

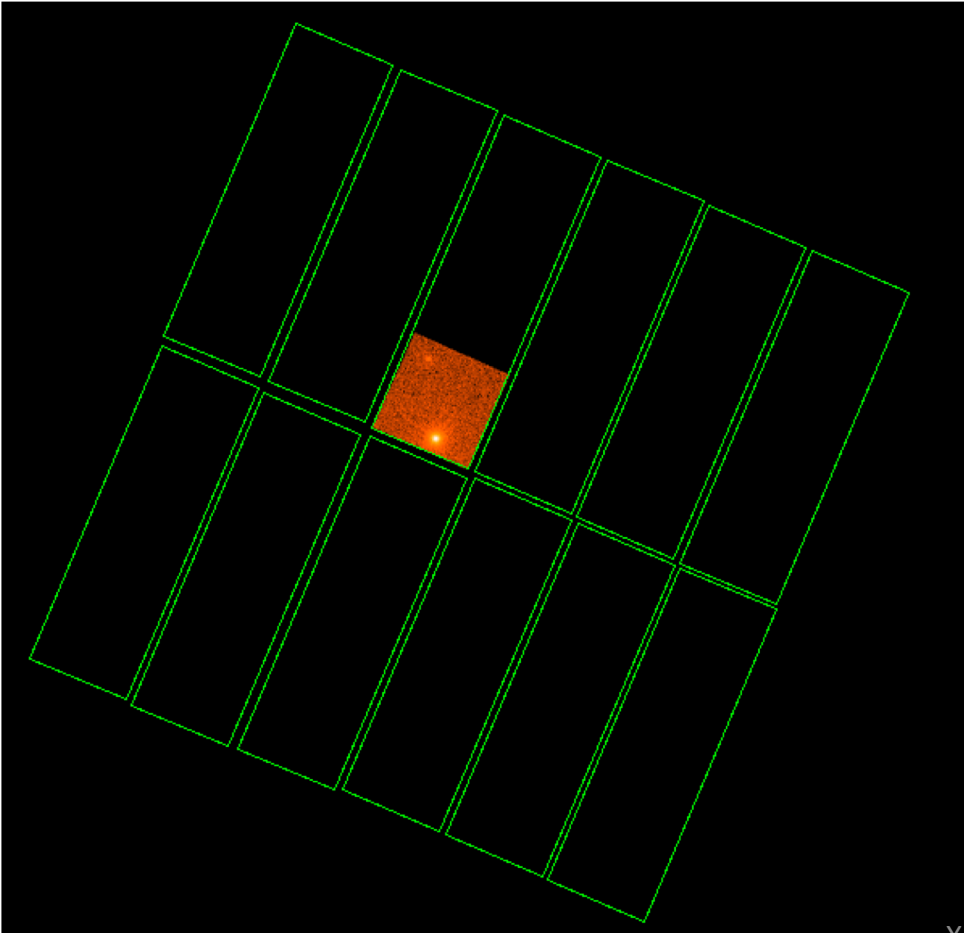


XMM-Newton EPIC-pn

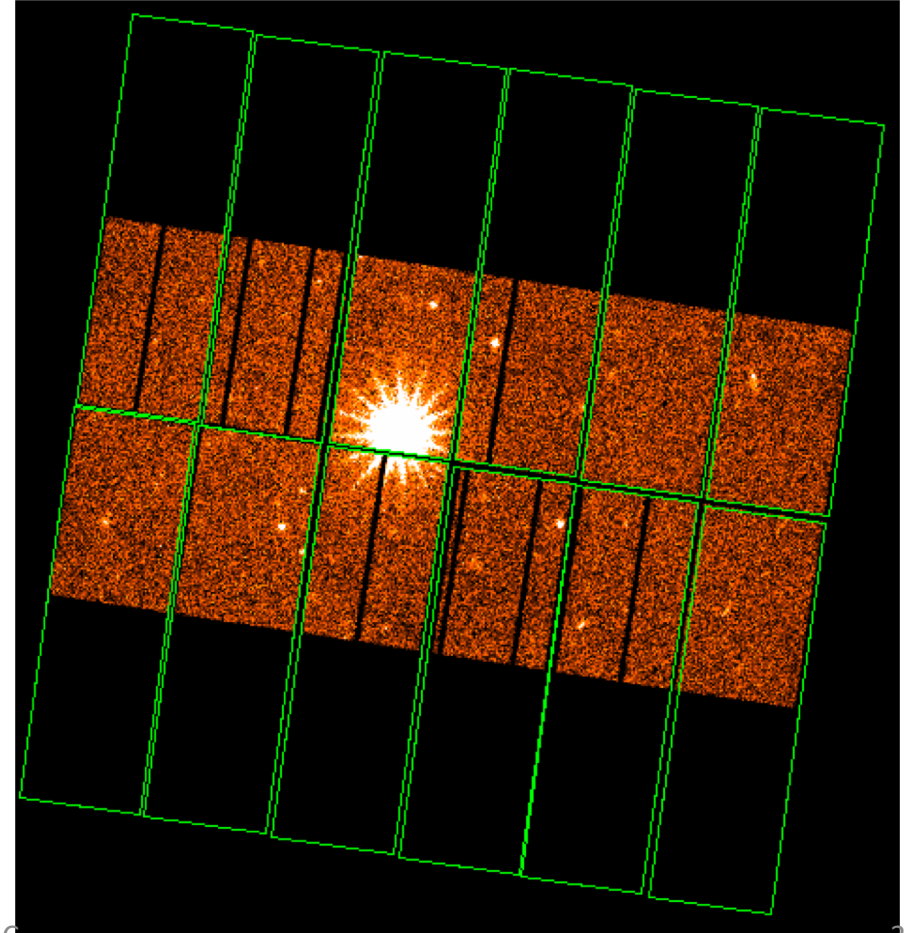
Energy Scale for Window Modes

Introduction

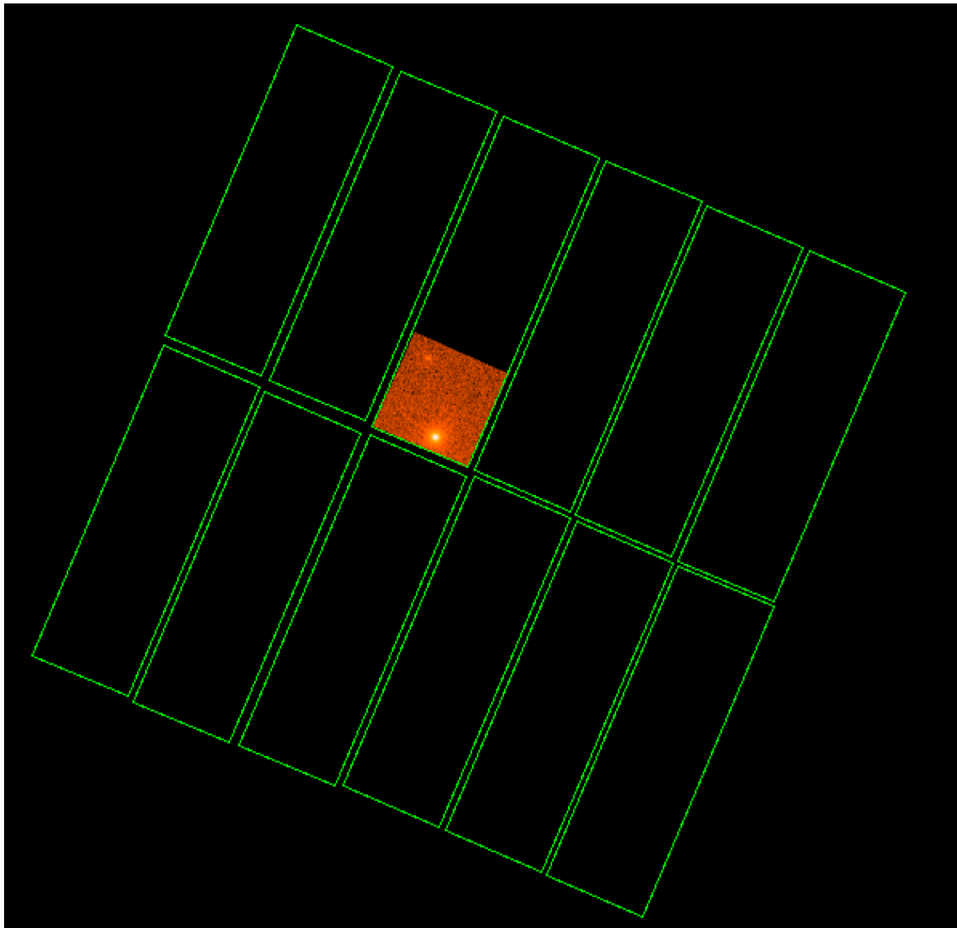
Small window mode

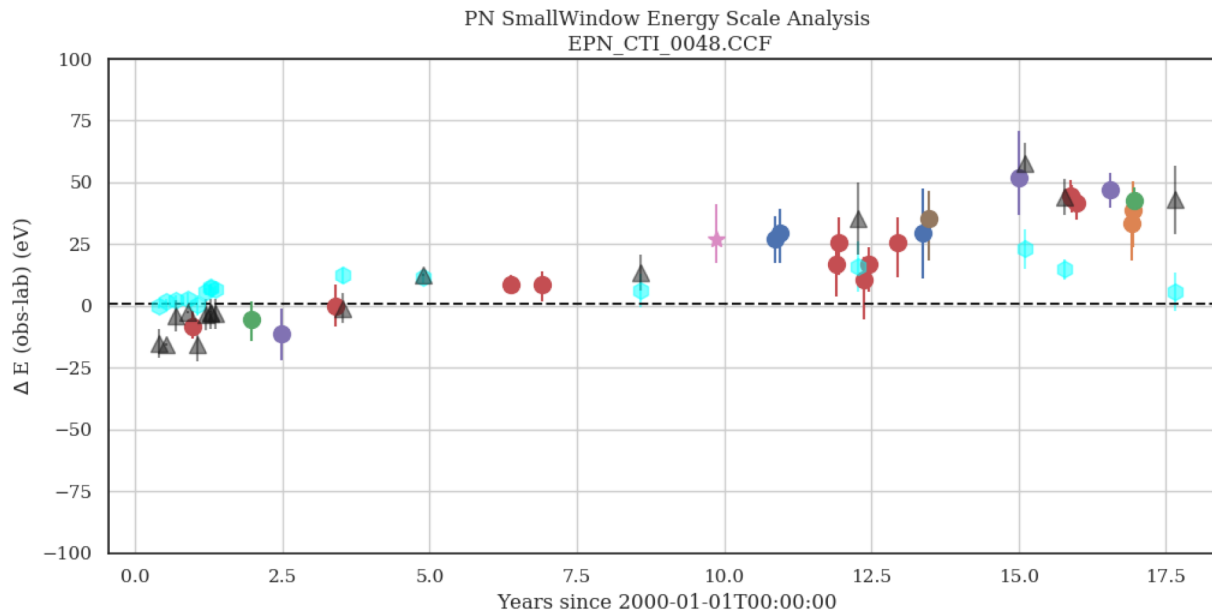


Large window mode



EPIC-PN Small Window Mode

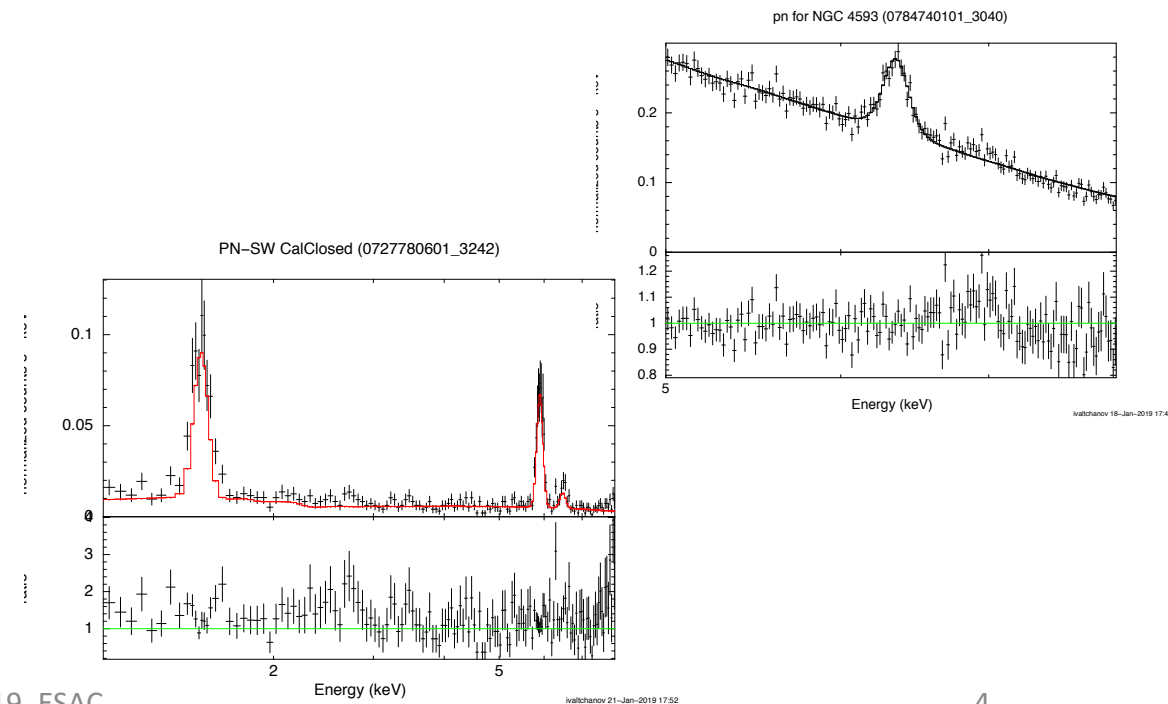


