XMM-Newton CCF Release Note

XMM-CCF-REL-354

Update of EPIC MOS CTI

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February 6, 2018

1 CCF components

Name of CCF	VALDATE (start of val. period)	EVALDATE (end of validity period)	List of Blocks changed	CAL VERSION	XSCS flag
EMOS1_CTI_0075	1999-12-10T00:00:00	2000-07-15T12:00:00	CTI_EXTENDED CTI_COLUMN		NO
EMOS1_CTI_0076	2000-07-15T12:00:01	2000-11-09T12:00:00	CTI_EXTENDED CTI_COLUMN		NO
EMOS1_CTI_0077	2000-11-09T12:00:01	2001-04-18T00:00:00	CTI_EXTENDED CTI_COLUMN		NO
EMOS1_CTI_0078	2001-04-18T00:00:01	2001-08-18T00:00:00	CTI_EXTENDED CTI_COLUMN		NO
EMOS1_CTI_0079	2001-08-18T00:00:01	2001-09-26T22:00:00	CTI_EXTENDED CTI_COLUMN		NO
EMOS1_CTI_0080	2001-09-26T22:00:01	2001-11-25T12:00:00	CTI_EXTENDED CTI_COLUMN		NO
EMOS1_CTI_0081	2001-11-25T12:00:01	2002-05-16T05:00:00	CTI_EXTENDED CTI_COLUMN		NO
EMOS1_CTI_0082	2002-05-16T05:00:01	2002-11-07T05:00:00	CTI_EXTENDED CTI_COLUMN		NO
EMOS1_CTI_0083	2002-11-07T05:00:01	2003-11-09T18:00:00	CTI_EXTENDED CTI_COLUMN		NO
EMOS1_CTI_0084	2003-11-09T18:00:01	2005-01-21T18:00:00	CTI_EXTENDED CTI_COLUMN		NO
EMOS1_CTI_0085	2005-01-21T18:00:01	2005-07-24T01:00:00	CTI_EXTENDED CTI_COLUMN		NO
EMOS1_CTI_0086	2005-07-24T01:00:01	2005-10-19T19:00:00	CTI_EXTENDED CTI_COLUMN		NO
EMOS1_CTI_0087	2005-10-19T19:00:01	2006-08-11T00:00:00	CTI_EXTENDED CTI_COLUMN		NO
EMOS1_CTI_0088	2006-08-11T00:00:01	2007-11-24T16:00:00	CTI_EXTENDED CTI_COLUMN		NO
EMOS1_CTI_0089	2007-11-24T16:00:01	2008-03-03T09:00:00	CTI_EXTENDED CTI_COLUMN		NO
EMOS1_CTI_0090	2008-03-03T09:00:01	2008-04-30T05:00:00	CTI_EXTENDED CTI_COLUMN		NO
EMOS1_CTI_0091	2008-04-30T05:00:01	2009-01-22T11:00:00	CTI_EXTENDED CTI_COLUMN		NO
EMOS1_CTI_0092	2009-01-22T11:00:01	2009-10-28T16:00:00	CTI_EXTENDED CTI_COLUMN		NO
EMOS1_CTI_0093	2009-10-28T16:00:01	2010-09-30T17:00:00	CTI_EXTENDED CTI_COLUMN		NO
EMOS1_CTI_0094	2010-09-30T17:00:01	2012-01-10T09:00:00	CTI_EXTENDED CTI_COLUMN		NO
EMOS1_CTI_0095	2012-01-10T09:00:01	2012-12-12T10:00:00	CTI_EXTENDED CTI_COLUMN		NO
EMOS1_CTI_0096	2012-12-12T10:00:01	2013-06-03T22:00:00	CTI_EXTENDED CTI_COLUMN		NO
EMOS1_CTI_0097	2013-06-03T22:00:01	2014-05-28T21:00:00	CTI_EXTENDED CTI_COLUMN		NO
EMOS1_CTI_0098	2014-05-28T21:00:01		CTI_EXTENDED CTI_COLUMN		NO

