XMM-Newton CCF Release Note

XMM-CCF-REL-400

Update of EPIC MOS gain

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1 CCF components

Name of CCF	VALDATE (start of val. period)	EVALDATE (end of validity period)	List of Blocks changed	CAL VERS.	XSCS flag
EMOS2_ADUCONV_0116	2022-07-09T05:00:01		OFFSET_GAIN		NO

2 Changes

The new ADUCONV CCF is adjusting the MOS2 CCD4 energy scale for epoch rev. 4136ff after release of new CTI CCF (MOS2 issue 104, see XMM-CCF-REL-393) as presented in Fig. 1 and Fig. 2. The new file contains updated values of the gain parameters for MOS2 CCD4 only and partially replace the previous most recent epoch for times of rev. 3206 onward (MOS2 issue 115).

These new gain parameters have been tuned to suppress the residuals present in the energy scale using previous CCF. The replacement CCF, as with their previous versions, assume a linear relationship between the charge deposited inside a pixel and the energy of the detected X–ray:

$$E_{\mathrm{eV}} = \mathrm{gain} \times E_{\mathrm{charge}} + \mathrm{offset}$$

The new gain and offset values have been calculated from observations of the on-board calibration sources, which offer three spectral lines: Al Kα at 1486.57 eV (Suresh et al 2000, J. Phys. B. At. Mol. Opt. Phys. 33), Mn Kα at 5895.75 eV and Mn Kβ at 6489.97 eV (Holzer et al 1997, Phys. Rev. A, 56, 6). The derived gain and offset values used in each CCF are averaged values taken from the calibration observations made during the corresponding CCF time period. Starting at rev. 918, the MOS calclosed observations are performed during slews. For the analyses, several slew calclosed observations were combined to achieve reasonable statistics.

However, observations during eclipse seasons have been neglected, since the cooler EPIC MOS Analogue Electronics (EMAE) require a smaller gain correction. This effect is most notable in the calibration observations, since these were performed immediately after the end of the eclipses; by the time science observations commence, the EMAE has returned to its nominal temperature and so this temperature variation during eclipse has no impact on science observations.

Calculating the linear gain term, further spurious points that deviate from the mean value by more than 5 times the average error of the points are also rejected; such rejection is not required for the constant offset term.

3 Scientific Impact of this Update

The new ADUCONV CCF is adjusting the MOS2 CCD4 energy scale for epoch rev. 4136ff after release of new CTI CCFs (MOS1 issue 100, MOS2 issue 104, see XMM-CCF-REL-393). The EPIC-IDT decided against the adjustment of other CCDs than MOS2 CCD4. For MOS2 CCD4 the energy scale is now reconstructed to about 5 eV at 1.5 keV and 10 eV at 6 keV or better for most sources (not too bright). The improvement of this new gain on existing data is expected to be up to 20 eV at 6 keV and up to 25 eV at 1.5 keV for the most recent epoch.

4 Estimated Scientific Quality

The energy scale accuracy is better or about 10 eV over the whole energy range for i) not too bright sources and ii) outside of eclipse seasons (at the start of revolutions).

In the latter two cases, as explained in XMM-CCF-REL-124, the energy scale can be significantly over-corrected.

5 Test procedures & results

The new ADUCONV CCFs have been tested with SASv21.0. Illustration examples of the MOS2 CCD4 deviation in line energies using the previous CCF and using the new CCF are shown in Fig. 1 and Fig. 2. The current calibration line monitoring of all MOS2 CCDs is provided in Fig. 3 and Fig. 4.

To present any data points, all illustrations mostly use data with extremely low count statistics due to restricted individual exposure times and the more than 20 years of decay of the onboard calibration source. Therefore the data spread appears larger than it really is for data of better count statistics.

6 Expected Updates

Owing to the continuous evolution of the MOS LTCTI and gain, periodic updates of the energy scale correction based on newly accumulated data will be necessary.

