

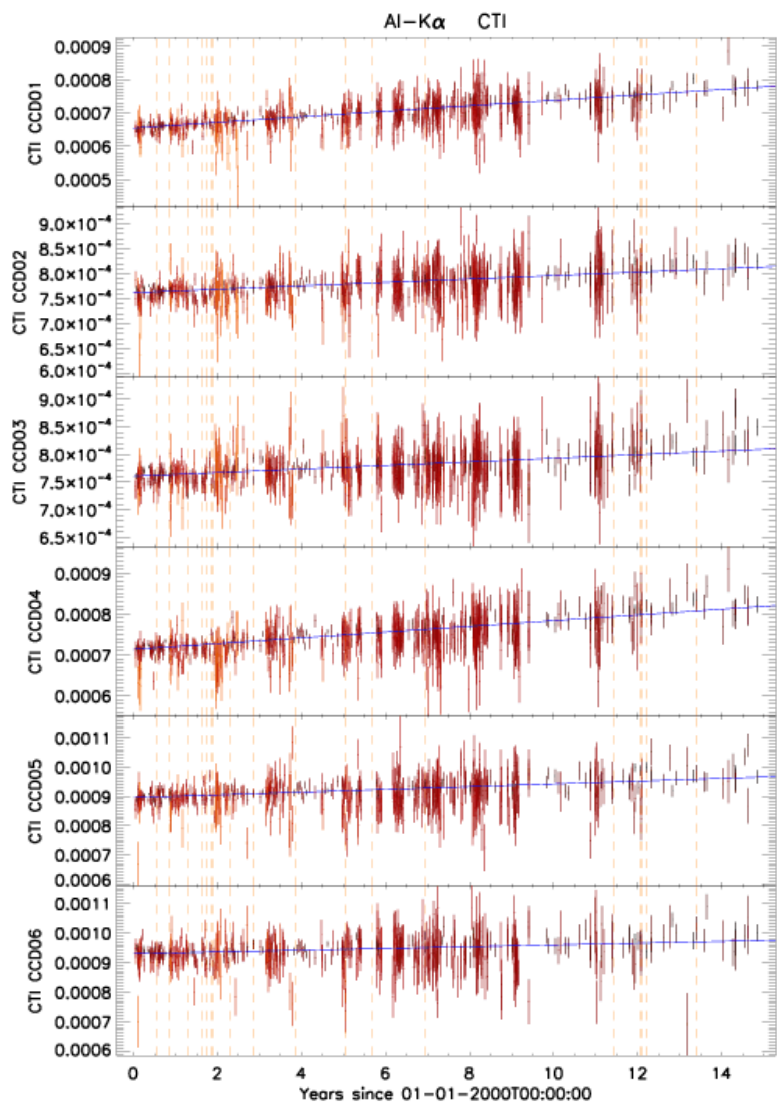
Quiescent Background and the EPIC-pn Energy Scale

Michael Smith
10th IACHEC, Beijing
20-23 April 2015

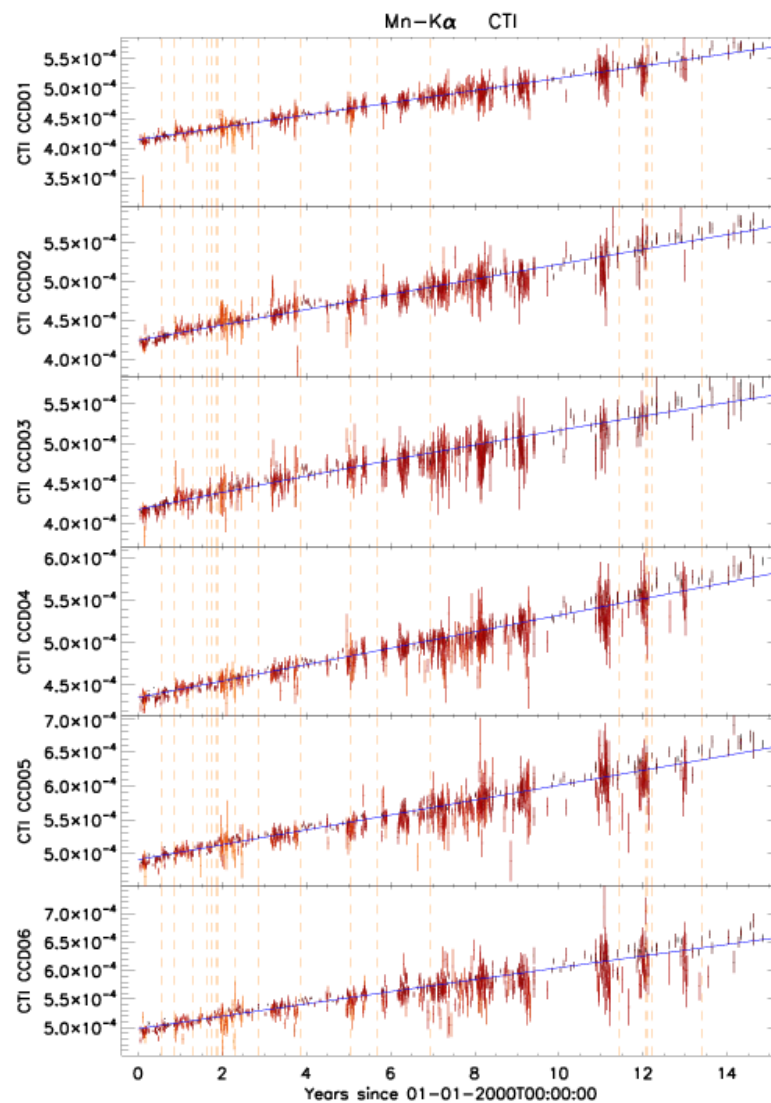
EPIC-pn energy scale is calibrated and monitored using regular 'CalClosed' exposures:

- ❖ These are exposures taken with filter wheel in the closed position, and the detector illuminated by the internal Fe^{55} calibration source, providing characteristic X-ray lines at Al-K α (1.5 keV), Mn-K α (5.9 keV) and Mn-K β (6.5 keV).
- ❖ These observations allow in-flight measurement of charge transfer inefficiency (CTI) and monitoring of the reconstructed line energies.

EPIC-pn Long-Term CTI



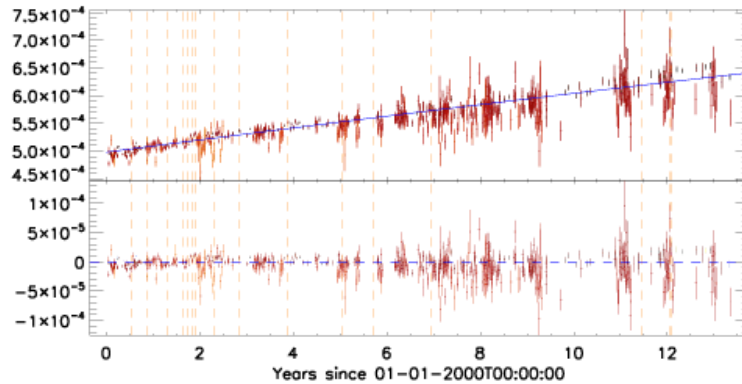
Long-term CTI trend can be well modelled by a 2nd order polynomial function



