

Charge Injection System (CIS) Reprocessing Update - 2

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The University of Chicago
December 19, 2022



Preparing DB File:

Options:

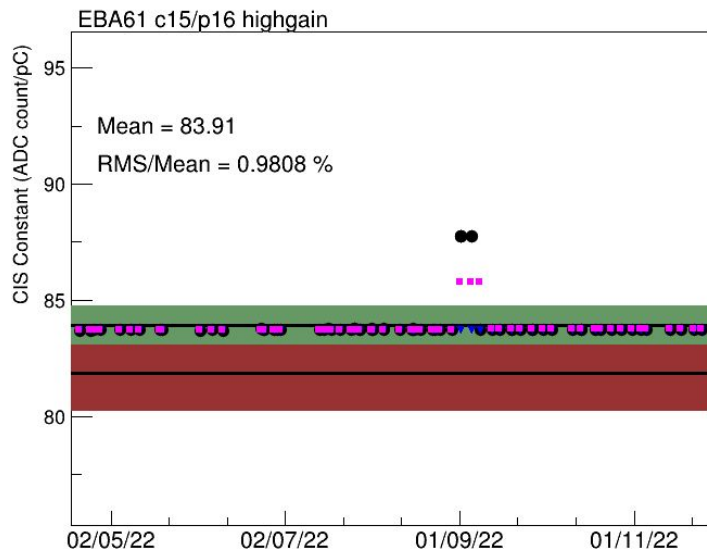
1. Make changes to individual channels marked in this presentation and merge with main DB file
2. Make suggested changes for all channels and directly produce one DB file (no updating individual channels afterwards) i.e. remove bad runs and slightly reduce database change threshold for all channels

We plan to upload new CIS conditions by **Wednesday, December 21st**

Checks in Laser

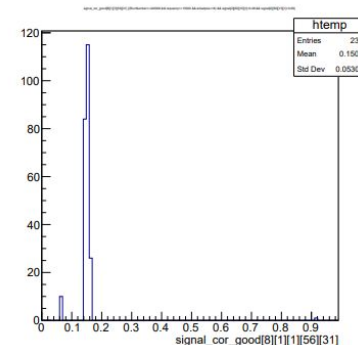
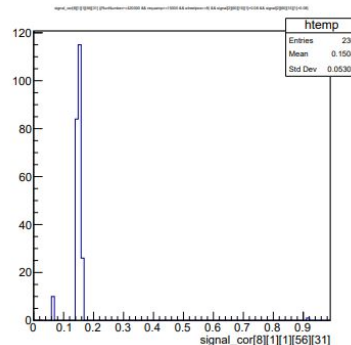
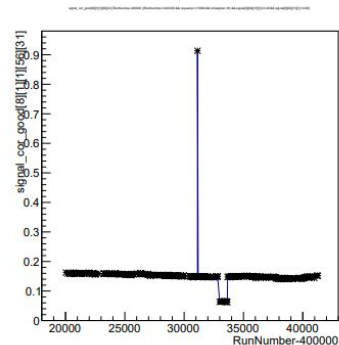
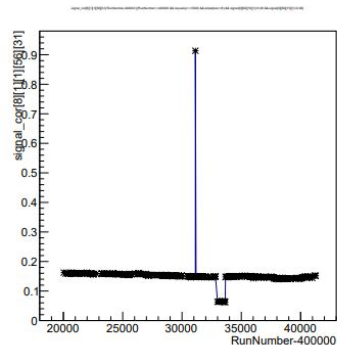
(Laser Plots from Pawel)

EBA 61 C15

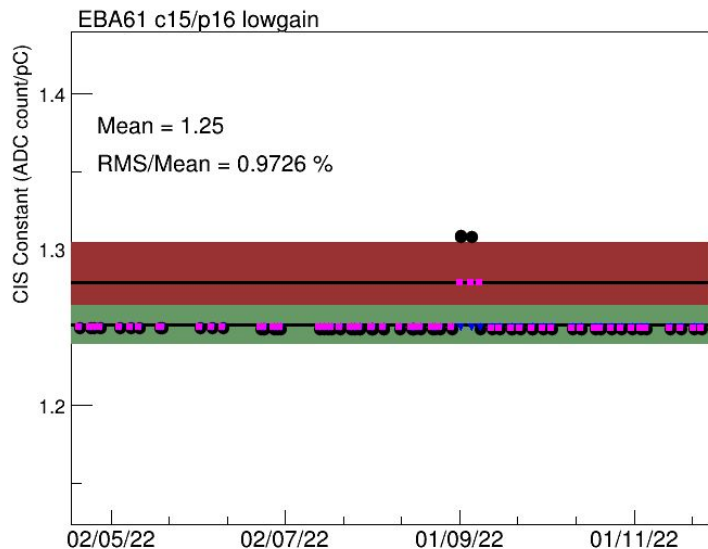


qlflags:

Remove the bad runs because we see jump in opposite direction, so these bad runs are likely a relic of of problem in CIS circuit. (433072 433116)

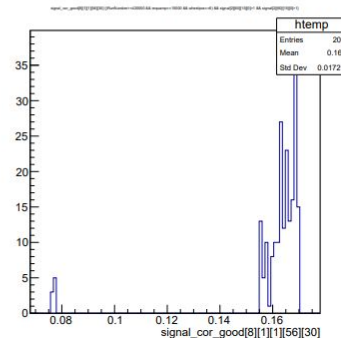
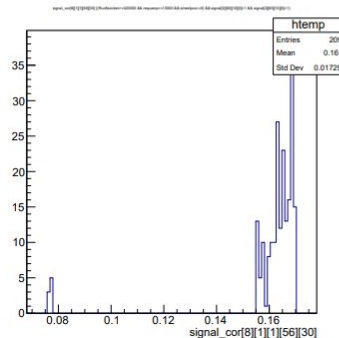
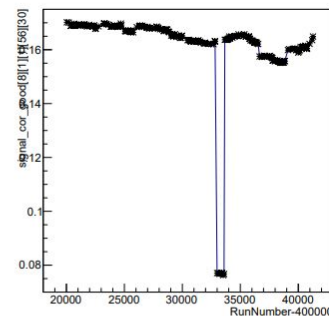
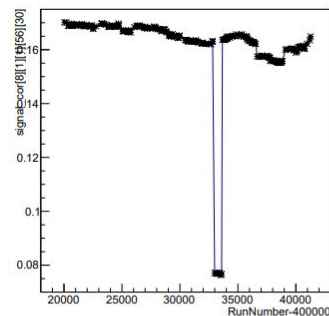


EBA 61 C15

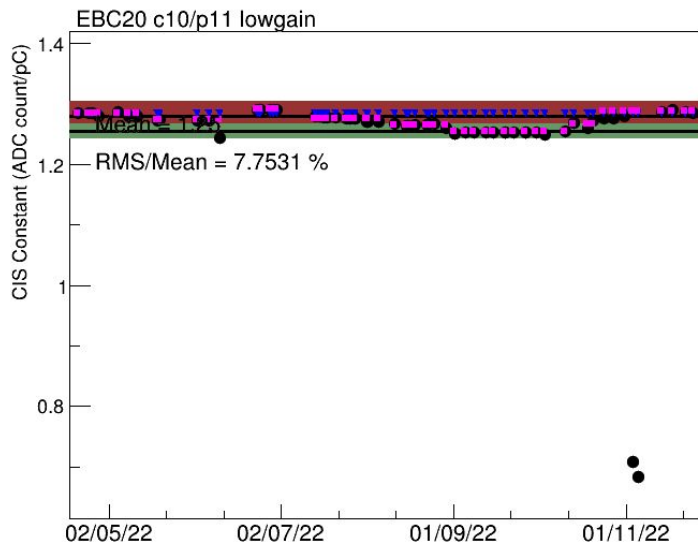


qlflags:

Remove the bad runs because we see jump in opposite direction, so these bad runs are likely a relic of of problem in CIS circuit. (433072 433116)

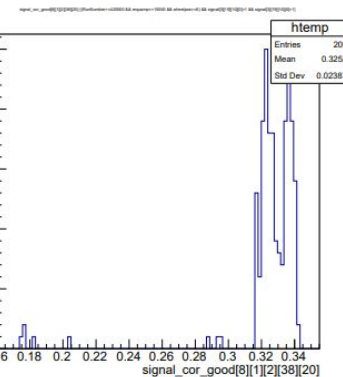
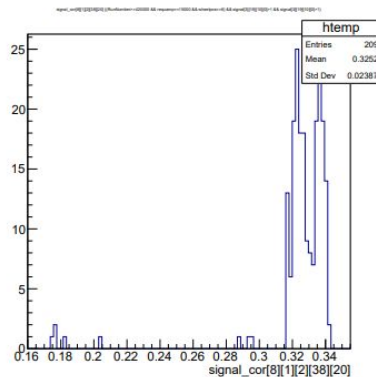
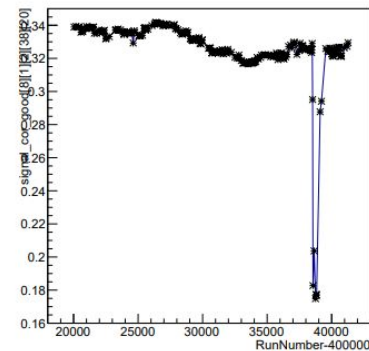
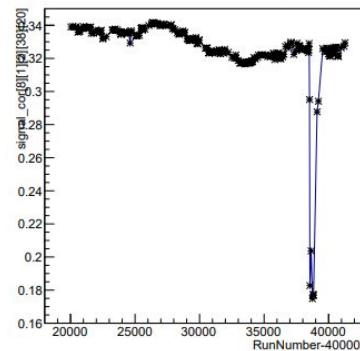


EBC 20 C10

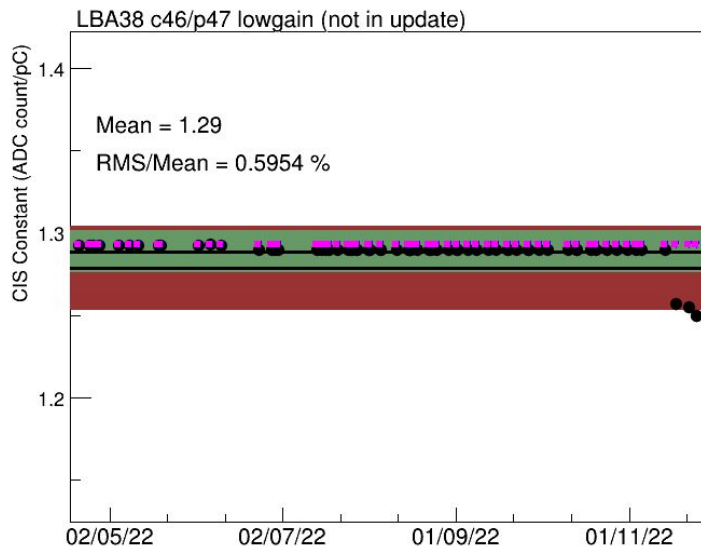


qflags:

We change to run_window=2 (but it makes no difference compared to run_window=3) to include jump at the end of the year. We see it in the same direction in Laser.

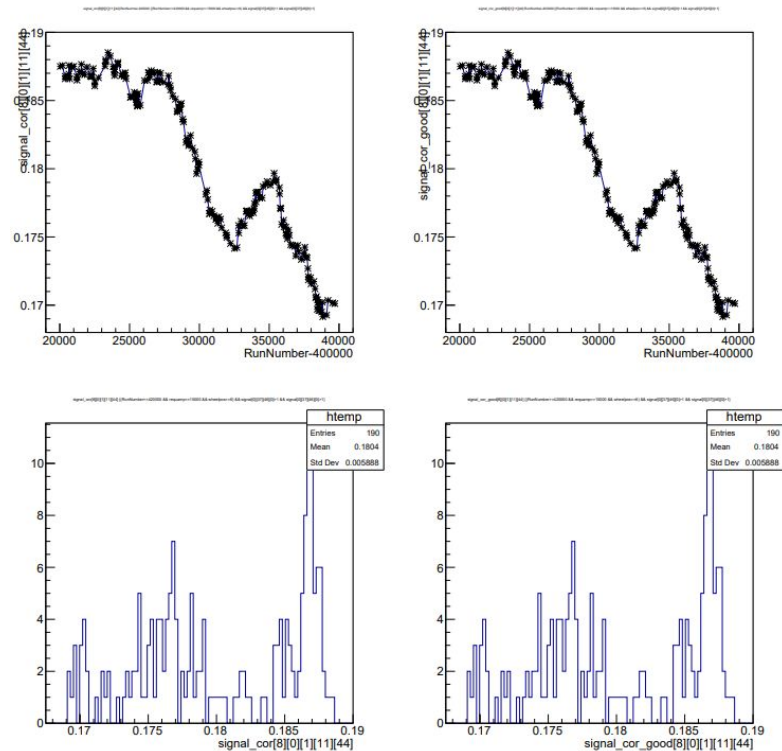


LBA 38 C46

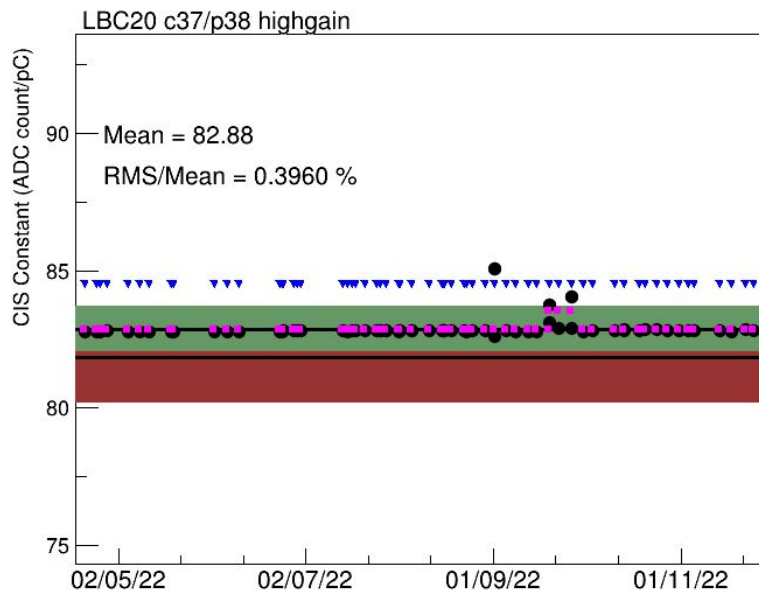


qflags:

Laser sees problem in pulse shape and is not stable (better to ignore the jump and keep the pink database values as they are)

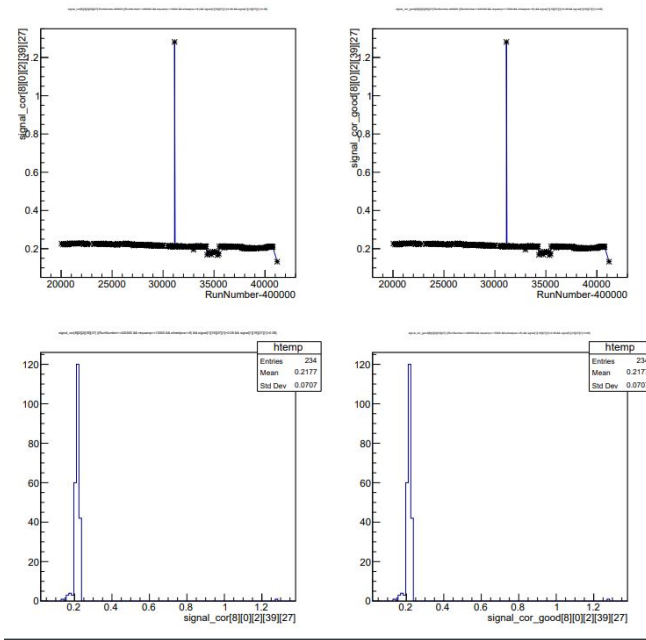


LBC 20 C37

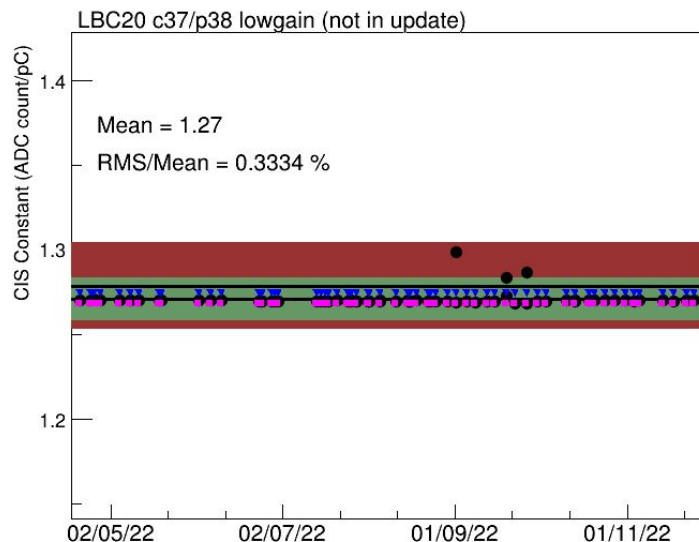


qflags:

Outlier runs in the middle of the month have distorted the CIS constant value, so we exclude them. We see a jump in opposite direction in Laser, which does not justify shifting CIS (433116 434584 435290 435469)

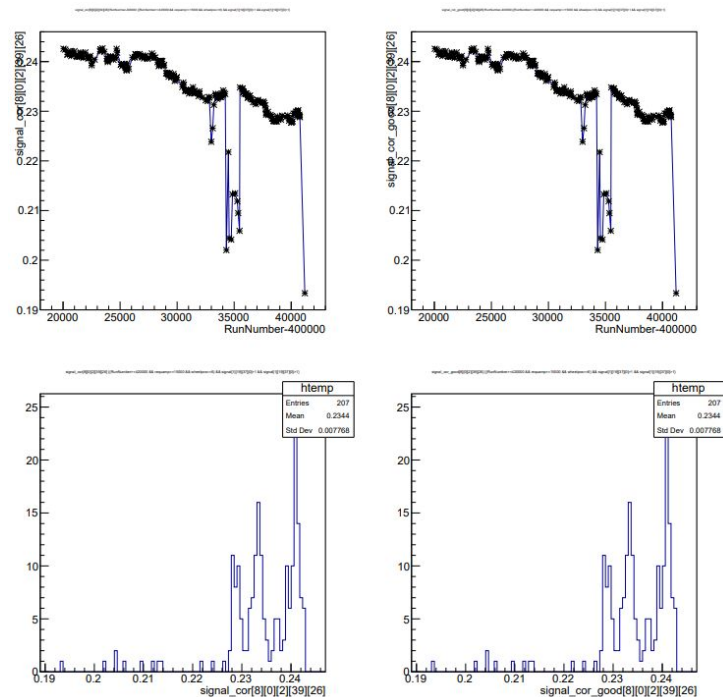


LBC 20 C37



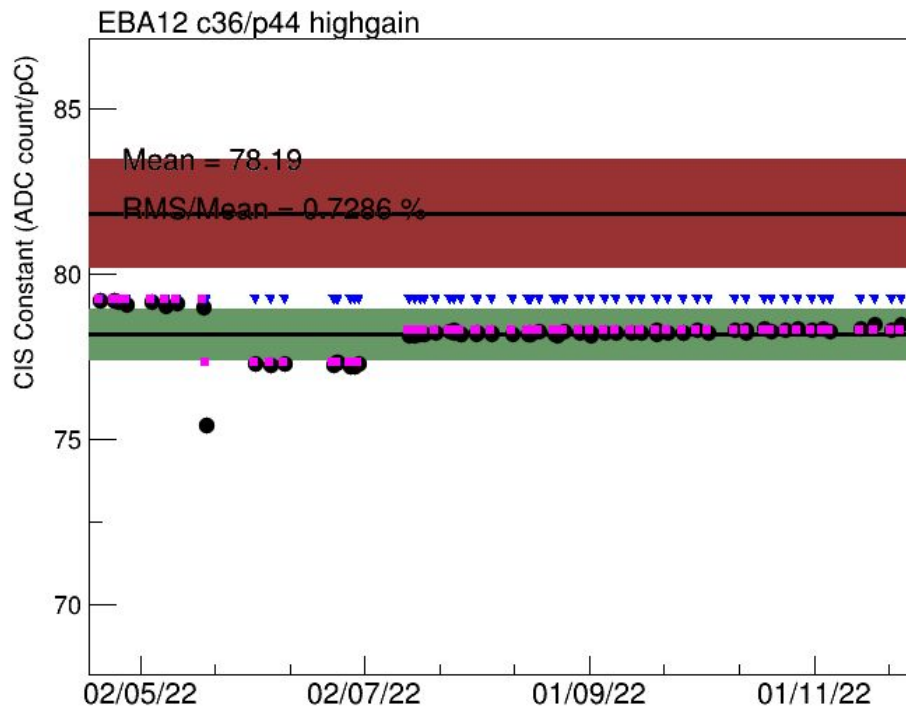
qflags:

Outlier runs in the middle of the month are excluded automatically by our algorithm (unlike in high gain)



Problematic Channels (Complete)

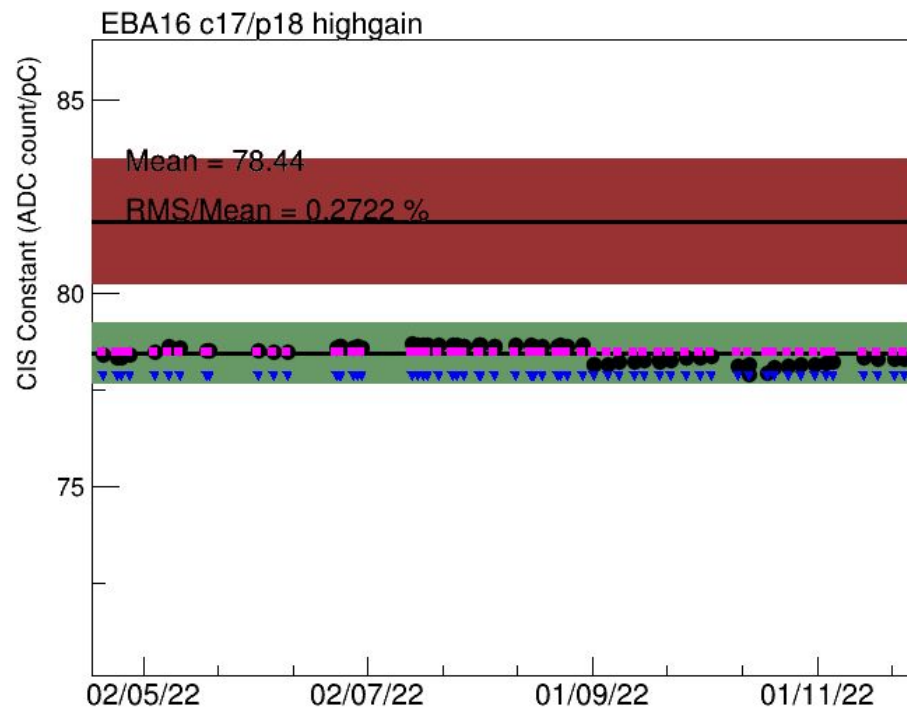
EBA 12 C36



There is one outlier value that we did not remove because it only appears in this channel. It seems to not affect the value of CIS constant

NO CHANGE:
Outlier value is
outside of data
taking

EBA 16 C17



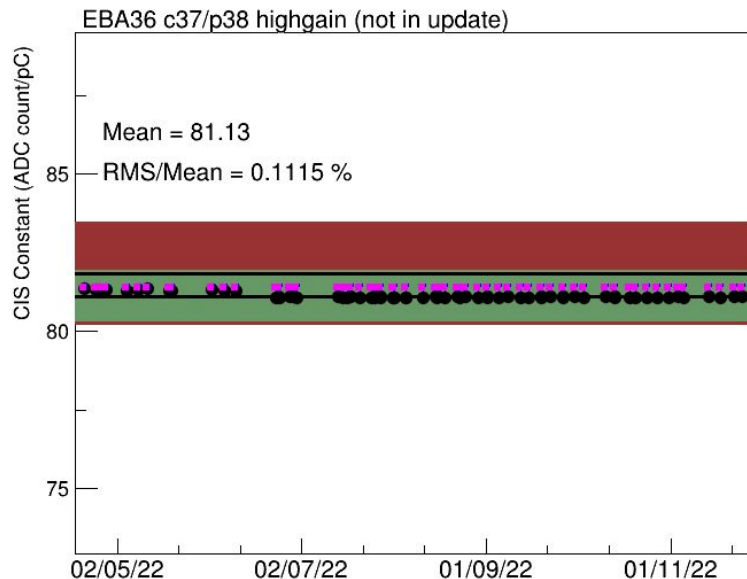
Should we make the update threshold smaller in this case to more accurately approximate the drifting behaviour?

CHANGE
THRESHOLD

ADC AFFECTED Bad Las Calib

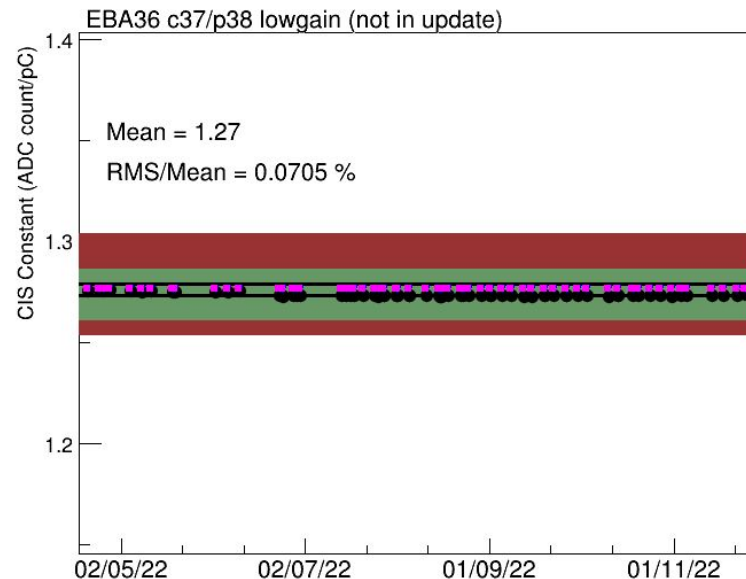
qflags:

EBA 36 C37



qflags: Large Inj. RMS

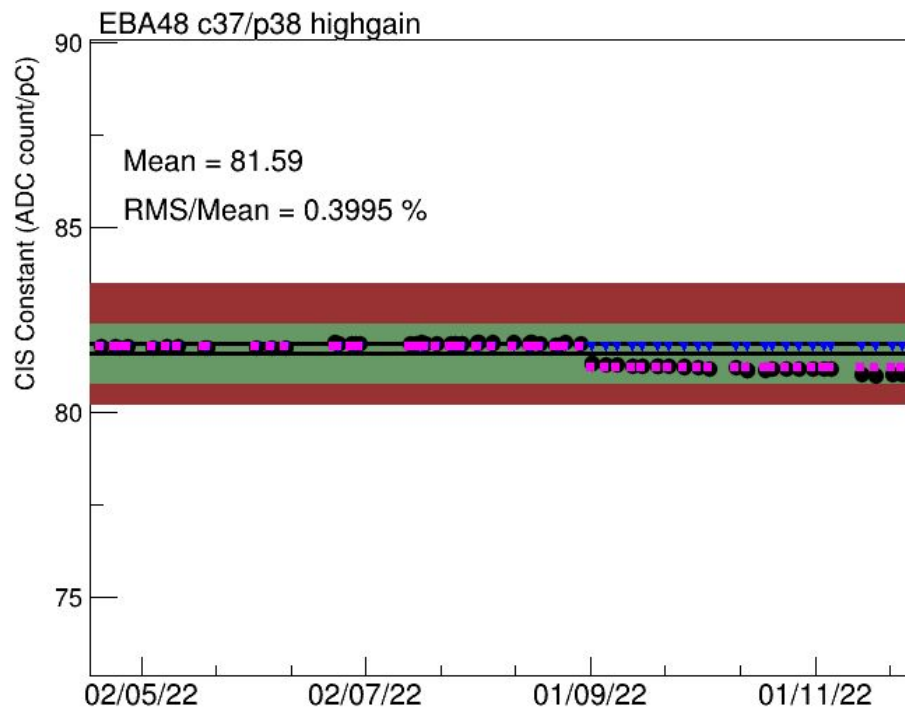
The future database values don't exactly align with the most recent runs. Decrease update threshold?



qflags: Large Inj. RMS

**CHANGE
THRESHOLD**

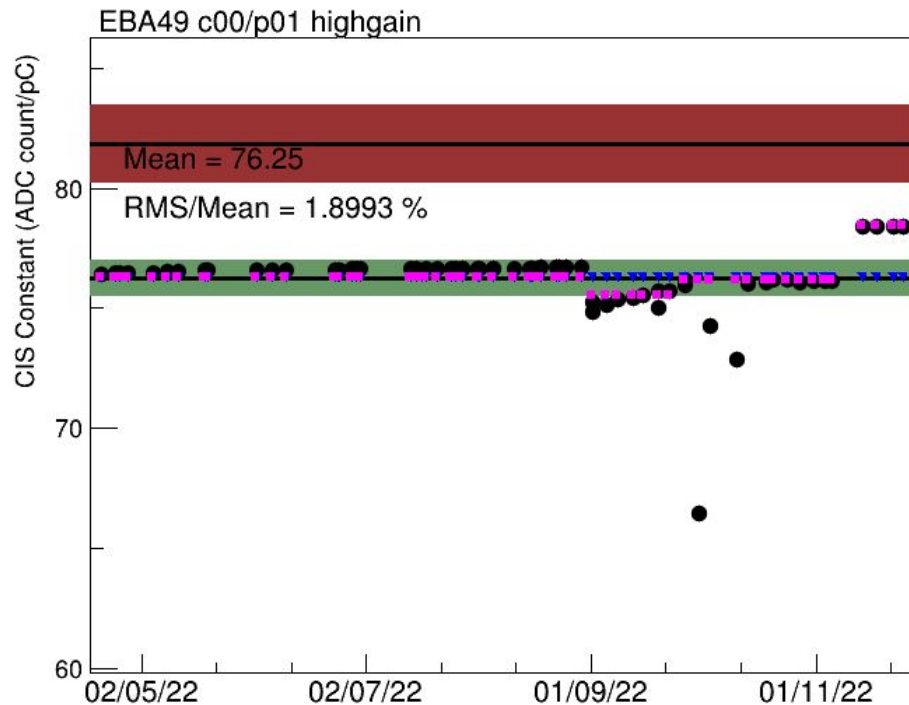
EBA 48 C37



The future database values don't exactly align with the runs in the last runs of the month. Decrease update threshold?

CHANGE
THRESHOLD

EBA 49 C00



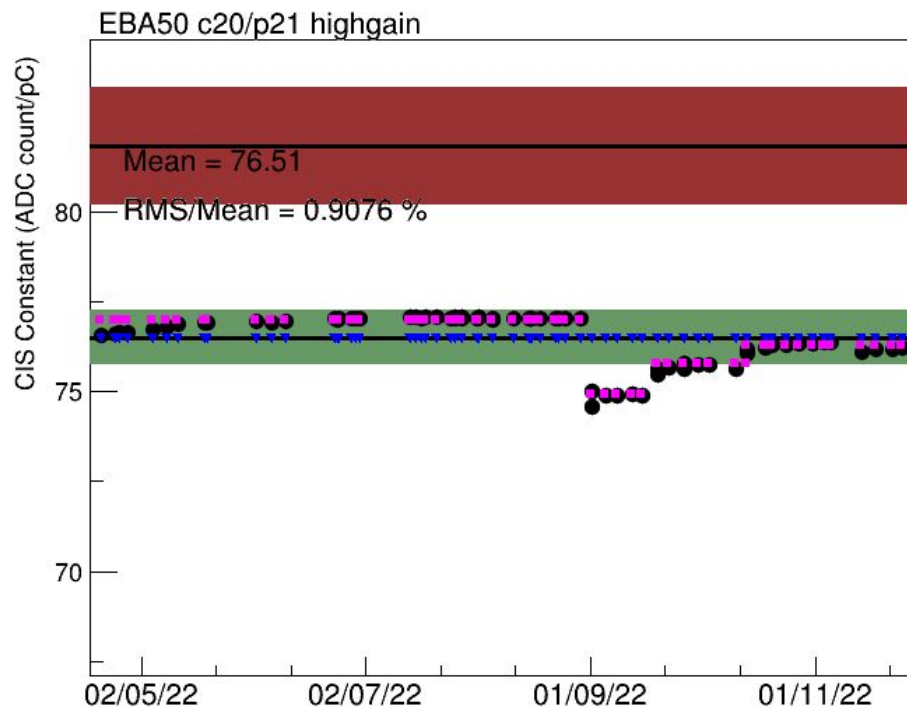
CIS constant is stable over most of the runs, but there are some obvious outliers in the middle. Is this ok? The reprocessing seems to interpret these as outliers and assigns the closest stable value.

NO CHANGE

ADC AFFECTED Bad CIS Calib

qflags:

EBA 50 C20



ADC AFFECTED Bad CIS Calib

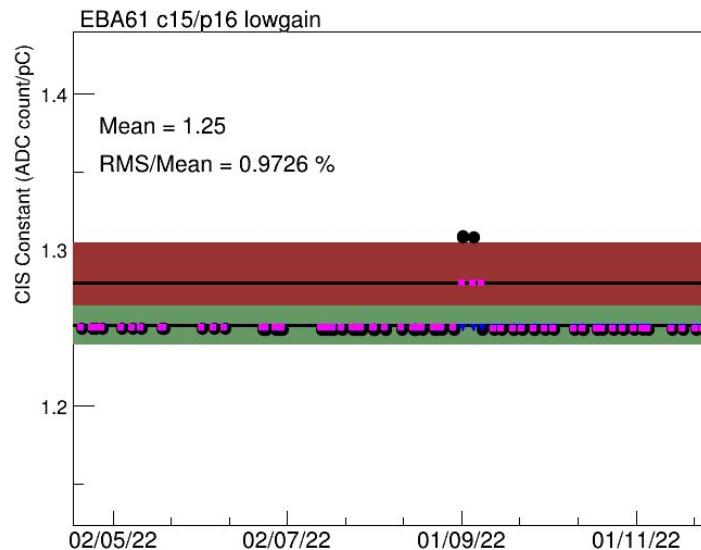
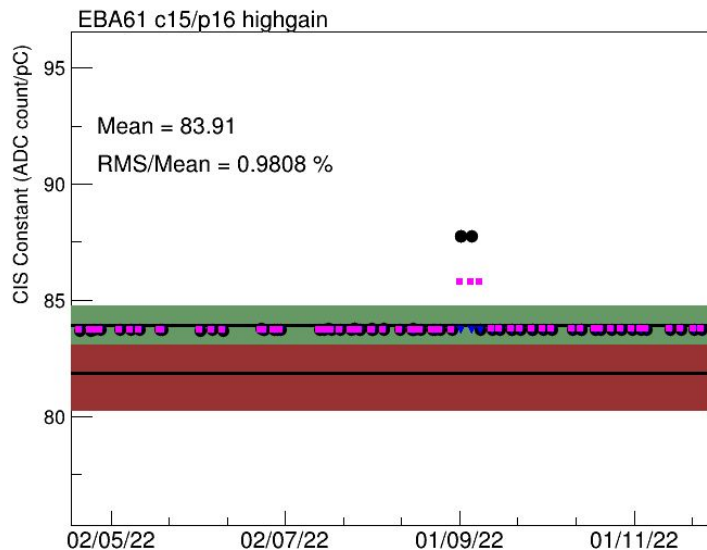
Bad Las Calib

qflags:

CIS constant is stable over most of the runs, but there are some obvious outliers. Is this ok? The reprocessing seems to interpret these as outliers and assigns the closest stable value.

NO CHANGE

EBA 61 C15



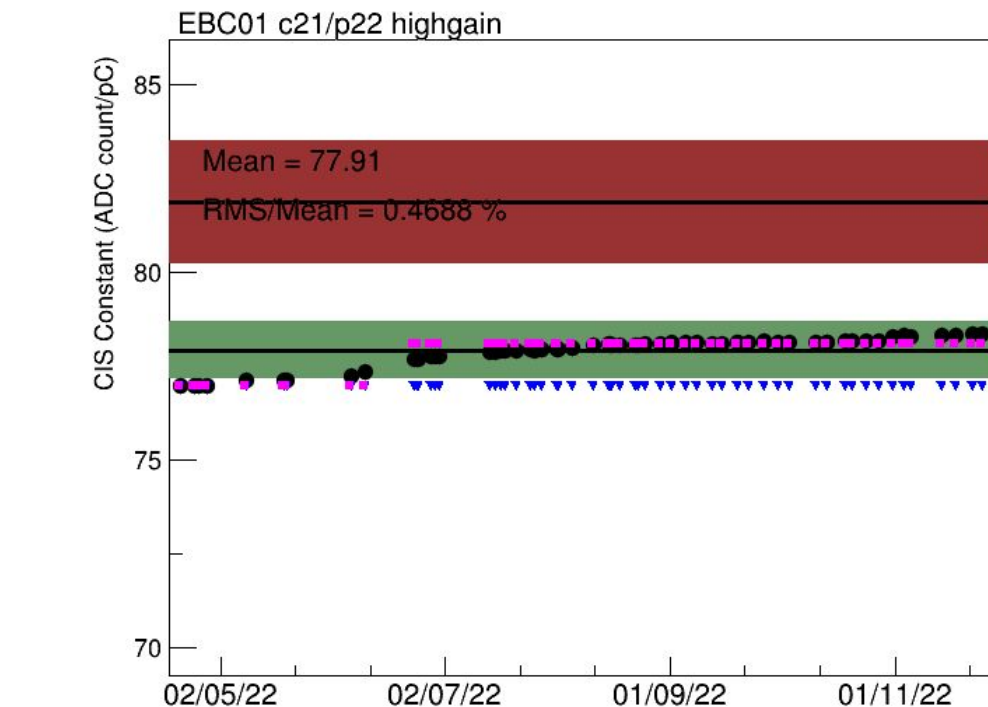
qlags:

Outlier runs in the middle of the month have distorted the CIS constant value. We could rerun ONLY this channel with `run_window = 2` to fix those values

qlags

REMOVE BAD
RUNS (SEE
LASER0

EBC 01 C21



ADC AFFECTED Bad Las Calib

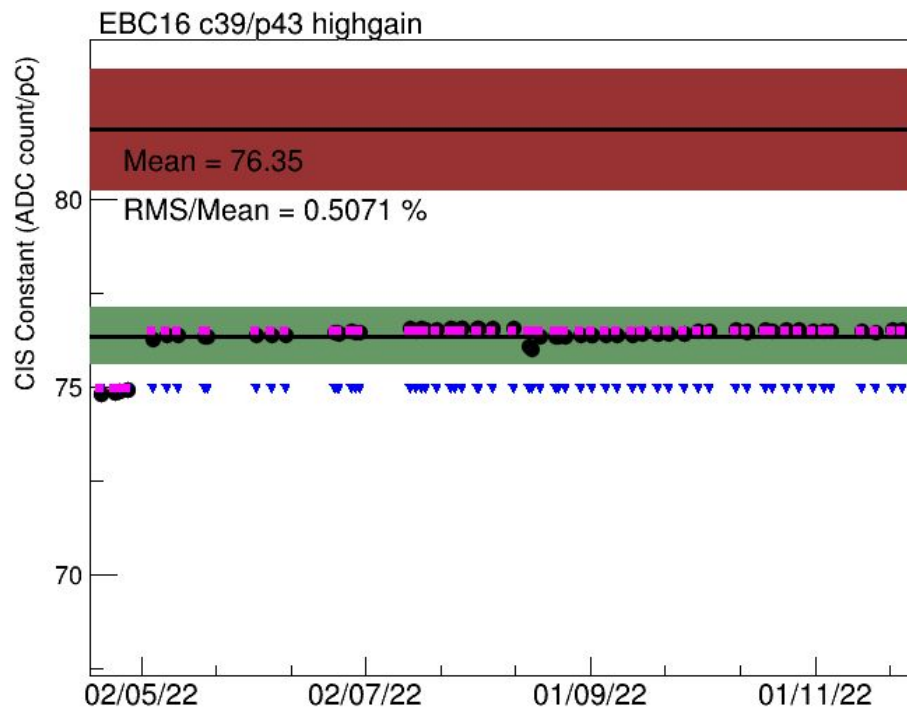
Bad CIS Calib

qflags:

Should we make the update threshold smaller in this case to more accurately approximate the drifting behaviour?