Name of CCF	VALDATE (start of val. period)	EVALDATE (end of validity period)	List of Blocks changed	CAL VERSION	XSCS flag
EMOS2_CTI_0076	1999-12-10T00:00:00	2000-07-15T12:00:00	CTI_EXTENDED CTI_COLUMN		NO
EMOS2_CTI_0077	2000-07-15T12:00:01	2000-11-09T12:00:00	CTI_EXTENDED CTI_COLUMN		NO
EMOS2_CTI_0078	2000-11-09T12:00:01	2001-04-18T00:00:00	CTI_EXTENDED CTI_COLUMN		NO
EMOS2_CTI_0079	2001-04-18T00:00:01	2001-08-18T00:00:00	CTI_EXTENDED CTI_COLUMN		NO
EMOS2_CTI_0080	2001-08-18T00:00:01	2001-09-26T22:00:00	CTI_EXTENDED CTI_COLUMN		NO
EMOS2_CTI_0081	2001-09-26T22:00:01	2001-11-25T12:00:00	CTI_EXTENDED CTI_COLUMN		NO
EMOS2_CTI_0082	2001-11-25T12:00:01	2002-05-16T05:00:00	CTI_EXTENDED CTI_COLUMN		NO
EMOS2_CTI_0083	2002-05-16T05:00:01	2002-11-07T05:00:00	CTI_EXTENDED CTI_COLUMN		NO
EMOS2_CTI_0084	2002-11-07T05:00:01	2003-11-09T18:00:00	CTI_EXTENDED CTI_COLUMN		NO
EMOS2_CTI_0085	2003-11-09T18:00:01	2005-01-21T18:00:00	CTI_EXTENDED CTI_COLUMN		NO
EMOS2_CTI_0086	2005-01-21T18:00:01	2005-07-24T01:00:00	CTI_EXTENDED CTI_COLUMN		NO
EMOS2_CTI_0087	2005-07-24T01:00:01	2005-10-19T19:00:00	CTI_EXTENDED CTI_COLUMN		NO
EMOS2_CTI_0088	2005-10-19T19:00:01	2006-04-15T08:00:00	CTI_EXTENDED CTI_COLUMN		NO
EMOS2_CTI_0089	2006-04-15T08:00:01	2006-10-09T20:00:00	CTI_EXTENDED CTI_COLUMN		NO
EMOS2_CTI_0090	2006-10-09T20:00:01	2007-08-02T23:00:00	CTI_EXTENDED CTI_COLUMN		NO
EMOS2_CTI_0091	2007-08-02T23:00:01	2008-01-15T13:00:00	CTI_EXTENDED CTI_COLUMN		NO
EMOS2_CTI_0092	2008-01-15T13:00:01	2008-07-26T23:00:00	CTI_EXTENDED CTI_COLUMN		NO
EMOS2_CTI_0093	2008-07-26T23:00:01	2009-07-05T01:00:00	CTI_EXTENDED CTI_COLUMN		NO
EMOS2_CTI_0094	2009-07-05T01:00:01	2009-11-09T16:00:00	CTI_EXTENDED CTI_COLUMN		NO
EMOS2_CTI_0095	2009-11-09T16:00:01	2010-05-14T02:00:00	CTI_EXTENDED CTI_COLUMN		NO
EMOS2_CTI_0096	2010-05-14T02:00:01	2010-12-23T11:00:00	CTI_EXTENDED CTI_COLUMN		NO
EMOS2_CTI_0097	2010-12-23T11:00:01	2011-09-10T17:00:00	CTI_EXTENDED CTI_COLUMN		NO
EMOS2_CTI_0098	2011-09-10T17:00:01	2012-03-02T05:00:00	CTI_EXTENDED CTI_COLUMN		NO
EMOS2_CTI_0099	2012-03-02T05:00:01	2012-12-12T10:00:00	CTI_EXTENDED CTI_COLUMN		NO
EMOS2_CTI_0100	2012-12-12T10:00:01	2013-06-03T22:00:00	CTI_EXTENDED CTI_COLUMN		NO
EMOS2_CTI_0101	2013-06-03T22:00:01	2014-05-28T21:00:00	CTI_EXTENDED CTI_COLUMN		NO
EMOS2_CTI_0102	2014-05-28T21:00:01		CTI_EXTENDED CTI_COLUMN		NO

2 Changes

A new set of CTI CCFs have been derived for the MOS taking into account the latest measured degradation rate of the parallel CTI. The first 12 CCFS of this new set (MOS1 issue 75–85, MOS2 issue 76-87) covers the same time periods as previous CTI CCFs (MOS1 issue 58–69, MOS2 issue 59–70, see XMM-CCF-REL-278). These first 12 CCFs use the same values for parallel and serial CTI as their previous versions, but updated values of the column offsets.

