Charge Injection System (CIS) Reprocessing Update

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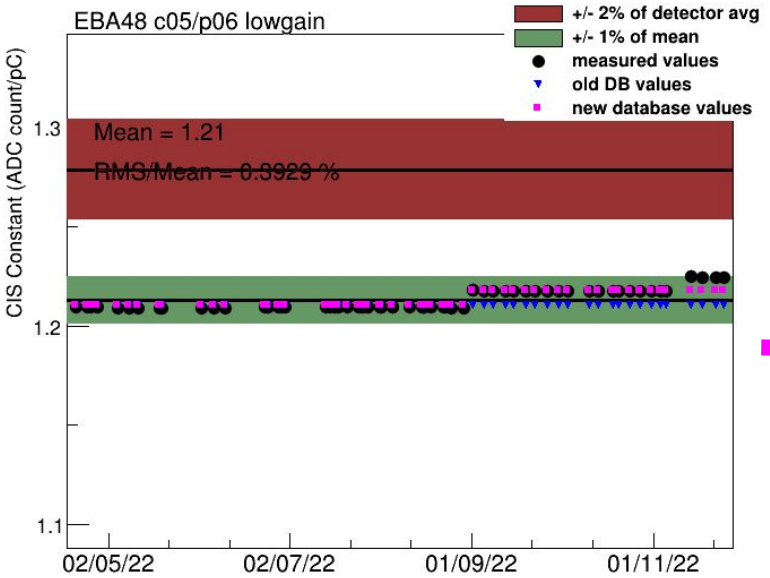
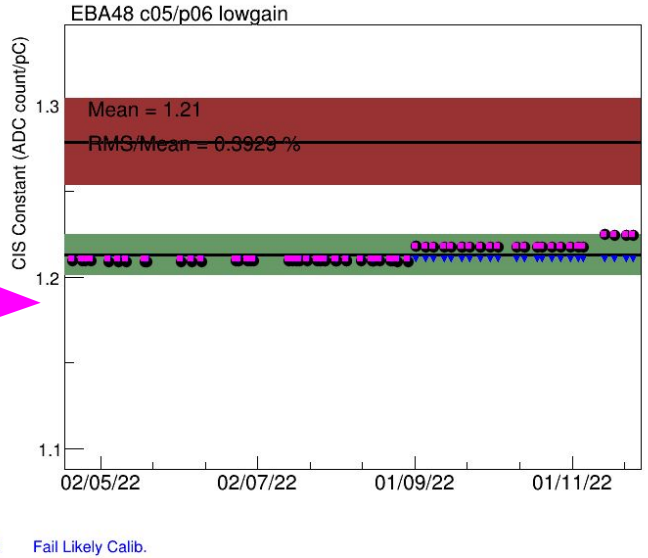
Introduction

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



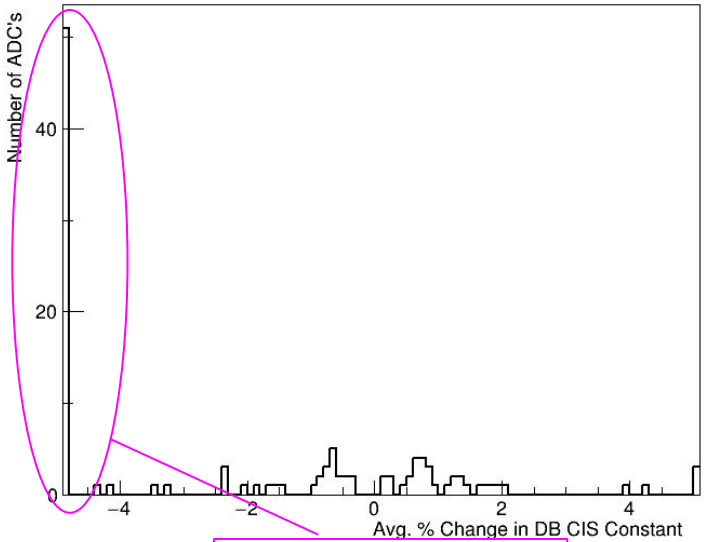
Run Window = 10 (there are periods where the CIS constant has not been at a value for more than 10 runs)



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

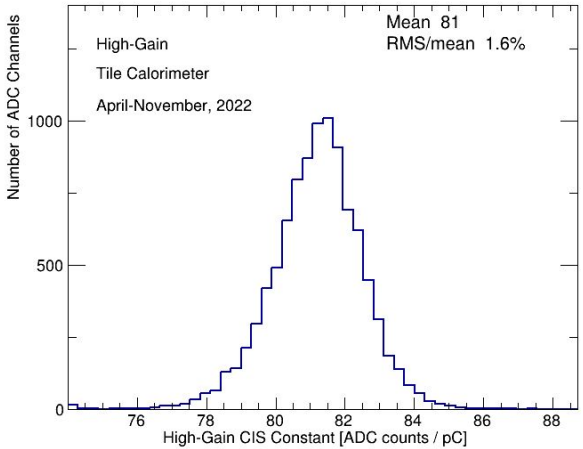
Run Selection

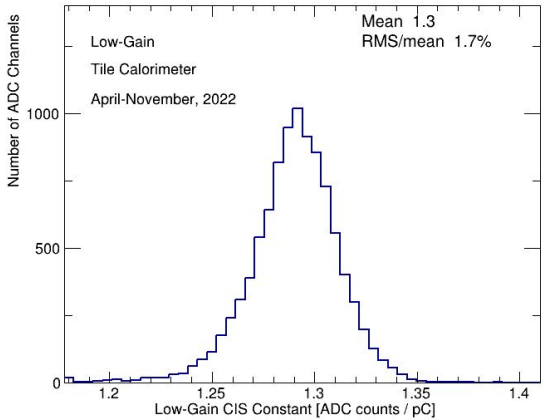
First IOV Runs: 413579 413594 414257 414464 414513 414763 415169 415434 415531 415564 415914 416099 416626 416941 417164 417535 417882 418169

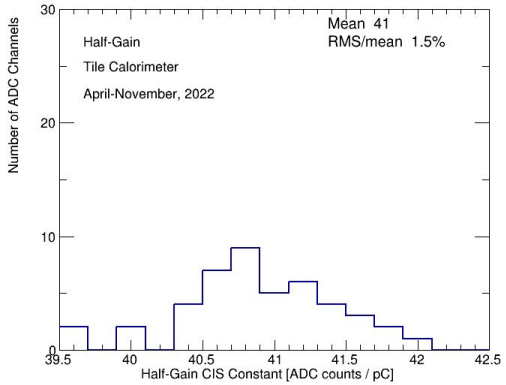
Reprocessing Runs: 418412 418778 418994 419504 420384 420709 421222 422100 422268 423827 424146 424613 426084 426286 426330 426571 426701 426816 428271 428437 428535 428588 428791 429095 429224 429253 429493 429511 429799 429890 429948 430406 430444 430900 431285 431304 431313 431374 431570 431991 432218 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