CHANGE
THRESHOLD

EBC 16 C39



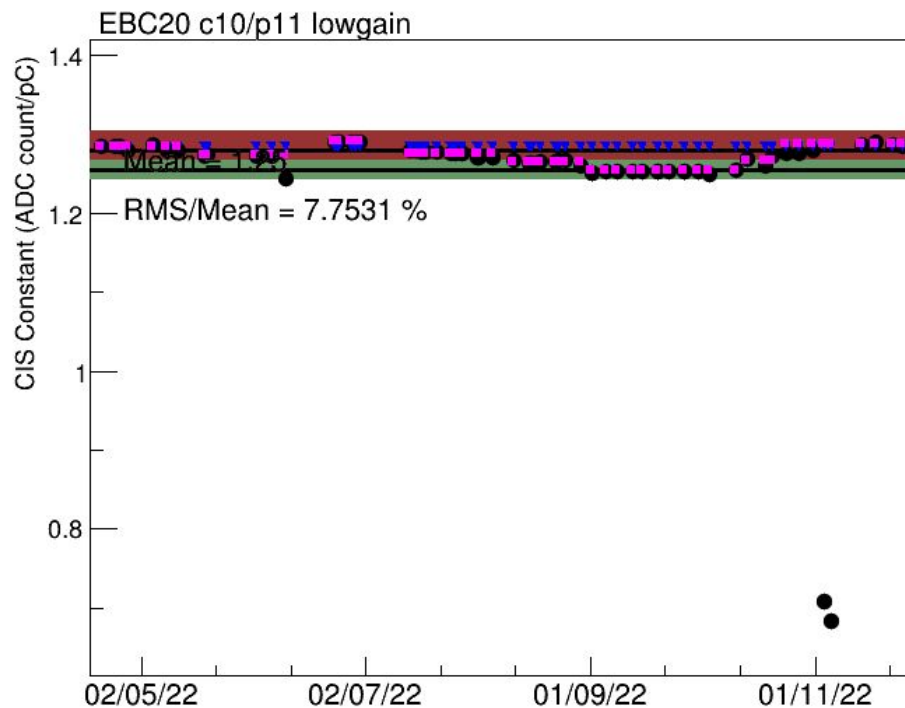
Should we make the update threshold smaller in this case to more accurately approximate the occasional variations?

CHANGE
THRESHOLD

ADC AFFECTED Bad CIS Calib

qflags:

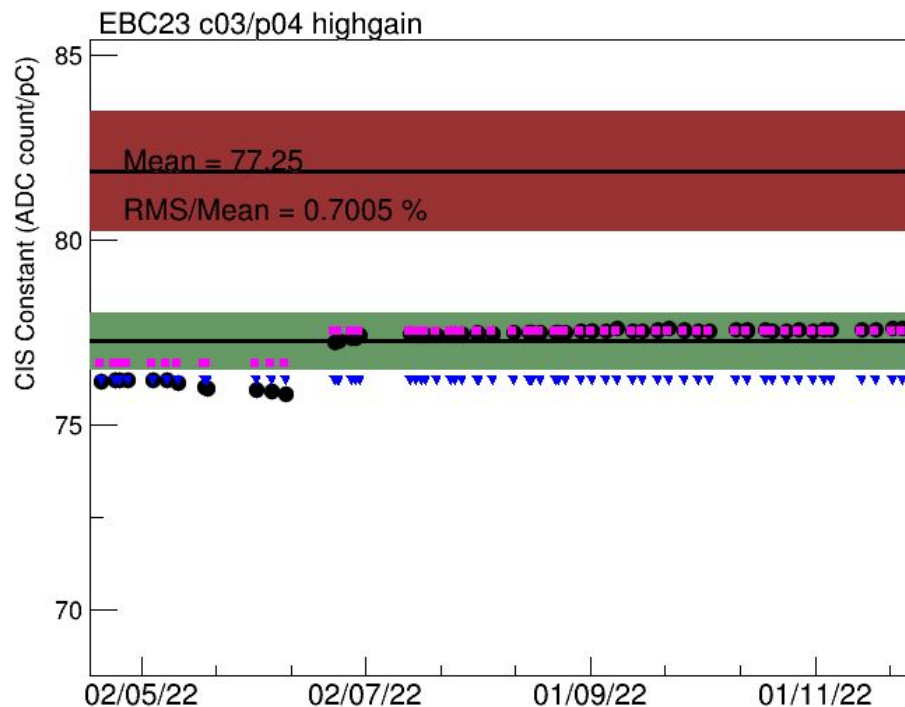
EBC 20 C10



It seems as though the outliers do not affect the calculation of the constant in this case. There is some slight variation still within each IOV.

CHANGE RUN
WINDOW (SEE
LASER)

EBC 23 C03



ADC AFFECTED Bad Las Calib

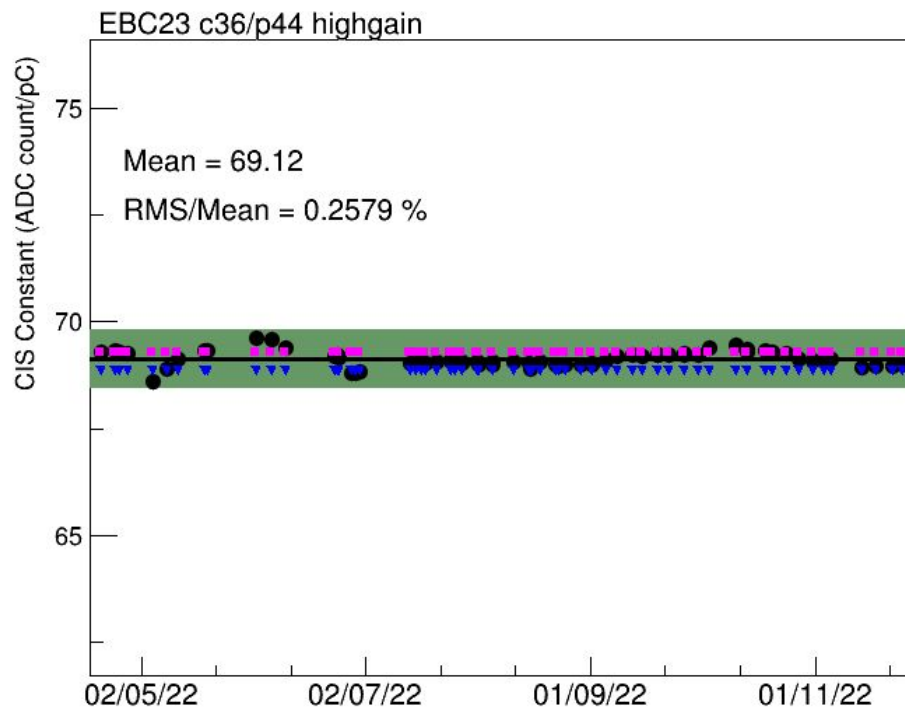
Bad CIS Calib

qflags:

Drifting behaviour at the beginning of the month does not match the future database value. We will have to address this channel individually (but it is ADC affected)

CHANGE
THRESHOLD

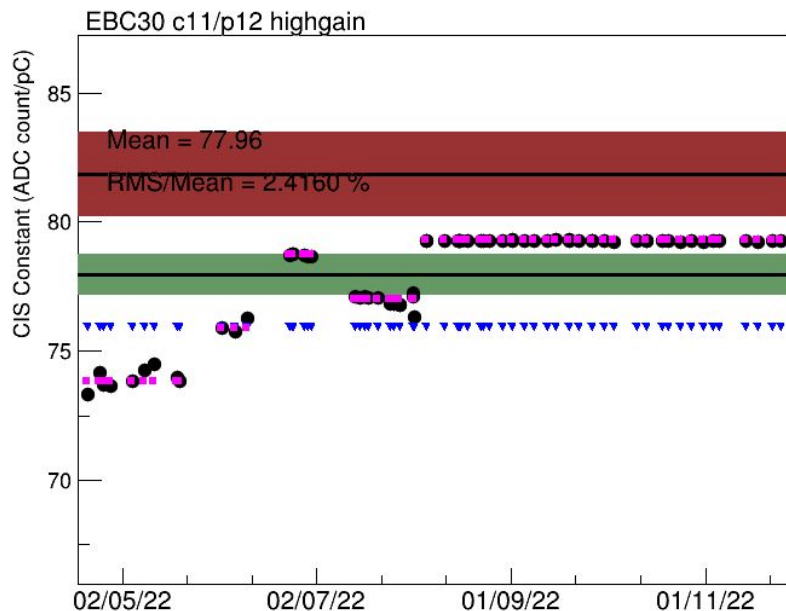
EBC 23 C36



Should we make the update threshold smaller in this case to more accurately approximate the occasional variations?

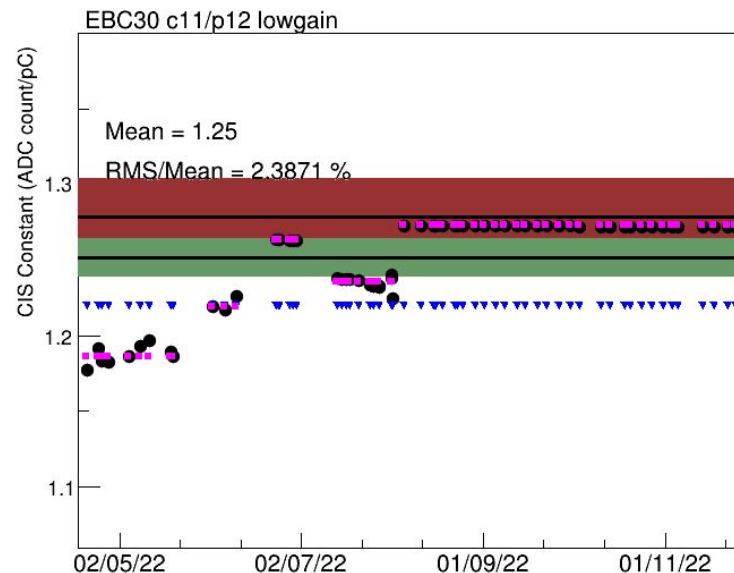
CHANGE
THRESHOLD

EBC 30 C11



qflags:

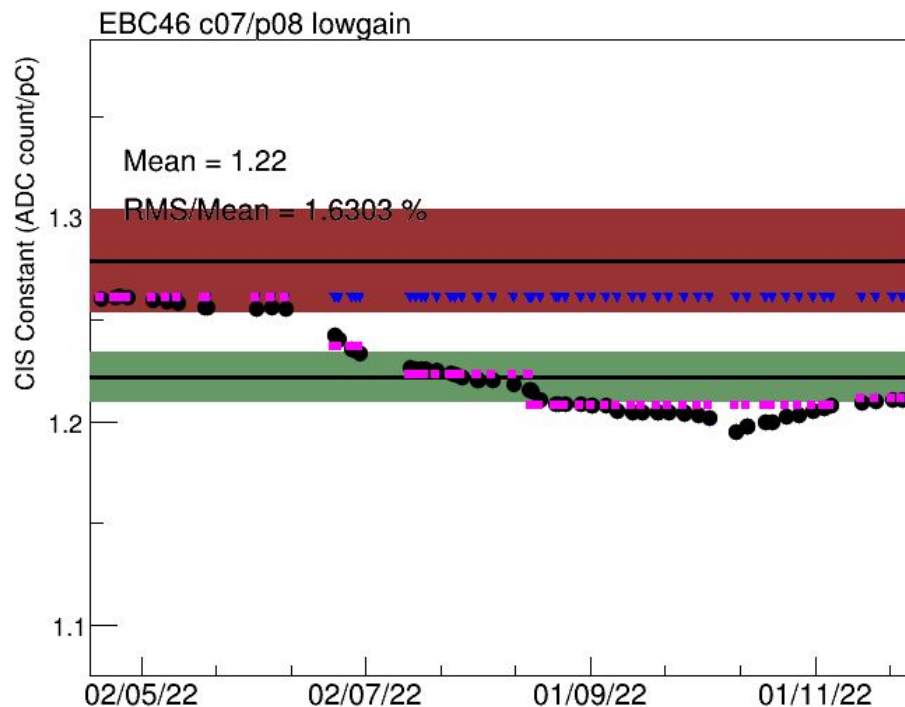
This is not stable for all of Run 3 data-taking. It is not flagged, either.



qflags:

NO CHANGE

EBC 46 C07



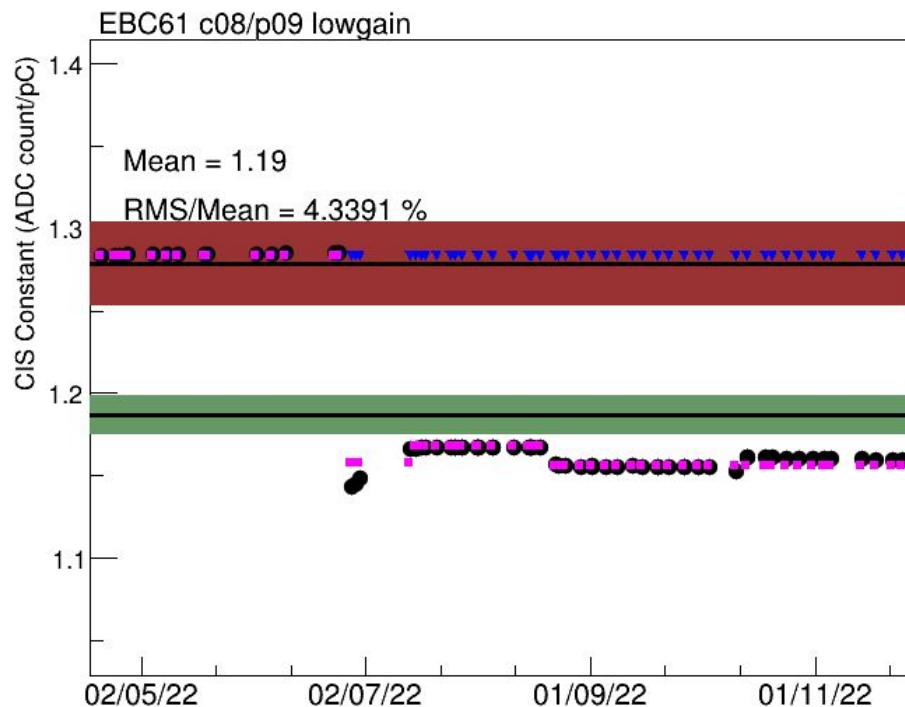
ADC AFFECTED Bad CIS Calib

qflags:

Obvious drifting behaviour (ADC affected). Should we make the update threshold smaller in this case to more accurately approximate the occasional variations?