The following CCFs cover new defined epochs which address the variability of column offsets of the focal CCD. Therefore the epoch conformity between MOS1 and MOS2 CCFs is broken after 2006-04-15 (rev. 1163). All of these following CCFs contain new calculated values for parallel and serial CTI as well as for the column offsets.

The serial CTI approximates the linear CTI model within the single epochs to the long term evolution, as it remains nearly constant since cooling. Only for MOS1 CCD4, the serial CTI model uses two different long term evolutions to address the additional noise after a partial damage due to a micro-meteorite impact on 2012-12-11.

The parallel CTI is calculated individually within the corresponding epochs independent of the general long term evolution. The column offset tables are calculated individually for the corresponding epochs, too.

3 Scientific Impact of this Update

The use of this set of CCFs will improve the MOS energy scale reconstruction for all observations later than revolution >2700 and also marginally the energy resolution, mainly for all observations later than revolution >1074.

The new set of CTI CCFs are released together with a new set of ADUCONV CCFs (MOS1 issues 87–110, MOS2 issues 88–114, see XMM-CCF-REL-355), since using the new CTI CCFs with the old ADUCONV CCFs, or the old CTI CCFs with new ADUCONV CCFs, may give unexpected results!

4 Estimated Scientific Quality

This issue ensures that the MOS energy scale remains within 5 eV at 2keV, and 10 eV for most sources (not too bright), for all observations (see a more detailed discussion in XMM-CCF-REL-124).

It is recalled that since SASv5.4 the MOS parallel CTI is modelled with the simple formula of the CTI loss per transfer:

- $CTIY(E,t) = (A + B * t) * E^{\alpha}$

where A is a constant, B the degradation rate (slope), α a power index (all 3 parameters take different values for different CCDs and different time periods), E the event energy in ADUs and t

the time since launch. Note that the serial CTI is also modelled with the same formula but is mostly constant since launch. Since SASv7.0, the energy correction uses an additional offset term:

- $E_{corr} = E + RAWY * CTIY + RAWX * CTIX - OFFSET(RAWX, RAWY)$

This algorithm allows an energy scaling of the CTI that fits very well the Mn and Al lines of the internal calibration source.

5 Test procedures & results

The new CTI CCFs have been evaluated and tested with the SASv16.1. The evolution of the MOS1/MOS2 parallel and serial CTI are presented in Fig. 1 to Fig. 4. Examples of column offset evolutions are presented in Fig. 5.

Plots of the line monitoring are presented in the accompanying release note XMM-CCF-REL-355 of the corresponding updated MOS ADUCONV CCFs.

6 Expected Updates

None.