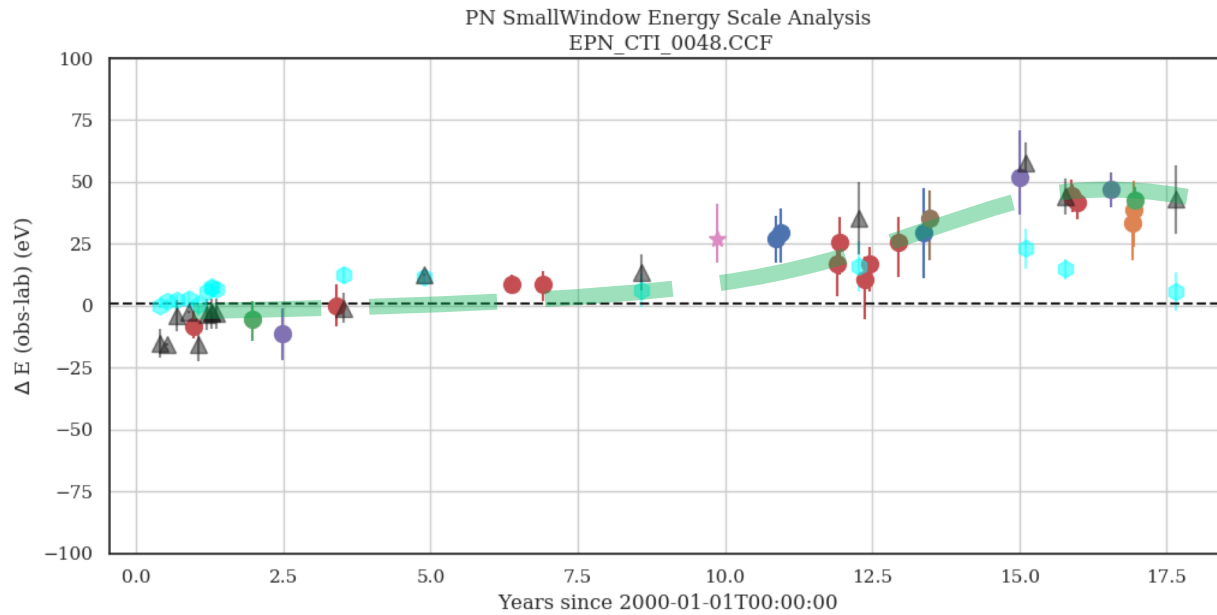


PN Small Window Mode

Processing with EPN_CTI_0048.CCF
Correction is based on FF or eFF mode.

CalClosed
AGNs with narrow Fe $K\alpha$

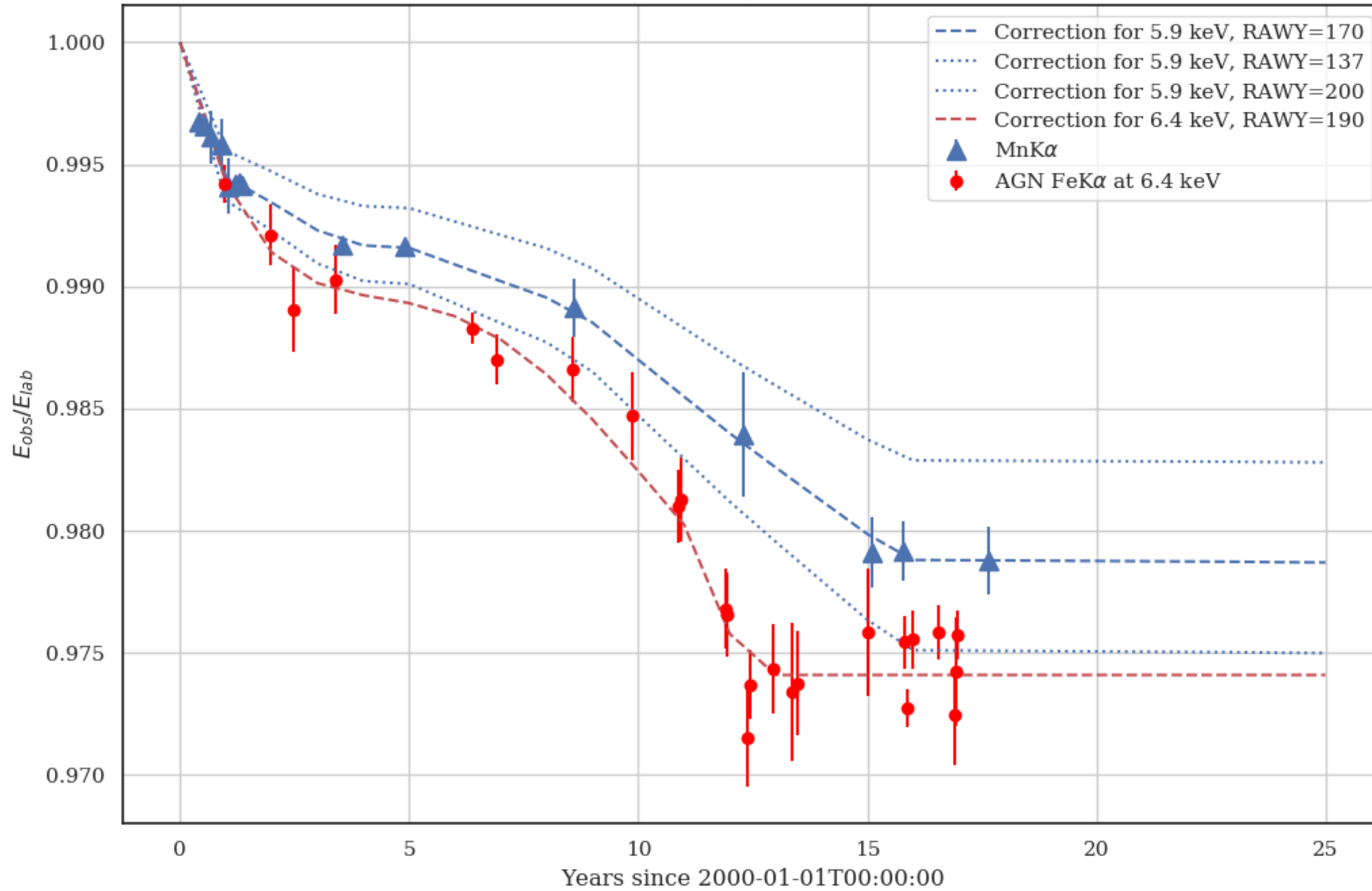




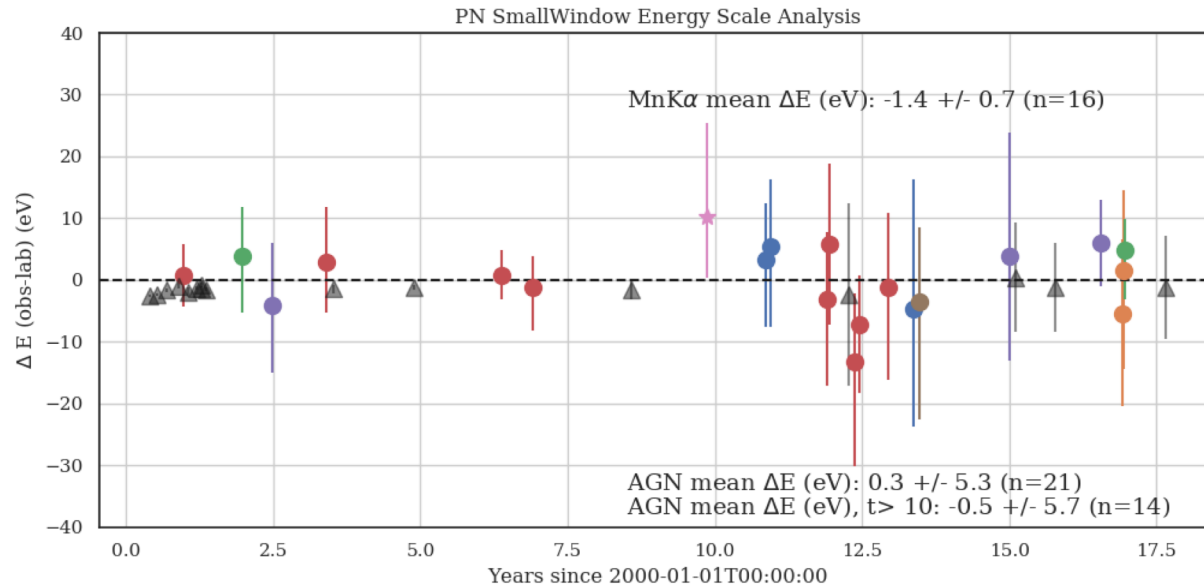
Systematic offset of 40-50 eV
at $t > 15$ years (rev > 2500)
deviation starting at $t \sim 10$.