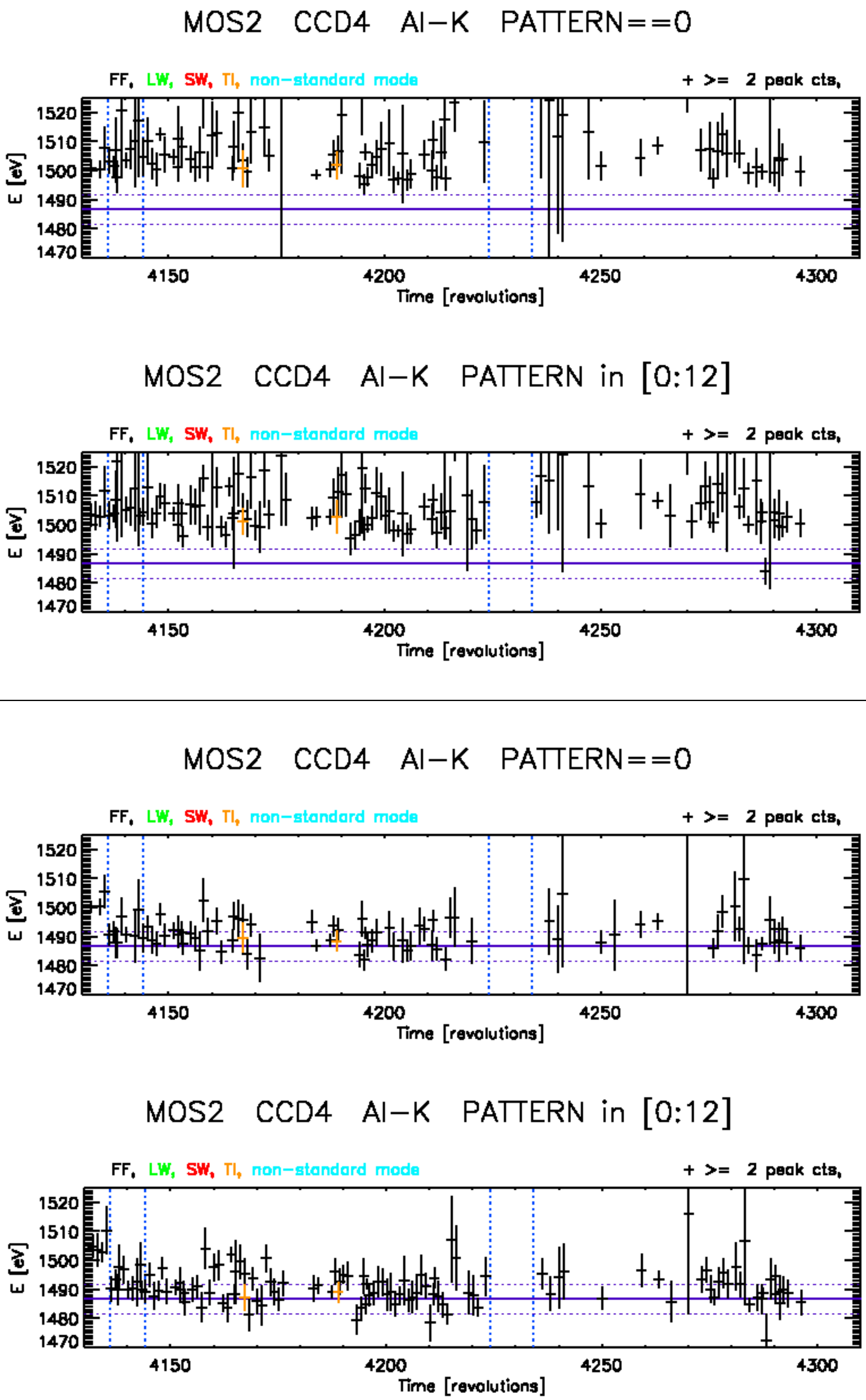

Figure 1: MOS2 CCD4 Al-K$_\alpha$ line energy scale using the old (upper two) and new ADUCONV CCF. Eclipse seasons are indicated by vertical blue lines. The horizontal solid line represents the laboratory line energy, the dotted lines the ±5 eV deviations. The plot covers only the new epoch discussed in this document.