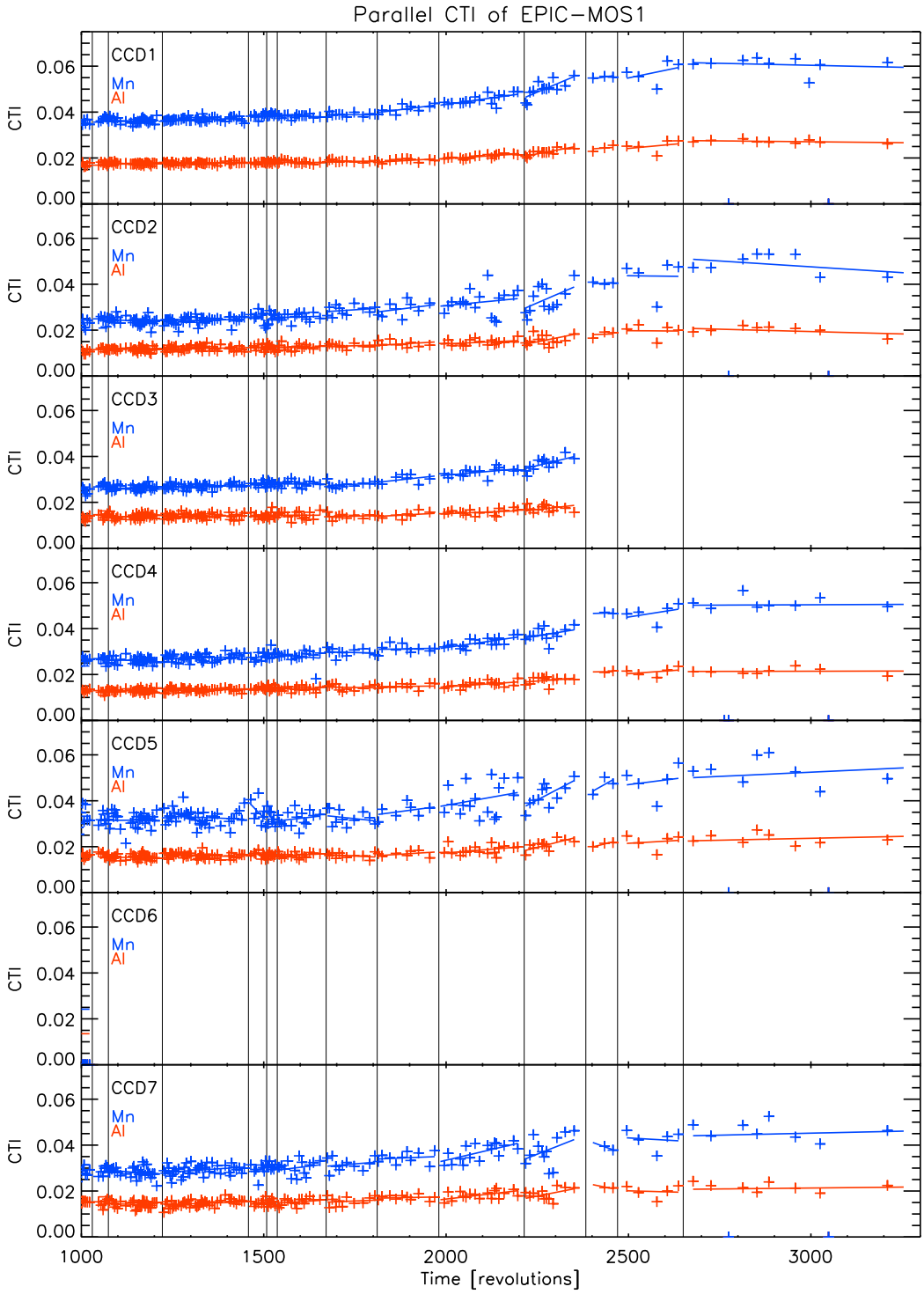

Figure 1: MOS1 parallel transfer losses for the new defined epochs revs. >1074 for CCD1 to CCD7 (top to bottom). In red, the CTI of the Al calibration line at about 1.5 keV, in blue, the CTI of the Mn Kα calibration line at about 5.9 keV, overlaid with the CTI models as parametrised in the new set of CCFs. The CCF epochs are indicated as solid vertical lines.

