

XMM-Newton CCF Release Note

XMM-CCF-REL-207

Update of EPIC MOS gain

Martin Stuhlinger, Darren Baskill

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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
EMOS1_ADUCONV_0029	1999-12-10T00:00:00	2000-07-15T12:00:00	OFFSET_GAIN		NO
EMOS1_ADUCONV_0030	2000-07-15T12:00:01	2000-11-09T12:00:00	OFFSET_GAIN		NO
EMOS1_ADUCONV_0031	2000-11-09T12:00:01	2001-04-18T00:00:00	OFFSET_GAIN		NO
EMOS1_ADUCONV_0032	2001-04-18T00:00:01	2001-08-18T00:00:00	OFFSET_GAIN		NO
EMOS1_ADUCONV_0033	2001-08-18T00:00:01	2001-09-26T22:00:00	OFFSET_GAIN		NO
EMOS1_ADUCONV_0034	2001-09-26T22:00:01	2001-11-25T12:00:00	OFFSET_GAIN		NO
EMOS1_ADUCONV_0035	2001-11-25T12:00:01	2002-05-16T05:00:00	OFFSET_GAIN		NO
EMOS1_ADUCONV_0036	2002-05-16T05:00:01	2002-11-07T05:00:00	OFFSET_GAIN		NO
EMOS1_ADUCONV_0037	2002-11-07T05:00:01	2003-11-09T18:00:00	OFFSET_GAIN		NO
EMOS1_ADUCONV_0038	2003-11-09T18:00:01	2005-01-21T18:00:00	OFFSET_GAIN		NO
EMOS1_ADUCONV_0039	2005-01-21T18:00:01	2005-07-24T01:00:00	OFFSET_GAIN		NO
EMOS1_ADUCONV_0040	2005-07-24T01:00:01	2005-10-19T19:00:00	OFFSET_GAIN		NO
EMOS1_ADUCONV_0041	2005-10-19T19:00:01		OFFSET_GAIN		NO
EMOS2_ADUCONV_0029	1999-12-10T00:00:00	2000-07-15T12:00:00	OFFSET_GAIN		NO
EMOS2_ADUCONV_0030	2000-07-15T12:00:01	2000-11-09T12:00:00	OFFSET_GAIN		NO
EMOS2_ADUCONV_0031	2000-11-09T12:00:01	2001-04-18T00:00:00	OFFSET_GAIN		NO
EMOS2_ADUCONV_0032	2001-04-18T00:00:01	2001-08-18T00:00:00	OFFSET_GAIN		NO
EMOS2_ADUCONV_0033	2001-08-18T00:00:01	2001-09-26T22:00:00	OFFSET_GAIN		NO
EMOS2_ADUCONV_0034	2001-09-26T22:00:01	2001-11-25T12:00:00	OFFSET_GAIN		NO
EMOS2_ADUCONV_0035	2001-11-25T12:00:01	2002-05-16T05:00:00	OFFSET_GAIN		NO
EMOS2_ADUCONV_0036	2002-05-16T05:00:01	2002-11-07T05:00:00	OFFSET_GAIN		NO
EMOS2_ADUCONV_0037	2002-11-07T05:00:01	2003-11-09T18:00:00	OFFSET_GAIN		NO
EMOS2_ADUCONV_0038	2003-11-09T18:00:01	2005-01-21T18:00:00	OFFSET_GAIN		NO
EMOS2_ADUCONV_0039	2005-01-21T18:00:01	2005-07-24T01:00:00	OFFSET_GAIN		NO
EMOS2_ADUCONV_0040	2005-07-24T01:00:01	2005-10-19T19:00:00	OFFSET_GAIN		NO
EMOS2_ADUCONV_0041	2005-10-19T19:00:01		OFFSET_GAIN		NO

2 Changes

A new set of ADU CONV CCFs have been generated which include updated values for the gain parameters. This new set of CCFs covers the same first 6 time periods as the previous ADU CONV CCFs (issue 20 to 25, see XMM-CCF-REL-161), but also establish new time periods. The previously latest time period before the cooling (issue 26) is now divided into two time periods from 2001-11-25 to 2002-06-16 (rev. 360–446) and 2002-06-16 to 2002-11-07 (rev. 446-534), respectively. The new set now contains 5 post-cooling time periods (replacing issue 27), with one of these periods identical to the epoch correcting the incorrect on-board voltages (replacing issue 28, see XMM-CCF-REL-200).