CHANGE
THRESHOLD,
RUN WINDOW

EBC 61 C08



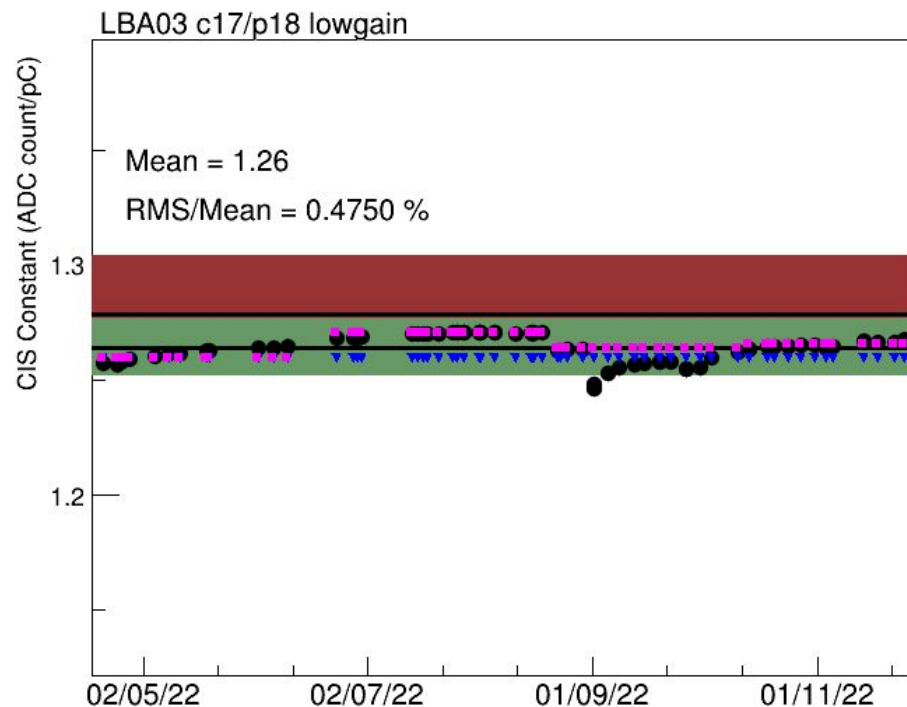
ADC AFFECTED Bad CIS Calib

qflags: Fail Likely Calib.

There small regions where the database value does not align well. Maybe we can try to play around with run_window and threshold.

RUN WINDOW

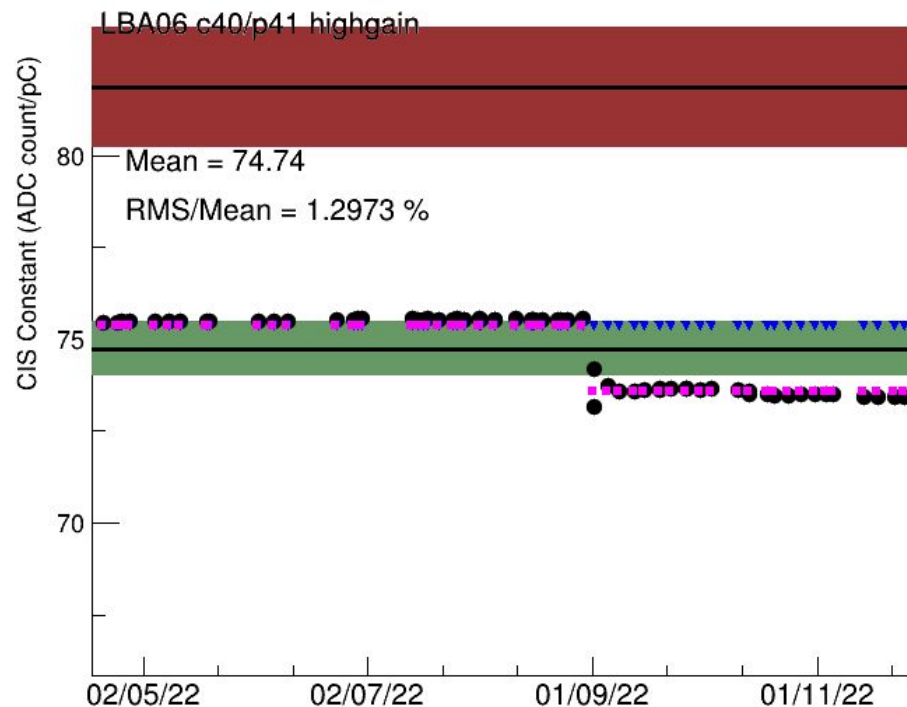
LBA 03 C17



Should we make the update threshold smaller in this case to more accurately approximate the occasional variations especially in the middle where the value is drifting?

CHANGE
THRESHOLD

LBA 06 C40

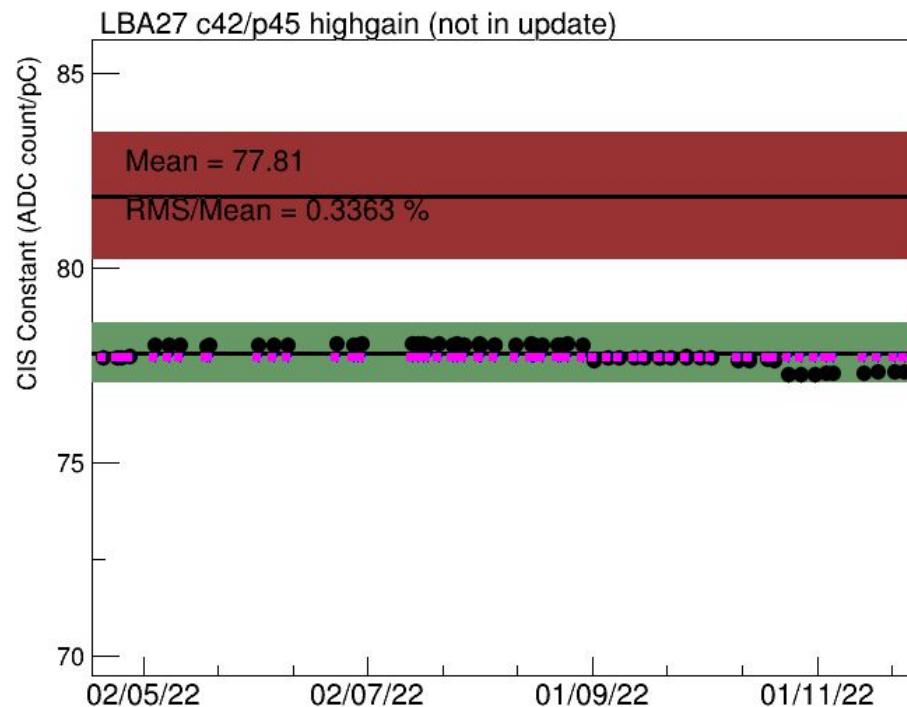


The two runs in the middle may just be outliers that we can exclude just for this channel?

ADC AFFECTED Bad CIS Calib

qflags: Fail Likely Calib.

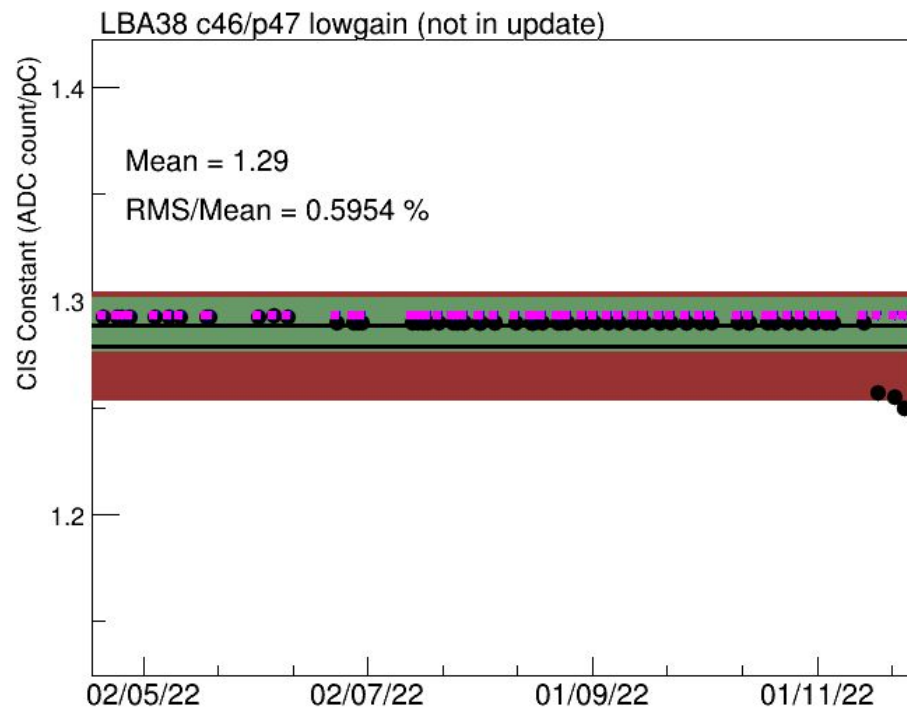
LBA 27 C42



The mean value is too close to the deviated values in the beginning and the end of the month. We will reduce the update threshold for this channel.

CHANGE
THRESHOLD

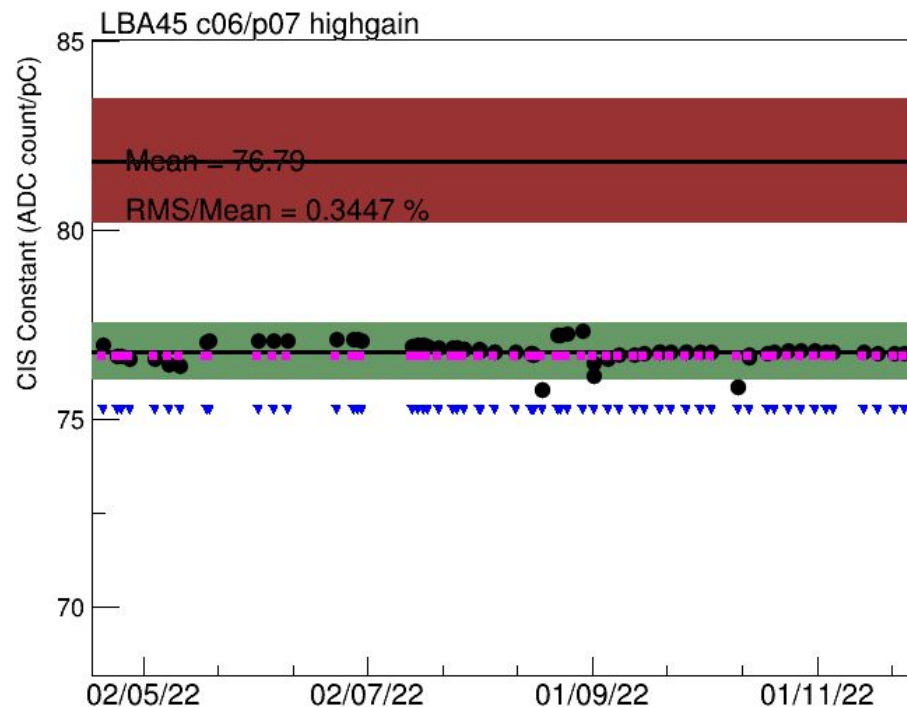
LBA 38 C46



The calibration values at the end of the month deviate very far from the database values (it will not be updated, but we do not understand what went wrong with these last calibration runs)

NO CHANGE
(SEE LASER)

LBA 45 C06



ADC Affected with large scatter. Our method creates some (bad) approximation. We could lower the update threshold again to capture this variation if needed.

