

EPIC Calibration meeting – Peguera – 8-9 April 2008

Participants: Uli Briel (UB), Guillermo Buenadicha (GB), Vadim Bruwitz (VB), Pedro Calderon (PC), Jenny Carter (JC), Ignacio de la Calle (IDC), Konrad Dennerl (KD), Carlos Gabriel (CG), Matteo Guainazzi (MG, secretary), Frank Haberl (FH), Marcus Kirsch (MK), Nicola LaPalombara (NLP), Jim Martin (JM), Hermann Marshall (HM), Andy Read (AR), Maria Santos Leo (MSL), Richard Saxton (RS), Steve Sembay (SS, Chair), Michael Smith (MS), Martin Stühlinger (MSt), Andrea Tiengo (AT)

M.Kirsch: Review of previous action items

14/1: Still *OPEN*, and unclear if the additional TIME column should be added to the ODF or to the calibrated event lists. MG will contact MJF for clarification

14/3: *CLOSED* (see MK presentation later)

17/8: *OPEN*

19/1: *OPEN*. UB will contact MJF for clarification. Depending on MJF answer, a SAS SPR will need to be opened (if this is the case, action on MG)

19/2: *CLOSED* (see RS presentation)

K.Dennerl: Update of EPIC-pn long-term monitoring

a) CTI

No change has been measured with respect to the trends discussed in previous meetings. In particular, no degradation followed the extra-heating of the pn camera. Data suggests also a possible correlation between CTI evolution and solar activities

CTI monitoring is made more and more difficult by the calibration source getting fainter. 30s of CAL_CLOSED exposure in 2000 yielded the same statistical quality as 200 ks nowadays.

b) Energy resolution

No significant change has been detected with respect to previous meetings. The statistical quality of the measurements of the Al-K line width has significantly degraded, due to the calibration source getting fainter.

c) Absolute energy scale

The recent release of CCF CTI#17 (pending only the formal approval by the SAS-CCB on April 10) solves deviations observed on the absolute energy scale after Rev.#1220.

K.Dennerl: Origin of gain offsets: new insights from eROSITA calibration

An extrapolation of the gain observed at the Mn-K and Al-K to 0 keV would yield negative ADU values. The same effect has been observed during the ground-based calibration of prototype CCDs developed for eROSITA. An empirical gain correction has been introduced in eROSITA to fix this. This piece of evidence may justify on an experimental basis *ad hoc* correction for the SAS,

involving negative values at 0 keV. The eROSITA correction - calibrated on singles events line spectra - over corrects higher pattern events lines. However, no overcorrection is observed in the pn, hence this issue does not affect the pn gain calibration.

F.Haberl: Using the RGS to calibrate the energy scale and redistribution of EPIC-pn

23 observations of 1E0102 have been combined to provide a line-rich RGS spectrum with enough statistical quality to be used for cross-calibrating the redistribution and the gain of the pn. The main results of the comparison can be summarized as follows:

- once only pn observations in SW mode are considered (not affected by pile-up, or by the position of the source across a chip gap in the earliest observations), the cross-normalization factor between RGS1 and pn (RGS2) is ~ 0.95 (~ 1.04)
- at energies below 1 keV the model is too low with respect to the data. This effect is mode and filter independent. This suggests that there is a lack of redistribution in the current calibration files
- on the contrary, at energies above 1 keV the data are systematically “at the right side” of the model in FF exposures only. This points to a gain effect. Changing the overall gain in FF is not practical, because all the special gain corrections for other modes are calculated with respect to the FF. It is therefore proposed to create a special a new set of parameters in the CCF (“special FF gain correction”) to handle this. The structure will be defined after the analysis is completed.

M.Kirsch: Rate-dependent CTI for the EPIC-pn Fast modes

An empirical correction for the rate-dependent CTI has been implemented through a new SAS task: `epfast`. It has been proven that this correction needs to be applied in addition to the *ground-based* special burst correction. The task removes the misalignment between data and calibration at the Al and Au edges. Scientific validation of the effect of this correction in the burst mode at the Fe-K complex energies – using the data of GROJ1650-40, where deep narrow absorption featured of FeXXV and FeXXVI were observed – is ongoing. It is proposed to:

- include `epfast` in SASv8.0, with correction function parameters (included in a new extension of the CTI CCF) corresponding to no correction
- activate via CCF change the `epfast` correction only once the scientific validation is completed
- change the special burst CTI correction in the CCF to the pre-flight values simultaneously to the activation of the rate-dependent CTI correction

To improve statistics, it is suggested to include in the analysis also spectra extracted from the 3 columns at the left side of the central.