This is 0.5-0.7 % effect,
but it is systematic!

PN SW without Long-term CTI correction



Use these curves to
derive a new correction



PN Small Window Mode

Results with the new correction

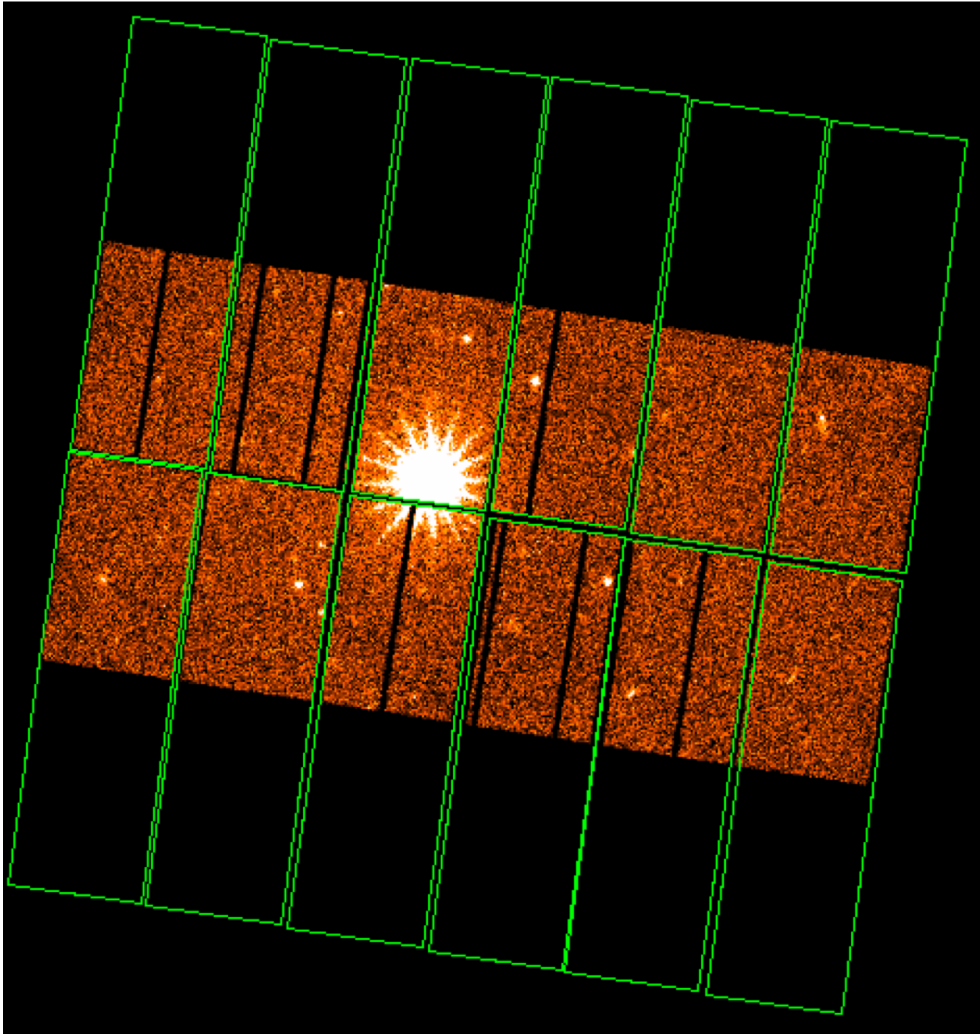
- Considered final for the moment
- Incorporated in the new CCF
- Discussed with MPE

(some further discussions on the interpretation, e.g. is it a long-term CTI effect or gain effect?)

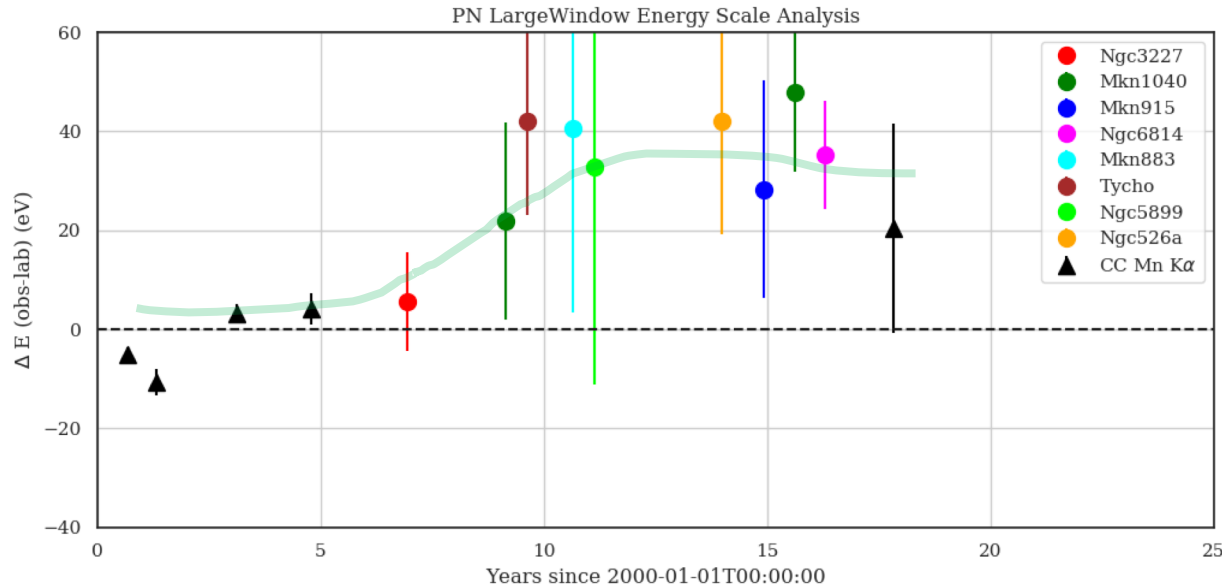
Current calibration!

EPN_CTI_0049 and EPN_CTI_0050

EPIC-PN Large Window Mode



Single events: `PATTERN == 0`



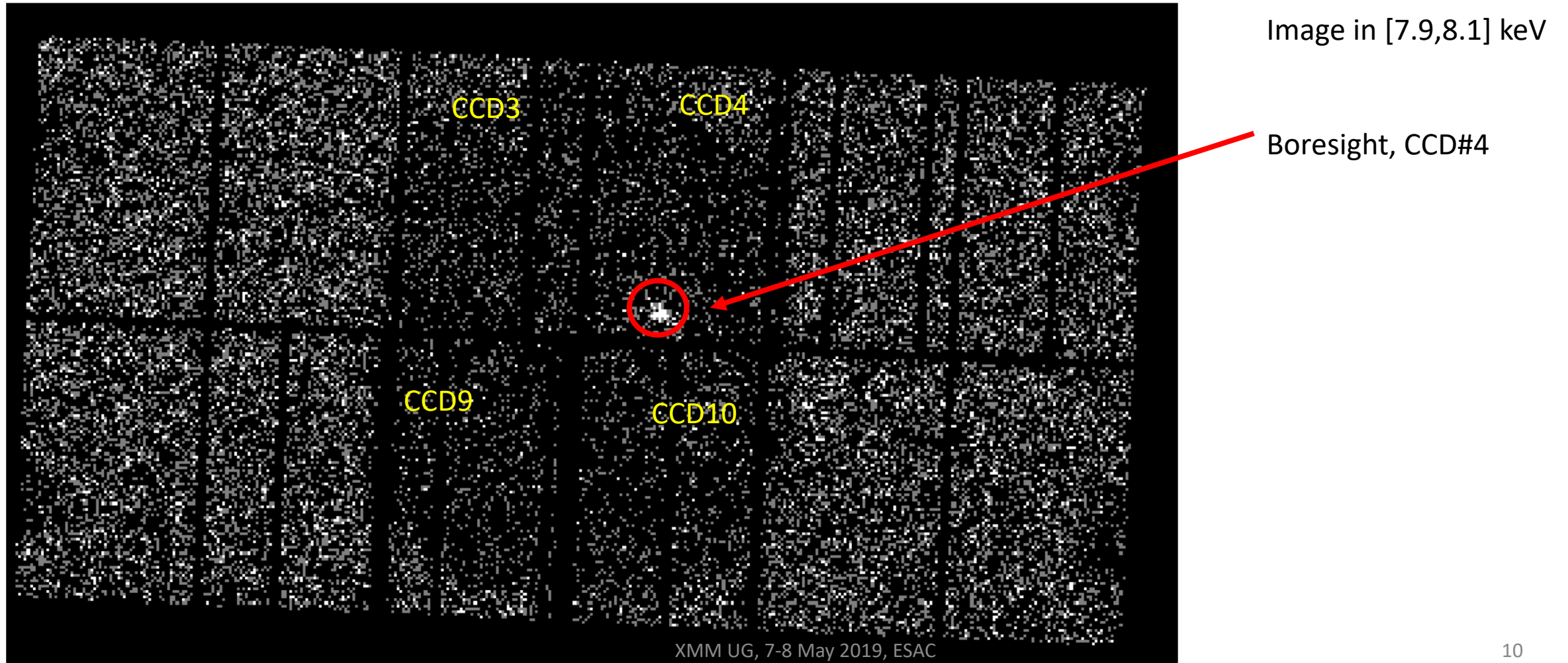
PN Large Window Mode

Too few suitable CC observations!

Boresight results (CCD#4).