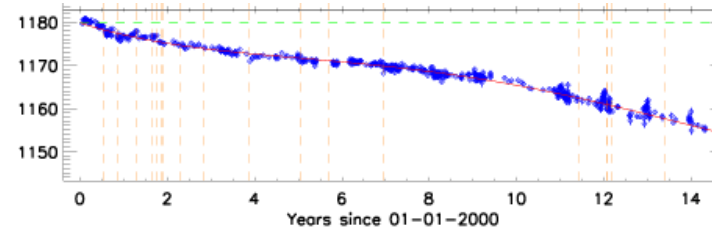
Long-Term CTI Correction Methods



Long-term CTI and model residuals



Line energy trend with **no correction** for the LTCTI

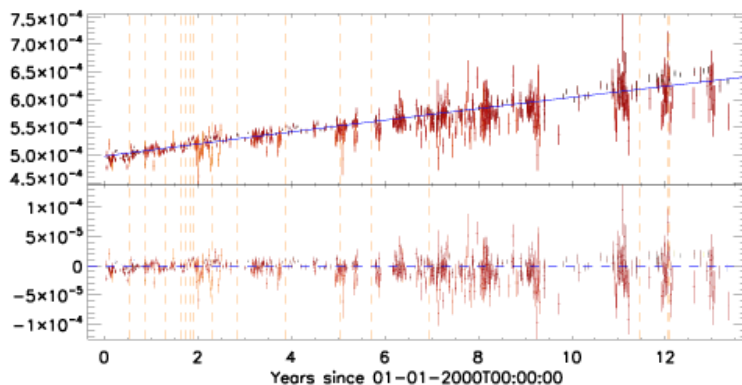


Expected line energy trend after CTI correction using the LTCTI model based on LTCTI model residuals

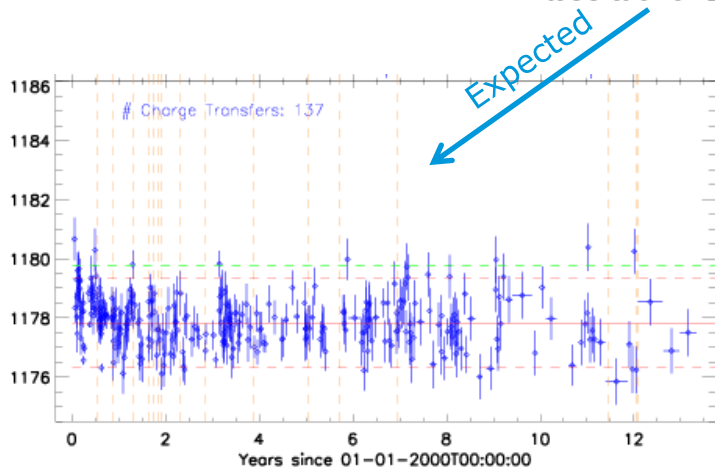
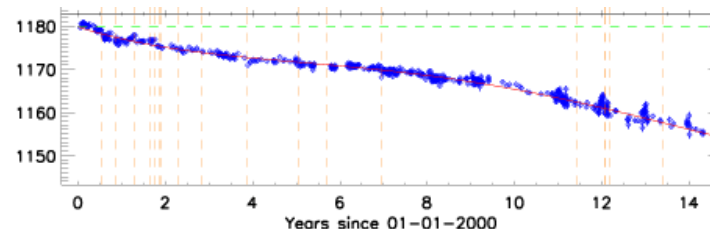
Actual line energy trend after CTI correction using the LTCTI model

Actual line energy trend after applying the empirical LTCTI correction
Current calibration