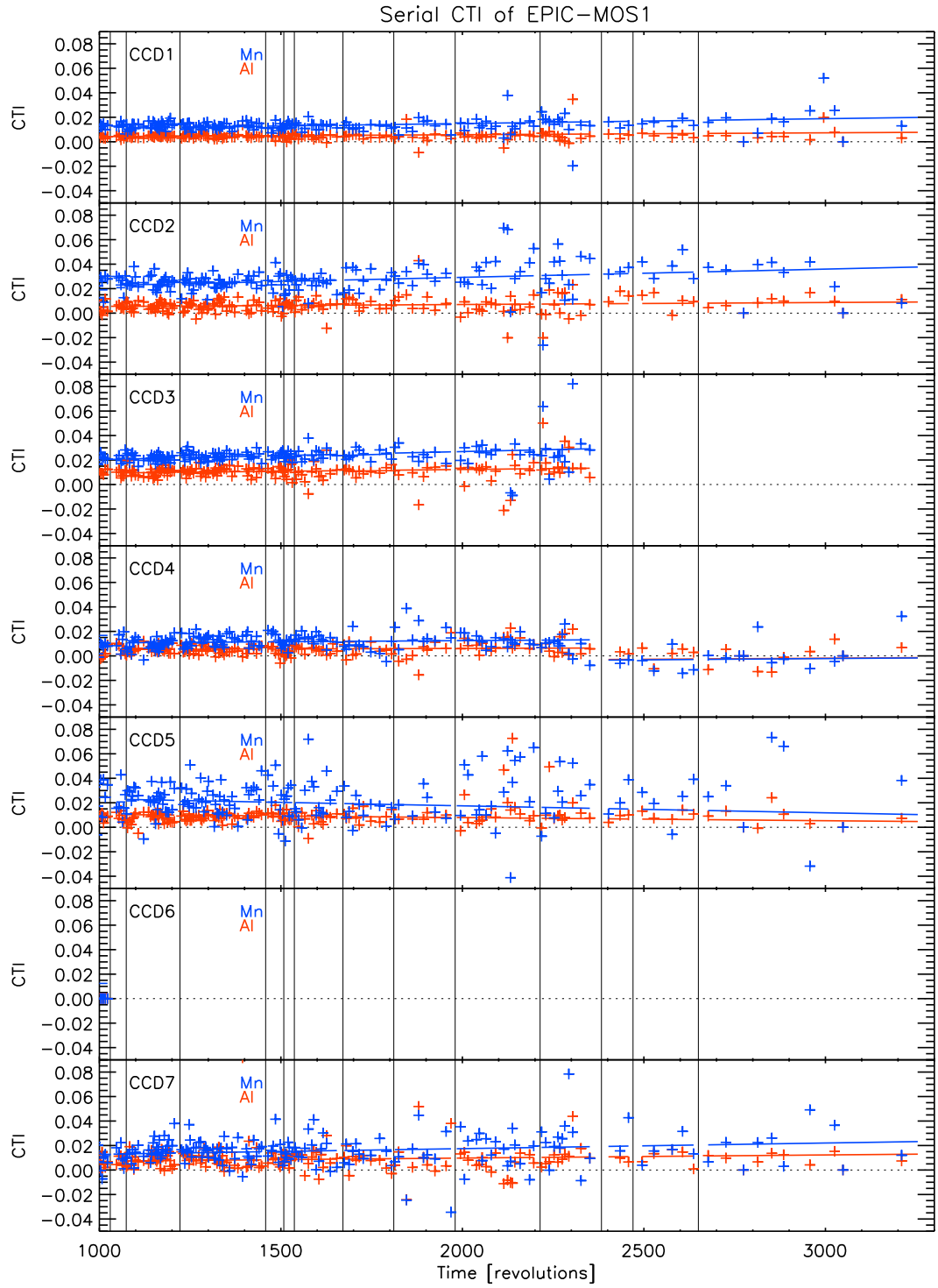

Figure 2: MOS1 serial transfer losses for the new defined epochs revs. >1074 for CCD1 to CCD7 (top to bottom). In red, the CTI of the Al calibration line at about 1.5 keV, in blue, the CTI of the Mn Kα calibration line at about 5.9 keV, overlaid with the CTI models as parametrised in the new set of CCFs. The CCF epochs are indicated as solid vertical lines.

