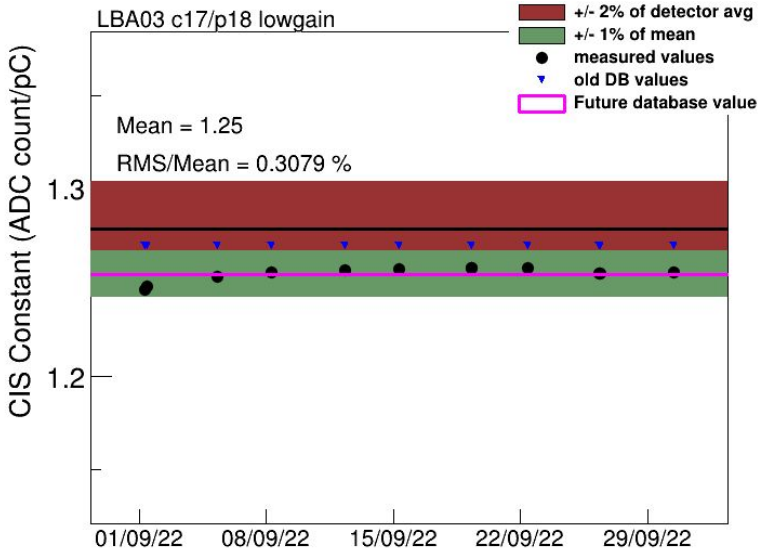
qflags:

LBA 51 Channel 12, LBA 03 Channel 17

- Similar upward drifting behavior in the beginning of the month, but by the end of the month, the vale seem,s to stabilize (so recalibrate from here)



qflags:

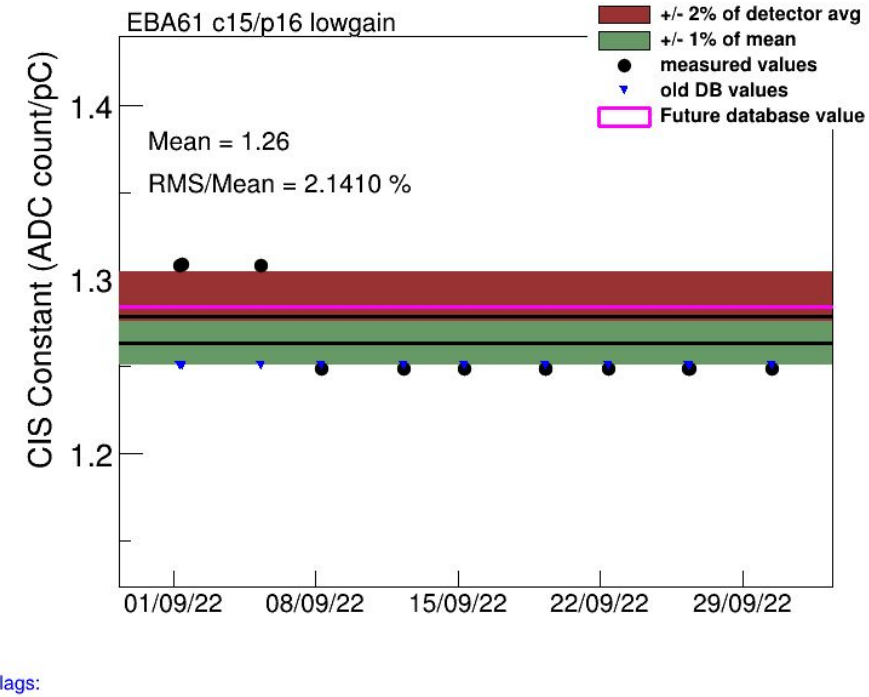


qflags:

Channels to Recalibrate

- LBC_m52_c34_highgain
- LBC_m52_c34_lowgain
- LBA_m03_c17_lowgain
- LBA_m51_c12_highgain
- EBA_m61_c15_highgain