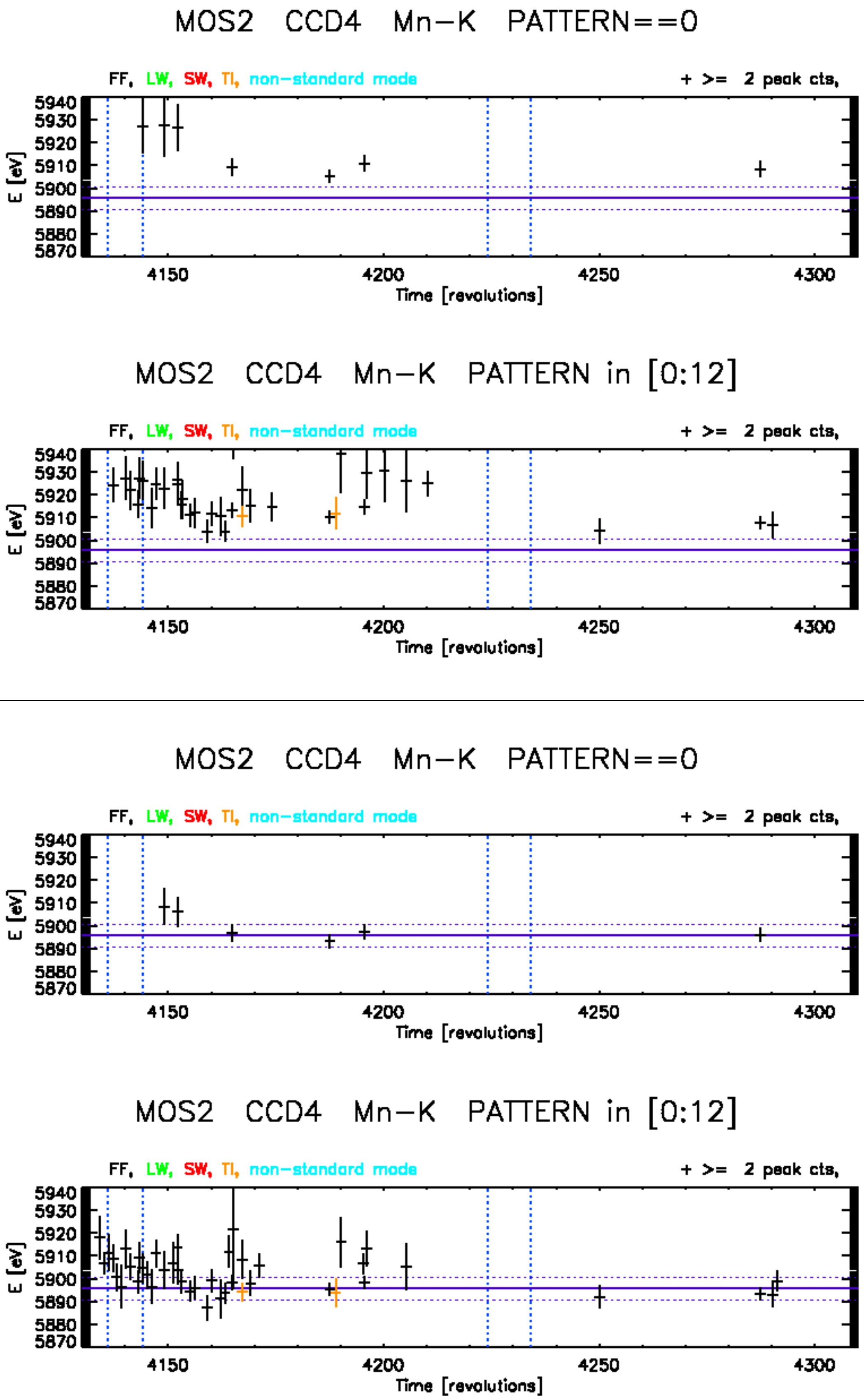

Figure 2: MOS2 CCD4 Mn-K$_\alpha$ line energy scale using the old (upper two) and new ADUCONV CCF. Eclipse seasons are indicated by vertical blue lines. The horizontal solid line represents the laboratory line energy, the dotted lines the ± 5 eV deviations. The plot covers only the new epoch discussed in this document.