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

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

The new gain and offset values have been calculated from observations of the on-board calibration sources, which offer three spectral lines: Al $K\alpha$ at 1486.57 eV (Suresh et al 2000, J. Phys. B. At. Mol. Opt. Phys. 33), Mn $K\alpha$ at 5895.75 eV and Mn $K\beta$ 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

For all CCDs and all time periods, the energy scale is now reconstructed to about 5 eV or better for the entire energy range. The improvement of this new gain on existing data is expected to be less than 5-10 eV at 6 keV, and less than 5 eV at 1.5 keV.

The new set of ADU CONV CCFs are released together with a new set of CTI CCFs (issues 17-29, see XMM-CCF-REL-206), since the new cti with old gains, and old cti with new gains may give unexpected results!



4 Estimated Scientific Quality

The energy scale accuracy is better or about 5 eV on the whole energy range for i) not too bright sources and ii) outside of eclipse seasons (at the start of revolutions). In this two cases, as explained in XMM-CCF-REL-124, the energy scale can be significantly over-corrected.

5 Test procedures & results

The new ADU CONV CCFs have been tested with SASv6.5.0. The results of the new CCFs are presented in Fig. 1 to Fig. 4.

6 Expected Updates

None.

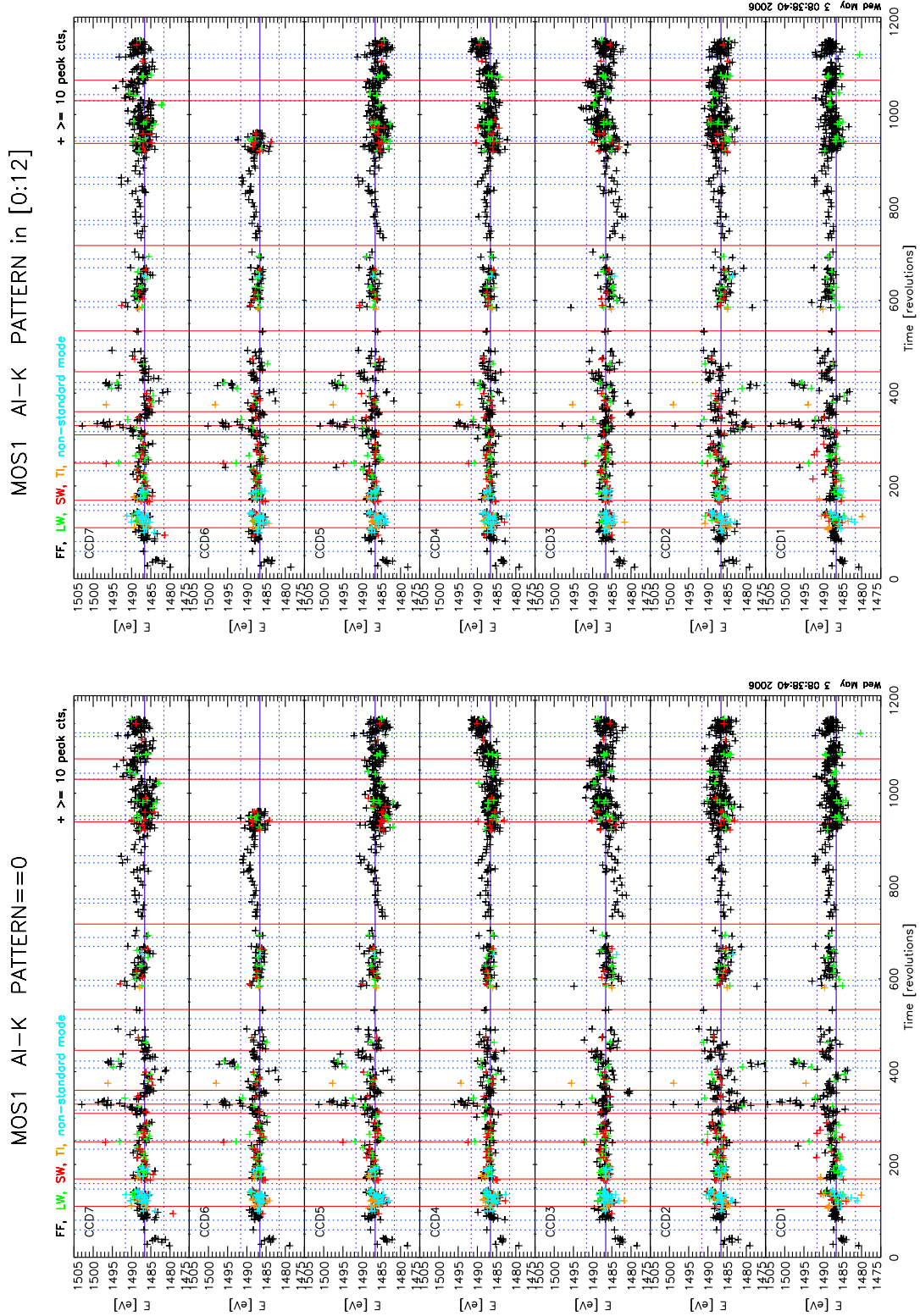


Figure 1: MOS1 Al K_{α} line energy scale using the new ADU CONV-0029-41 CCFs. Eclipse seasons are indicated by vertical blue lines, CCF epochs by red lines. The horizontal solid line represents the laboratory line energy, the dotted lines the ± 5 eV deviations.

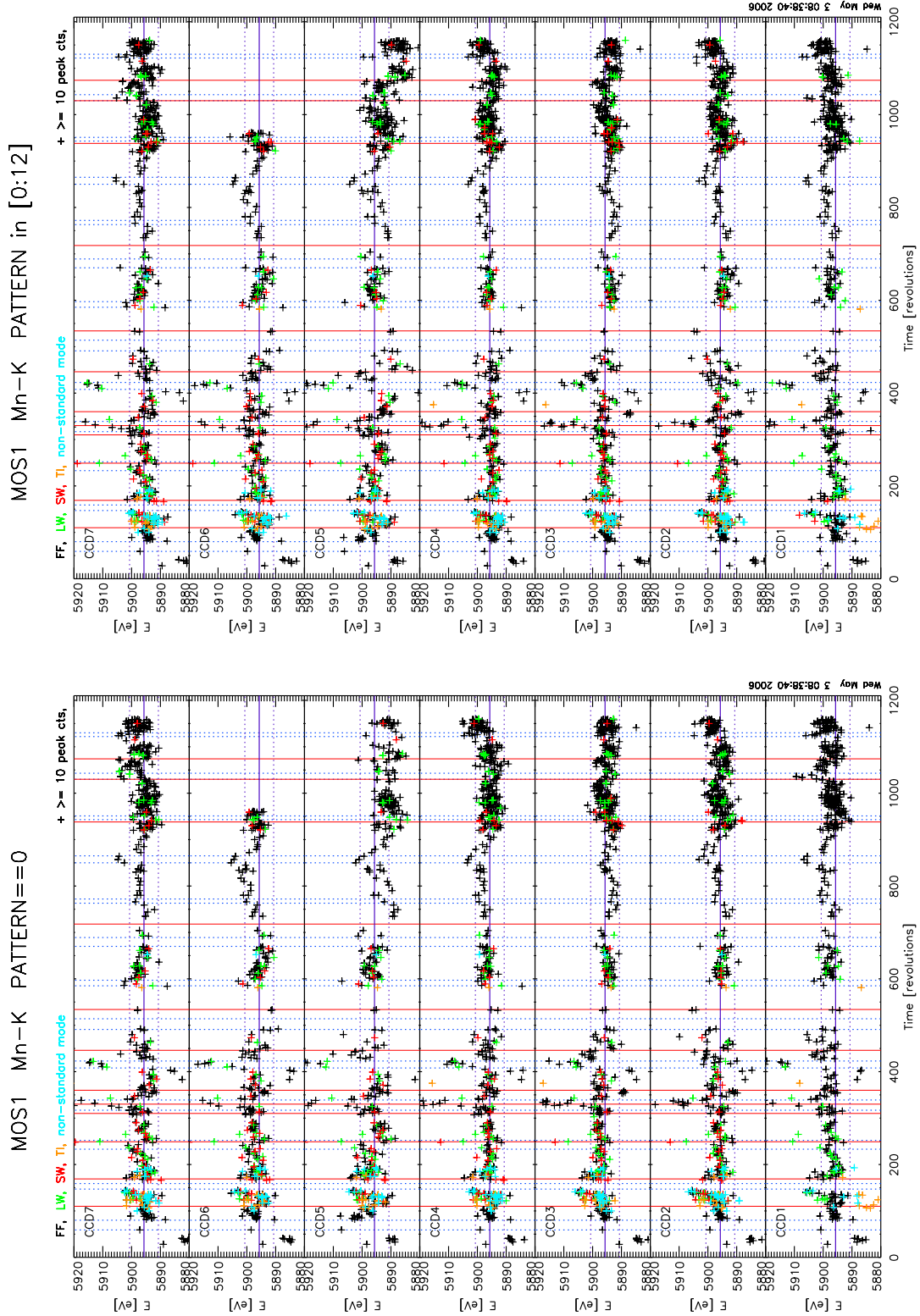


Figure 2: MOS1 Mn K_{α} line energy scale using the new ADU CONV-0029-41 CCFs. Eclipse seasons are indicated by vertical blue lines, CCF epochs by red lines. The horizontal solid line represents the laboratory line energy, the dotted lines the ± 5 eV deviations.