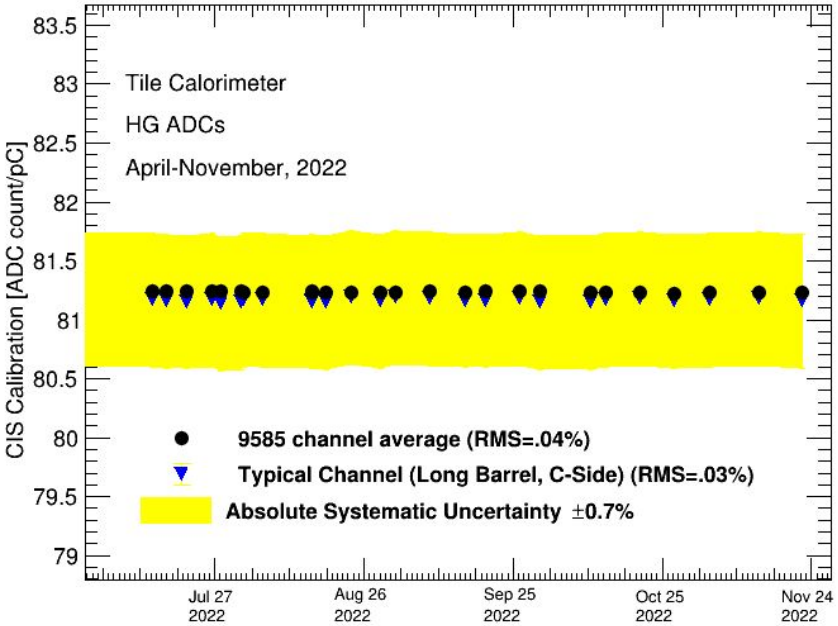
CIS Constant Distributions

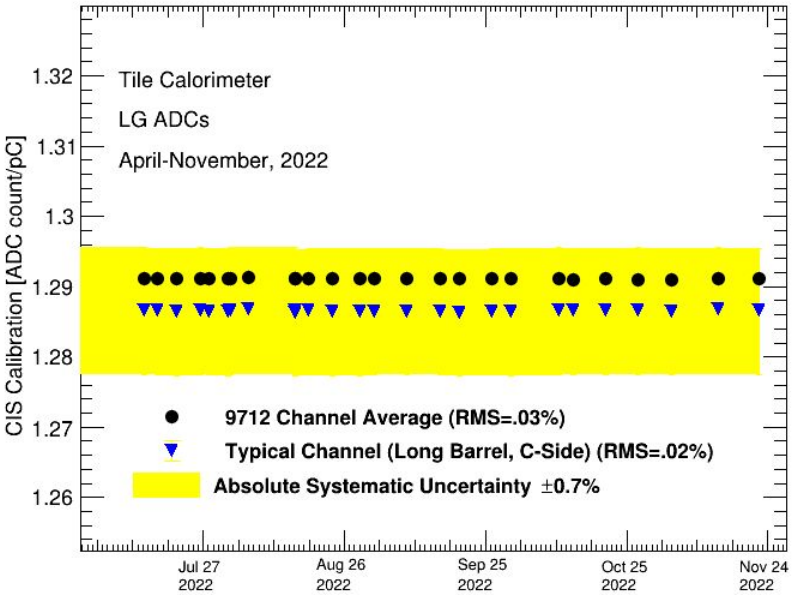




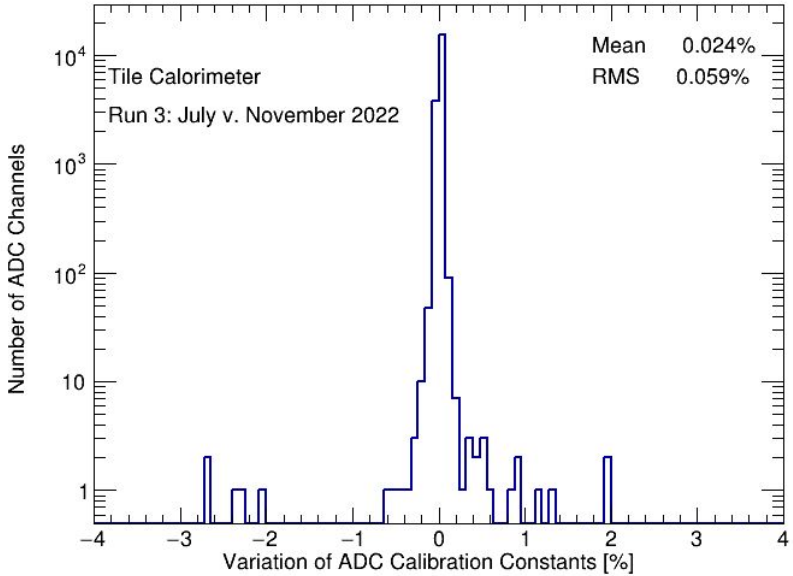


Detector Time Stability



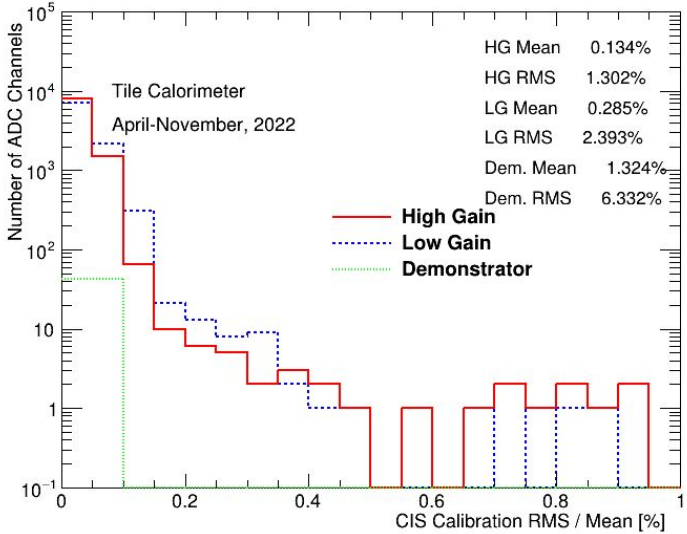


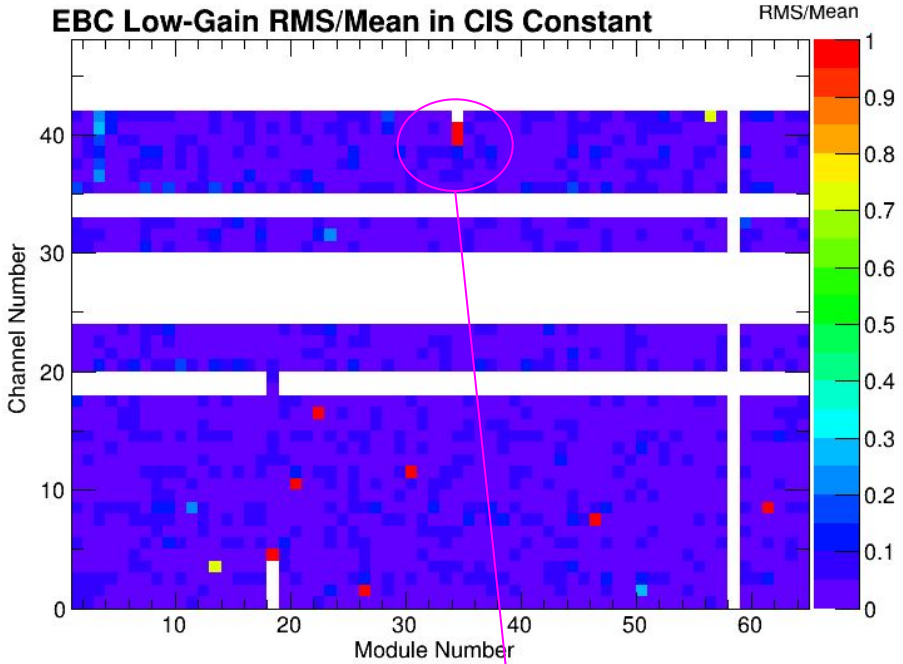
CIS Constant Long-Term Stability in Run 3



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

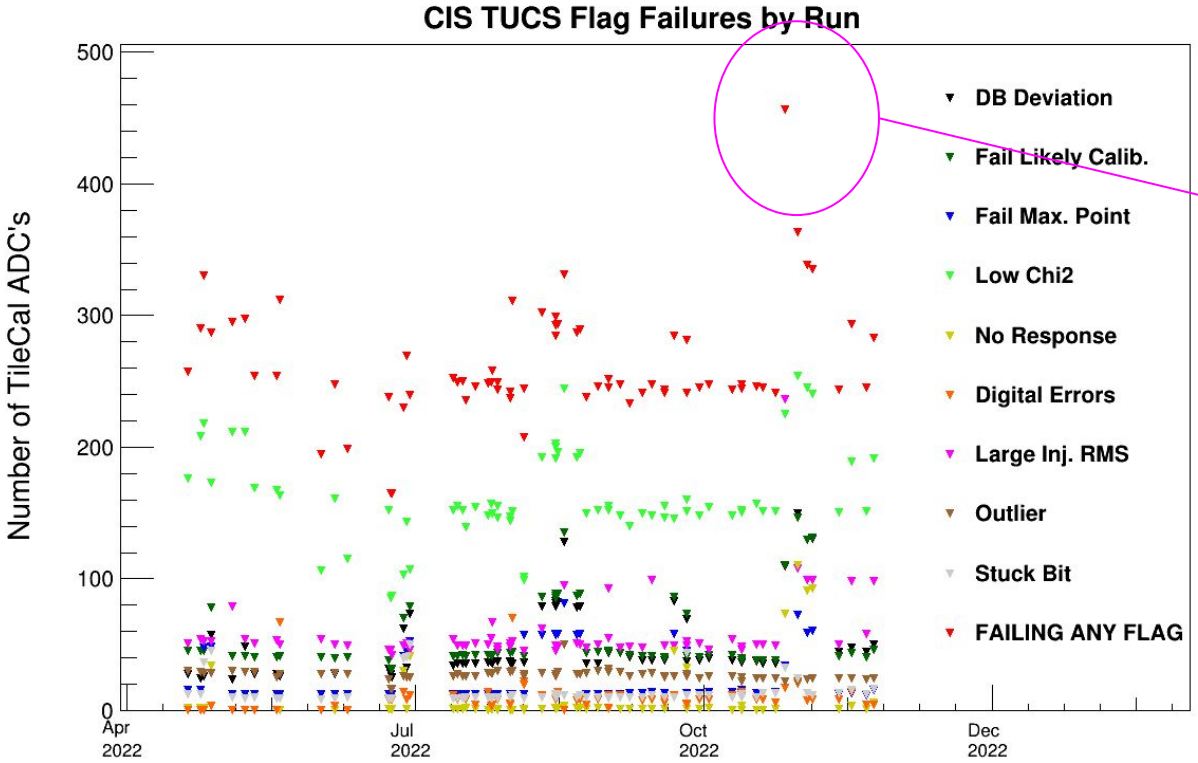




List of high RMS/mean channels identified given on next slide

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

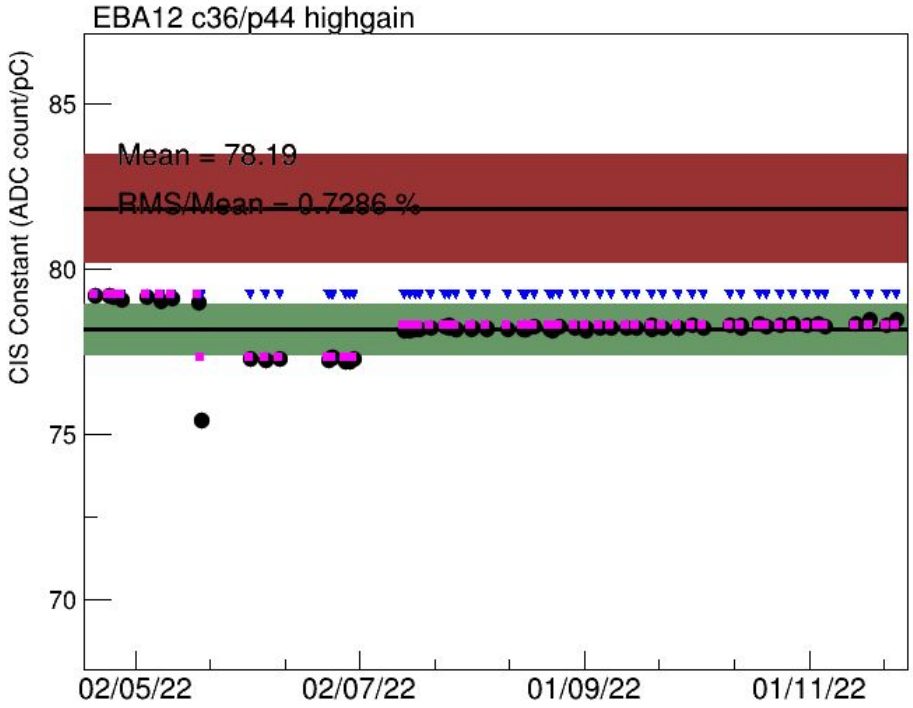
CIS TUCS Quality Flags



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

Problematic Channels (Representative Cases)

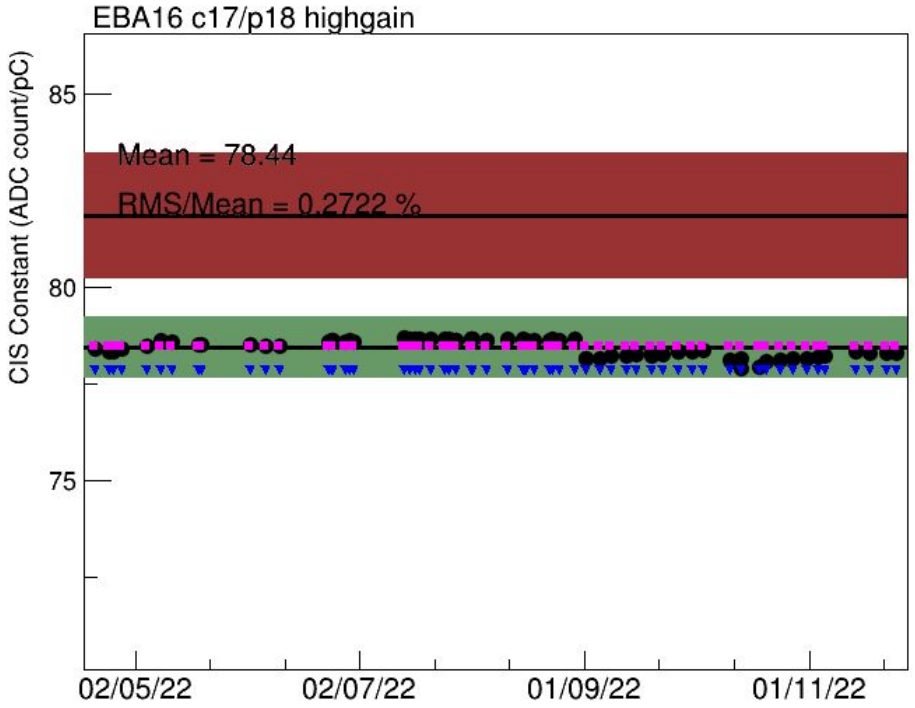
EBA 12 C36



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

qflags:

EBA 16 C17

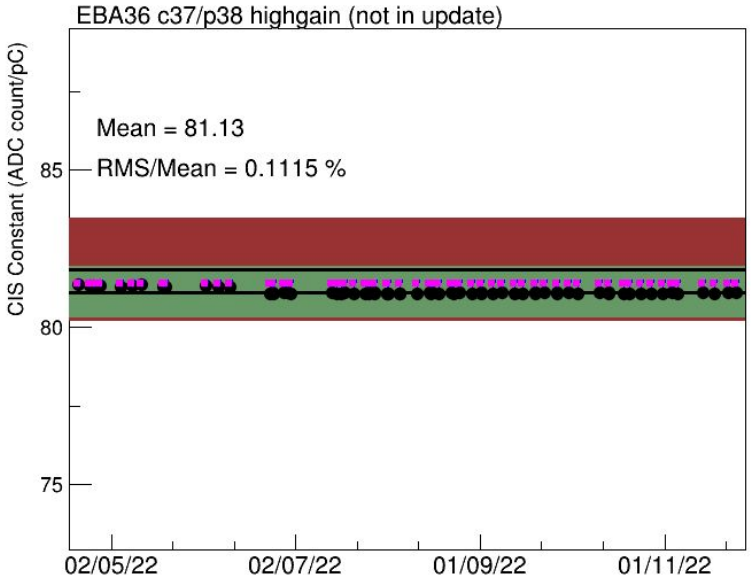


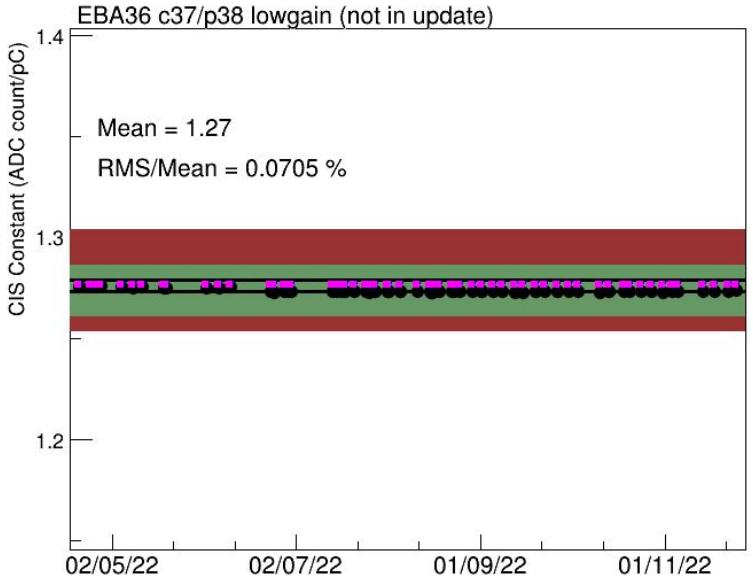
ADC AFFECTED Bad Las Calib

qflags:

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

EBA 36 C37



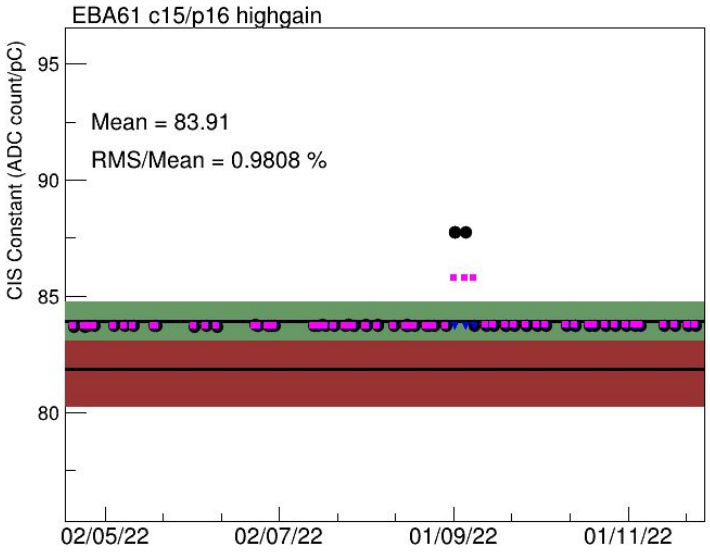


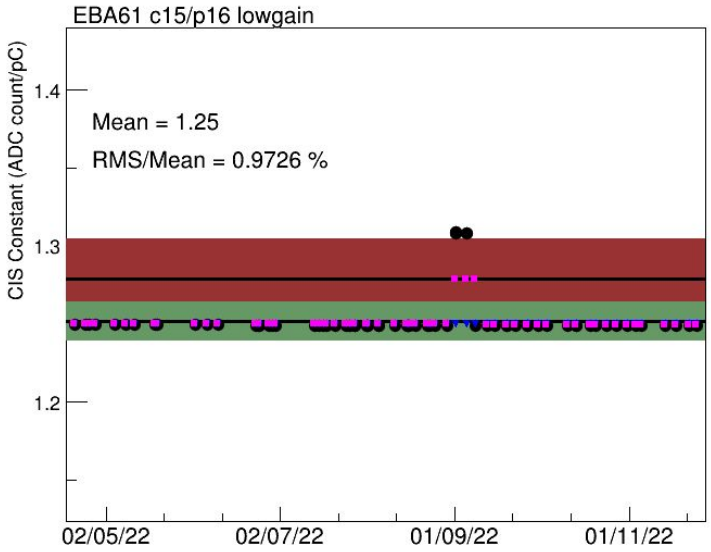
qflags: Large Inj. RMS

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

qflags: Large Inj. RMS

EBA 61 C15



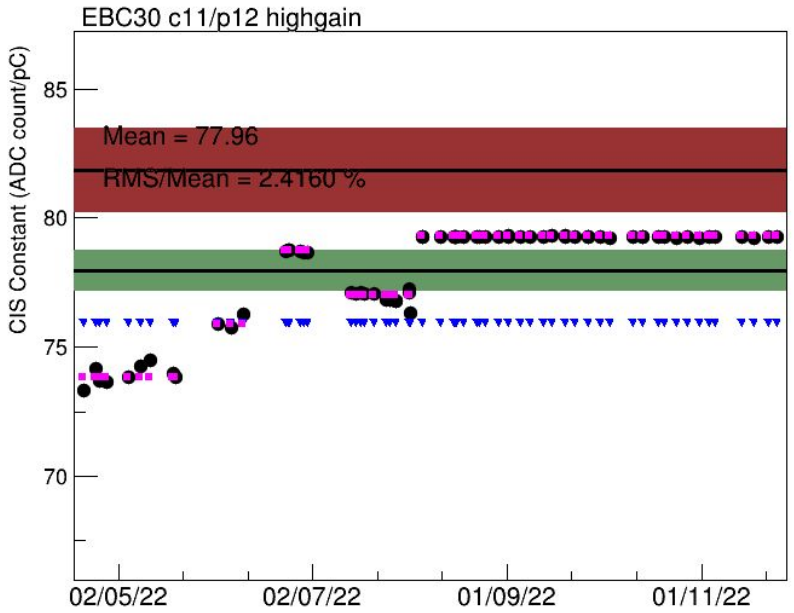


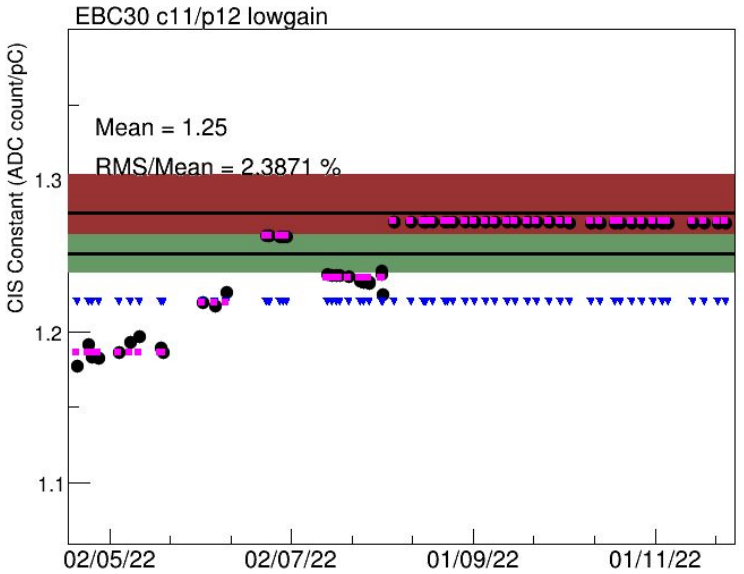
qflags:

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

EBC 30 C11



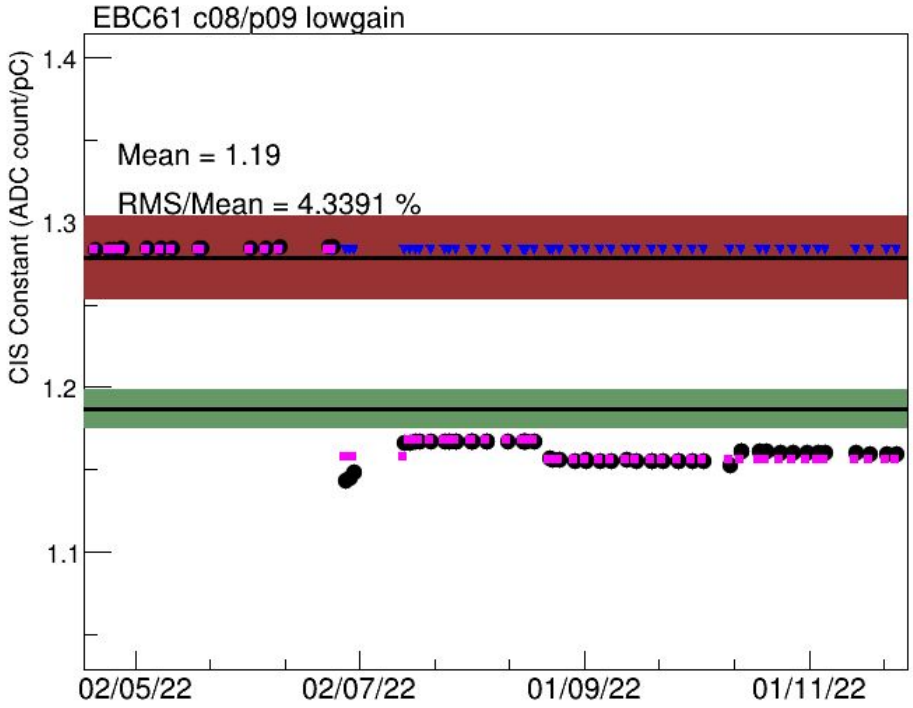


qflags:

qflags:

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

EBC 61 C08



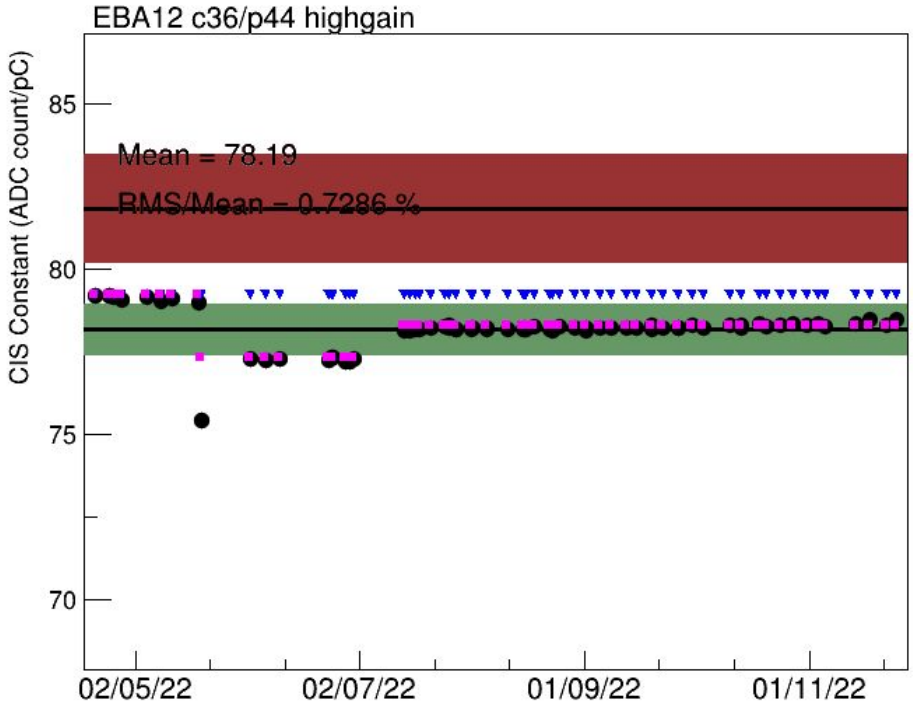
ADC AFFECTED Bad CIS Calib

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.

Problematic Channels (Complete)

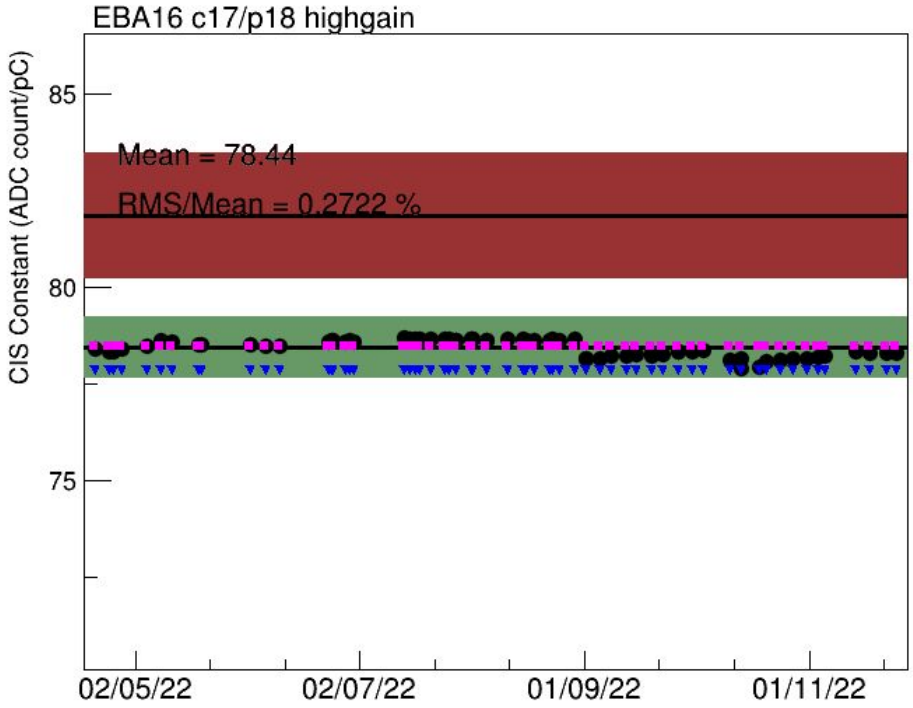
EBA 12 C36



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

qflags:

EBA 16 C17

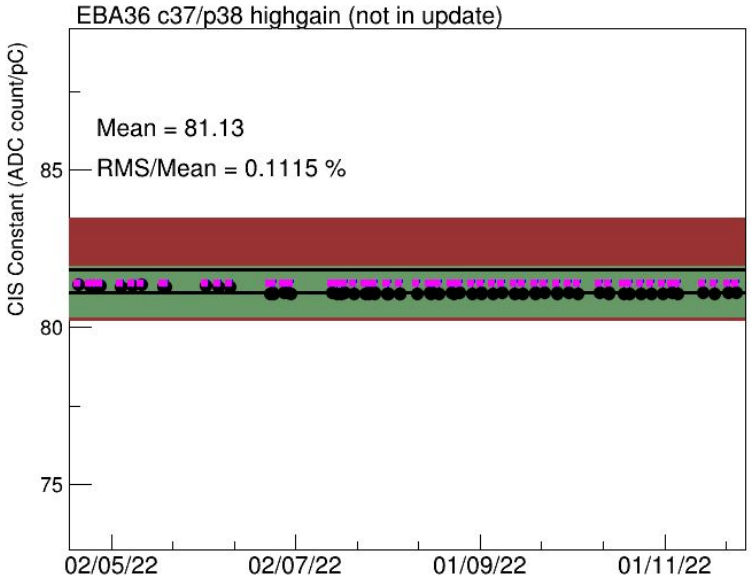


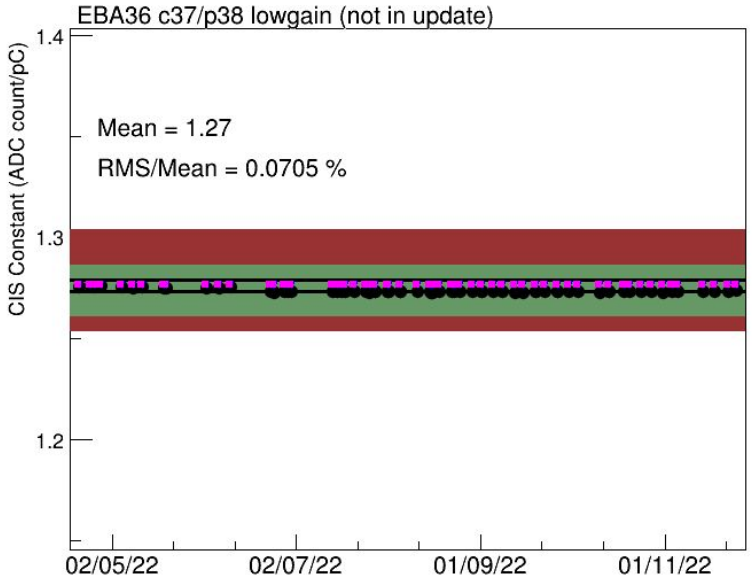
ADC AFFECTED Bad Las Calib

qflags:

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

EBA 36 C37



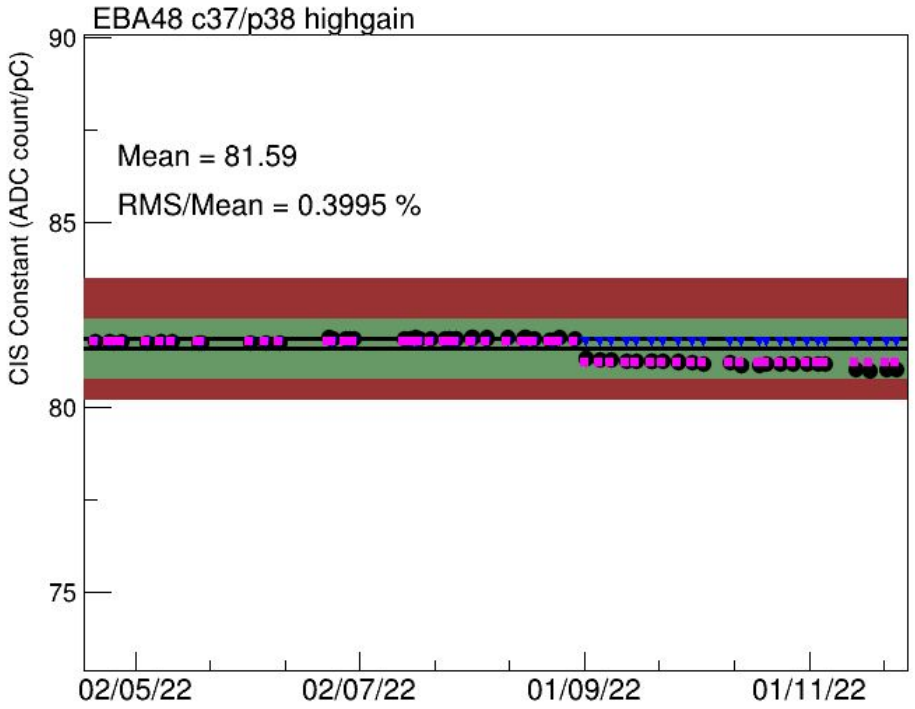


qflags: Large Inj. RMS

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

qflags: Large Inj. RMS

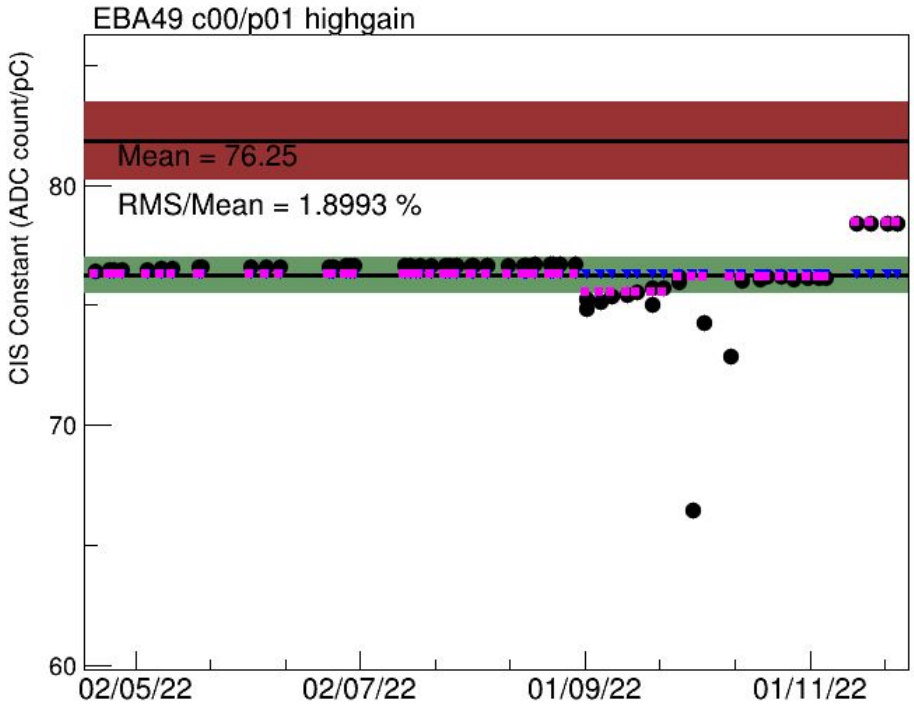
EBA 48 C37



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

qflags:

EBA 49 C00

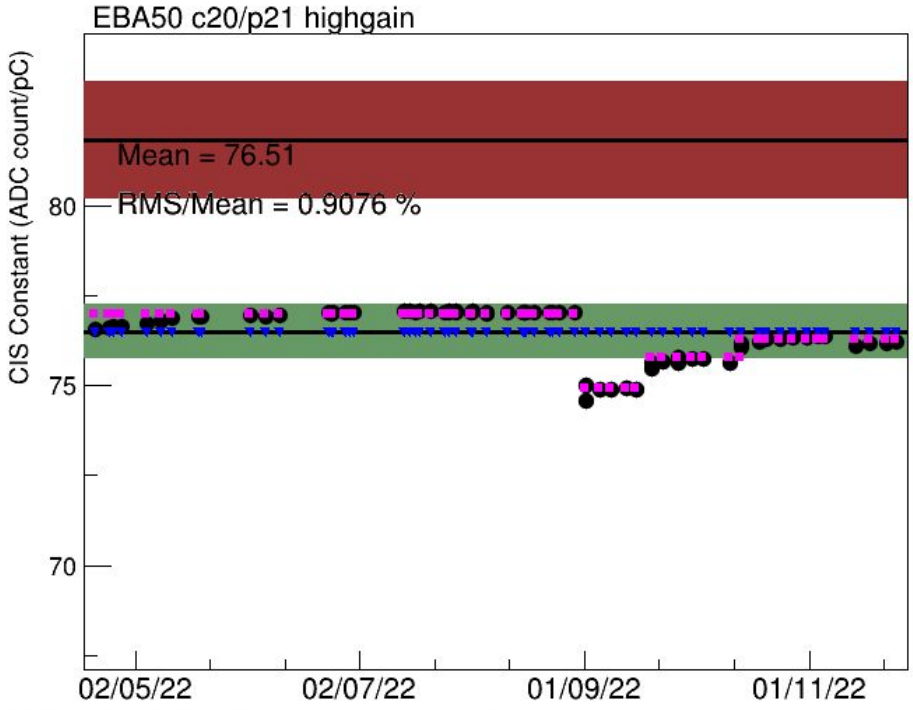


ADC AFFECTED Bad CIS Calib

qflags:

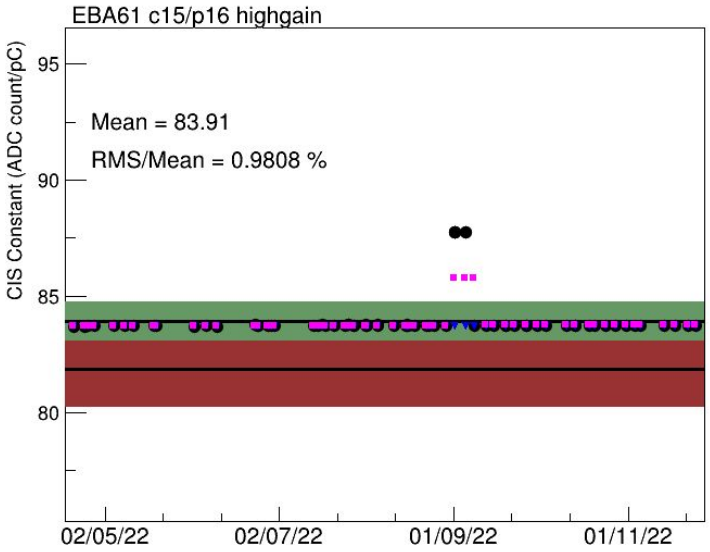
CIS constant is stable over most of the runs, but there are some obvious outliers in the middle. Is this ok? The reprocessing seems to interpret these as outliers and assigns the closest stable value.

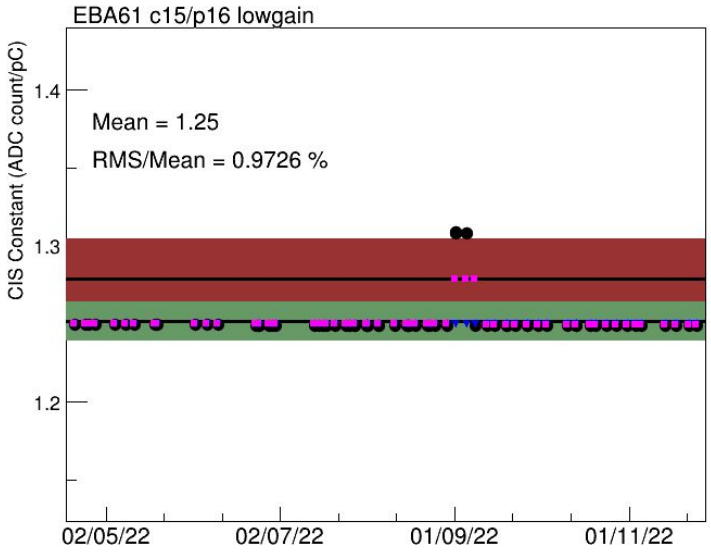
EBA 50 C20



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.