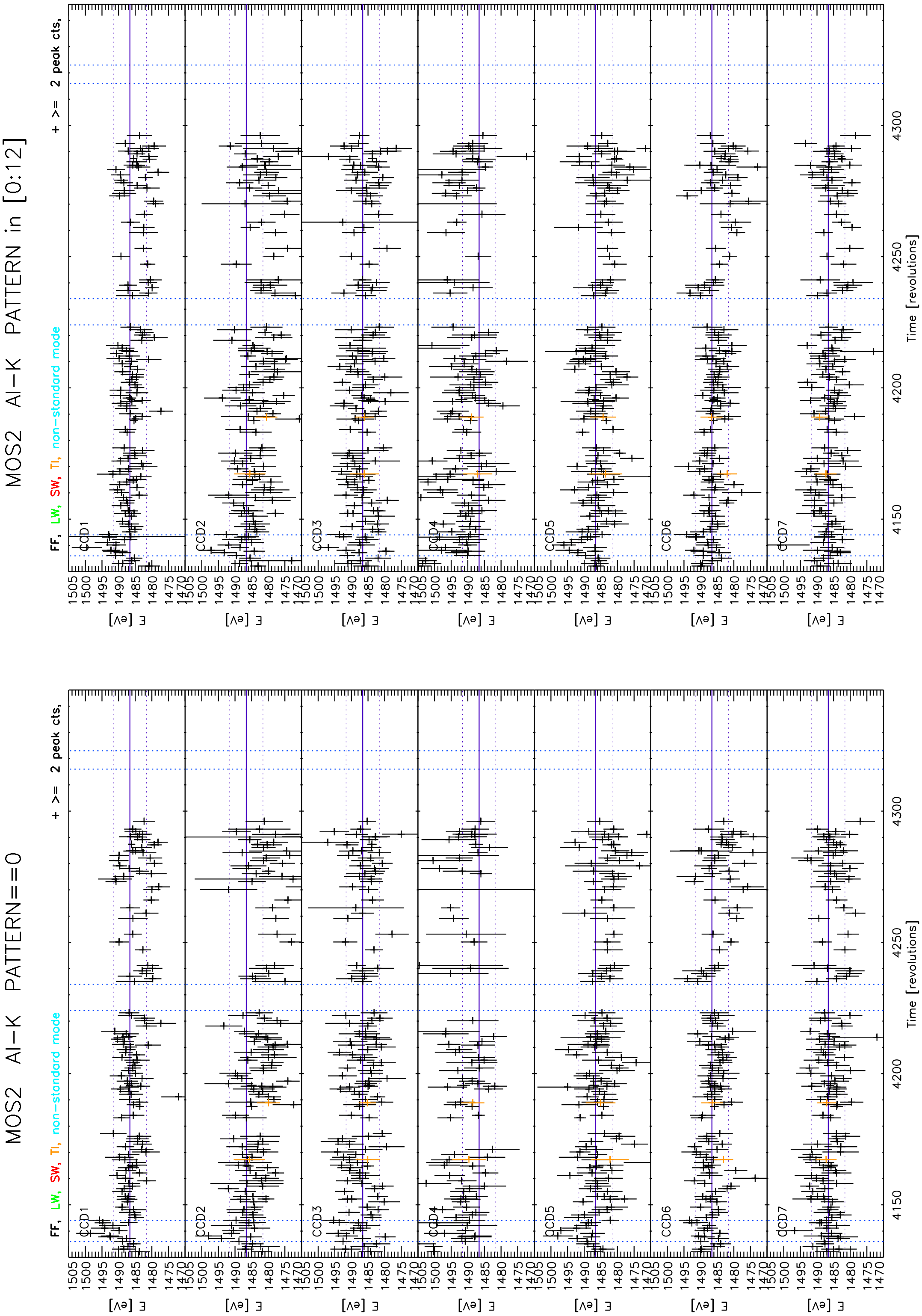

Figure 3: MOS2 Al K_α line energy scale using the new ADUCONV CCFs. Eclipse seasons are indicated by vertical blue lines. The horizontal solid line represents the laboratory line energy, the dotted lines the ±5 eV deviations. The plot covers only the new epoch discussed in this document.