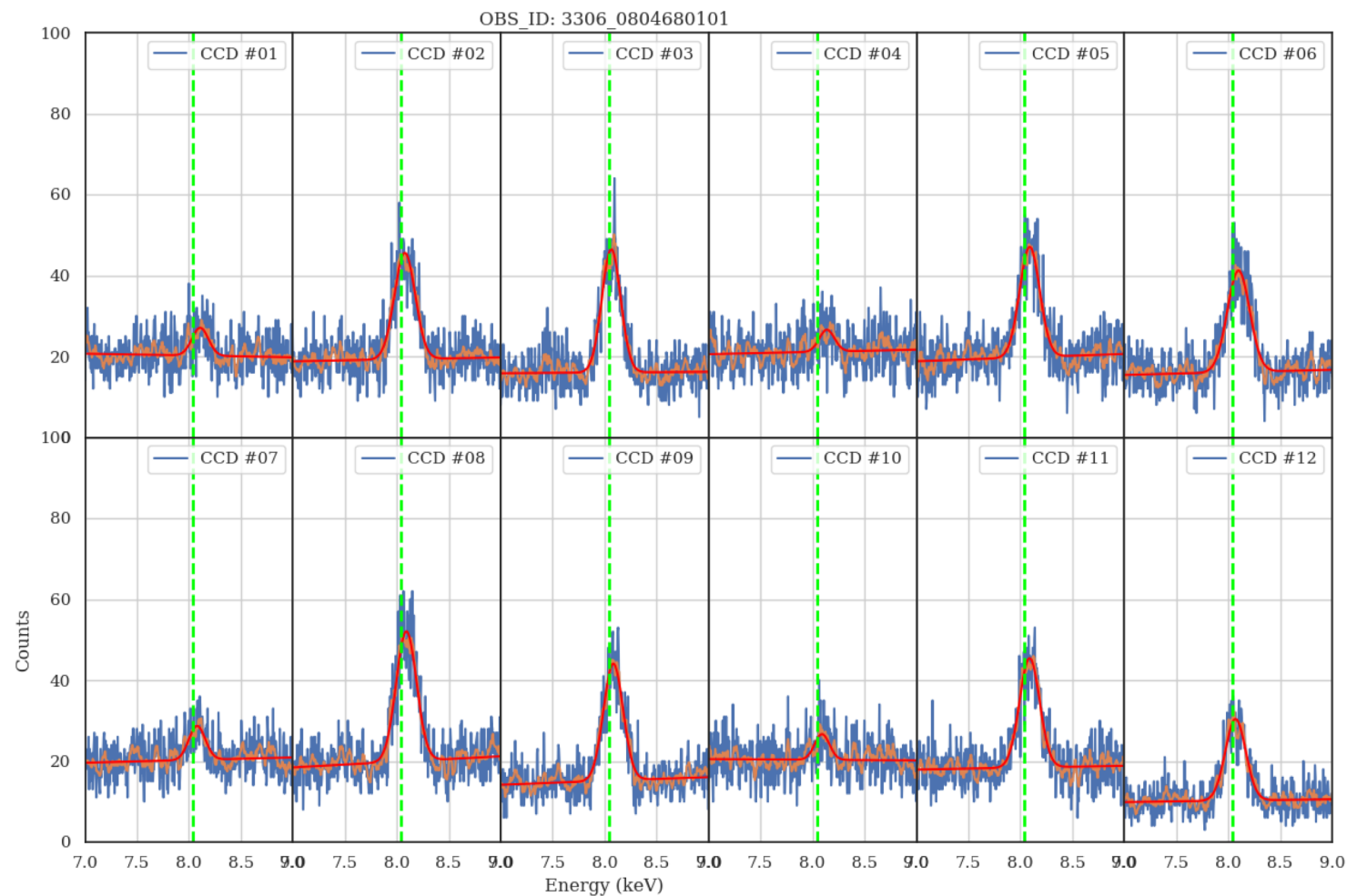
- The two most recent CC are separated by ~ 13 years.
- The most recent one (rev 3274 with expo 14.4 ks) is short $\rightarrow$ noisy line at 6 keV.
- Too few AGNs (9) and the iron lines (Fe K α) are faint.
- At $t > 8/9$ years systematic offset of ~ 30 -40 eV.

Cu K α line at 8.04 keV comes to help!



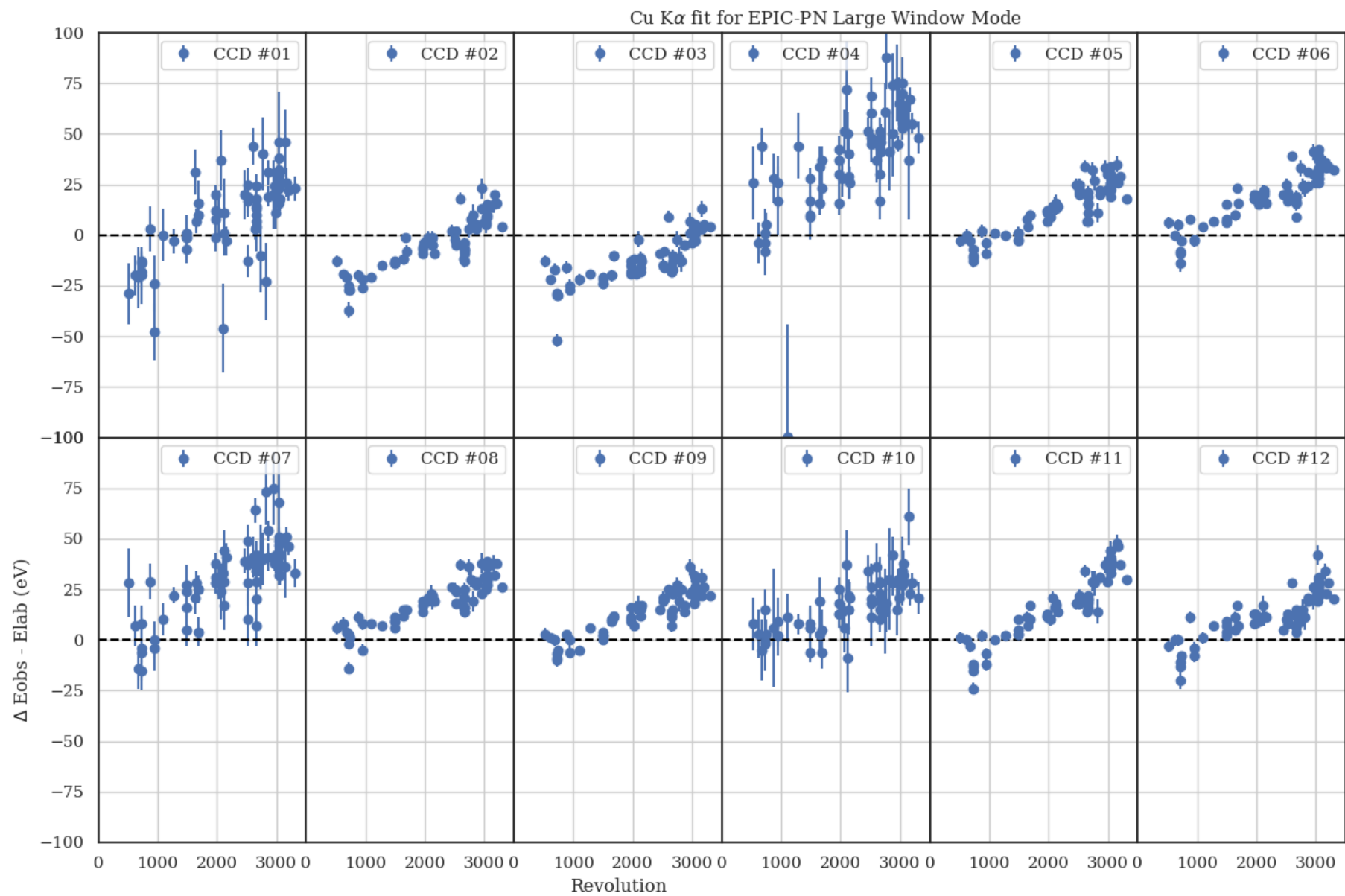
Spectra extracted from each CCD
after masking

Example Cu K α fit



XMM UG, 7-8 May 2019, ESAC

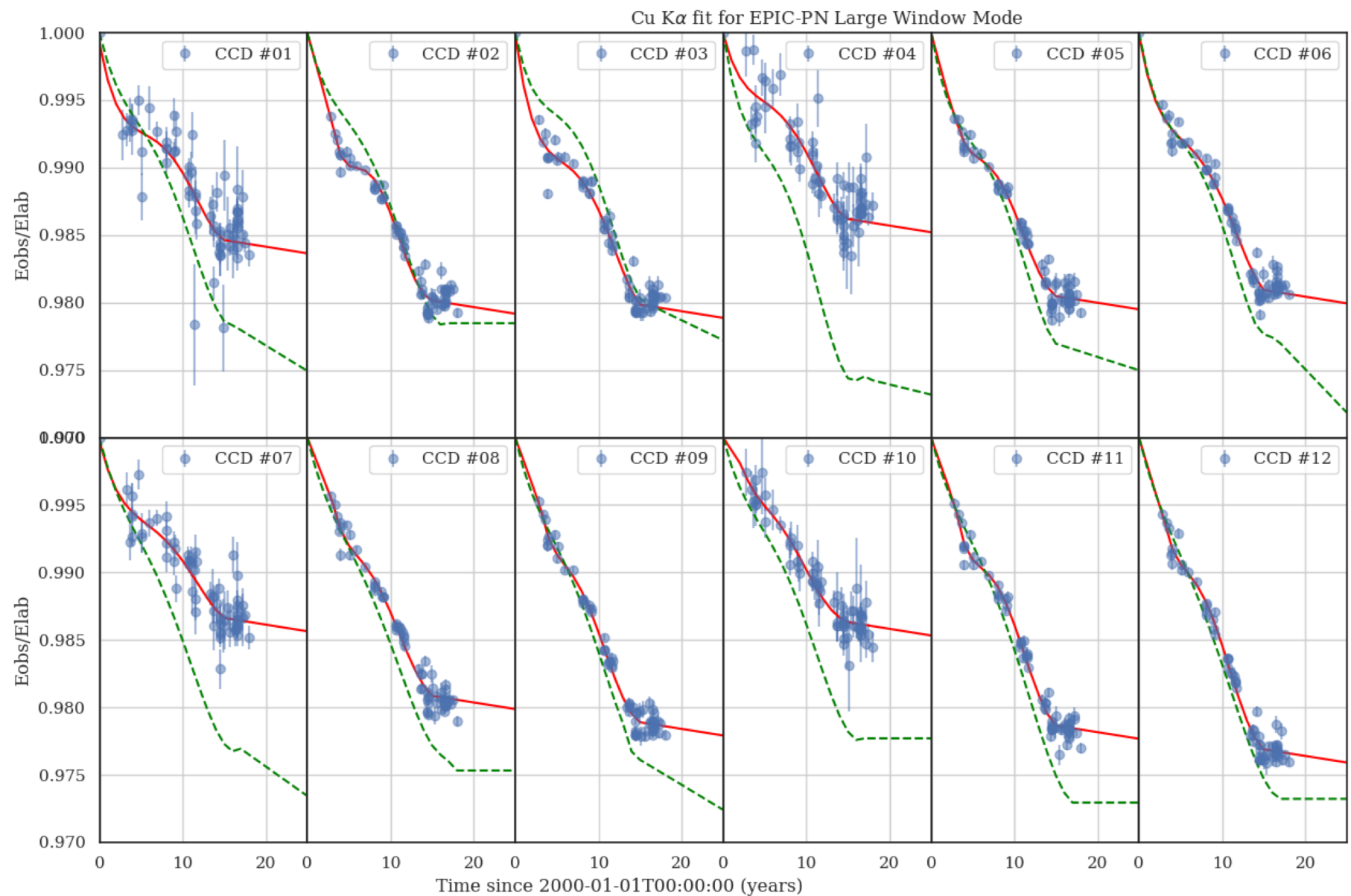
Note: the mask per CCD was derived from the illumination pattern of the calibration source at the Mn K α line.
➔ not optimal for Cu K α especially for CCDs 1 and 7.