Long-term CTI and model residuals



Line energy trend with **no correction** for the LTCTI



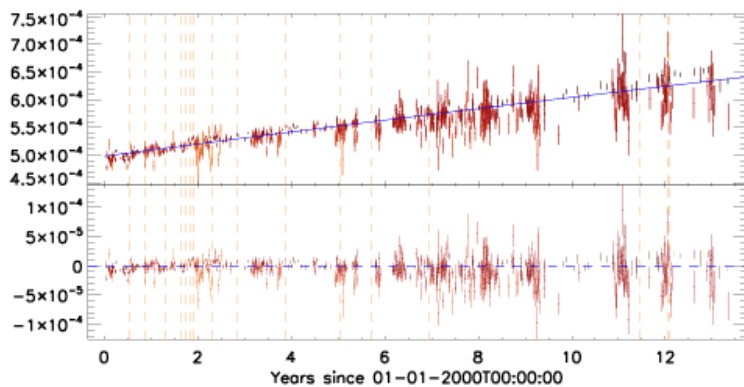
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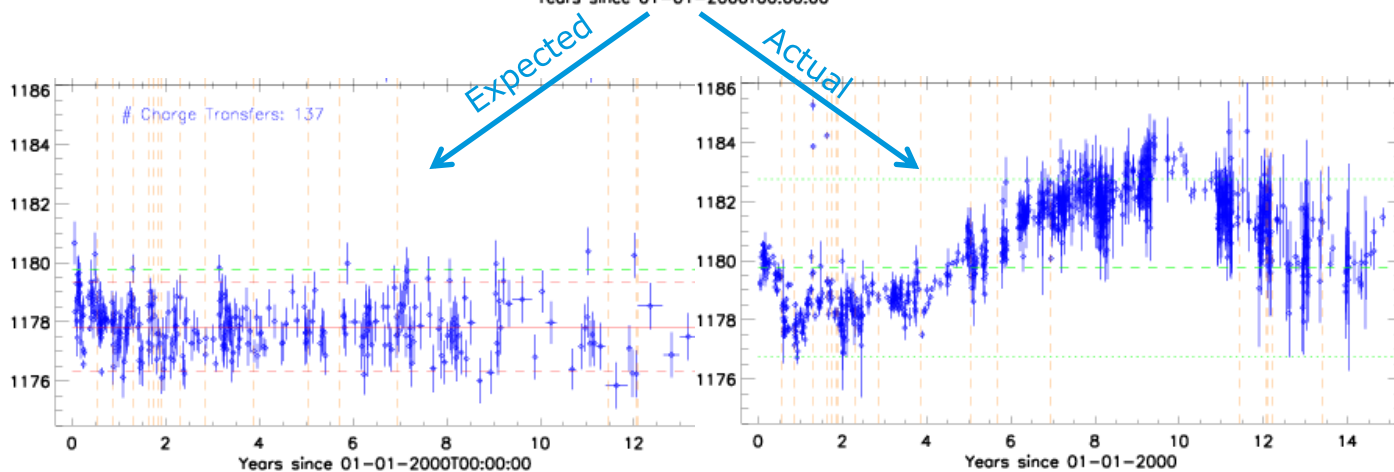
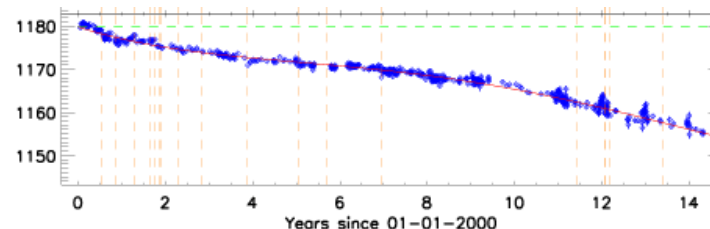
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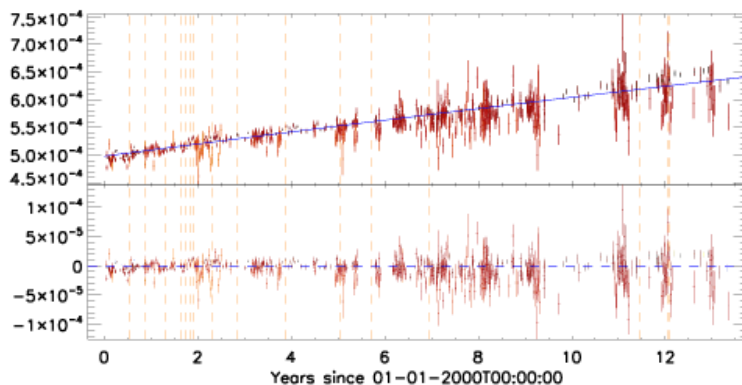
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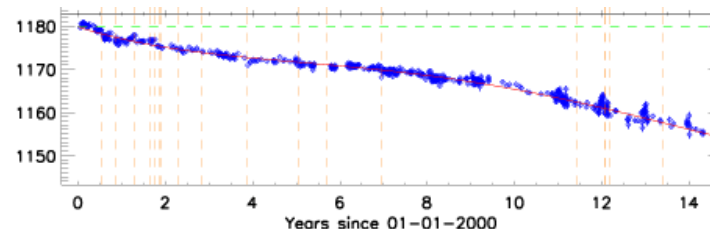
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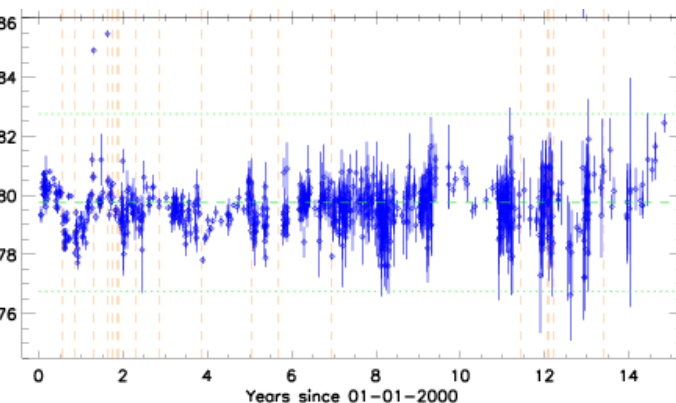
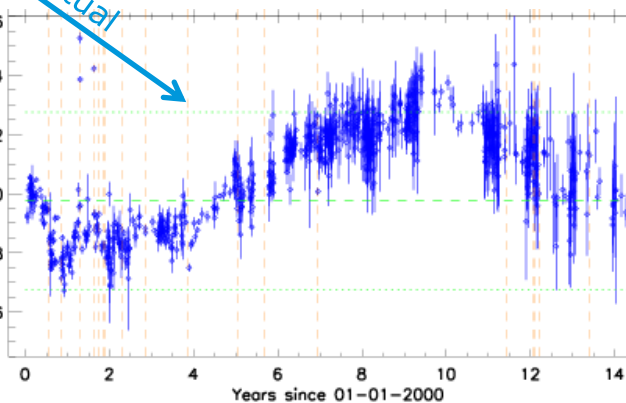
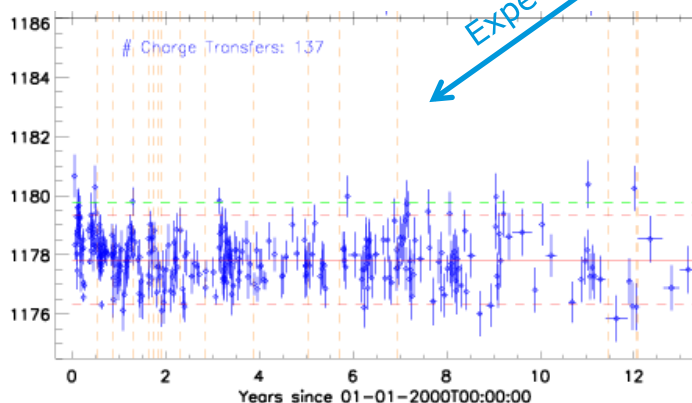
Line energy trend with **no correction** for the LTCTI



Current Calibration

Expected

Actual

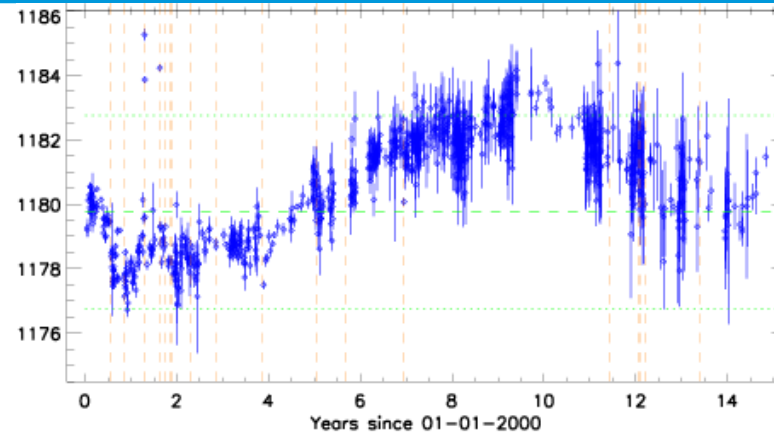


Expected line energy trend after CTI correction using the LTCTI model based on LTCTI model residuals

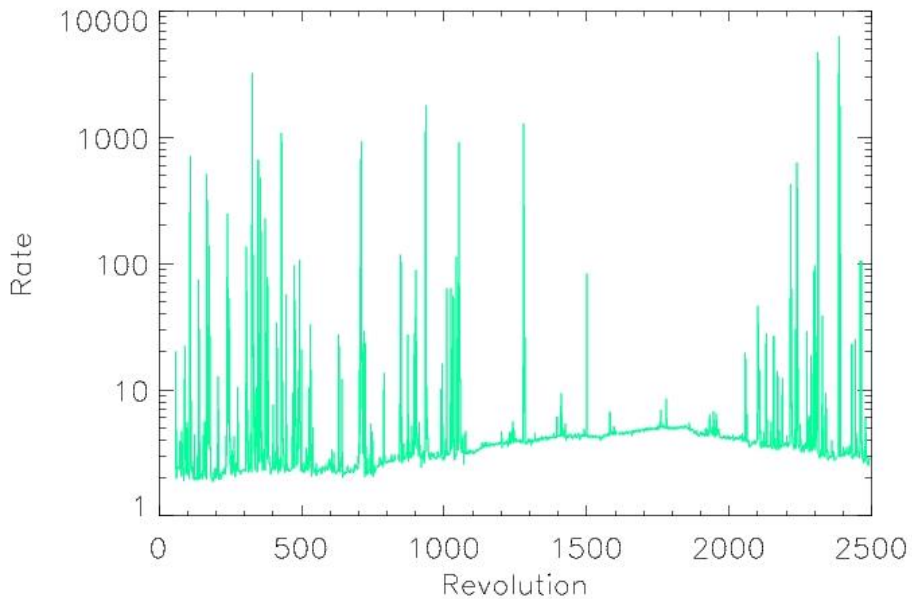
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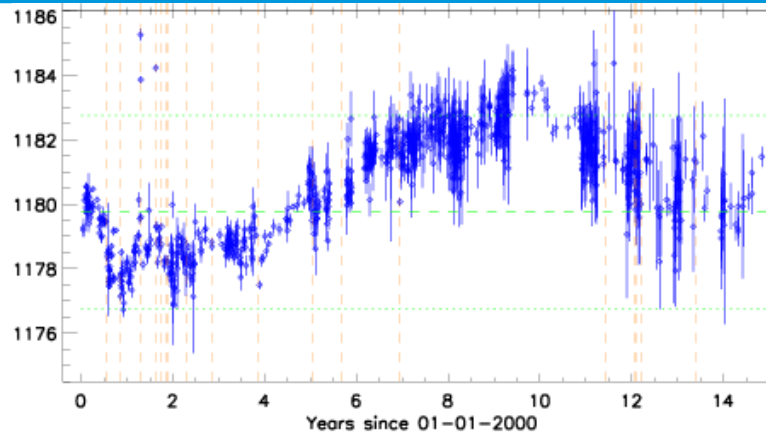
Line energy reconstruction using
LTCTI trend:



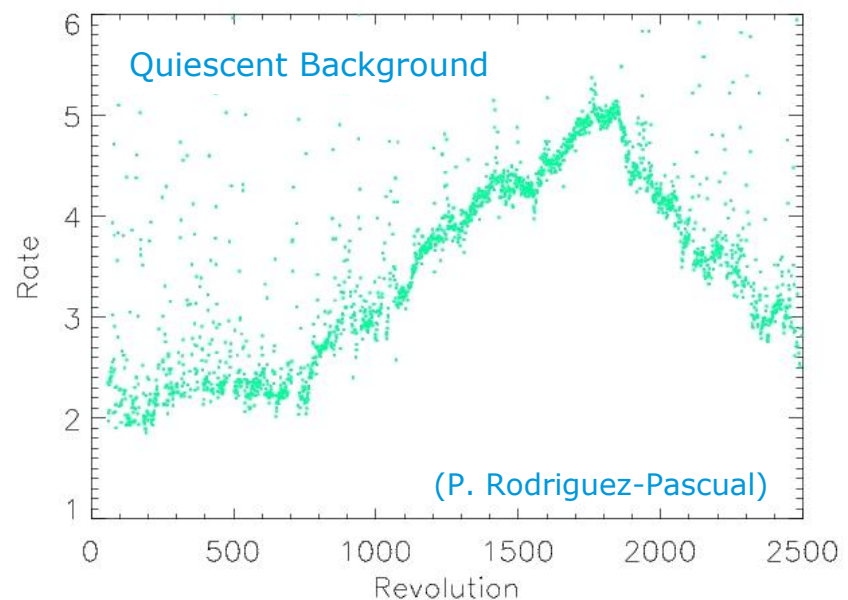
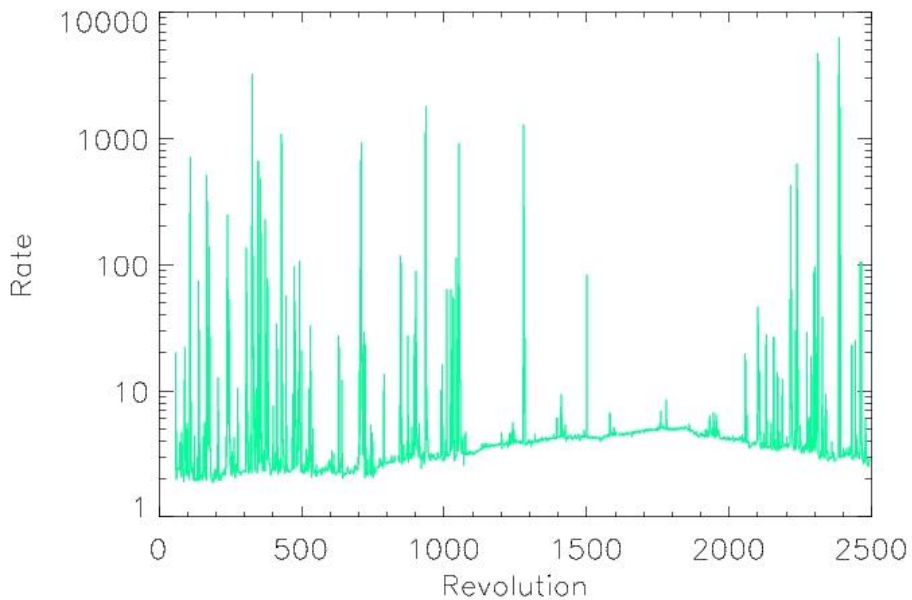
Radiation Monitor rate at apogee:



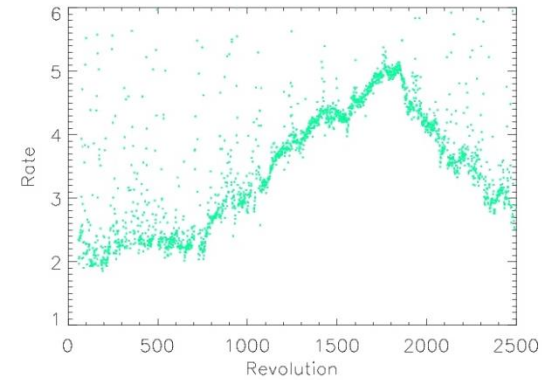
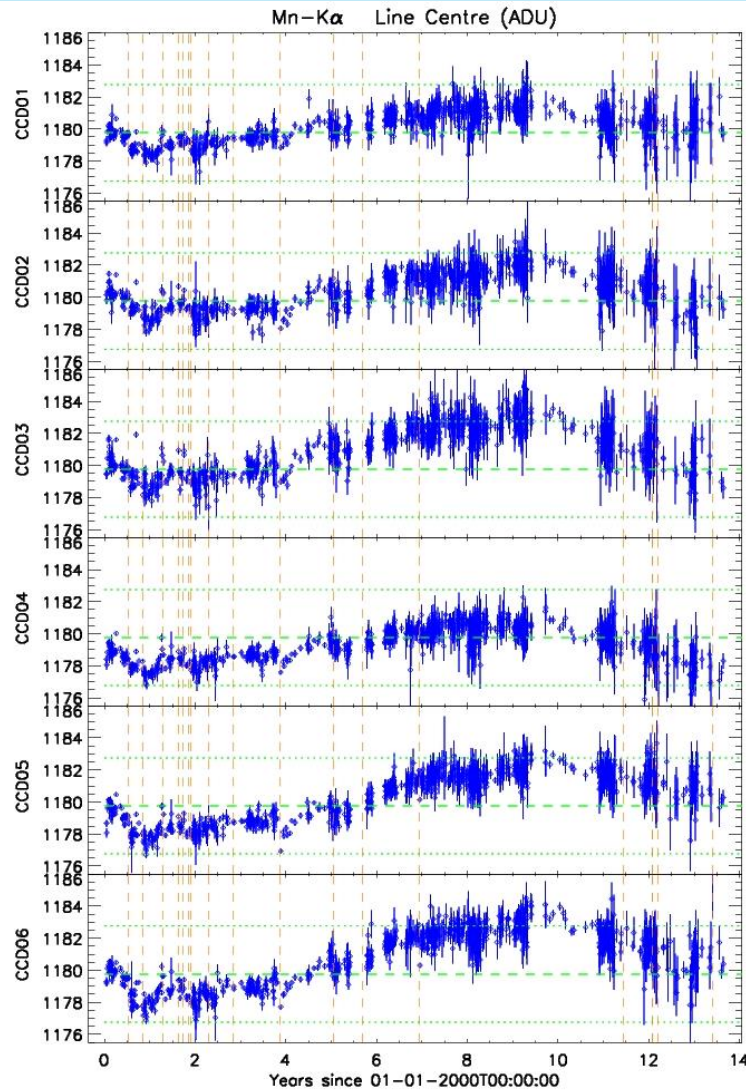
Line energy reconstruction using
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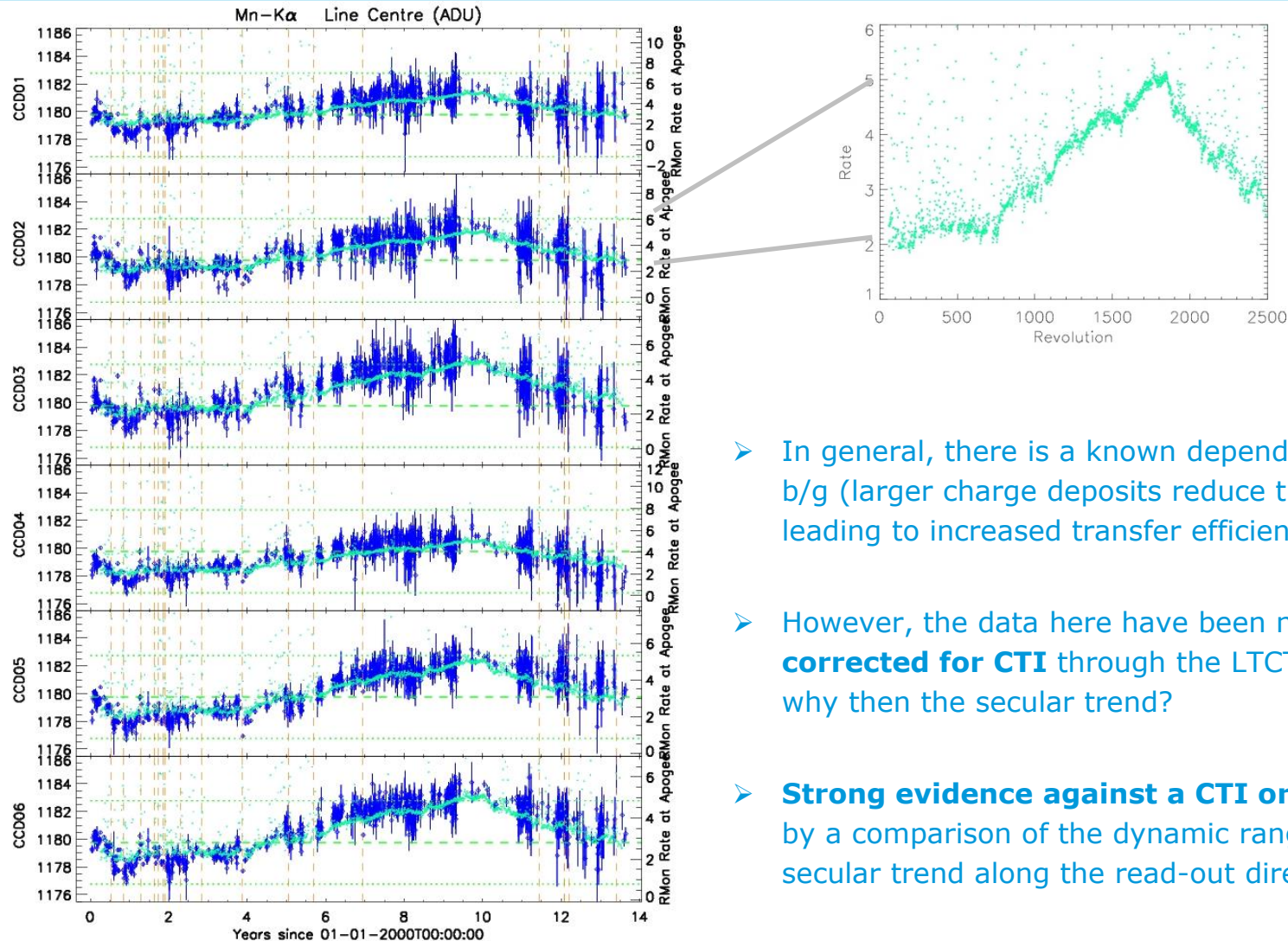
Radiation Monitor rate at apogee:



Strong Correlation with Quiescent Background

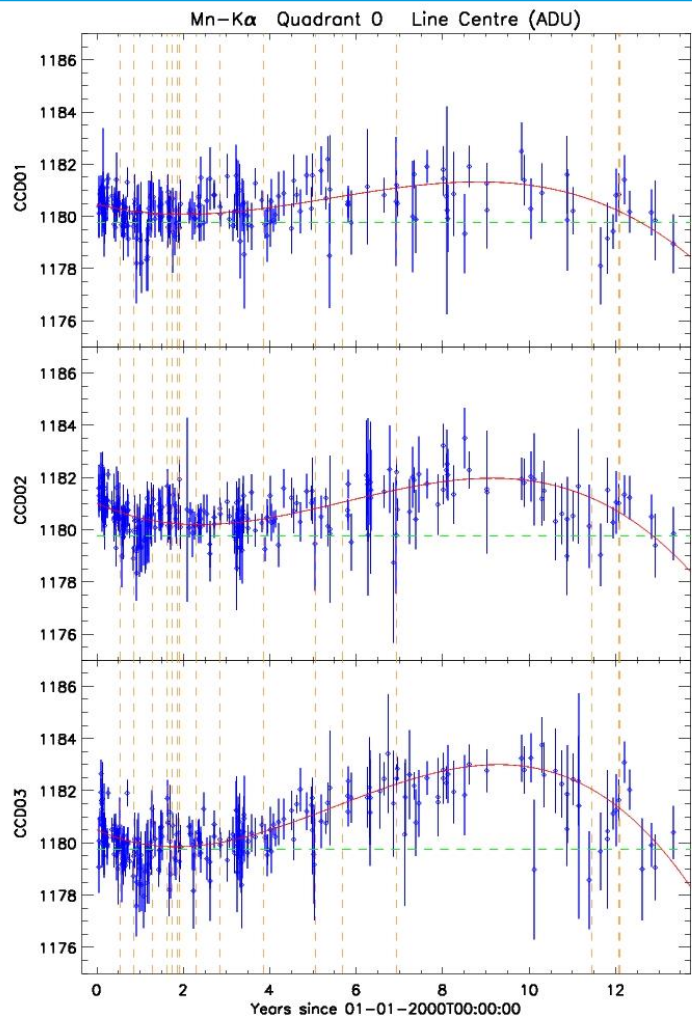


Strong Correlation with Quiescent Background



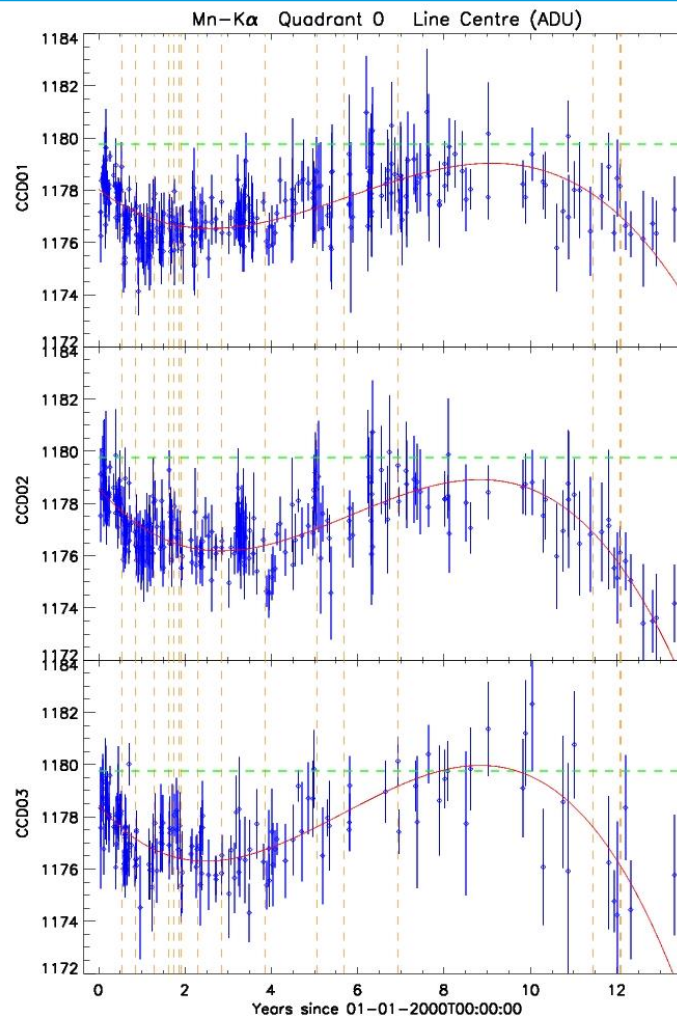
- In general, there is a known dependence of CTI on b/g (larger charge deposits reduce trap vacancies, leading to increased transfer efficiency).
- However, the data here have been nominally **corrected for CTI** through the LTCTI modelling – why then the secular trend?
- **Strong evidence against a CTI origin** is given by a comparison of the dynamic range of the secular trend along the read-out direction.

Residual Secular Trend Not Due to CTI



RAWY = [21,40]

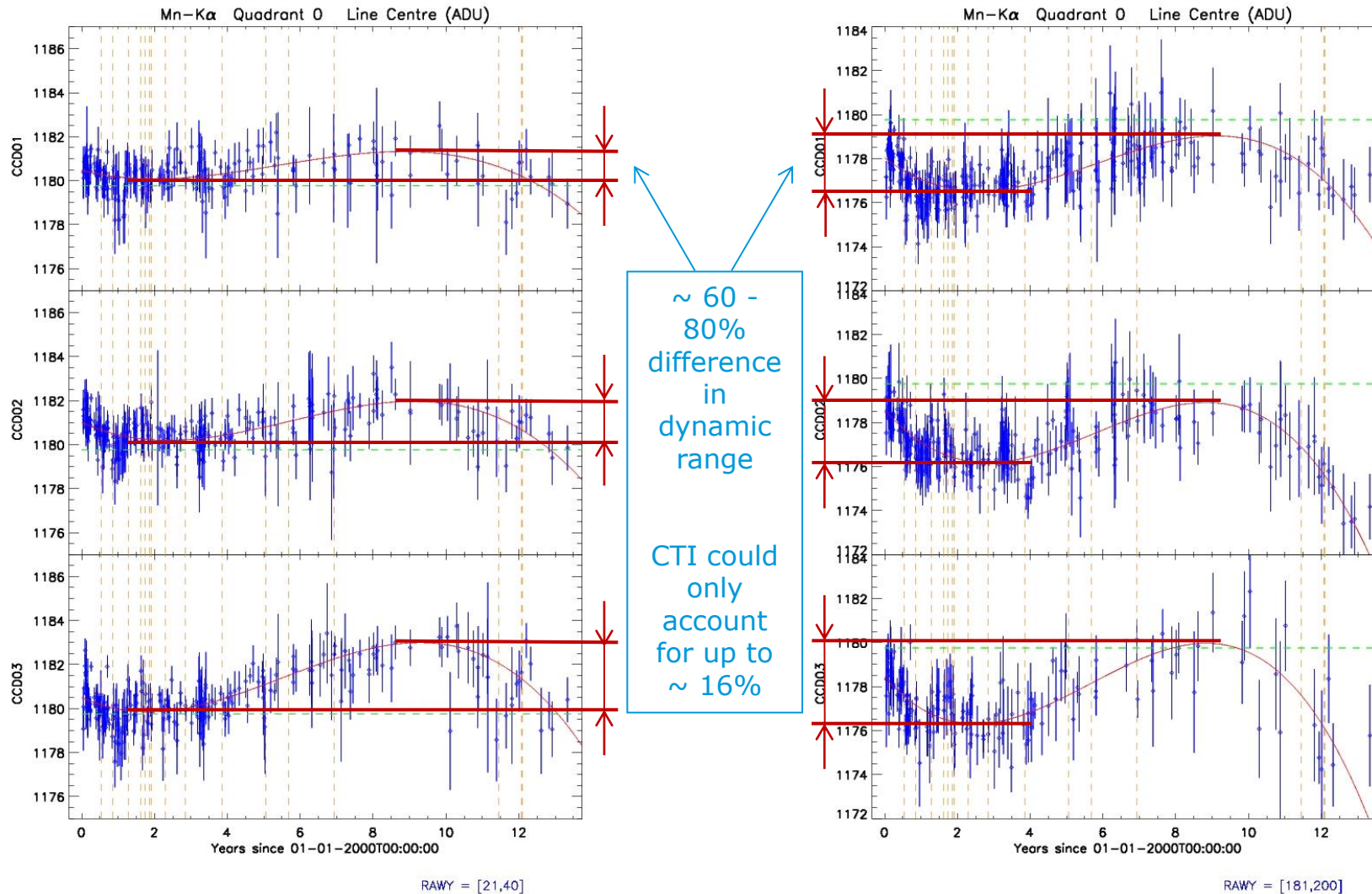
Close to read-out: ~ 30 shifts



RAWY = [181,200]