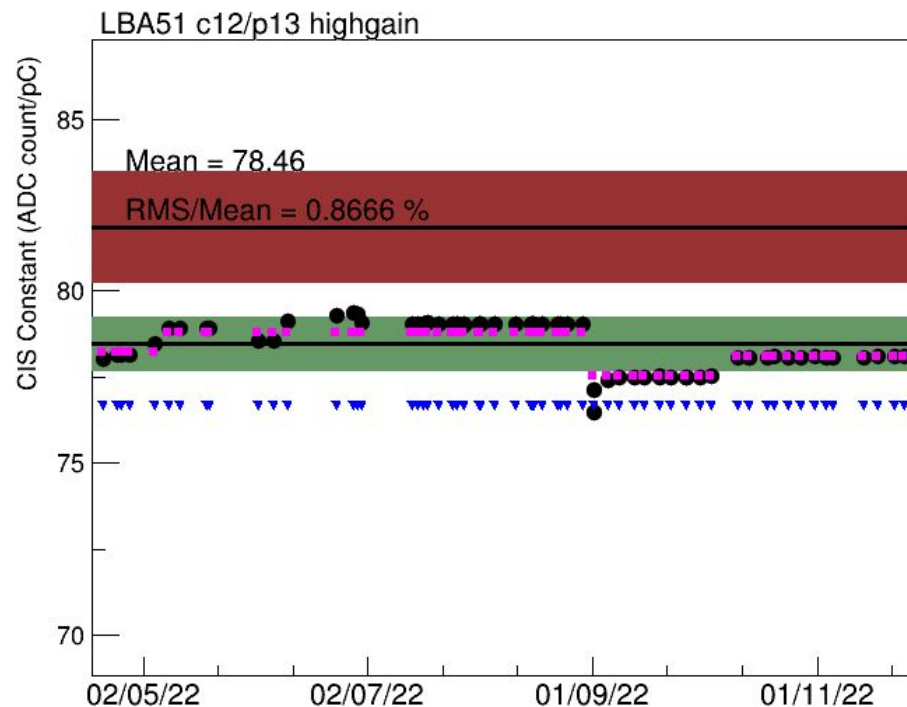
NO CHANGE

ADC AFFECTED Bad Las Calib

Bad CIS Calib

qflags:

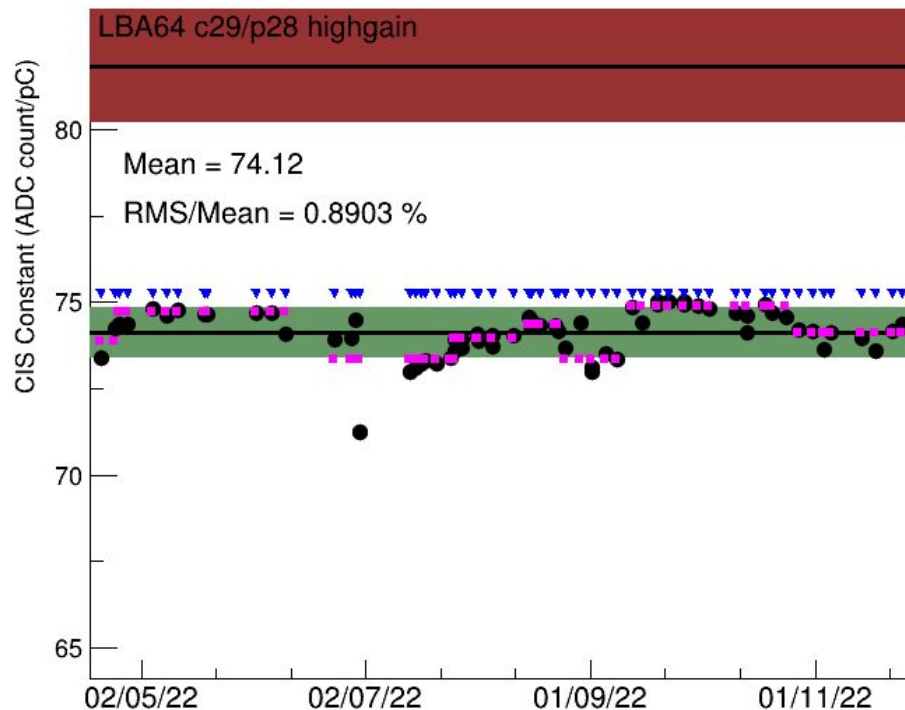
LBA 51 C12



ADC Affected with large scatter. Our method creates some (bad) approximation. We could lower the update threshold again to capture this variation if needed.

NO CHANGE

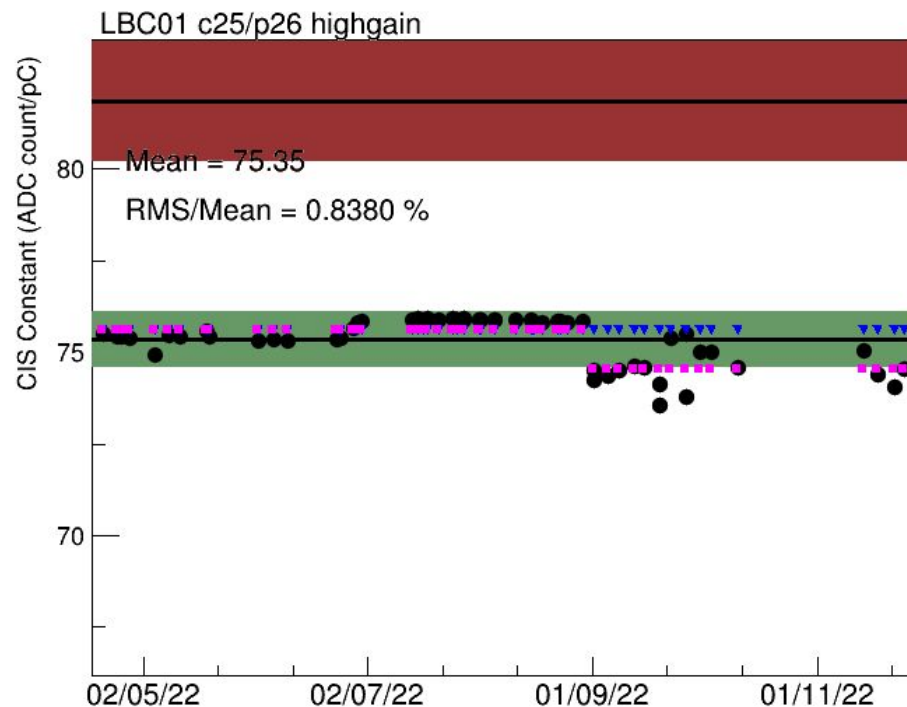
LBA 64 C29



ADC Affected with large scatter. Our method creates some (bad) approximation. We could lower the update threshold again to capture this variation if needed.

NO CHANGE

LBC 01 C25

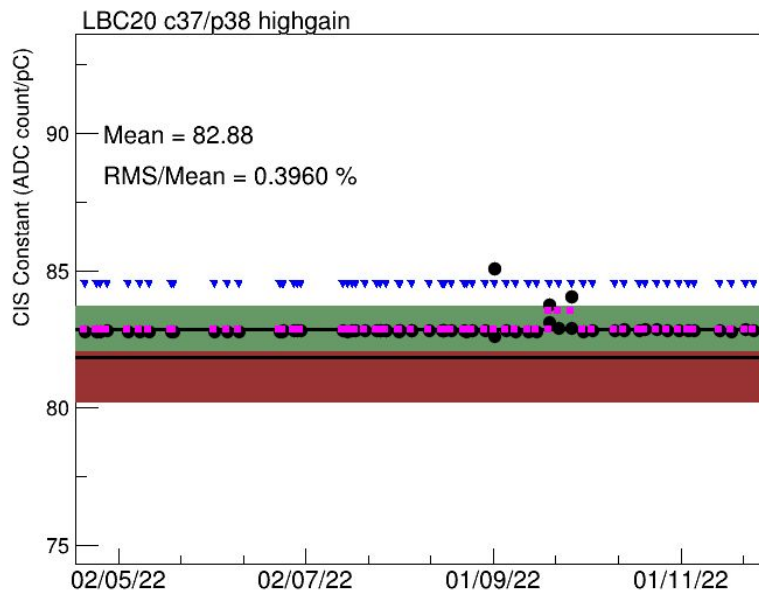


ADC Affected with large scatter. Our method creates some (bad) approximation. We could lower the update threshold again to capture this variation if needed.

NO CHANGE

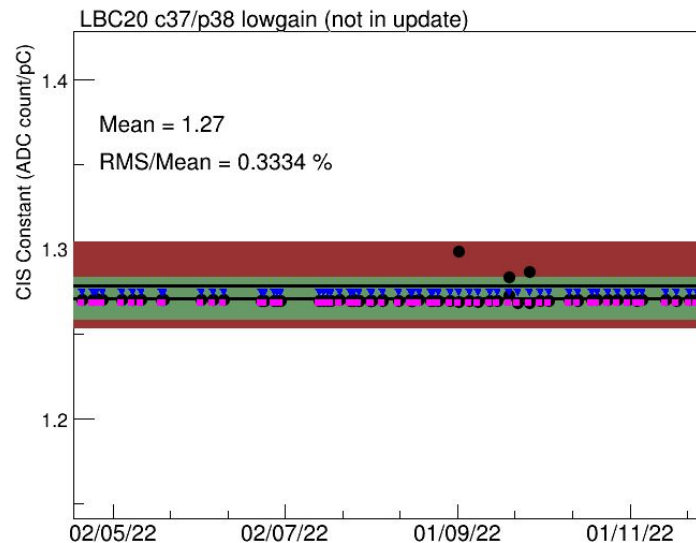
ADC AFFECTED Bad Las Calib Bad CIS Calib
qflags: Fail Likely Calib. Low Chi2

LBC 20 C37



qflags:

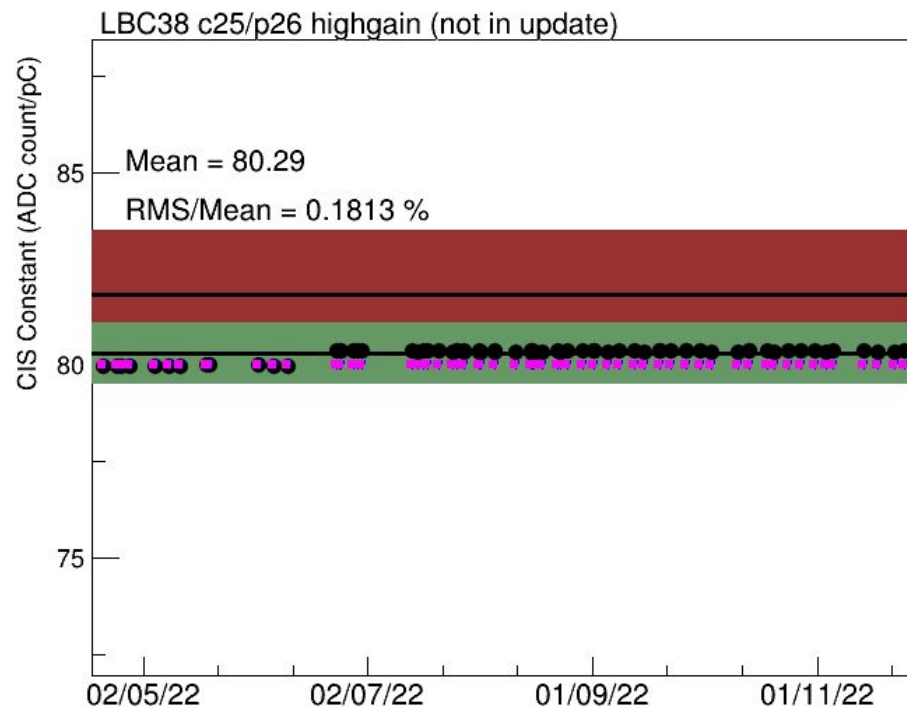
Outlier runs in the middle of the month have distorted the CIS constant value. We could rerun ONLY this channel with `run_window = 2` to fix those values



qflags:

REMOVE BAD
RUNS (SEE
LASER)

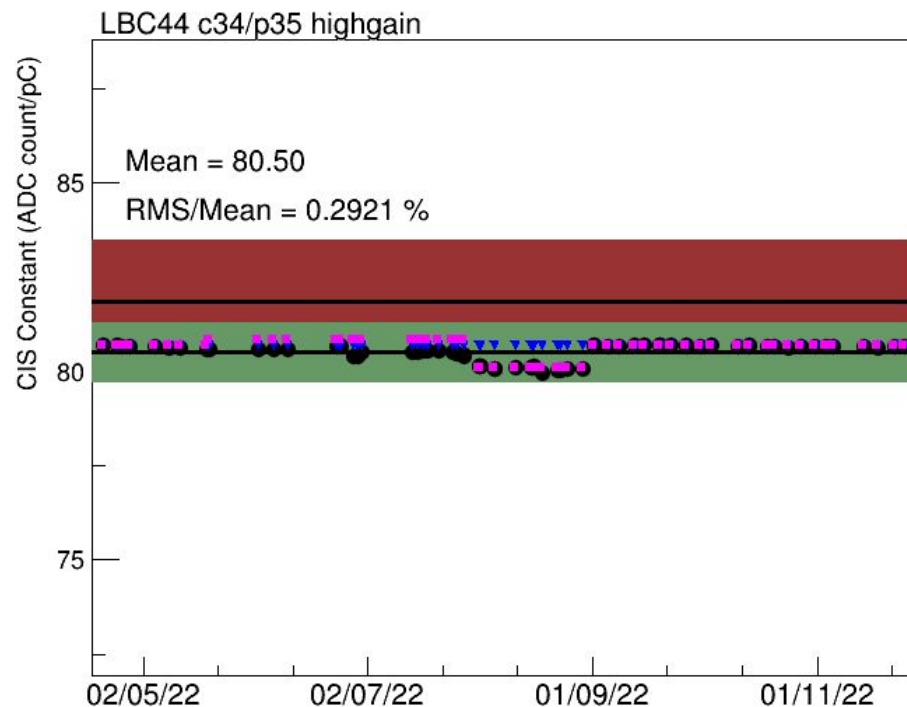
LBC 38 C25



The future database values don't exactly align with the most recent runs. Decrease update threshold?