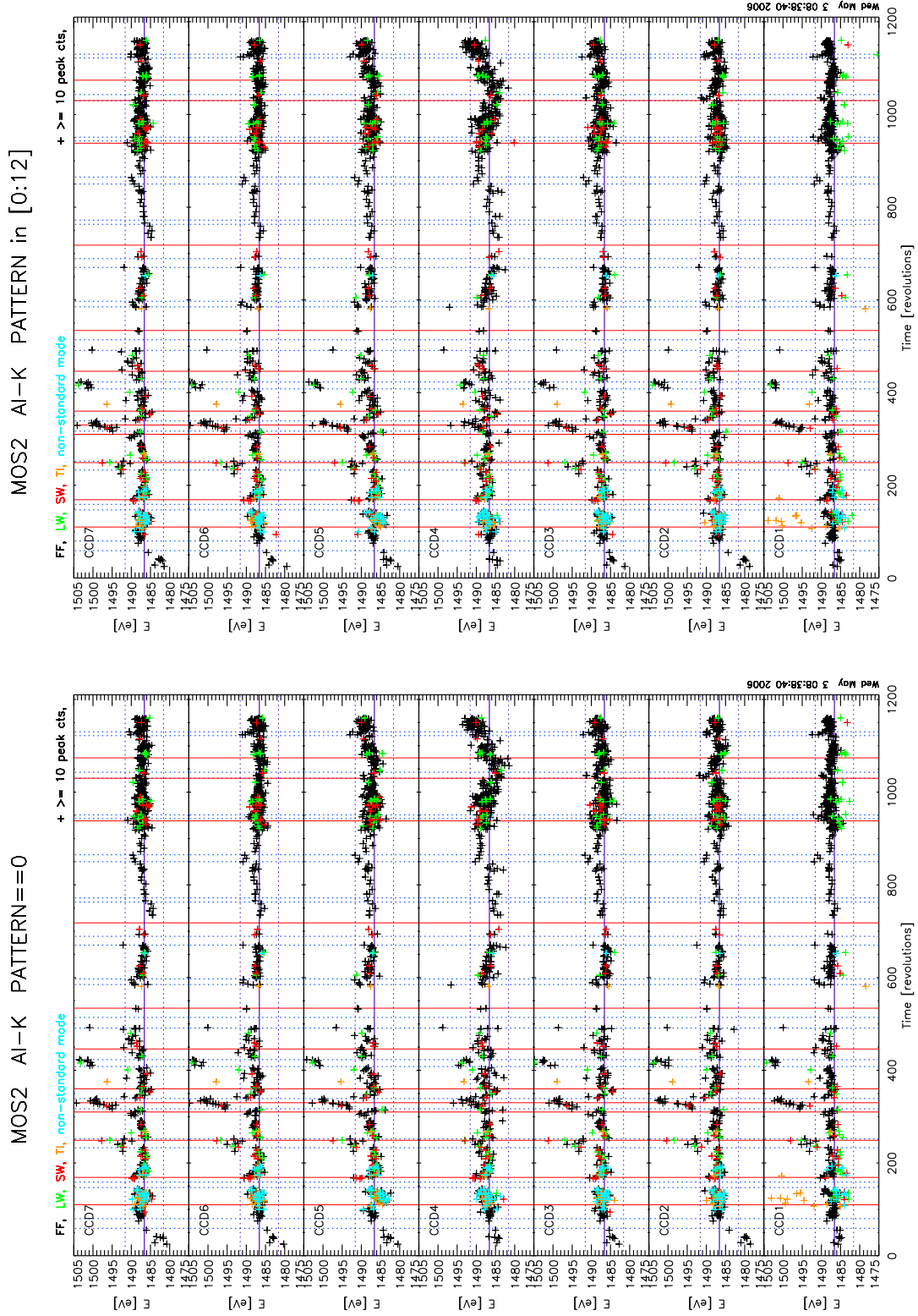


Figure 3: MOS2 Al K_{α} line energy scale using the new ADU CONV-0029-41 CCFs. Eclipse seasons are indicated by vertical blue lines, CCF epochs by red lines. The horizontal solid line represents the laboratory line energy, the dotted lines the ± 5 eV deviations.