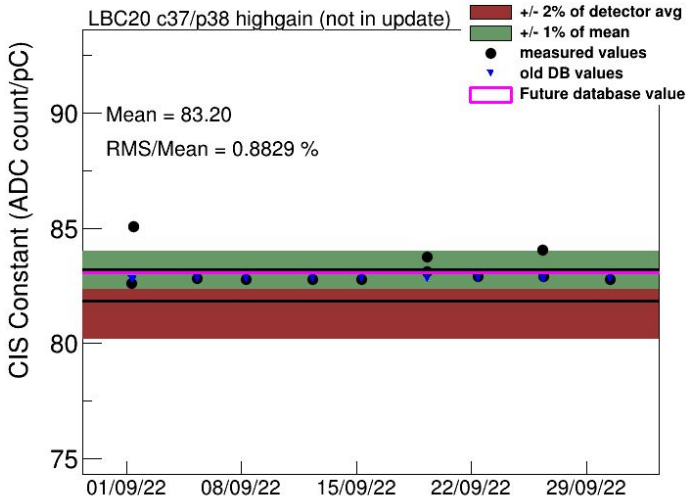
First three runs of the month are consistent for EBA61t, and then the value shifts (a bit unlike the other four)



COOL Flag Updates

Remove BadCIS (0)

NONE



qflags:

Add BadCIS (3)

LBC_m10_c37_highgain
LBC_m20_c37_highgain
LBC_m20_c37_lowgain

(either they are not in the update or they have a masked ADC anyways)

Ongoing Work/Further Questions

Overview of Recent Work (July 1 - October 1)

- We have performed 3 CIS DB updates (and have presented today on our 4th)
- Links to corresponding presentations:
  - https://indico.cern.ch/event/1194827/
  - https://indico.cern.ch/event/1157760/
  - https://indico.cern.ch/event/1157756/
- Major takeaways from CIS updates recently:
  - Timing shifts in June caused large number of recalibrations needed
  - Very good CIS comstant stability through mid August (see Appendices for up-to-date list of masked/affected channels)
  - Some modules were moved to half gain in August (LBC52) then back to normal due to electronics issues
  - Some isolated edge-cases in our codebase did not properly clean out invalid data (see next slide for further discussion of TUCS updates)

Updating TUCS

- Some TUCS functionalities in CIS are not working as desired (discovered after trying to investigate modules during/after last CIS update): hostorical plots of CIS constant by channel, especially
- We want to bring the documentation and code up to date
- Questions:
  - Are there any pieces of code/functionalities that should take priority to fix?
  - Are there any other plots or functionalities that are useful for other systems that we can develop?

Appendices

Current Status of ADC Masked/Affected Channels

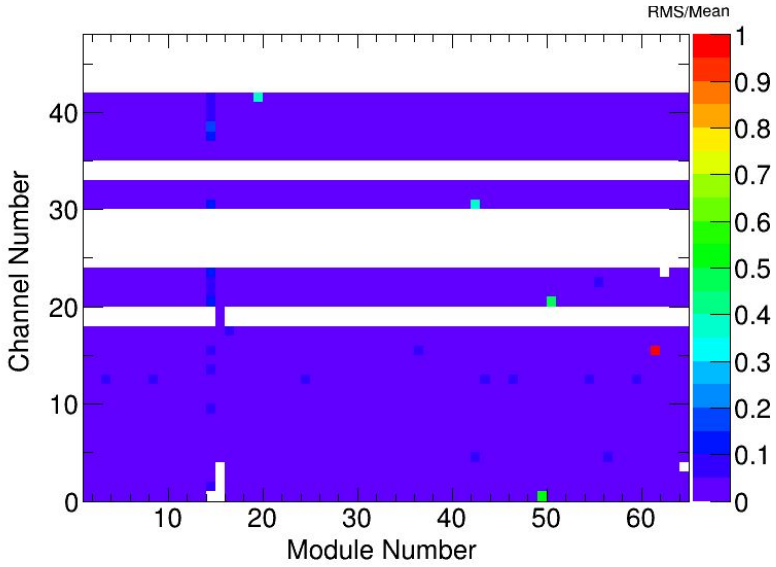
Affected channels: 16

LBC01 c25/p26 highgain
LBC44 c12/p13 highgain
LBC10 c37/p38 highgain
LBC16 c29/p28 highgain
LBC62 c08/p09 highgain
EBC23 c36/p44 highgain
EBC13 c03/p04 lowgain
EBC61 c08/p09 lowgain
LBA37 c21/p22 highgain
LBA45 c06/p07 highgain
LBA06 c40/p41 highgain
LBA52 c01/p02 lowgain
LBA64 c29/p28 highgain
EBA42 c30/p33 highgain
EBA49 c00/p01 highgain
EBA50 c20/p21 highgain