EBA 61 C15



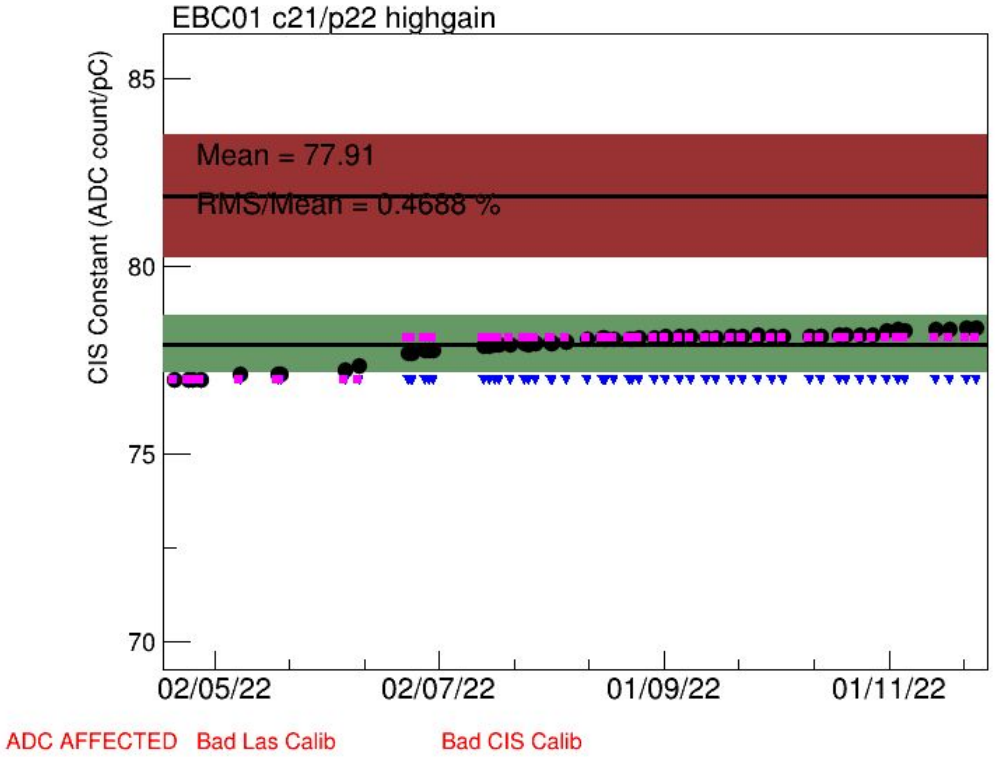


qflags:

qflags

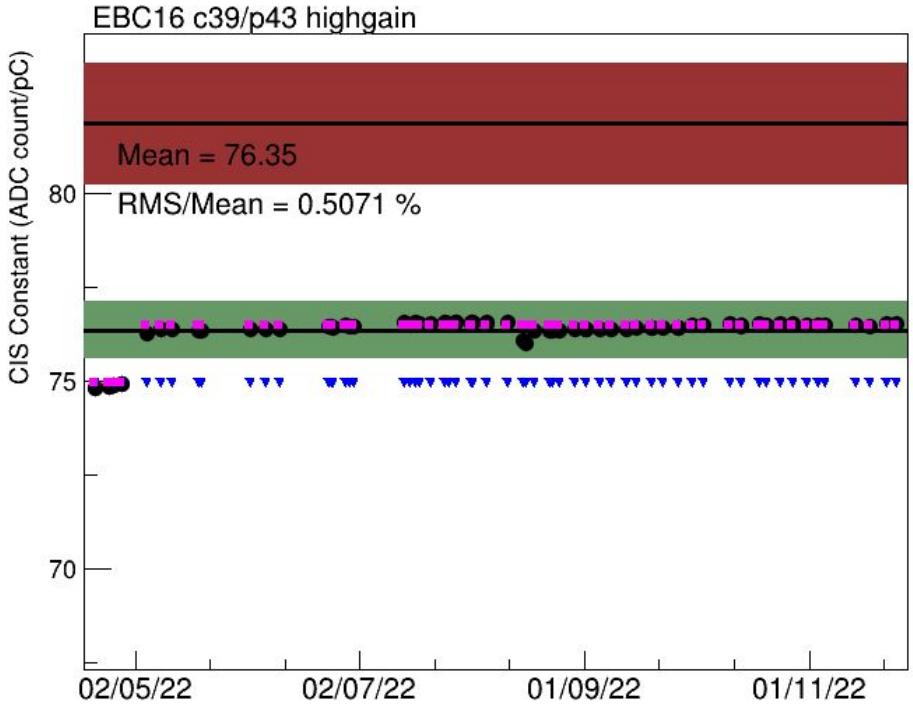
Outlier runs in the middle of the month have distorted the CIS constant value. We could rerun ONLY this channel with run_window = 2 to fix those values

EBC 01 C21



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

EBC 16 C39

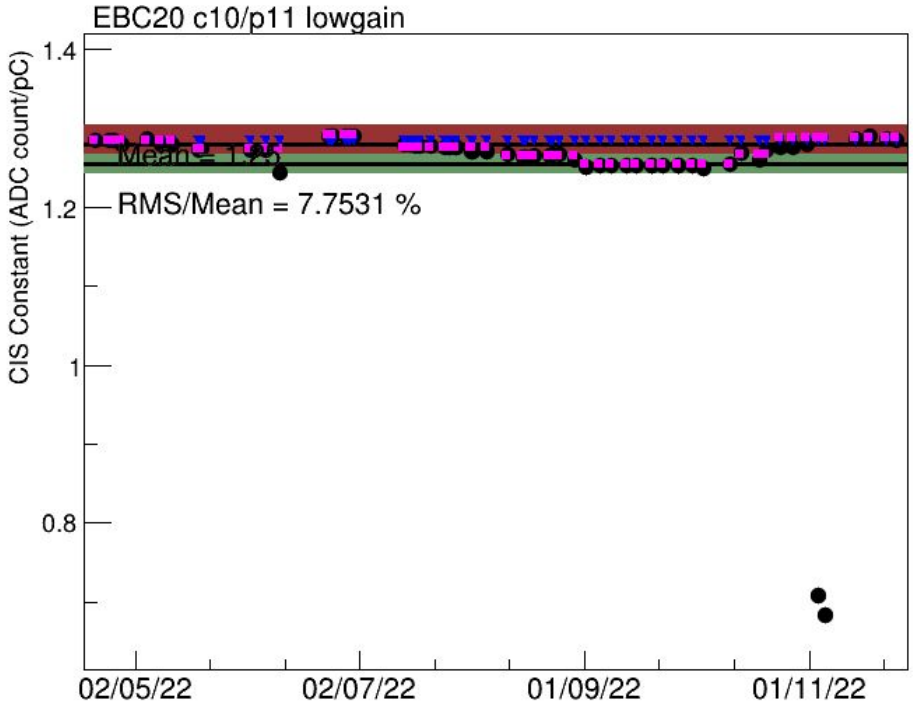


ADC AFFECTED Bad CIS Calib

qflags:

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

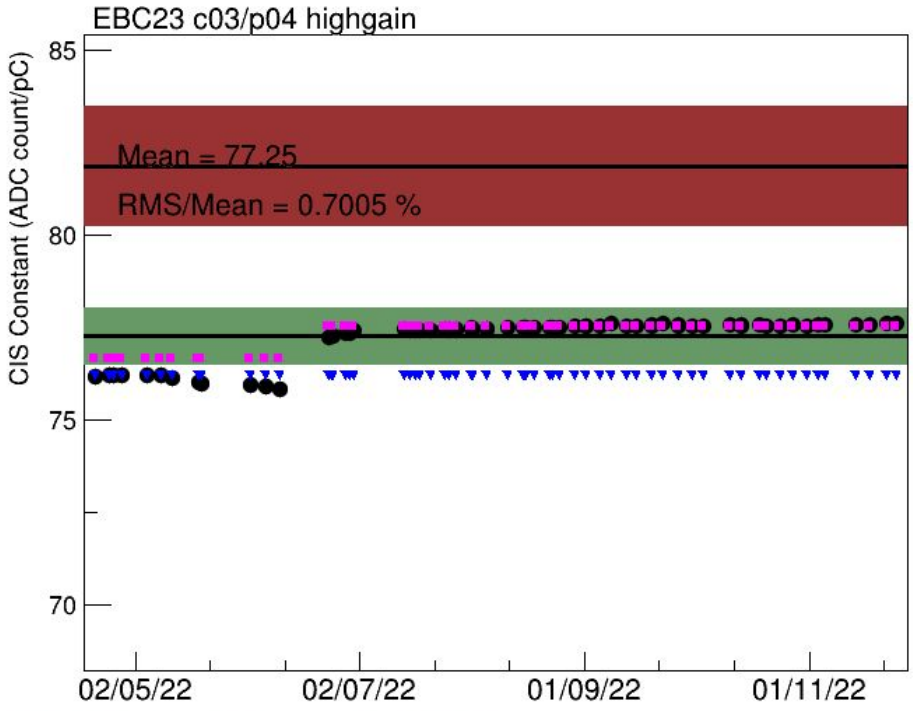
EBC 20 C10



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.

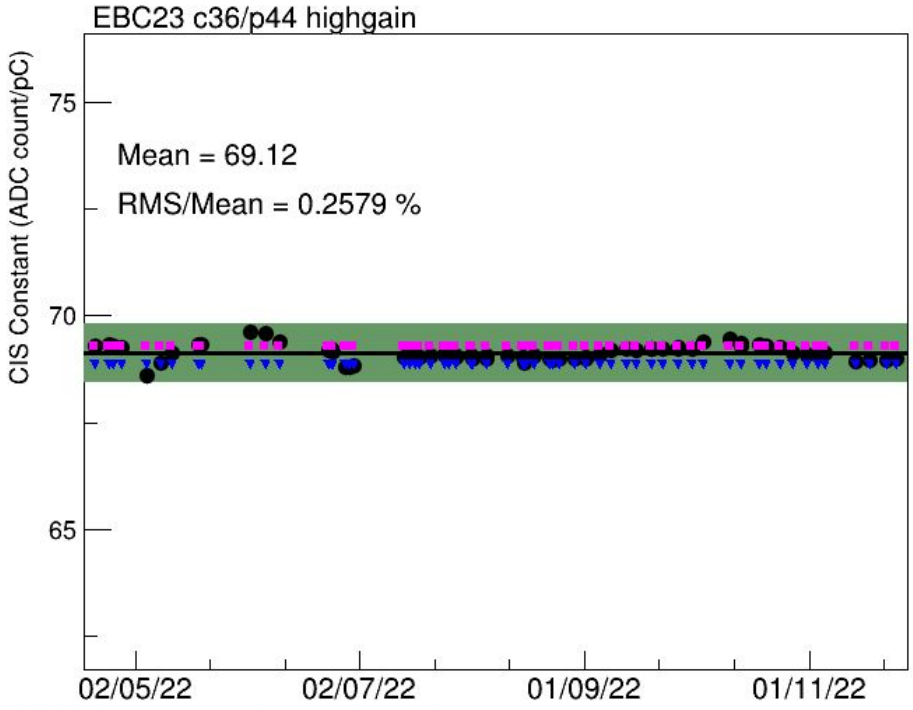
qflags:

EBC 23 C03



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)

EBC 23 C36

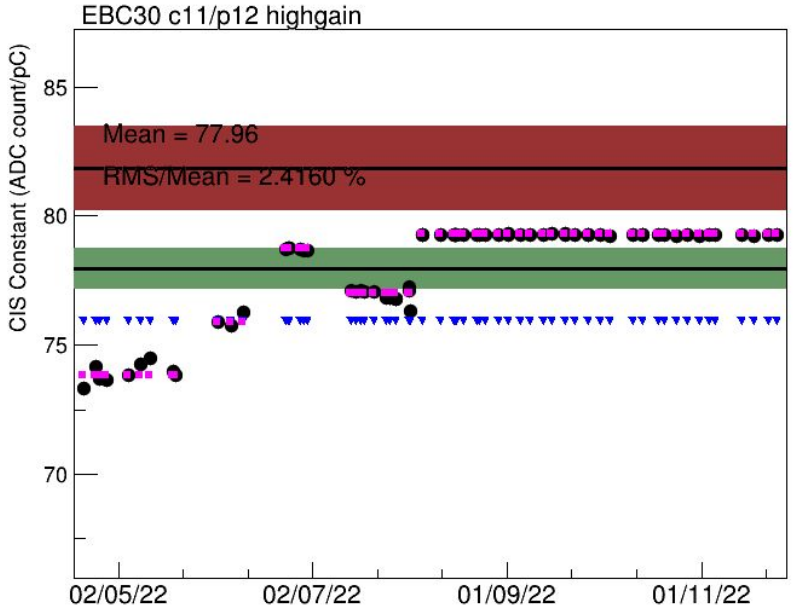


ADC AFFECTED Bad Las Calib Bad CIS Calib

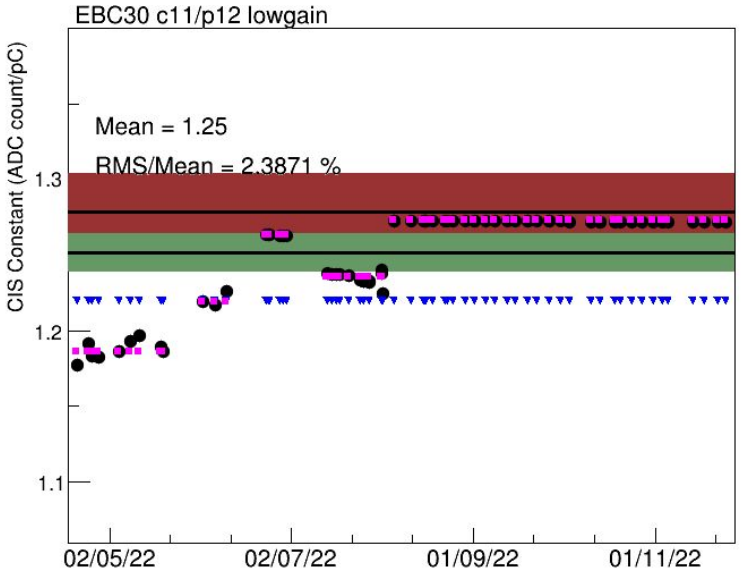
qflags: Fail Likely Calib.