CHANGE
THRESHOLD

LBA 44 C34



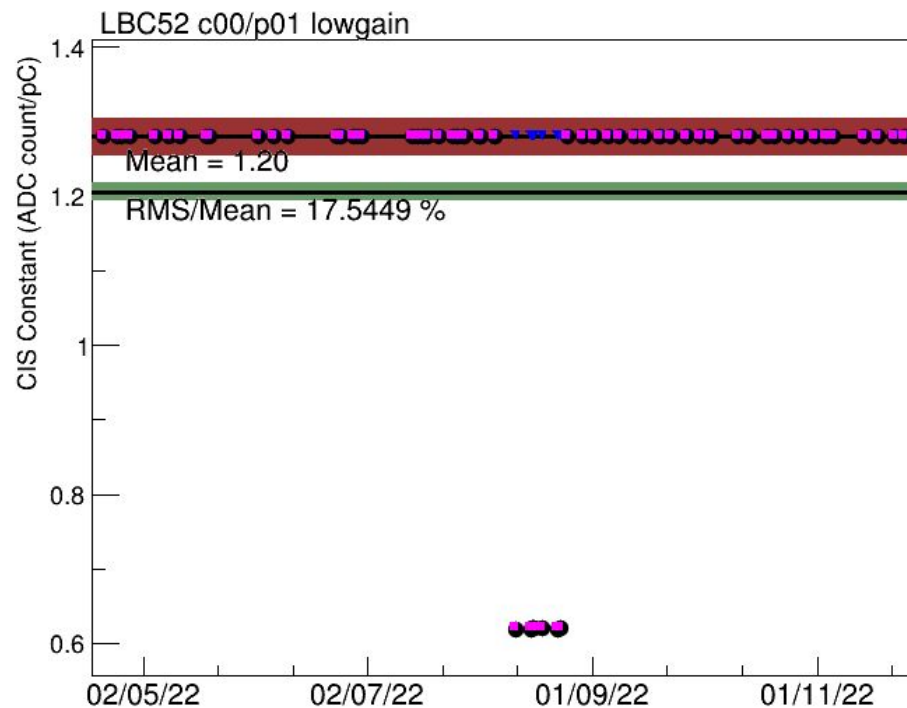
The reprocessing mostly approximates the constant, although there is quite a bit of variation. We could slightly reduce the update threshold in this case.

CHANGE
THRESHOLD

ADC AFFECTED Bad CIS Calib

qflags:

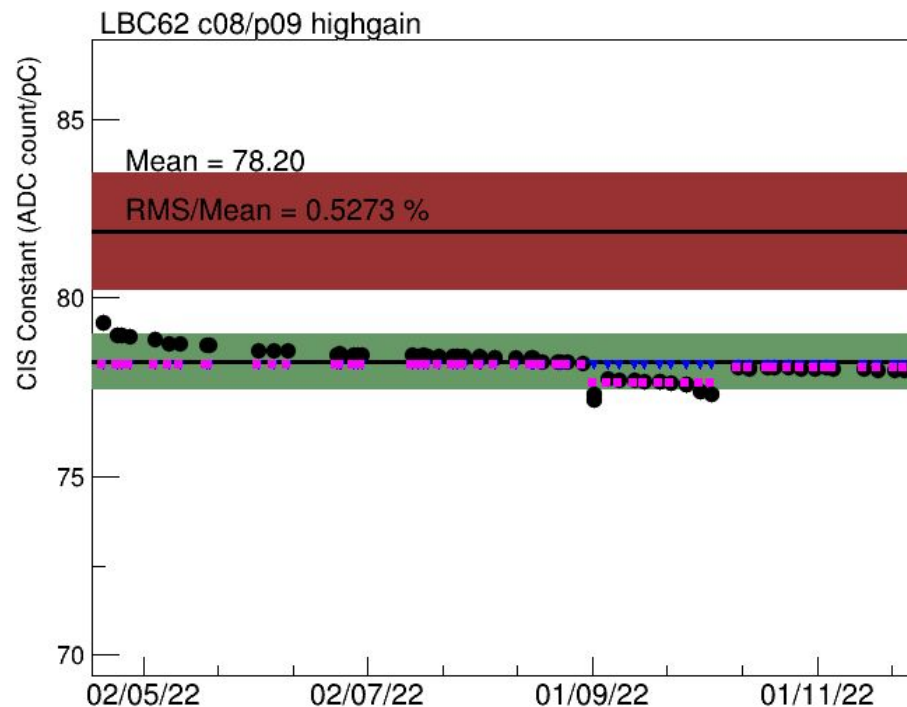
LBC 52 C00



Reprocessing accounts for the drop to half-gain in the middle of the month. No more action is needed.

NO CHANGE

LBC 62 C08



ADC AFFECTED Bad Las Calib

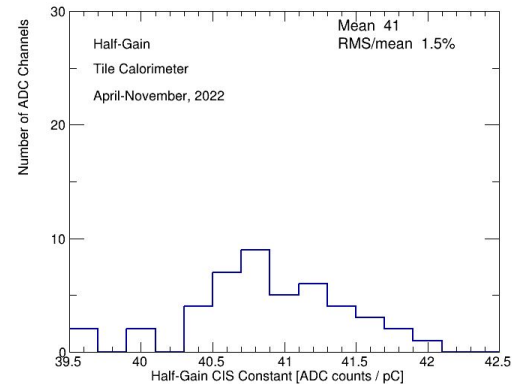
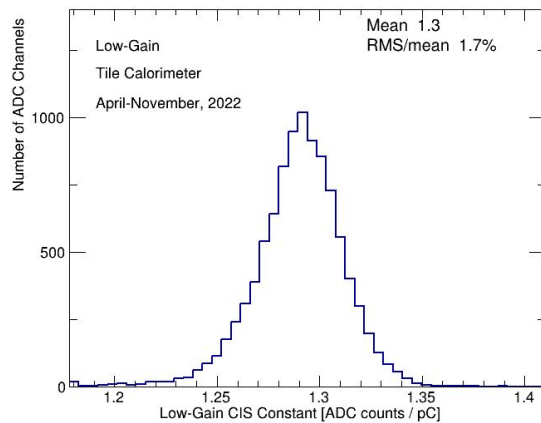
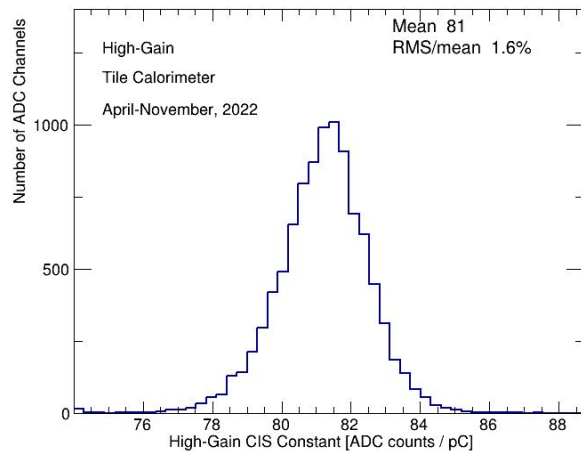
qflags:

Should we make the update threshold smaller in this case to more accurately approximate the drifting behaviour?

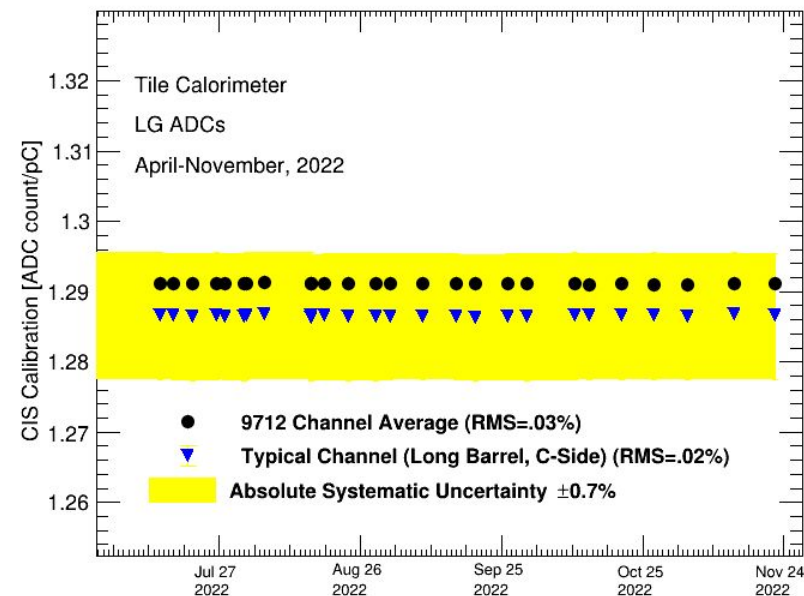
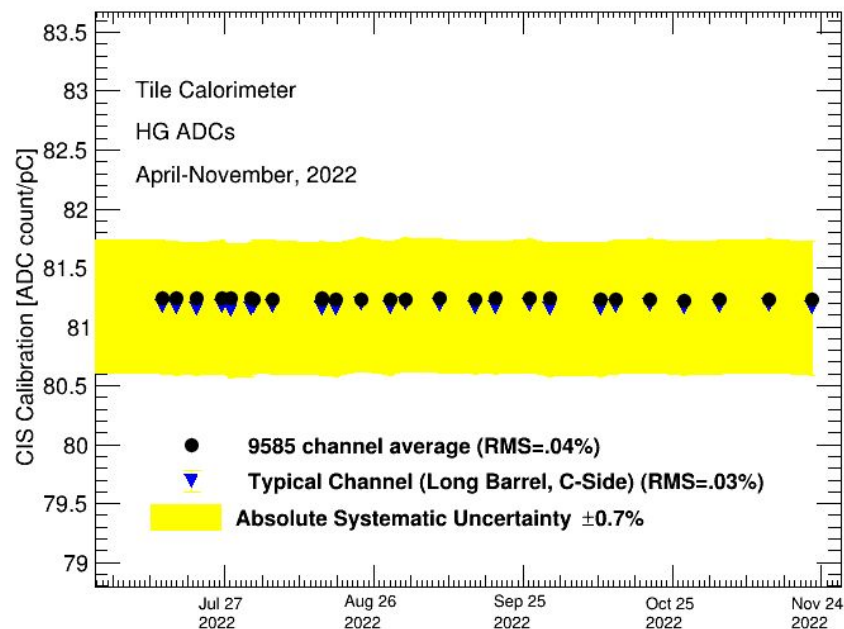
CHANGE
THRESHOLD