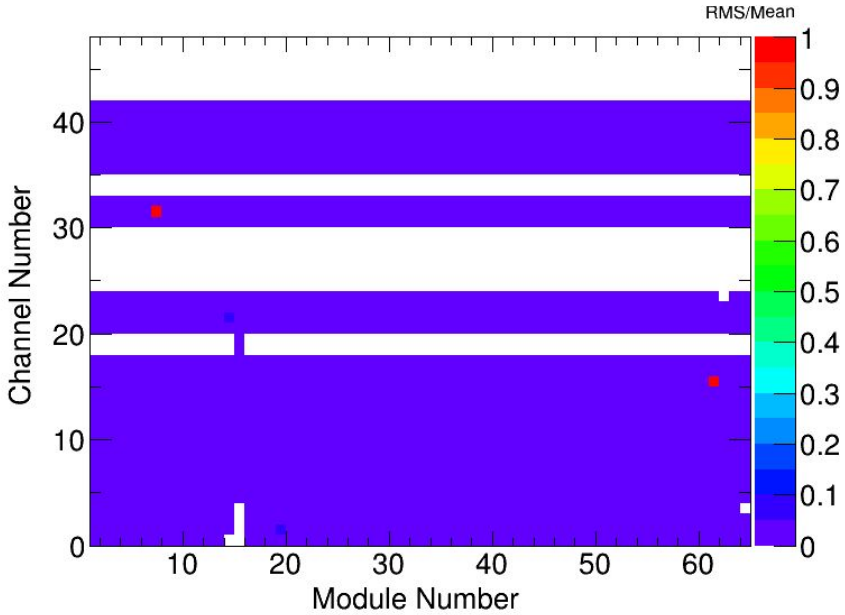
Masked channels: 11

LBC43 c24/p27 highgain
LBC47 c35/p34 lowgain
LBC52 c18/p19 highgain
LBC13 c15/p16 lowgain
LBC23 c20/p21 lowgain
LBC28 c04/p05 lowgain
EBC22 c16/p17 lowgain
LBA02 c06/p07 highgain
LBA02 c06/p07 lowgain
LBA35 c08/p09 highgain
EBA07 c31/p29 lowgain

RMS/Mean Channel Maps (EBA)