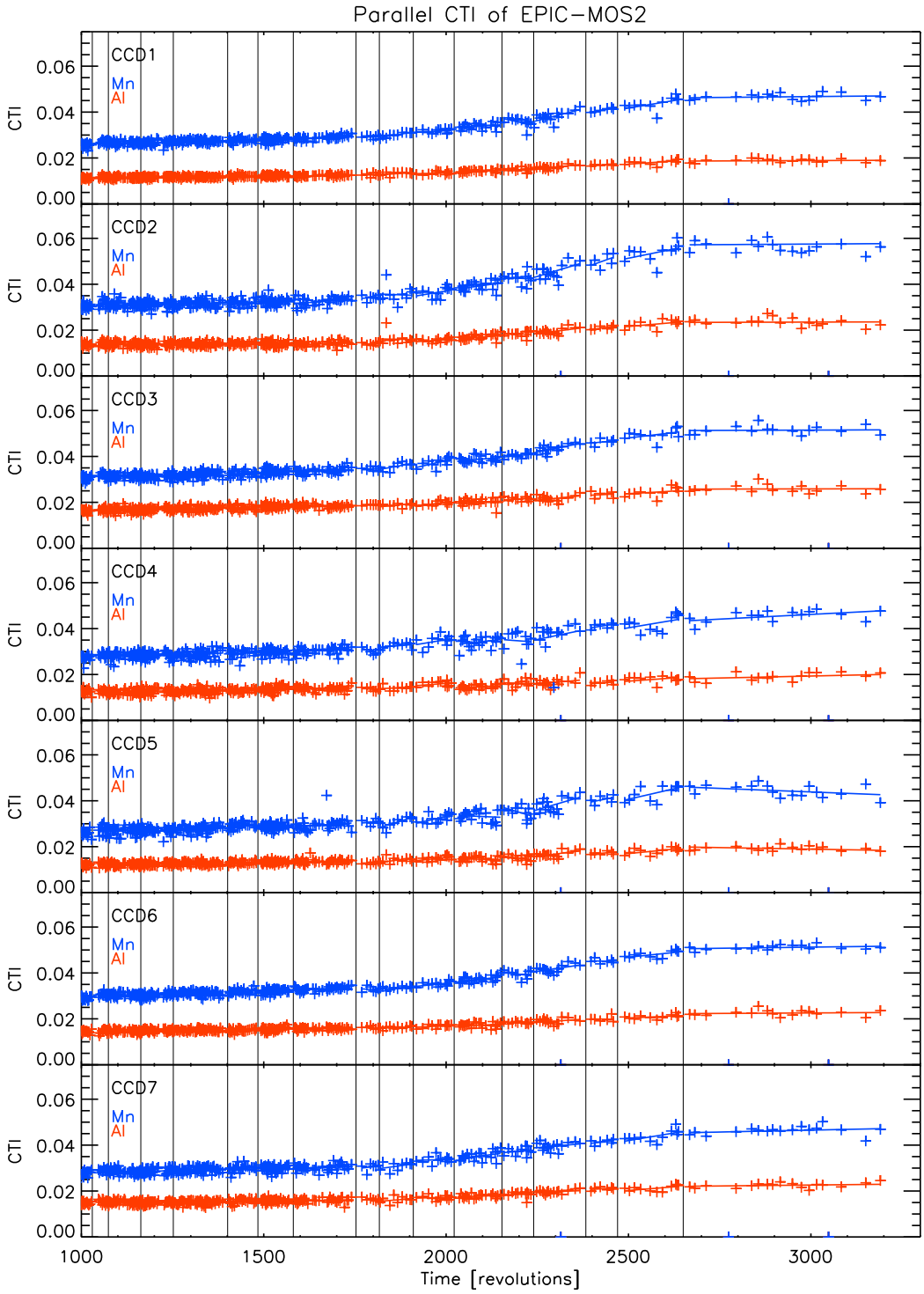

Figure 3: MOS2 parallel transfer losses for the new defined epochs revs. >1074 for CCD1 to CCD7 (top to bottom). In red, the CTI of the Al calibration line at about 1.5 keV, in blue, the CTI of the Mn Kα calibration line at about 5.9 keV, overlaid with the CTI models as parametrised in the new set of CCFs. The CCF epochs are indicated as solid vertical lines.