PN LW

LTCTI (v48)

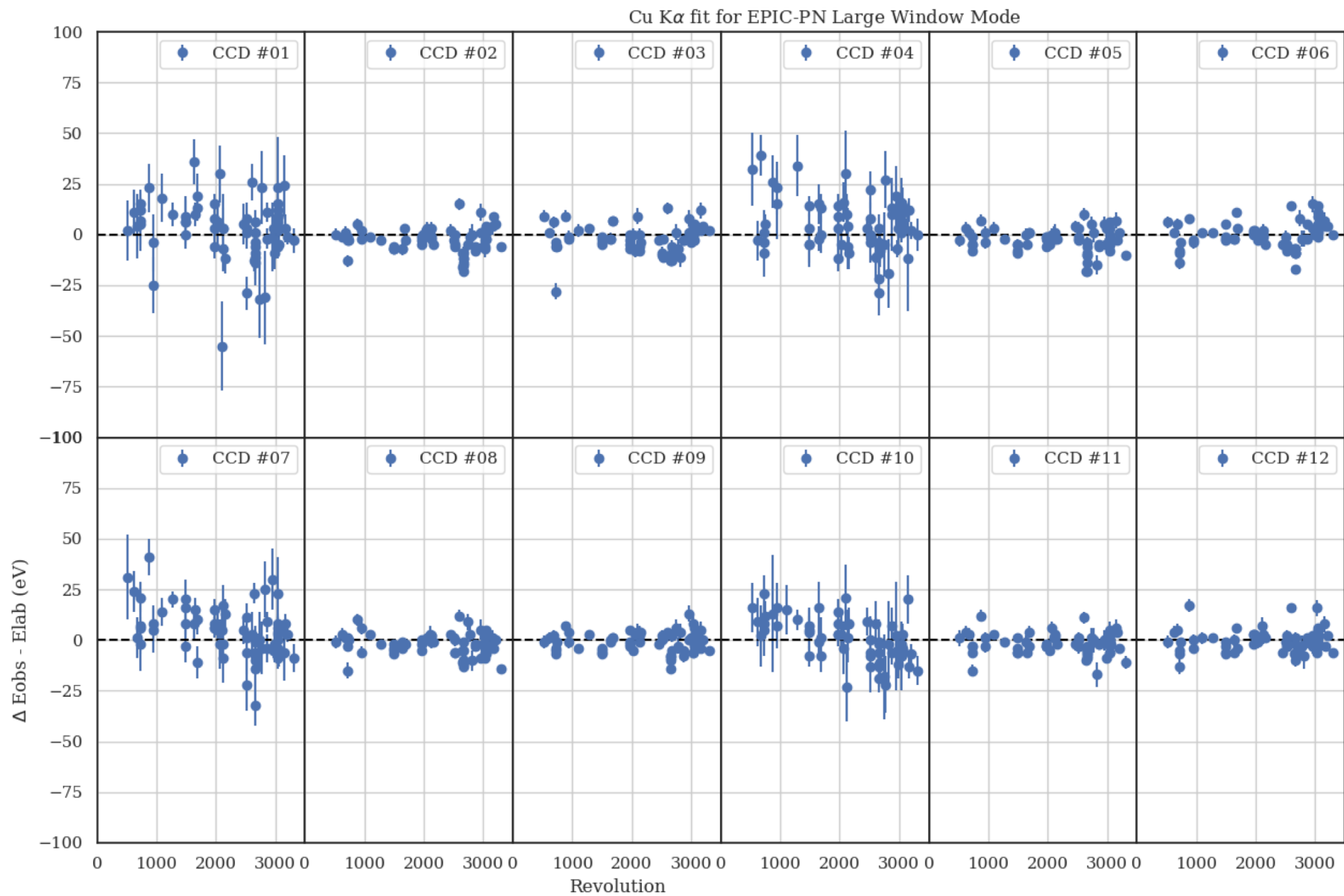
Cu K α (8.04 keV)