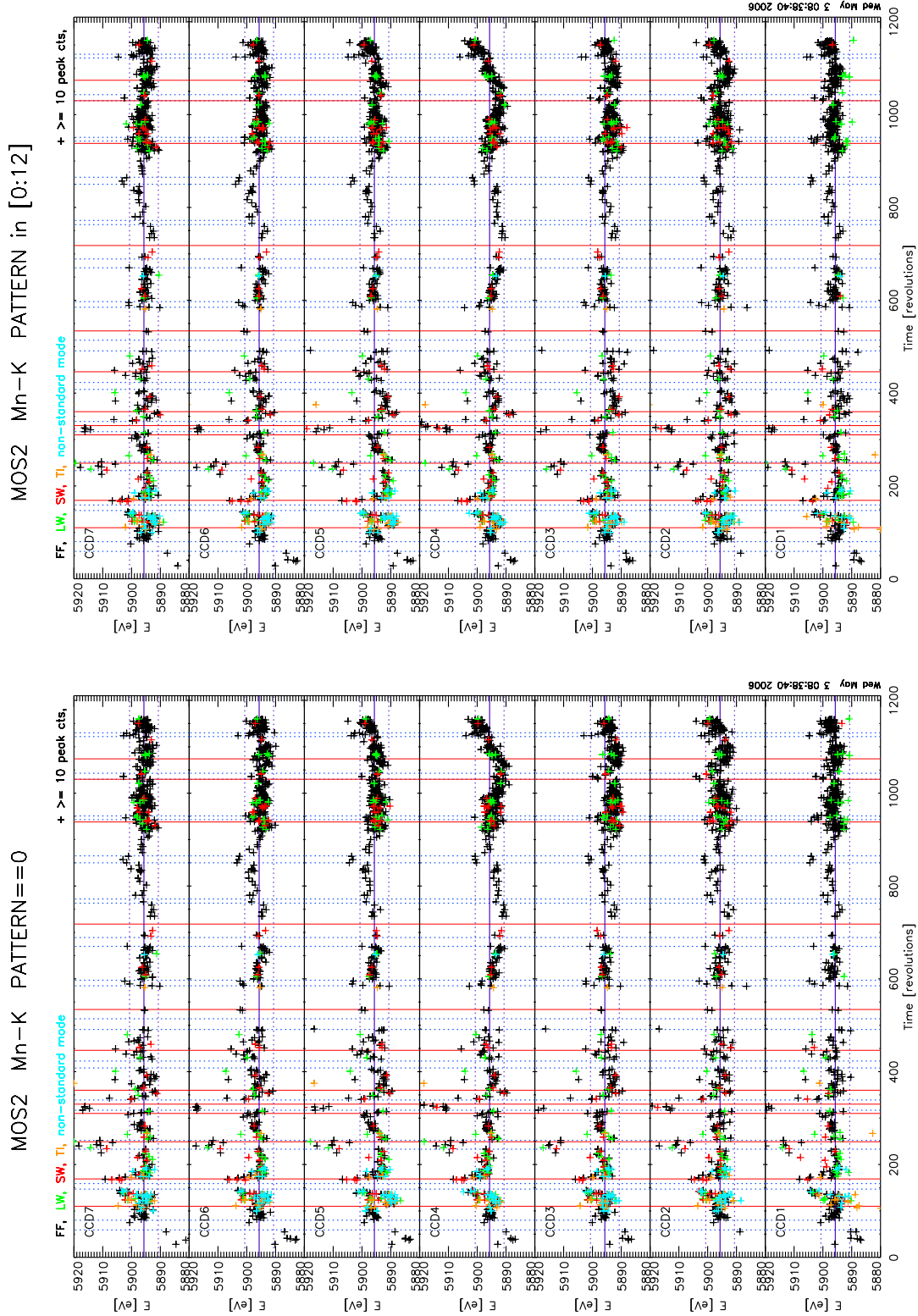


Figure 4: MOS2 Mn K_{α} line energy scale using the new ADU CONV-0029-41 CCFs. Eclipse seasons are indicated by vertical blue lines, CCF epochs by red lines. The horizontal solid line represents the laboratory line energy, the dotted lines the ± 5 eV deviations.