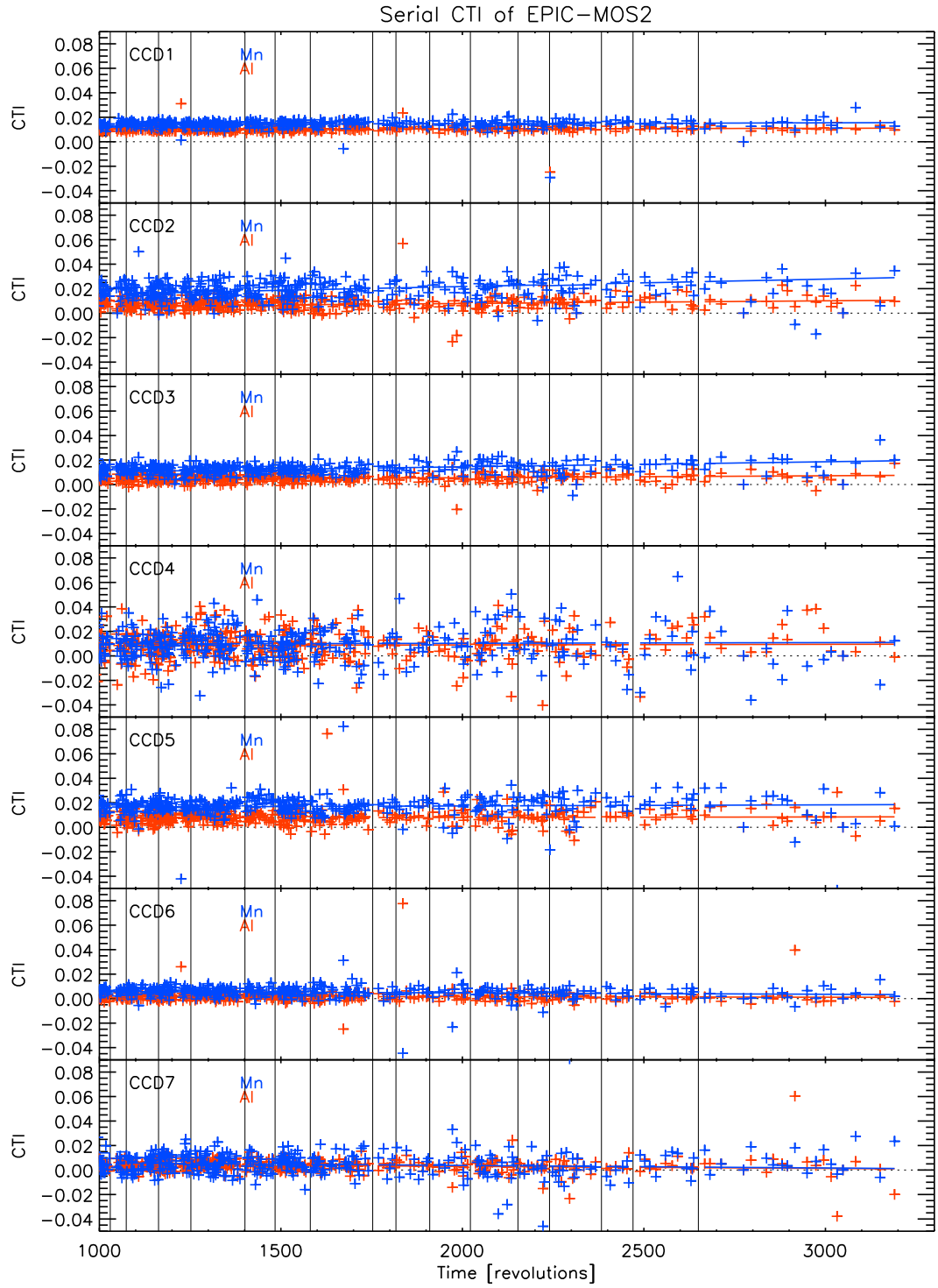

Figure 4: MOS1 serial transfer losses for the new defined epochs revs. >1074 for CCD1 to CCD7 (top to bottom). In red, the CTI of the Al calibration line at about 1.5 keV, in blue, the CTI of the Mn Kα calibration line at about 5.9 keV, overlaid with the CTI models as parametrised in the new set of CCFs. The CCF epochs are indicated as solid vertical lines.