PN LW

Deriving a correction with
Cu $K\alpha$

Green dashed line:
current extrapolated
(constant) from 5.9 keV



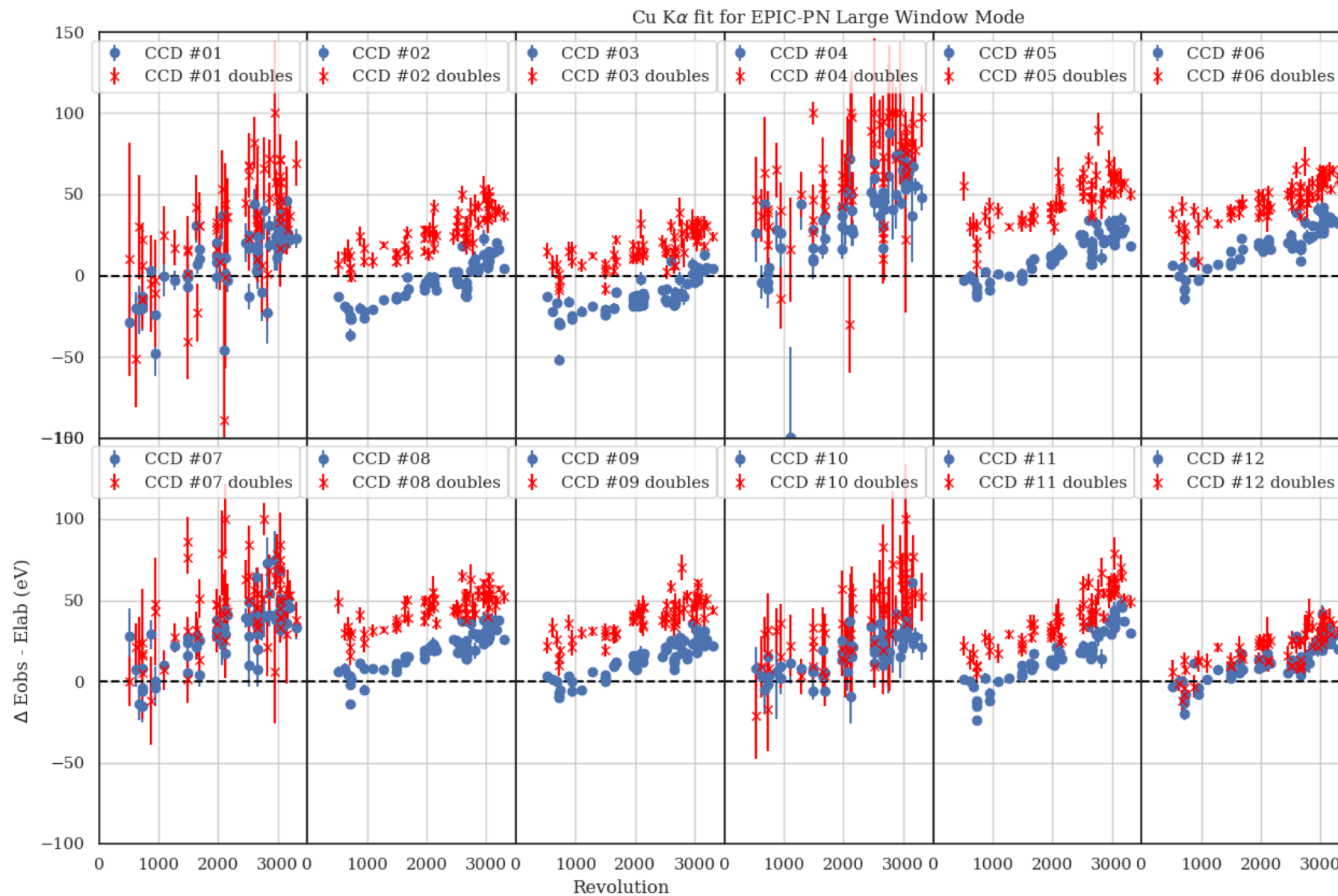
PN LW

Results at Cu $K\alpha$

Applying the correction

PN LW double events

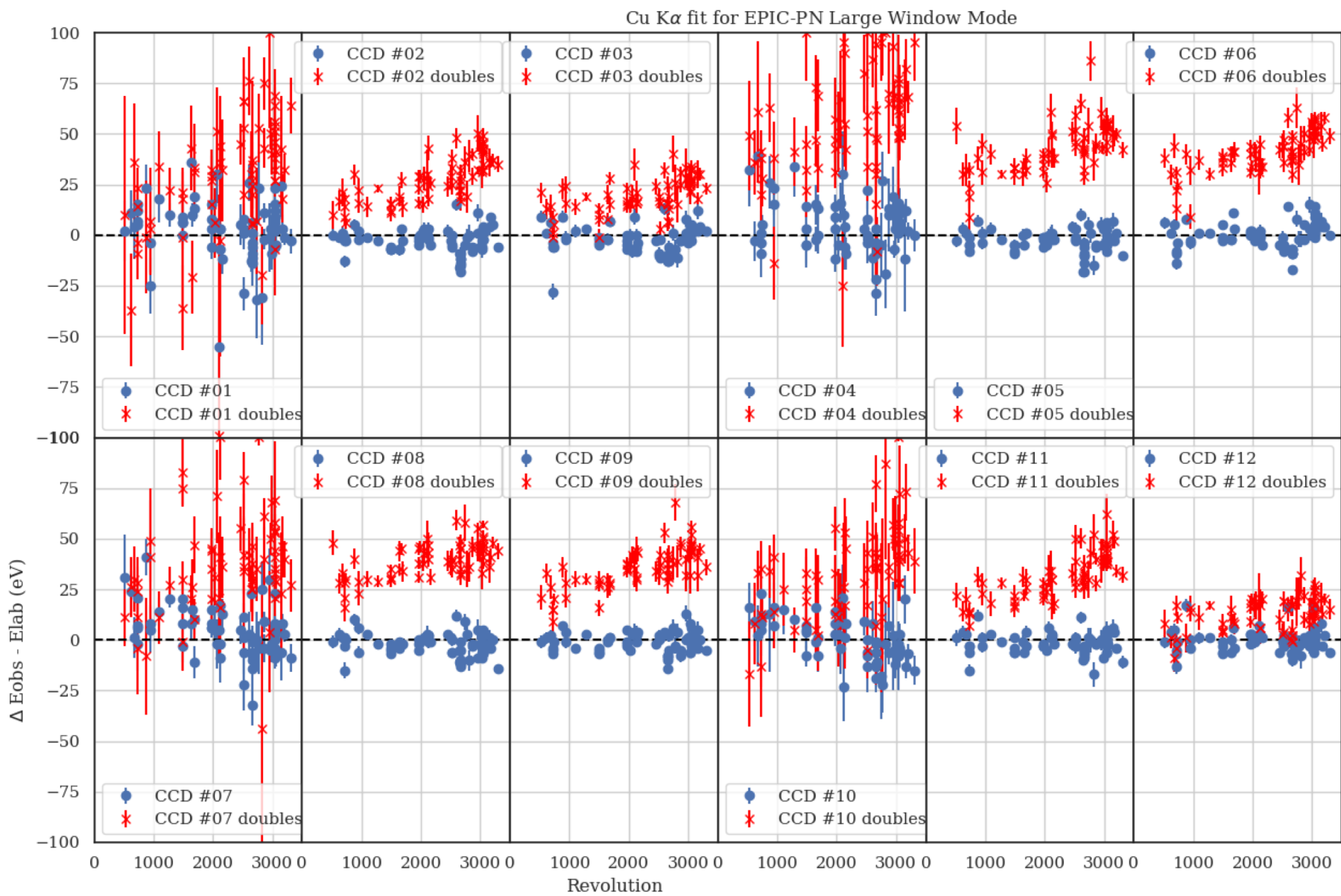
➔ PATTERN in [1:4]



Double events

Using CCF v48

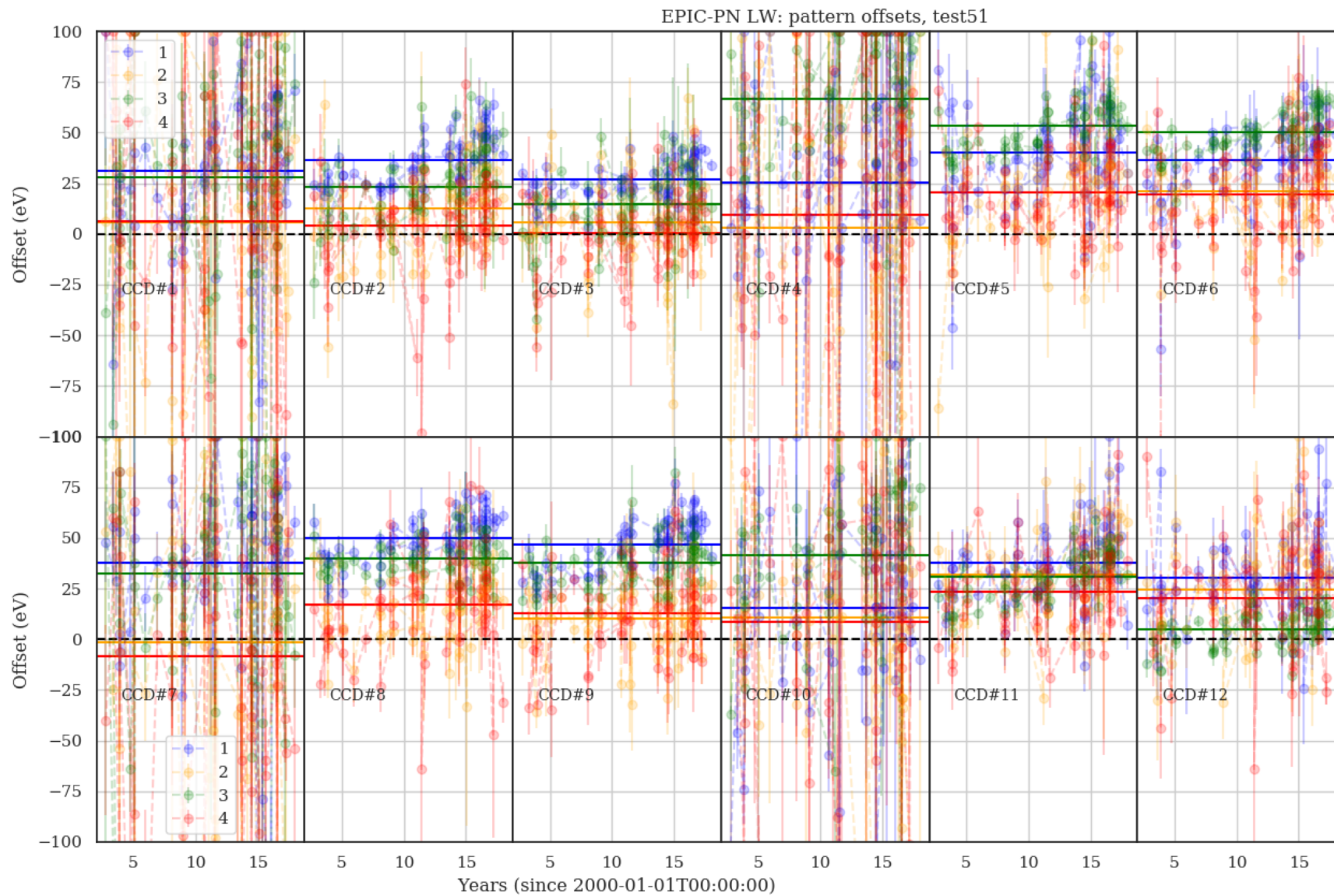
PATTERN in [1:4]



Double events

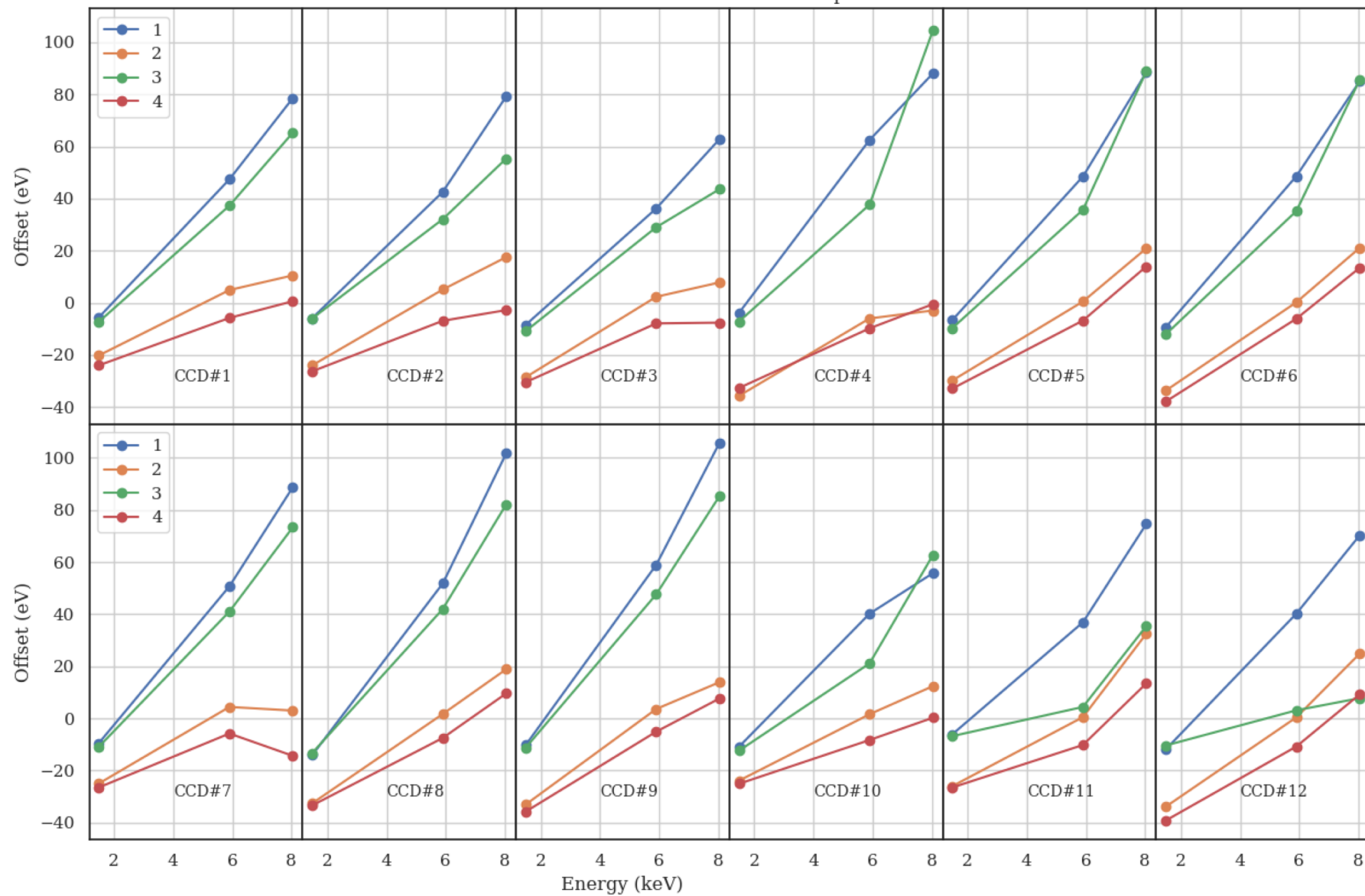
Using CCF v49 (new)

PATTERN in [1:4]