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

EBC 30 C11



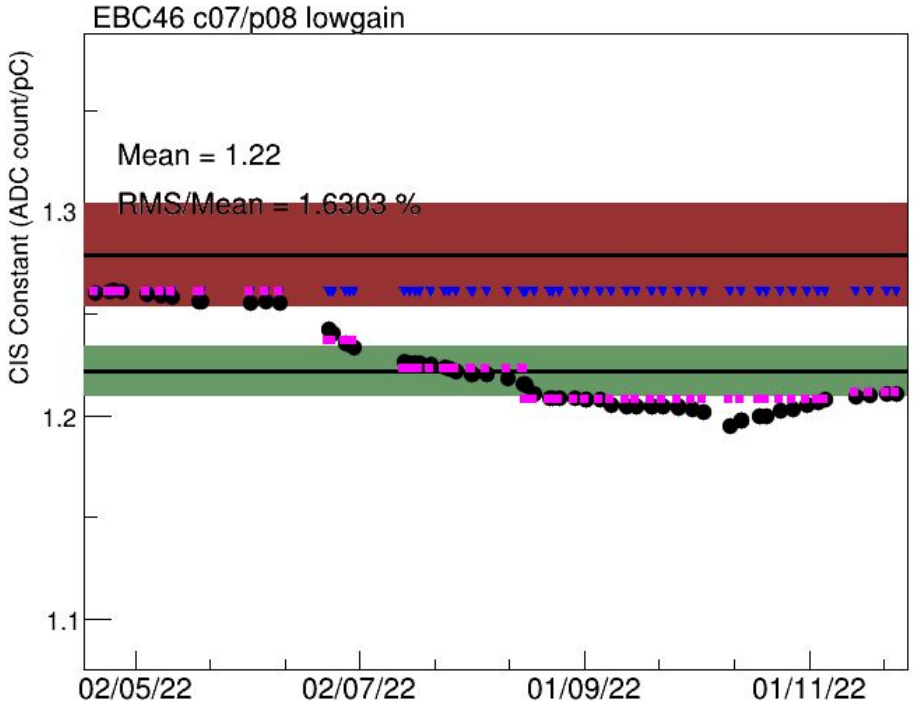
qflags:



qflags:

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

EBC 46 C07

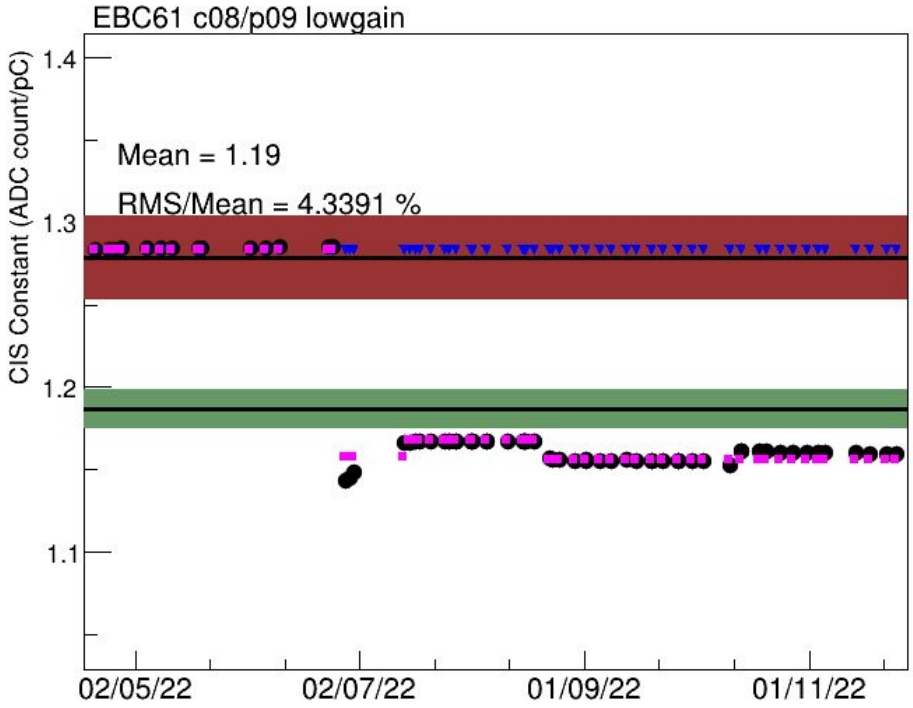


ADC AFFECTED Bad CIS Calib

qflags:

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

EBC 61 C08

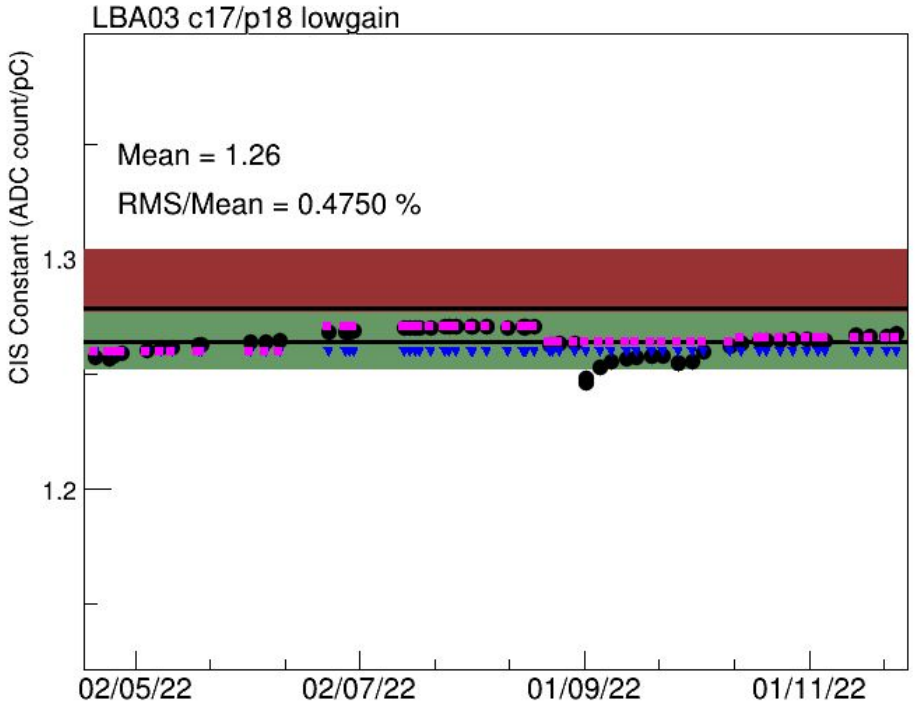


ADC AFFECTED Bad CIS Calib

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.

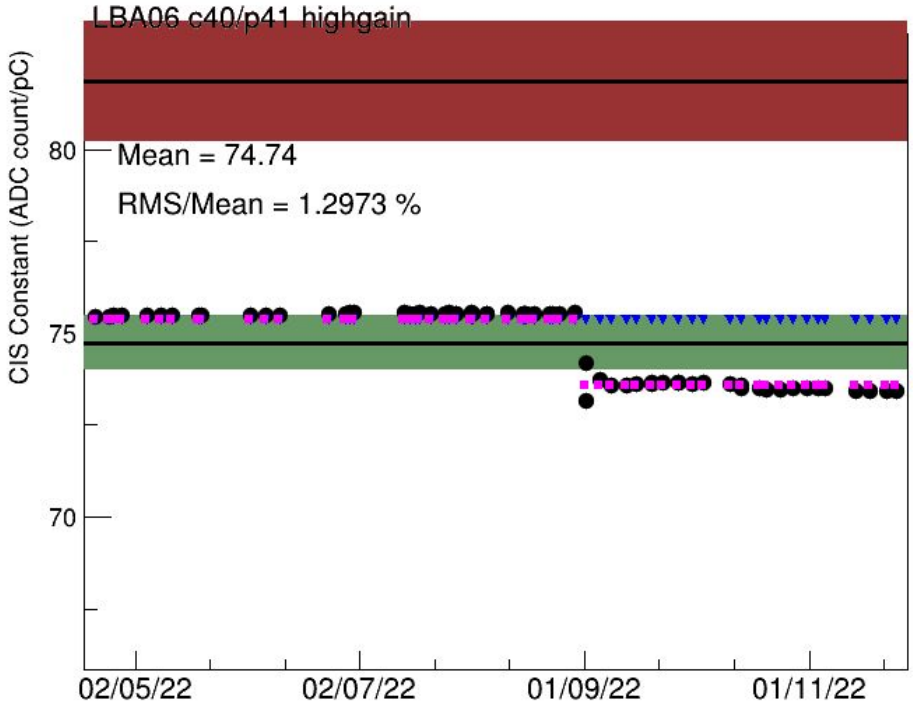
LBA 03 C17



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?

qflags:

LBA 06 C40

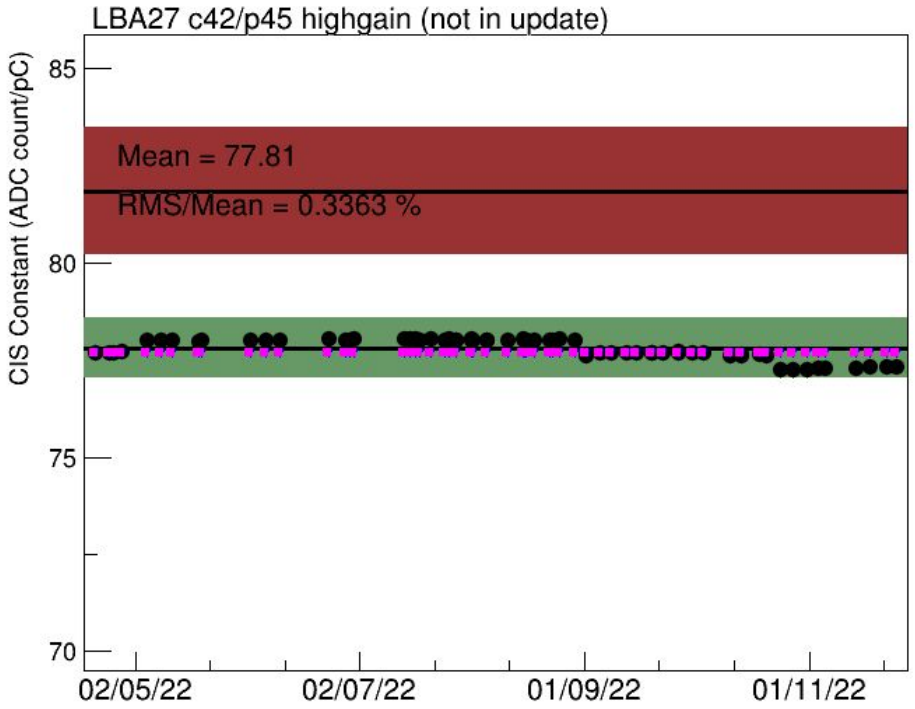


ADC AFFECTED Bad CIS Calib

qflags: Fail Likely Calib.