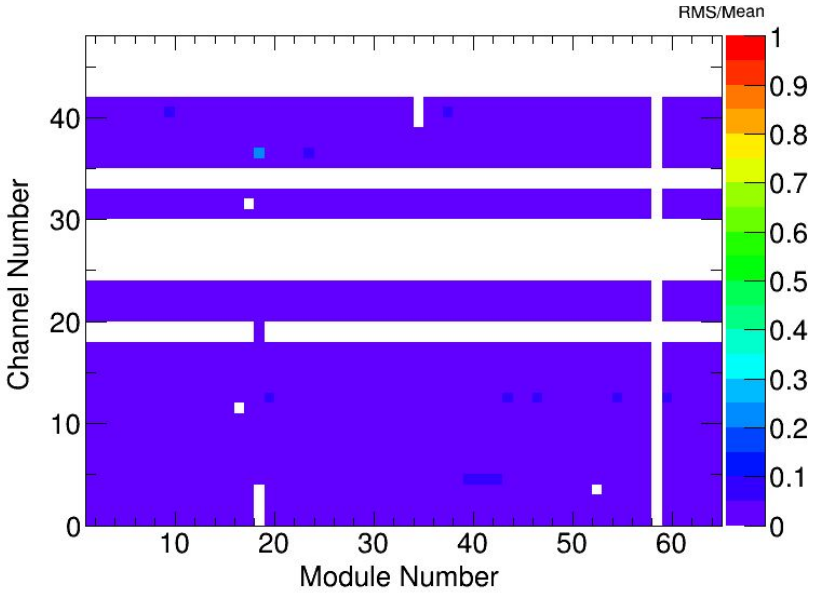


High gain

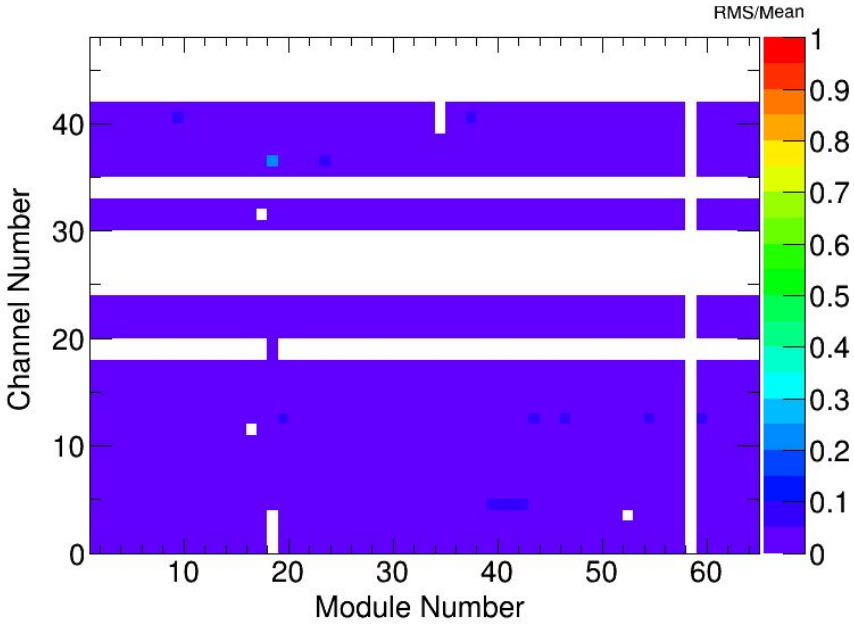


Low gain

RMS/Mean Channel Maps (EBC)

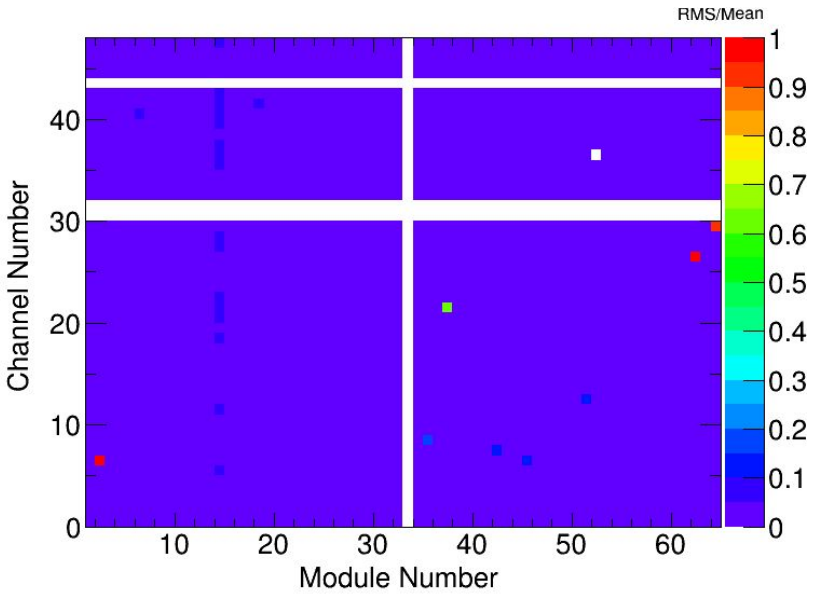


High gain

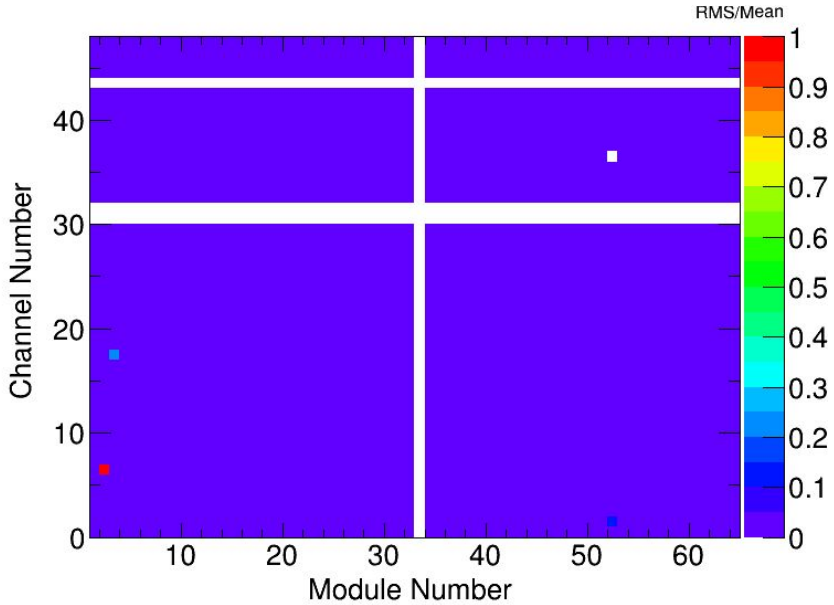


Low gain

RMS/Mean Channel Maps (LBA)