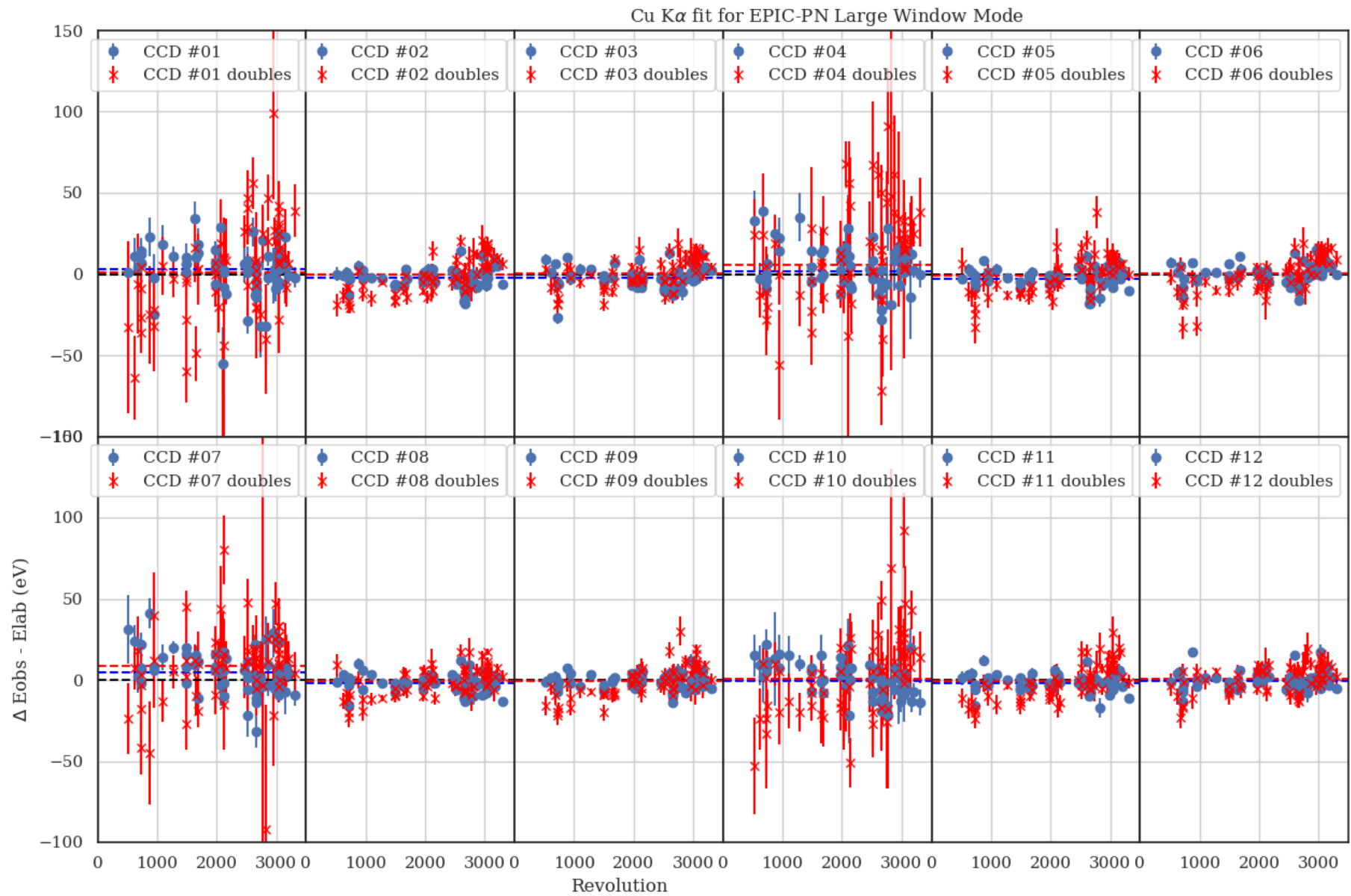


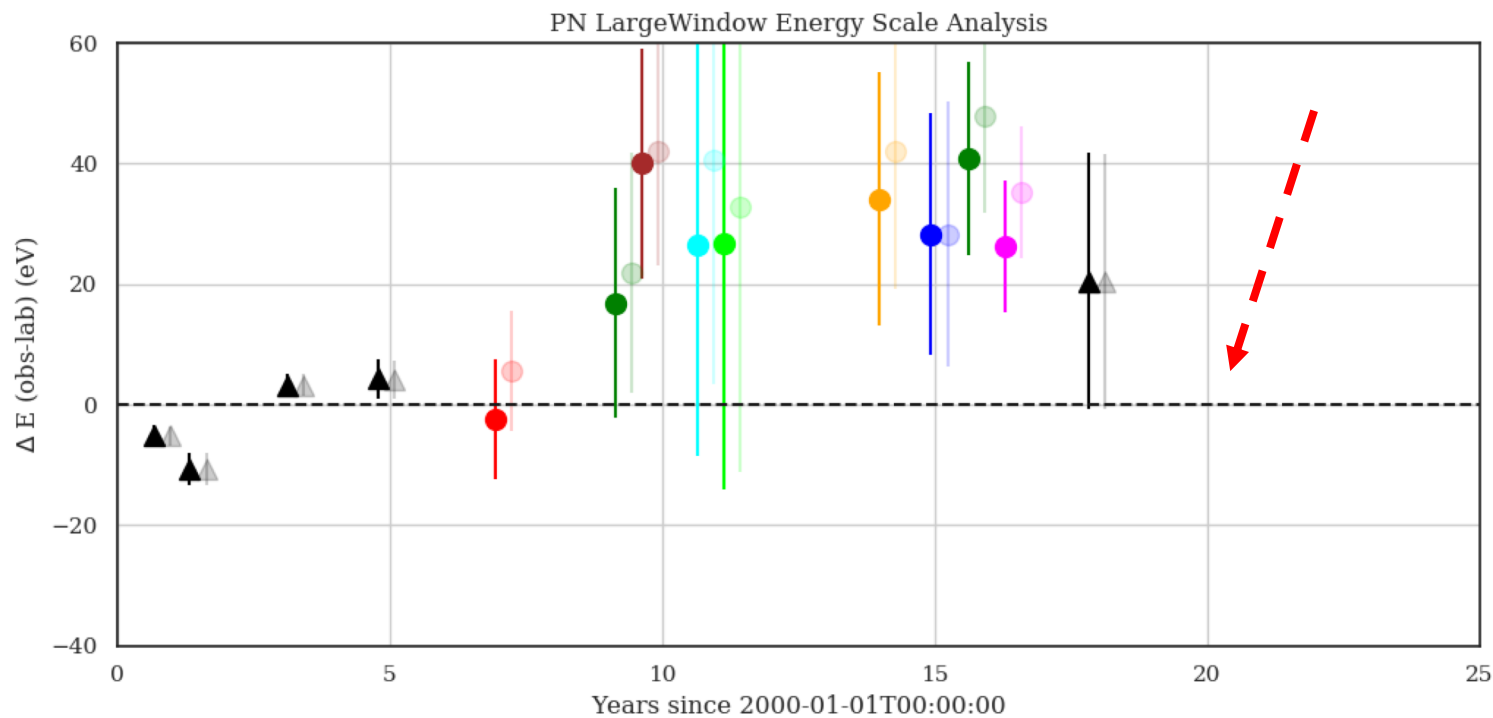
Horizontal lines are the mean values per pattern

EPIC-PN LW: pattern offsets



Incorporate the derived offsets in COMB_EVT_OFFSET at 8.04 keV





Fe $K\alpha$ sources:

The heavy symbols are the new LTCTI
for PN LW
based on Cu $K\alpha$

Some small improvement but still a
systematic ~ 30 eV offset.

Conclusions

In current /ccf/pub EPN_CTI_0049 and 0050 CCFs:

- **PN Small Window mode:** new long-term CTI at 5.9 and 6.4 keV derived and implemented. Based on CalClosed and AGNs.
- **PN Large Window mode:** new long-term CTI derived and implemented at 8.04 keV, based on Cu K α line.
 - Offsets for patterns 1 to 4 at 8.04 keV derived and implemented.
- **PN Large Window mode:** not enough observations to allow update to the long-term CTI at 5.9 and to add 6.4 keV energy point (work in progress).

More details

- Two release notes:

[XMM-CCF-0366:](#)

EPIC-pn Energy Scale for Small Window Mode: long-term CTI and pattern corrections

[XMM-CCF-0367:](#)

EPIC-pn Energy Scale for Large Window Mode: long-term CTI and pattern corrections

Future improvements

- Update the long-term CTI for both SW and LW modes with new observations → currently extrapolation from $t=15$ to $t=25$.
- Improve the correction at 6 keV for PN LW
- Better understanding of the long-term CTI correction behaviour as function of energy

The end

Overflow slides

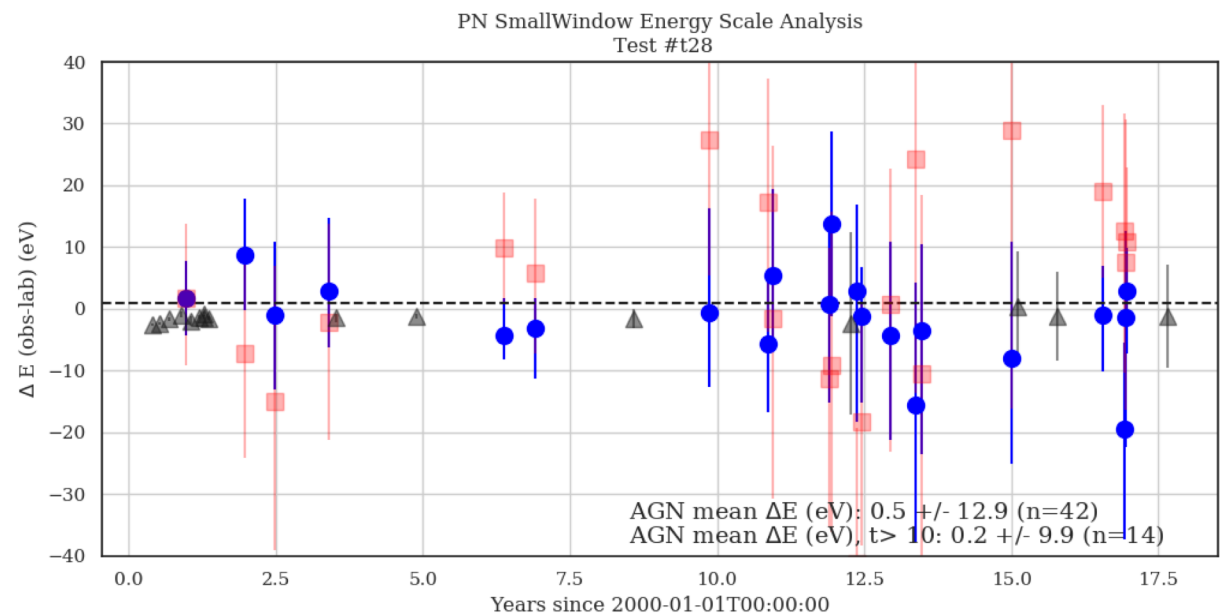
PN Small Window mode: pattern analysis

Notes:

CalClosed events selection is with **pattern** == 0 and **pat_seq** == 0 and **flag** == 0

AGNs selection: **pattern** <= 4 and **flag** == 0

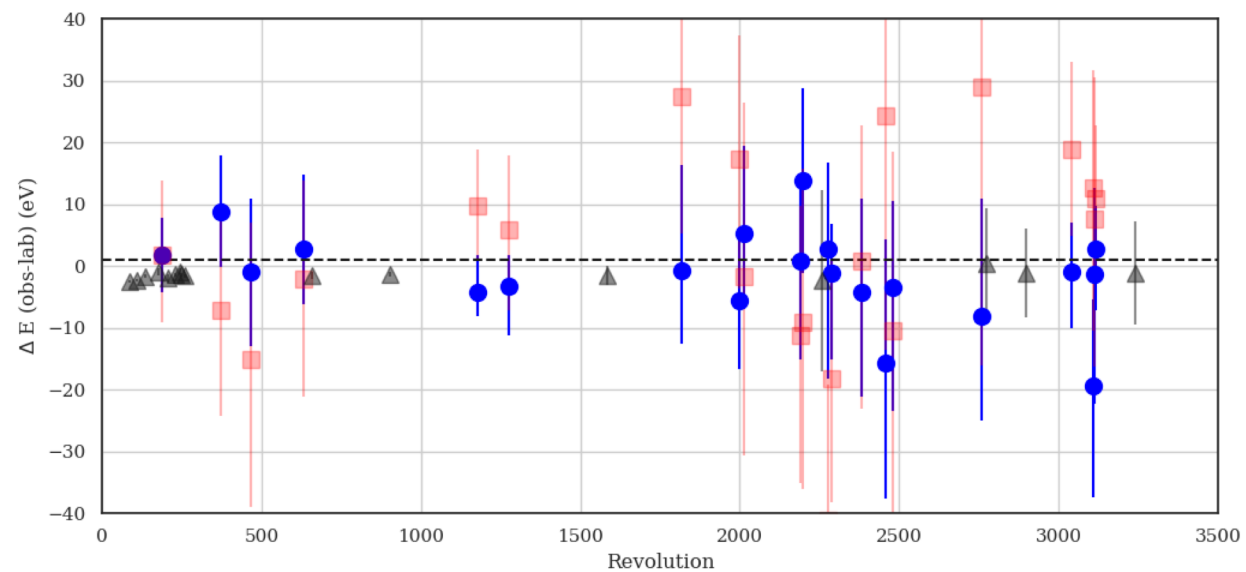
Not enough statistics to split the analysis per pattern.



AGNs results:

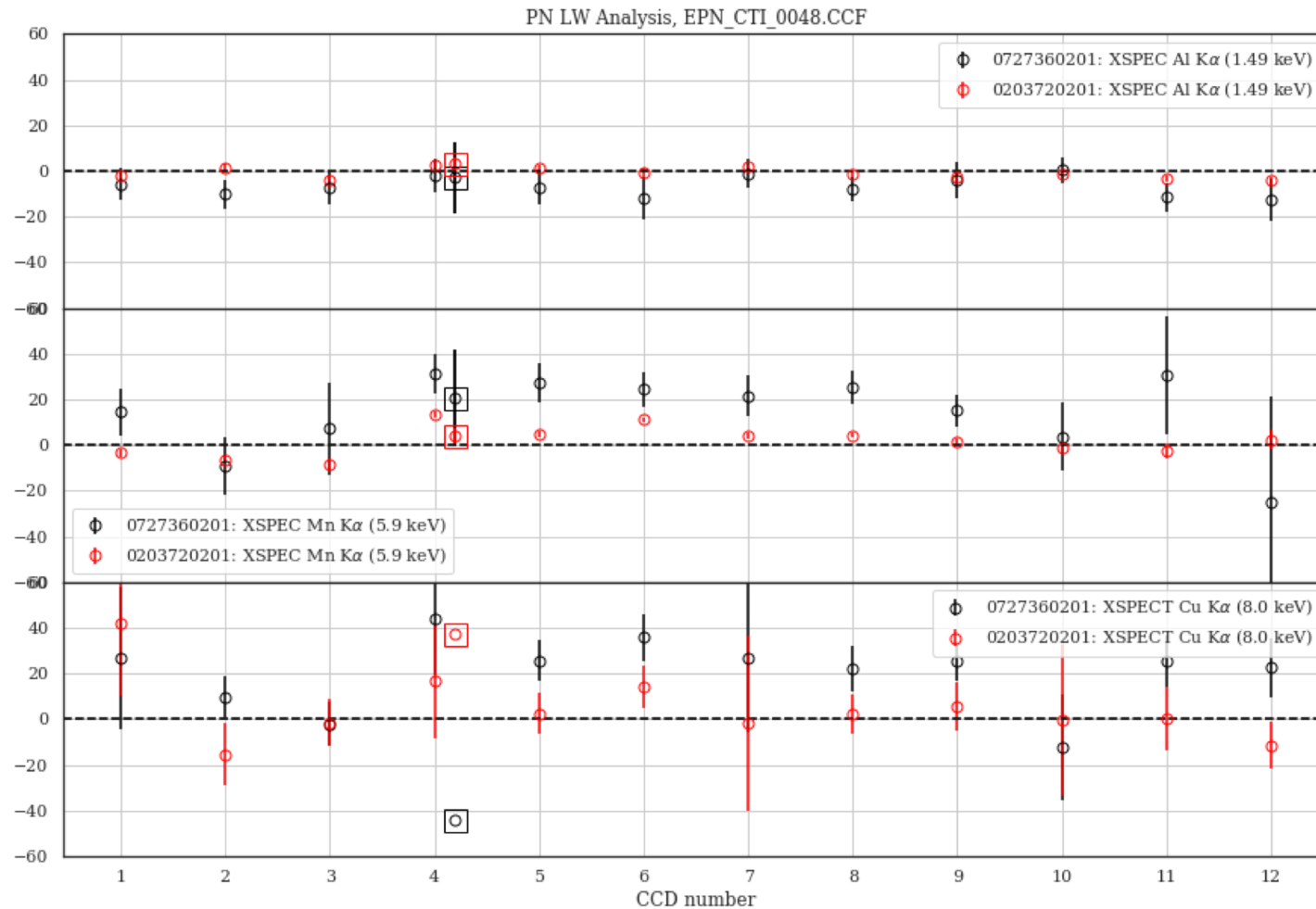
Blue: pattern == 0

Red: pattern in [1,4]



No change for the energy offset per pattern
for this mode (MODE_ID==3)

CALCLOSED analysis per CCD



Only two epochs

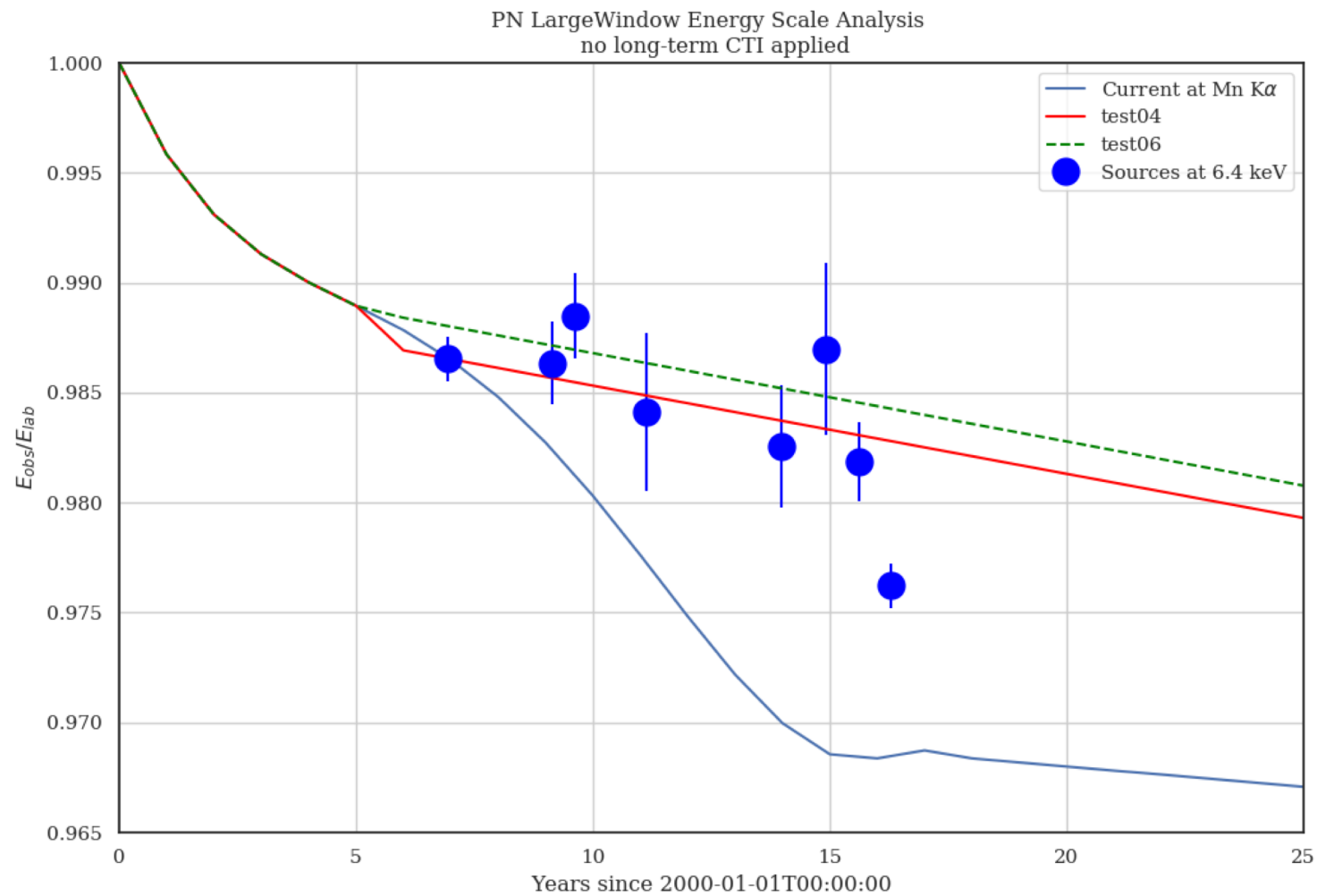
Three lines investigated:

Top: Al Kα at 1.49 keV

Middle: Mn Kα at 5.9 keV

Bottom: Cu Kα at 8 keV

Obvious offset for high energy and recent epochs.



Work in progress:

Deriving a correction curve at 6.4 keV