Far from read-out: ~ 190 shifts

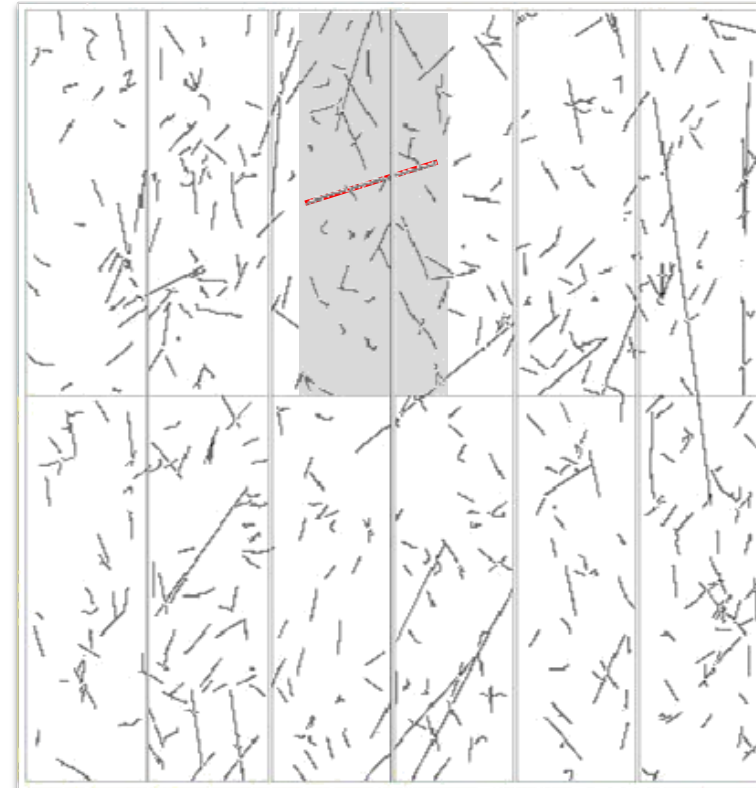
Residual Secular Trend Not Due to CTI



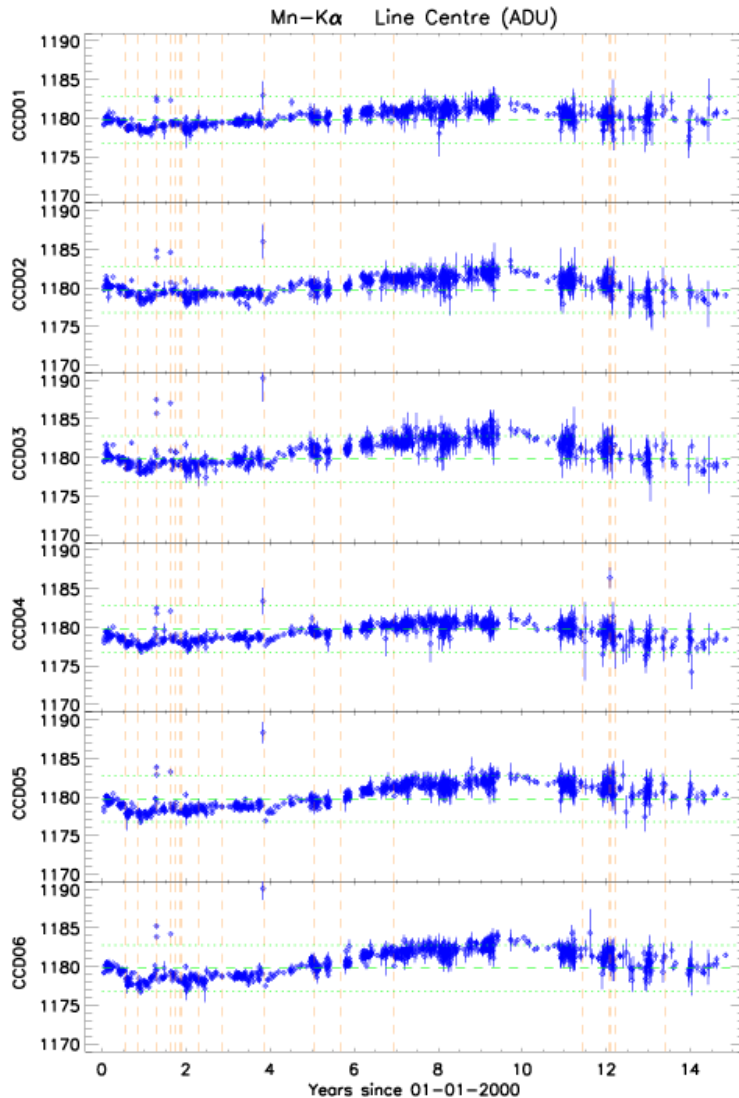
Close to read-out: ~ 30 shifts

Far from read-out: ~ 190 shifts

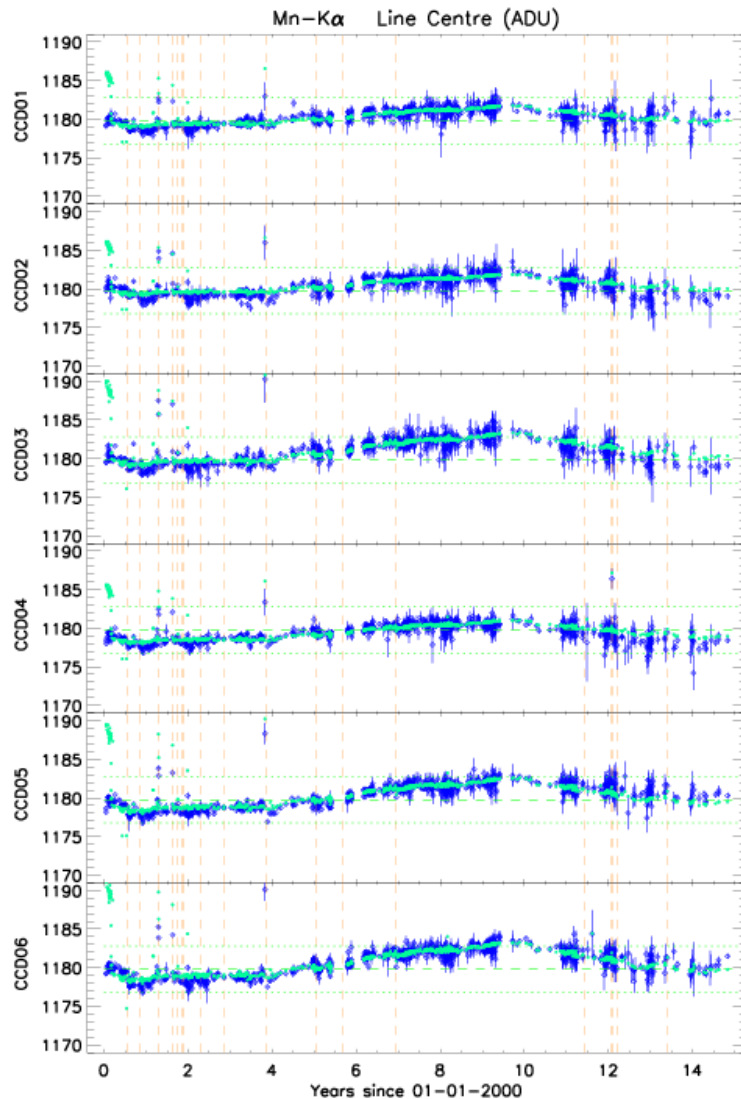
- ❖ Essentially a quiescent background dependent gain effect.
- ❖ Background level correlates with data processing parameter **NDISCLIN**
- ❖ This is a proxy measure of the Minimising Ionising Particle (MIP) incidence.
- ❖ MIPs deposit substantially higher charges than those released by X-ray photons.
- ❖ Higher charge at the CAMEX may increase the detector gain.