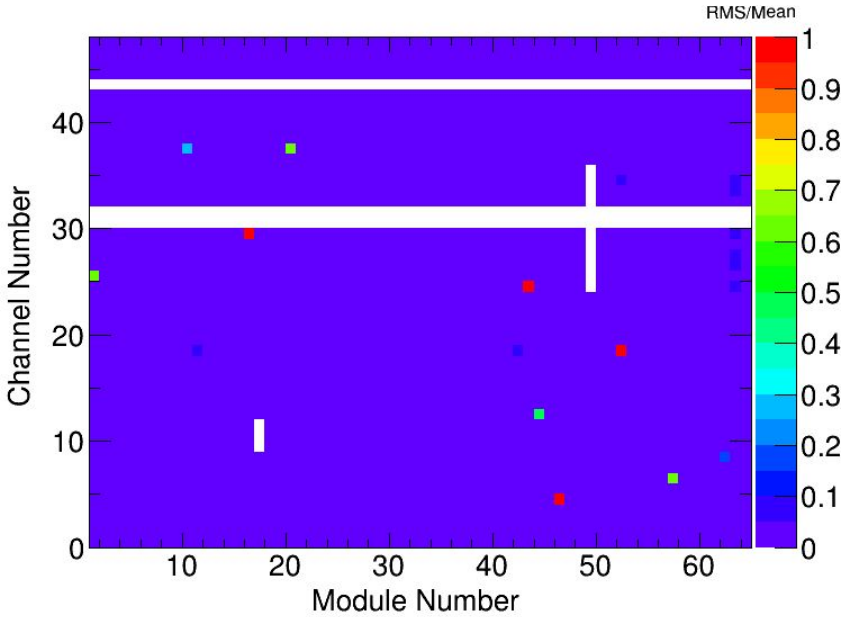


High gain

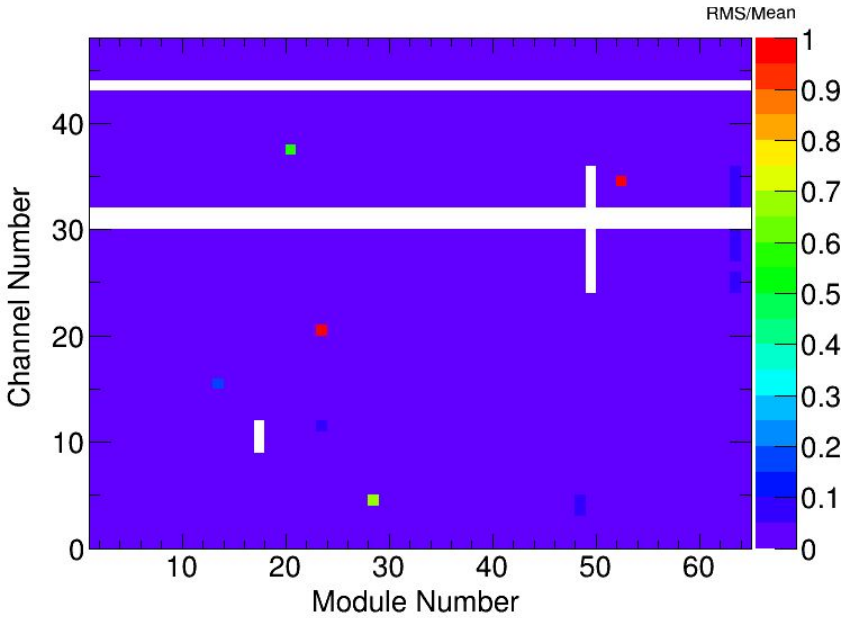


Low gain

RMS/Mean Channel Maps (LBC)



High gain



Low gain

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	$\geq$ 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%