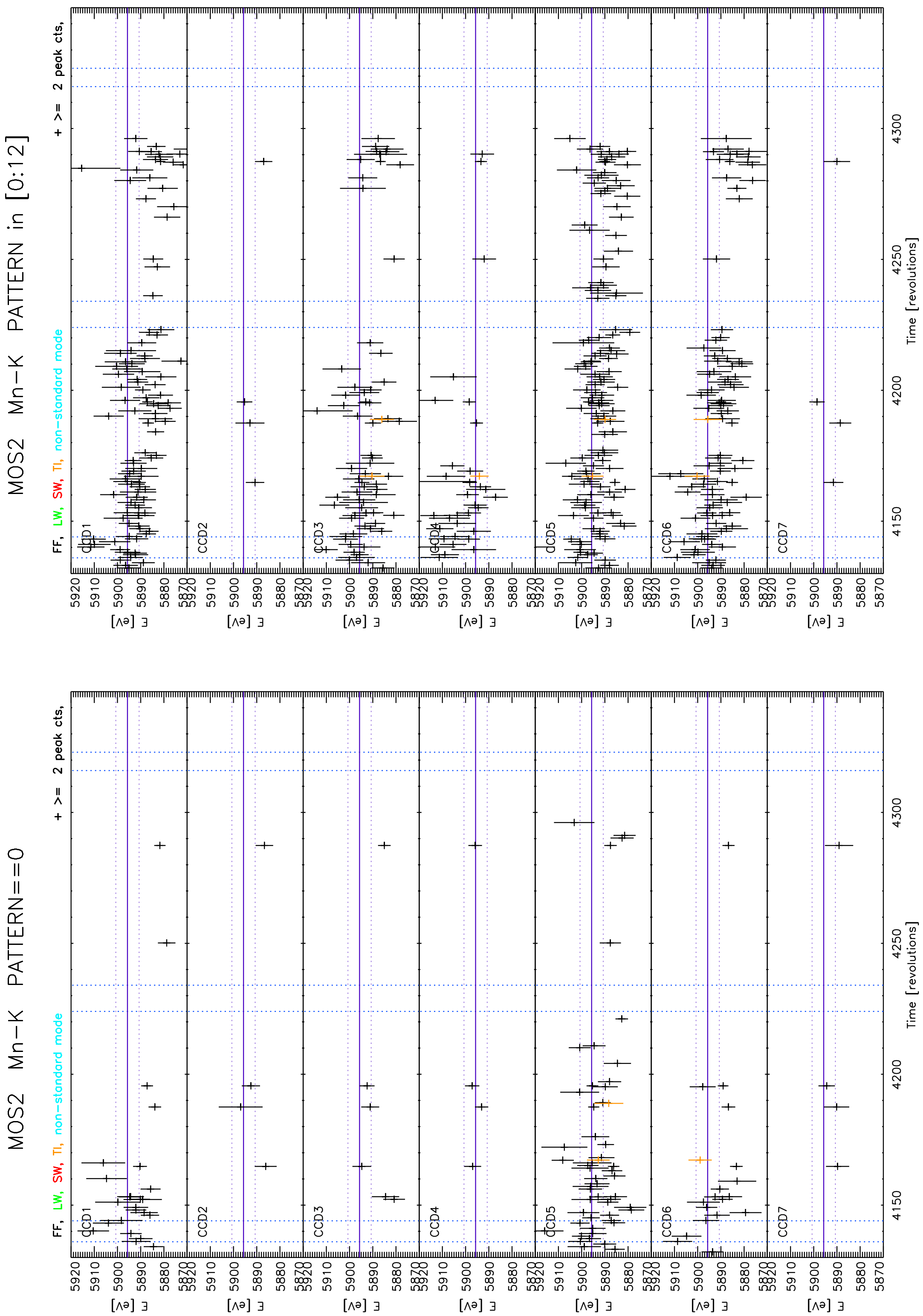

Figure 4: MOS2 Mn K_{α} line energy scale using the new ADUCONV CCFs. Eclipse seasons are indicated by vertical blue lines. The horizontal solid line represents the laboratory line energy, the dotted lines the ± 5 eV deviations. The plot covers only the new epoch discussed in this document.