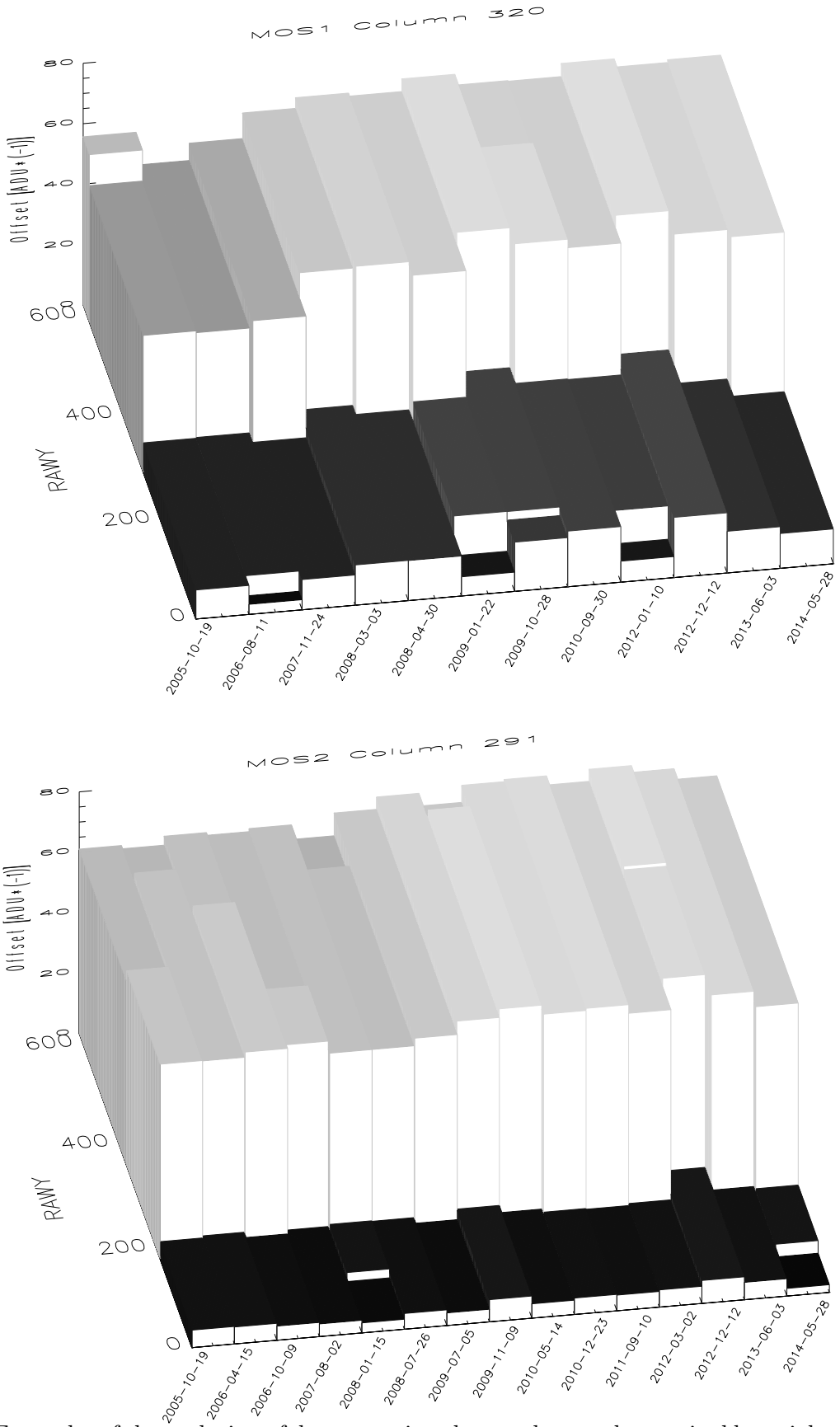

Figure 5: Examples of the evolution of deep traps in columns close to the nominal boresight positions for the later epochs, MOS1 column RAWX=320 (on top) and MOS2 column RAWX=291 (on bottom). For each presented epoch, the offset of a calibration line position to the expected value [in ADU] within a column is plotted. For the analysis, each column is split into about 10 sections along RAWY to achieve sufficient statistics.