Public Plots

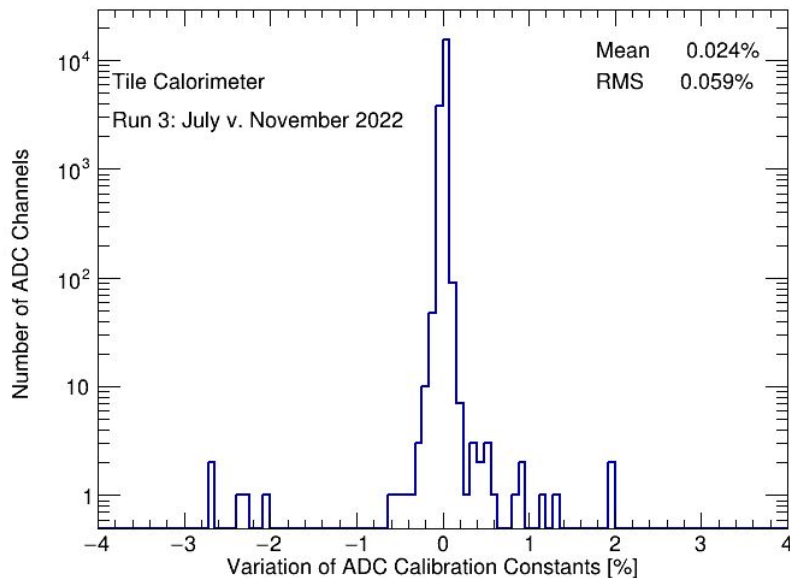
CIS Constant Distributions



Detector Time Stability



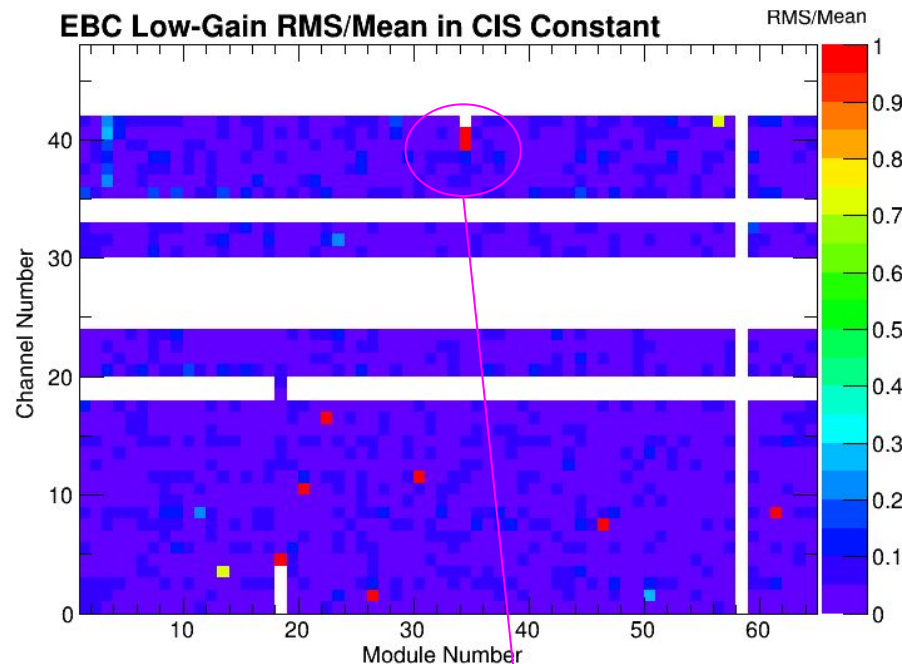
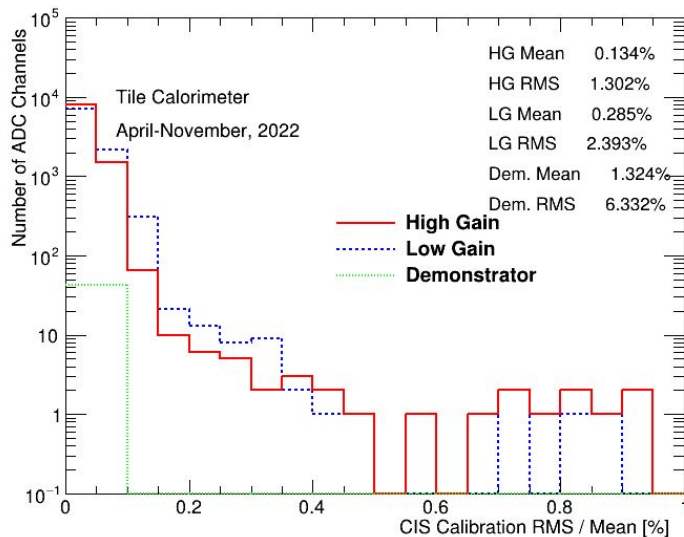
CIS Constant Long-Term Stability in Run 3



Module (>1% change)

Module (>1% change)	Percent Change
EBC_m30_c11_lowgain	-2.672517260729627
EBC_m30_c11_highgain	-2.66492136411393
LBA_m02_c06_lowgain	-2.3228977296997737
EBA_m49_c00_highgain	-2.285064866896219
LBA_m02_c06_highgain	-2.0493624322471105
LBA_m51_c12_highgain	1.1879758996524132
LBC_m57_c06_highgain	1.2925450958705886
LBC_m46_c04_highgain	1.9335982057240222
LBA_m35_c08_highgain	1.9759920794871568

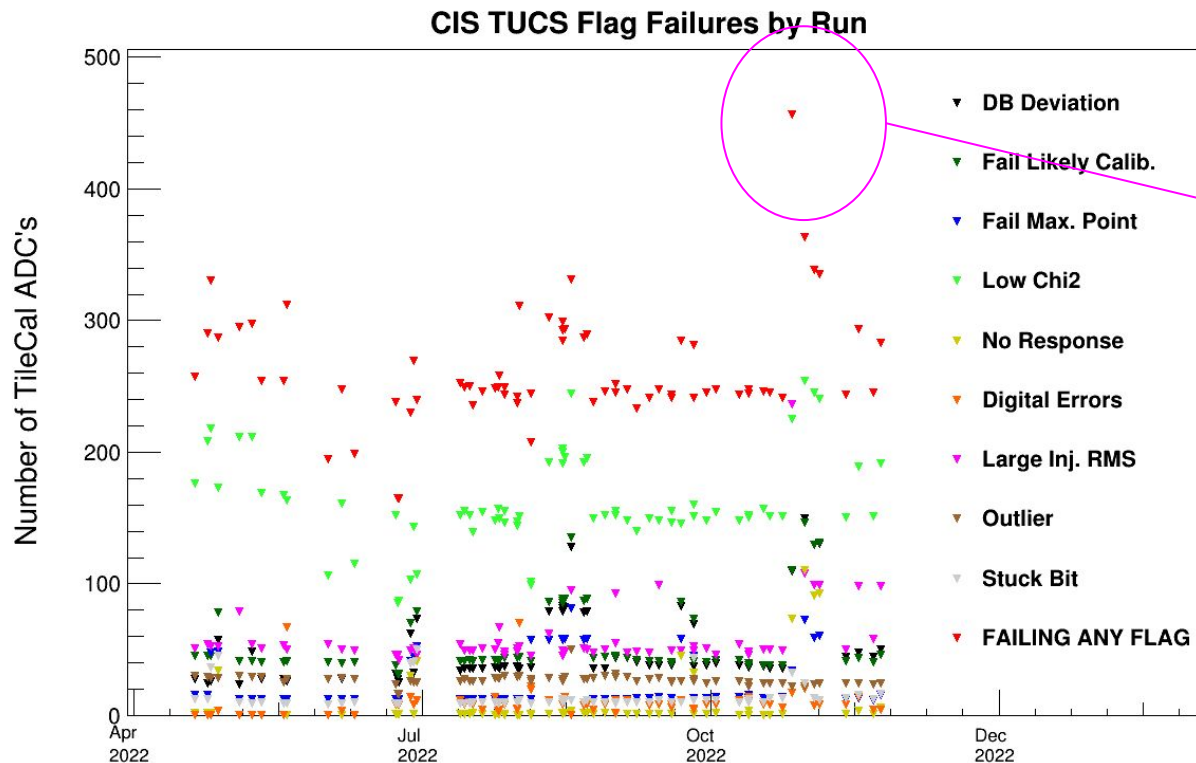
CIS Constant RMS/Mean



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

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

CIS TUCS Quality Flags



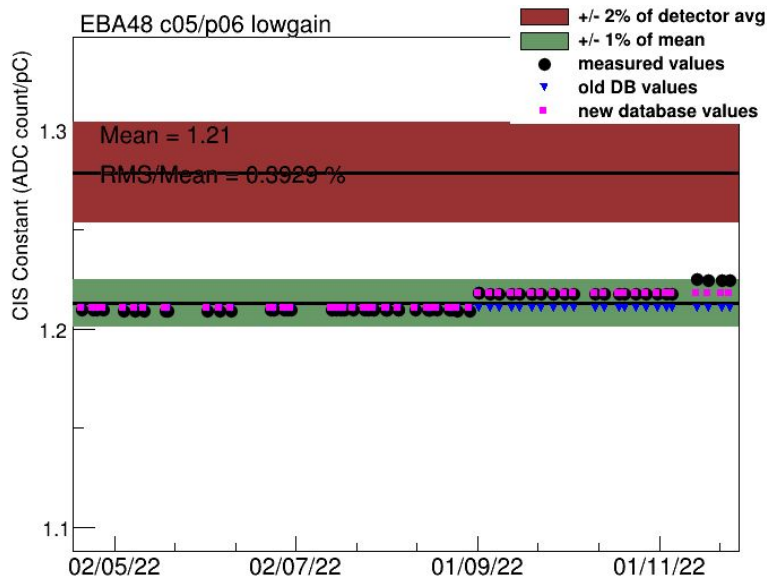
High number of failing flags does not pose a noticeable issue when analyzing the channel-by-channel plots by hand

Appendices

Introduction

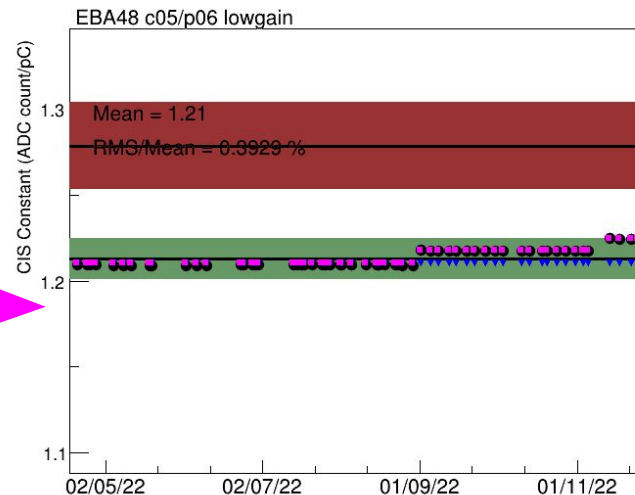
1. **Set reference values (First IOV):** Using March-April runs, we set a reference value for the CIS constants in all channels using the `--recalALL` option
2. **Choose best run_window parameter:** From April-November we compare all channels to the First IOV value above and updated if needed with a threshold of 0.5% deviation. To account for shifts in the constants, we try different run_window (10,7,4,3). This parameter dictates the minimum number of runs in each IOV
3. **Final adjustments:** Merge all of the .db files after running the above process for each partition. Some channels have more variation, so we may need to set a smaller threshold by hand (~0.1%)

MultipleIOV Choice



qflags: Fail Likely Calib.

Run Window = 10 (there are periods where the CIS constant has not been at a value for more than 10 runs)

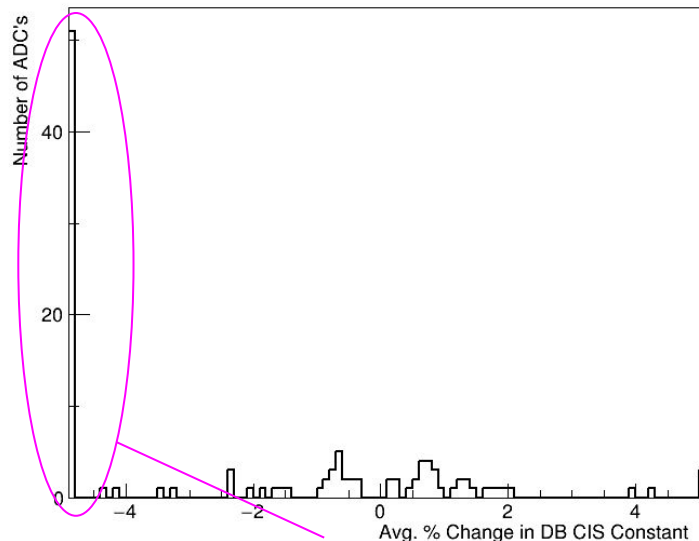


qflags: Fail Likely Calib.

Run Window = 3 (4 was not quite enough to recalibrate the ones at the end of the reprocessing period)

Summary

- CIS runs from April 21 - November 28 (to end of Run 3 data taking in 2022)
- 115 Channels updated (with respect to reference value)
- 66 Good (>1 successful calibration)
- 73 >5% change
- 20 Masked
- 29 Affected



Overflow is due to LBC52 Lowgain channels being switched to half gain

Run Selection

First IOV Runs: 413579 413594 414257 414464 414513 414763 415169 415434 415531 415564 415914 416099
416626 416941 417164 417535 417882 418169

Reprocessing Runs: 418412 418778 418994 419504 420384 420709 421222 422100 422268 423827 424146
424613 426084 426286 426330 426571 426701 426816 428271 428437 428535 428588 428791 429095 429224 429253
429493 429511 429799 429890 429948 430406 430444 430900 431285 431304 431313 431374 431570 431991 432218
432548 432824 433072 433116 433430 433655 433937 434229 434572 434584 435091 435269 435290 435722 435886
436536 436813 436852 437309 437563 437792 438209 438370 438544 438745 439596 439991 440217 440463

- We used all runs previously validated in our monthly updates
- For November 1st - November 28th, we validated the following runs:
 - **Runs used (5):** 438544 438745 439596 439991 440217 440463
 - We excluded missing runs that were CIS pulse tests by Andrey and Humphry

Current Status of ADC Masked/Affected Channels

Affected channels: 29

Masked channels: 20

EBA19 c41/p41 highgain	LBC23 c20/p21 lowgain
EBA07 c31/p29 lowgain	LBC28 c04/p05 lowgain
LBC41 c25/p26 highgain	EBC56 c41/p41 lowgain
LBC43 c24/p27 highgain	EBC18 c04/p05 lowgain
LBC47 c35/p34 lowgain	EBC22 c16/p17 lowgain
LBC08 c03/p04 lowgain	LBA15 c02/p03 highgain
LBC52 c18/p19 lowgain	LBA35 c08/p09 highgain
LBC52 c18/p19 highgain	LBA02 c06/p07 highgain
LBC13 c15/p16 highgain	LBA02 c06/p07 lowgain
LBC13 c15/p16 lowgain	
LBC19 c22/p23 lowgain	

EBA42 c30/p33 highgain	EBC03 c40/p42 lowgain
EBA49 c00/p01 highgain	EBC03 c41/p41 highgain
EBA50 c20/p21 highgain	EBC03 c41/p41 lowgain
EBA50 c31/p29 highgain	EBC46 c07/p08 lowgain
EBA16 c17/p18 highgain	EBC13 c03/p04 lowgain
LBC01 c25/p26 highgain	EBC16 c39/p43 highgain
LBC44 c34/p35 highgain	EBC61 c08/p09 lowgain
LBC44 c12/p13 highgain	EBC23 c03/p04 highgain
LBC46 c04/p05 highgain	EBC23 c36/p44 highgain
LBC10 c37/p38 highgain	LBA06 c40/p41 highgain
LBC16 c29/p28 highgain	LBA52 c01/p02 lowgain
LBC62 c08/p09 highgain	LBA64 c29/p28 highgain
EBC01 c21/p22 highgain	LBA37 c21/p22 highgain
EBC03 c39/p43 lowgain	LBA45 c06/p07 highgain
EBC03 c39/p43 highgain	

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 $< 1\%$