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

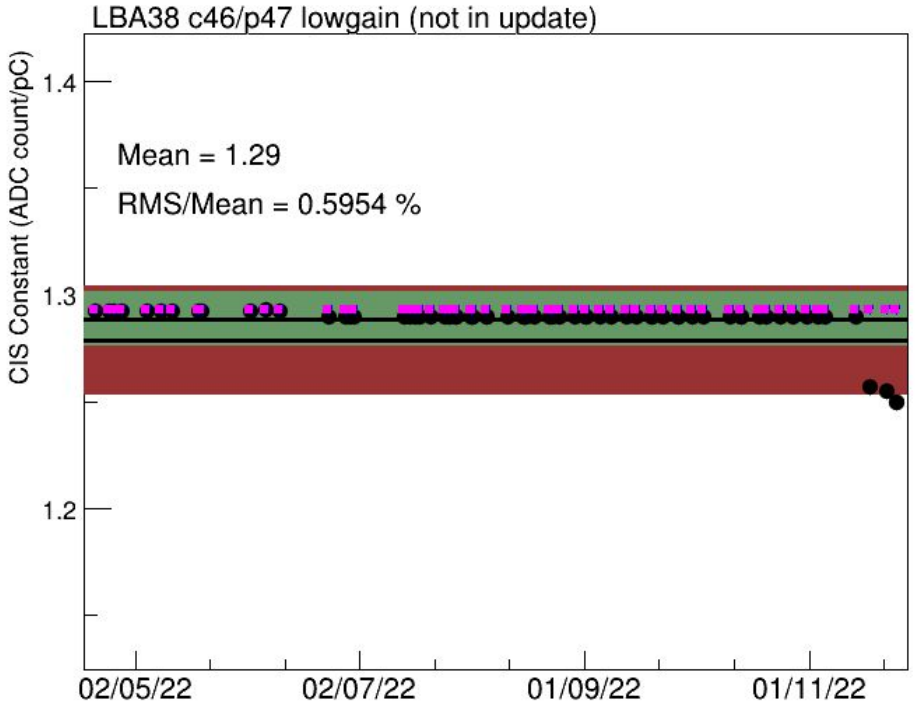
LBA 27 C42



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.

qflags:

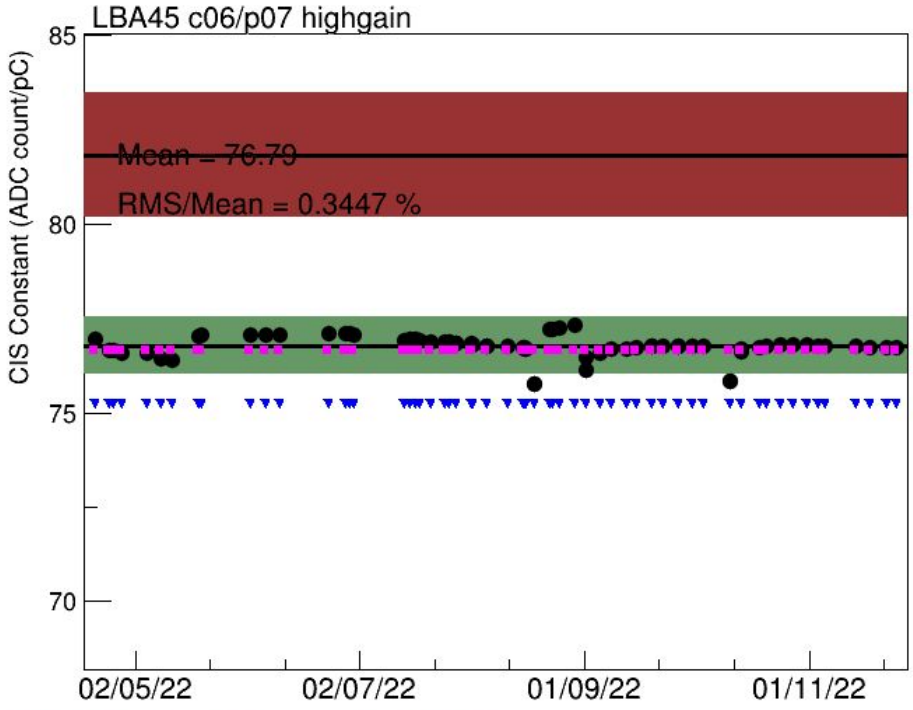
LBA 38 C46



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)

qflags:

LBA 45 C06

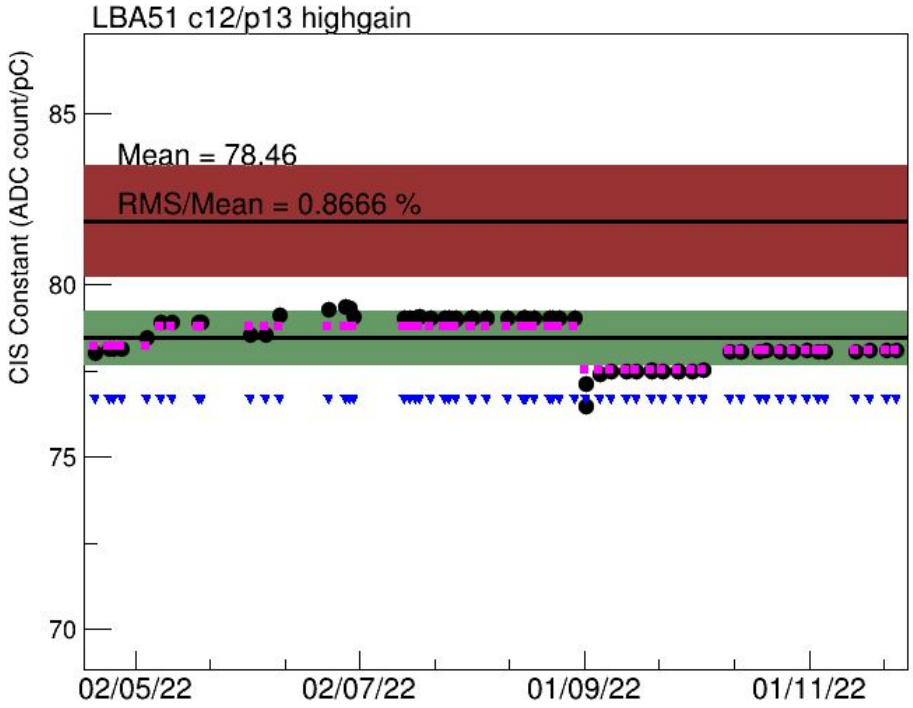


ADC AFFECTED Bad Las Calib Bad CIS Calib

qflags:

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

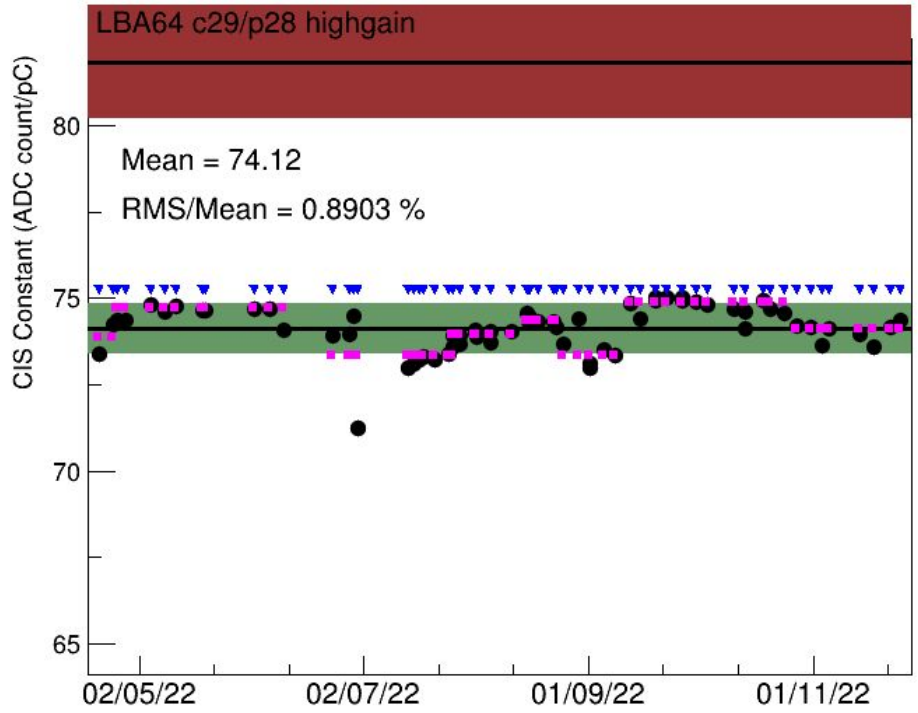
LBA 51 C12



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

qflags:

LBA 64 C29

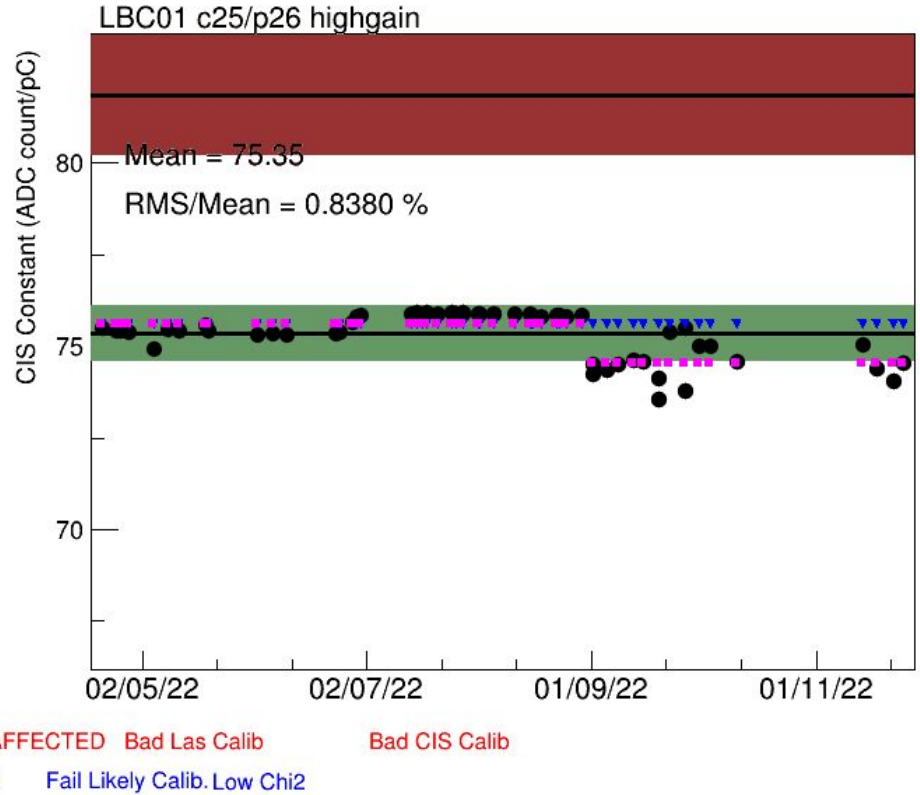


ADC AFFECTED Bad CIS Calib

qflags: Fail Likely Calib.

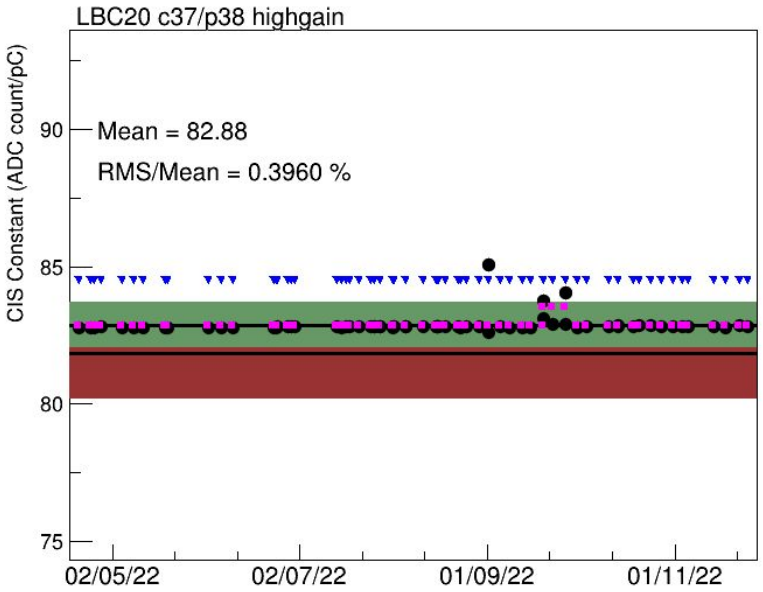
ADC Affected with large scatter. Our method creates some (bad) approximation. We could lower the update threshold again to capture this variation if needed.