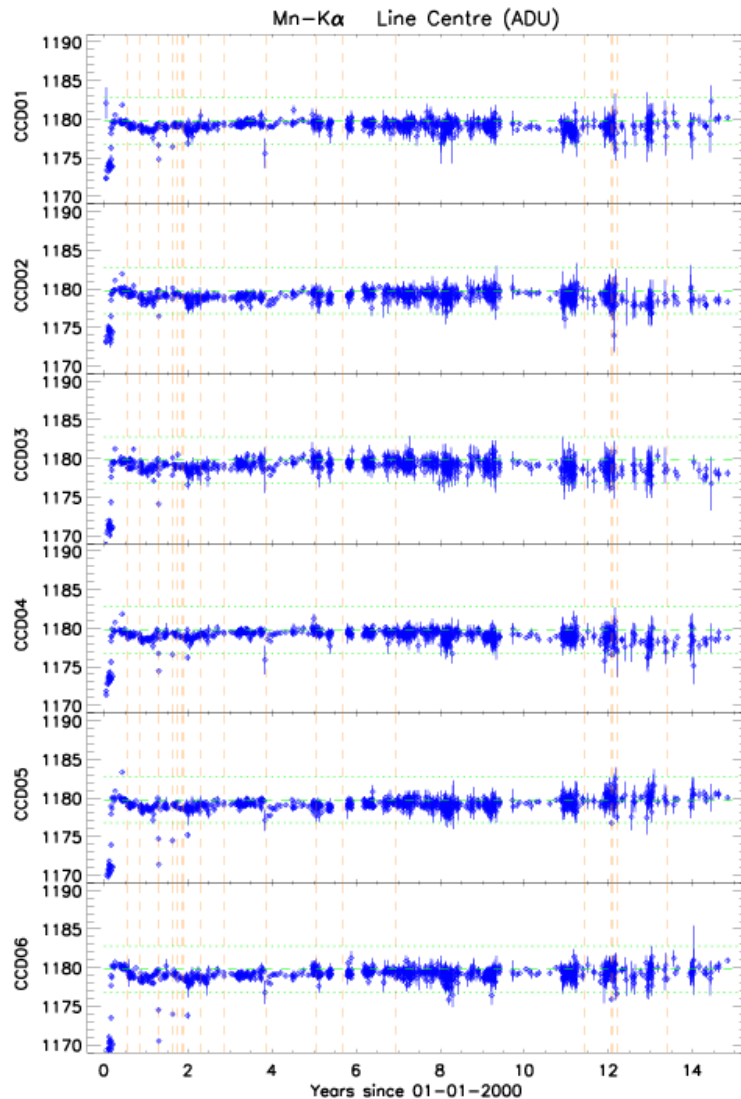
(K. Dennerl)



- Long-Term CTI corrected Energies

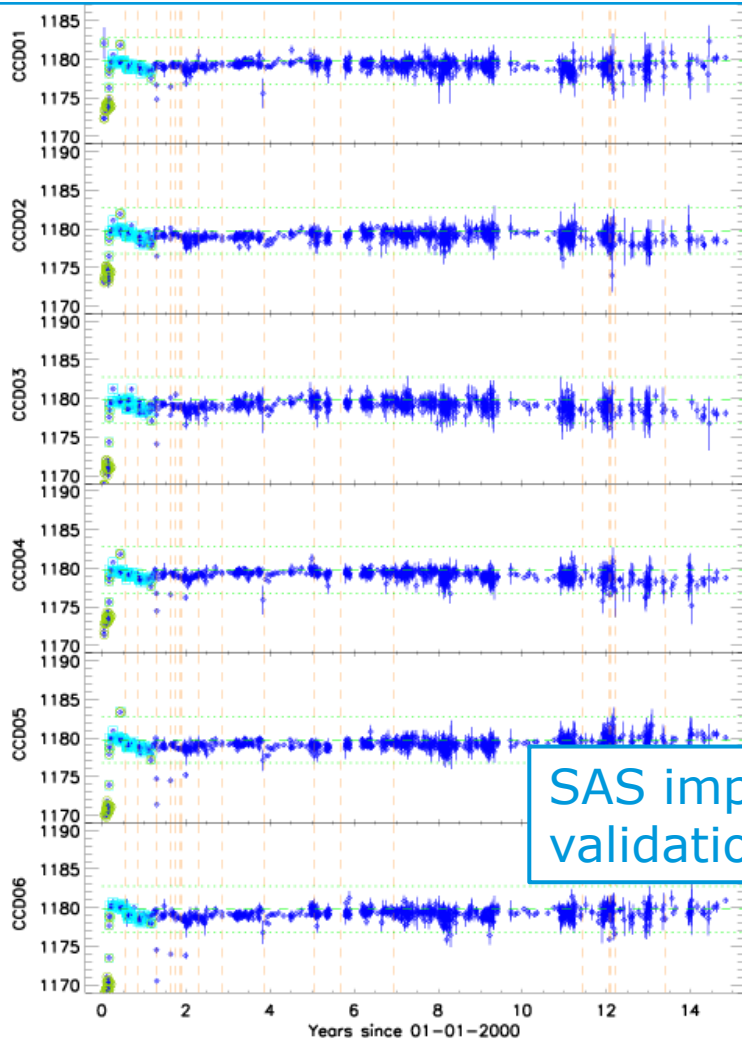


- Long-Term CTI corrected Energies
- Determine mode / CCD dependent **NDISCLIN** rate scaling

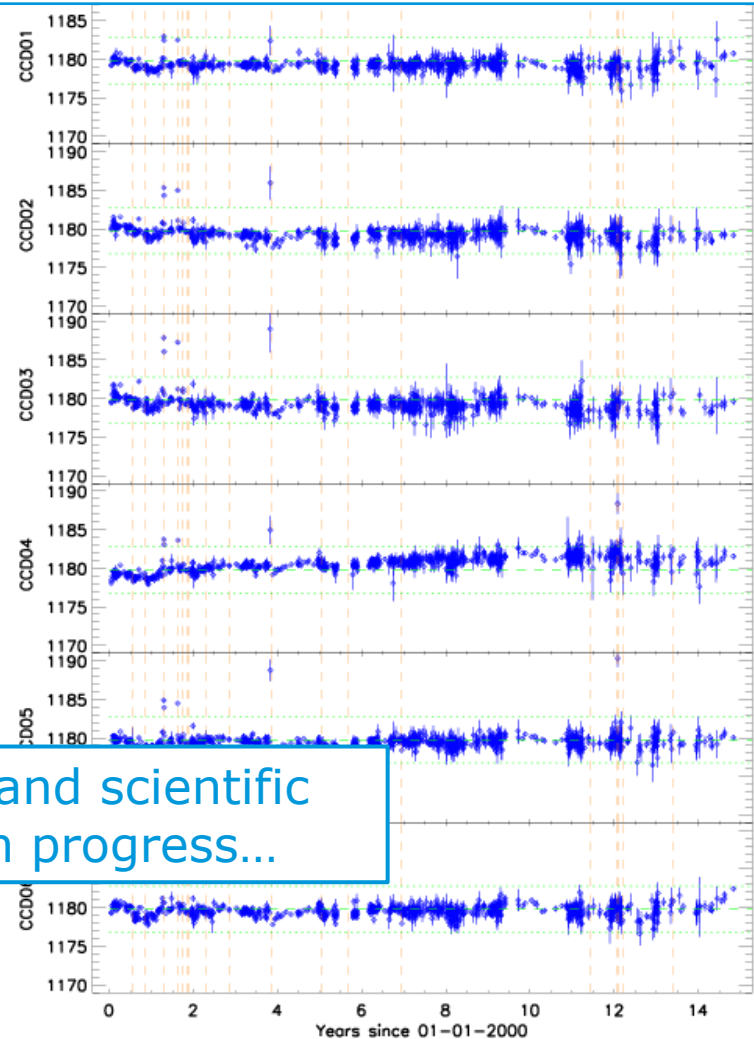


- Long-Term CTI corrected Energies.
- Determine mode / CCD dependent **NDISCLIN** rate scaling.
- Use this for an additional background-dependent gain correction.

With Background Gain Correction



With Current Public EPN_CTI.CCF



SAS implementation and scientific validation still work in progress...