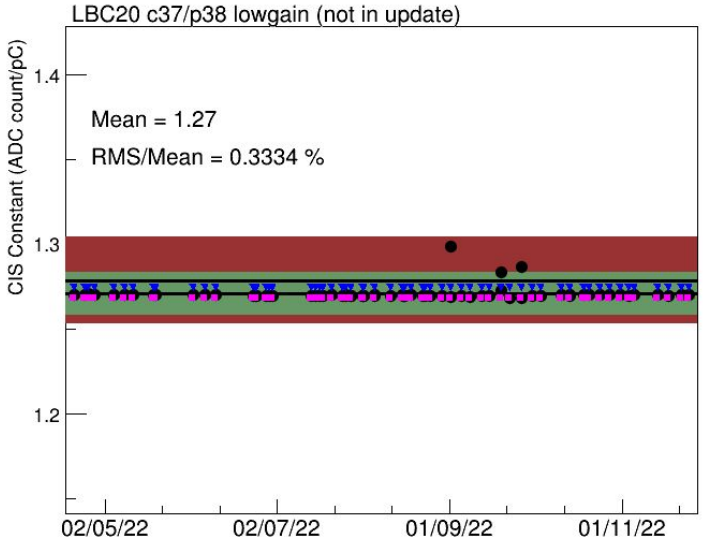
LBC 01 C25



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

LBC 20 C37



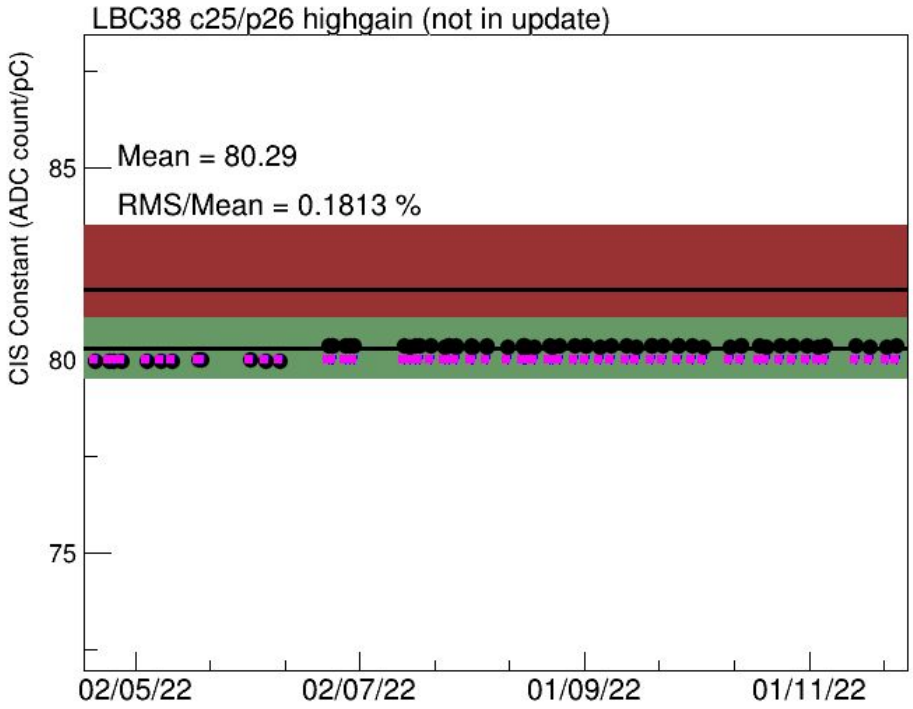


qflags:

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:

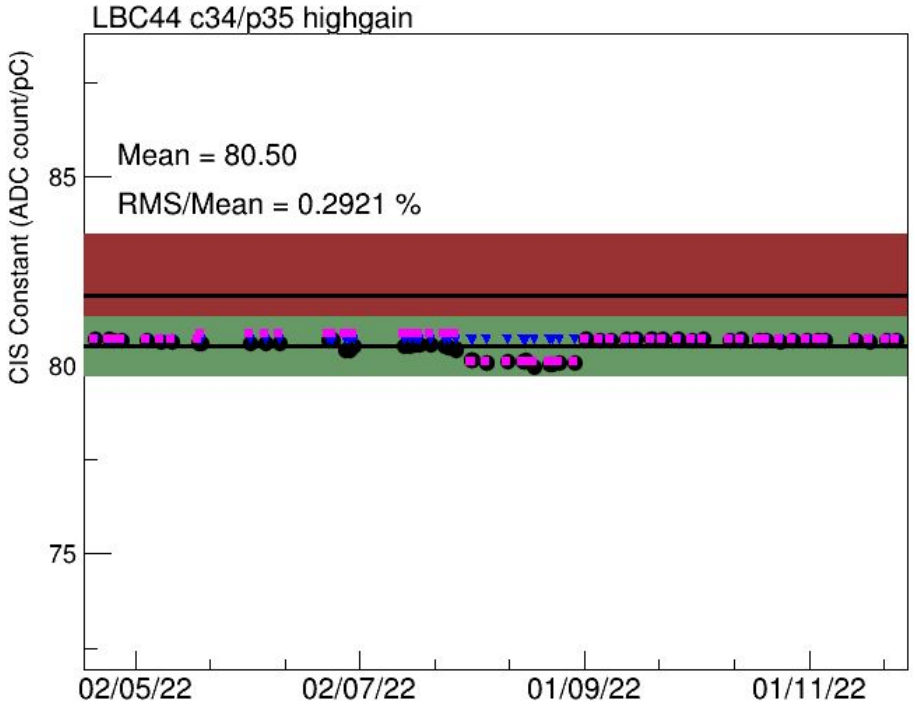
LBC 38 C25



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

qflags: Large Inj. RMS Low Chi2

LBA 44 C34

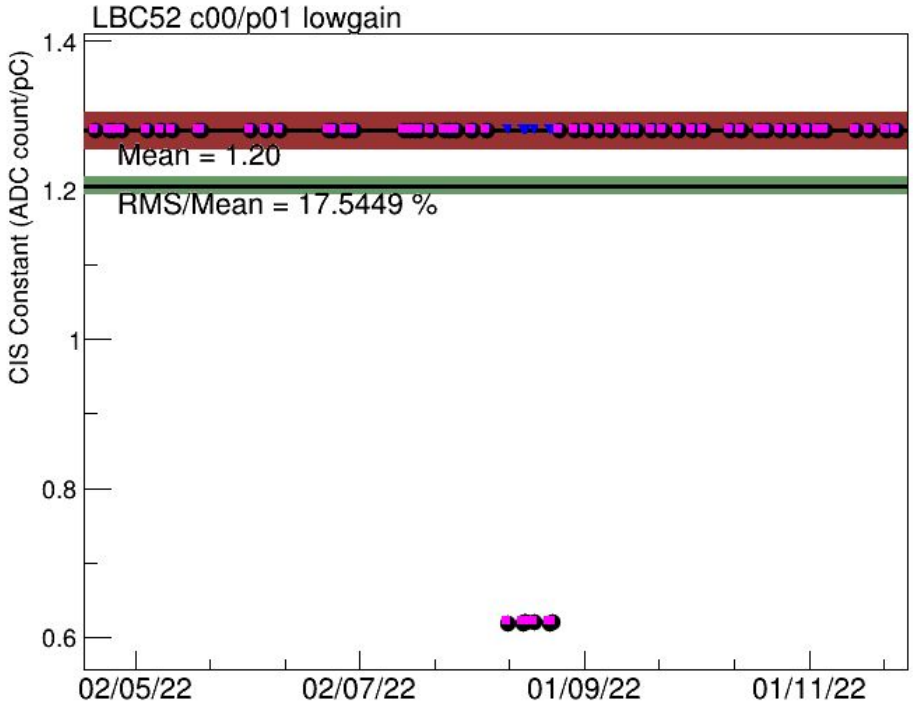


ADC AFFECTED Bad CIS Calib

qflags:

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

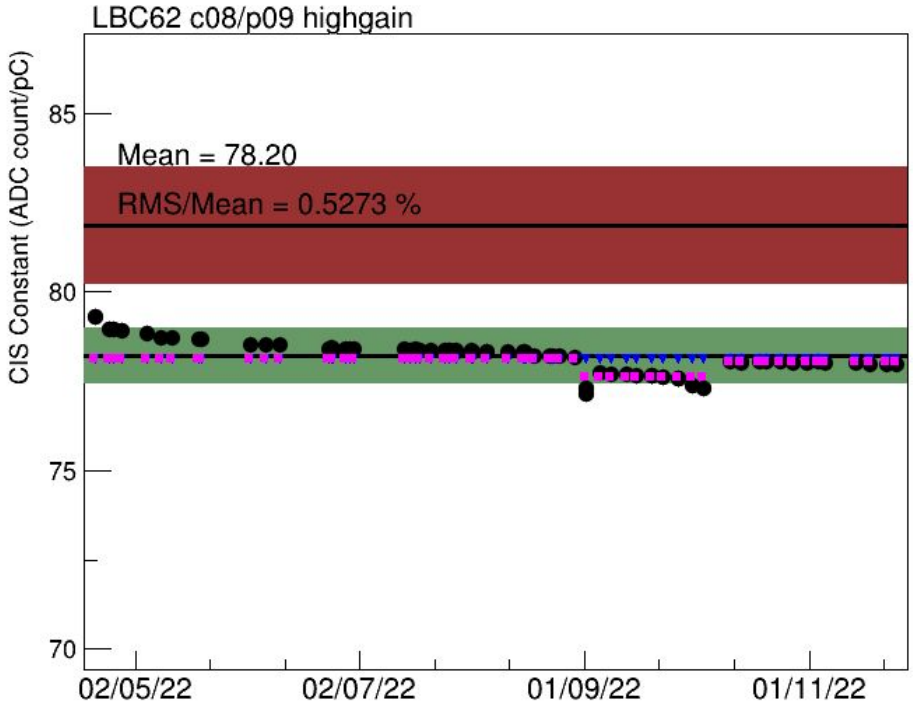
LBC 52 C00



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

qflags:

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?

Appendices

Current Status of ADC Masked/Affected Channels

Masked channels: 20

EBA19 c41/p41 highgain

EBA07 c31/p29 lowgain

LBC41 c25/p26 highgain

LBC43 c24/p27 highgain

LBC47 c35/p34 lowgain

LBC08 c03/p04 lowgain

LBC52 c18/p19 lowgain

LBC52 c18/p19 highgain

LBC13 c15/p16 highgain

LBC13 c15/p16 lowgain

LBC19 c22/p23 lowgain

LBC23 c20/p21 lowgain

LBC28 c04/p05 lowgain

EBC56 c41/p41 lowgain

EBC18 c04/p05 lowgain

EBC22 c16/p17 lowgain

LBA15 c02/p03 highgain

LBA35 c08/p09 highgain

LBA02 c06/p07 highgain

LBA02 c06/p07 lowgain

Affected channels: 29

EBA42 c30/p33 highgain

EBA49 c00/p01 highgain

EBA50 c20/p21 highgain

EBA50 c31/p29 highgain

EBA16 c17/p18 highgain

LBC01 c25/p26 highgain

LBC44 c34/p35 highgain

LBC44 c12/p13 highgain

LBC46 c04/p05 highgain

LBC10 c37/p38 highgain

LBC16 c29/p28 highgain

LBC62 c08/p09 highgain

EBC01 c21/p22 highgain

EBC03 c39/p43 lowgain

EBC03 c39/p43 highgain

EBC03 c40/p42 lowgain

EBC03 c41/p41 highgain

EBC03 c41/p41 lowgain

EBC46 c07/p08 lowgain

EBC13 c03/p04 lowgain

EBC16 c39/p43 highgain

EBC61 c08/p09 lowgain

EBC23 c03/p04 highgain

EBC23 c36/p44 highgain

LBA06 c40/p41 highgain

LBA52 c01/p02 lowgain

LBA64 c29/p28 highgain

LBA37 c21/p22 highgain

LBA45 c06/p07 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%