M.Kirsch: EPIC-pn time jumps – the end of the story

A residual 2.2% of observations exhibit time jumps non-detected by SAS, once the jump threshold is optimized to the “22” value. This fraction is, however, mode-dependent, being the highest for exposures in SW, which are often used for timing observations of, e.g., pulsars.

UB will solicit MF and EK to provide comments on these results, and to deliver a specific section of the document describing them. A draft version of this document is available in the ESAC Documentation Management System.

It is in principle possible to implement MK time jump detection software in the SAS to remove the time jumps altogether. This could represent a significant effort, though. MG will raise a SAS SCR, describing MK's software, to bring the issue at the SAS-CCB.

SASv8.0 would be a good opportunity to extend time randomization to the pn as well. This is pending checks that MJF would like to make before giving the final "green light". This issue needs to be urgently fixed, because April 23 is the deadline for SASv8.0 code freezing. CG will contact MJF to ask for his conformance to the implementation of pn randomization in SASv8.0.

K.Dennerl: Experience with combined Fe55/Tycho SNR calibration (NRCO71) - PN

The data analysis suggests that the presence of Tycho does not have any impact on the measurement of the Mn-K line. It, however, does prevent the measurement of the Al-K line from being used for CTI determination.

The question arose on whether it would be advisable to switch Tycho observations in LW, and on whether the same experiment could as in NRCO#71 be fruitfully performed on other targets. The routine calibration plan will be analysed, to see on which other sources the same experiment could be carried out.

The NRCO was not requested to be scheduled in such a way, that the same offset table was used. During the discussion it has been suggested that the procedure for the scheduling of an NRCO needs to be tightened to make sure that the Instrument Team are aware of what has been scheduled in response to a given NRCO, and can provide feedback, in due time. At the same time, the Calibration Scientist will chase the Team Member responsible for the NRCO data analysis if no results has been produced within 1 month after the data delivery.

A.Tiengo: Experience with combined Fe55/Tycho SNR calibration (NRCO71) - PN

The Al-line is too weak to provide meaningful results.

At higher energies, both the Tycho Fe line (blended with the calibration Mn-K beta) and the calibration Mn-K alpha change their line energy. No change in the line width is observed (the calibration line remains unresolved).

S.Sembay: New refinement to MOS low-energy QE

There are theoretical reasons (Holland et al. 1993) to believe that the time scale of emptying filled traps could be of the same order of the row transfer time in the MOS. An study has been conducted to investigate whether the residuals at the O edge could be explained in this context. The results is negative, using both of the following two methods:

- analysis of the rate-dependency of gain offset at the O edge
- comparison between the precursor-cleaned spectrum and the full spectrum at the O edge

No evidence exists for a rate-dependent CTI in the MOS.

During the discussion, the following MOS issues were also touched:

- the shape of the MOS patch is not circular. The current implementation is too crude, and needs to be refined. This is a long term effort
- The latest off-axis redistribution is too large. An update of the CCF is required
- A refinement of the QE has to be delivered to the SOC. This activity is, however, currently on hold, awaiting further investigation on the redistribution

A.Read: Update on the EPIC PSF

The elliptical parametrization of the 2-D PSF is being tested. It can go into SASv8.0 for `arfgen` to improve the EEF calculation. A set of 2XMM off-axis sources is available in the cross-calibration archive for testing.

A more detailed parametrization of the 2-D PSF (including spokes, azimuthal modulation in MOS2) has been studied. Although the calibration is in good shape, there is still some more work to do before it can be implemented in `inmldetect/CAL`.

T.Song: Image deconvolution of XMM-Newton data

An IDL program is being developed – and will be eventually made public, once robust – deconvolving XMM-Newton MOS images. First results are very encouraging.

M.Kirsch: Evaluation of the MOS timing mode calibration

Variation of the relative flux between MOS and pn larger than 10% are present in ~10 observations (out of ~20) in the cross-calibration archive. Most of them (all but 3) are in counting mode at least in one camera. No correlation with flu or time is observed (possible correlation with the upload of MOS BRAT tables should be investigated). The possibility that this is due to the imperfect GTI treatment is being investigated by the SAS Team

The MOS relative timing is 10^8 . However, the absolute timing is not O.K.. It is better than 10ms, whereas for the pn is as accurate as 100 micro-seconds. It is not clear why this is the case: the absolute timing should be, if anything, better.

Future observation of the CRAB should be done with both MOS cameras in timing Mode. More statistics is badly needed.

R.Saxton: Statistical evaluation of the flux cross-calibration of the EPIC cameras

The results of a systematic comparison of the flux measured in 2XMM sources can be summarized as follows:

- in Bands 2 (0.5-10 keV), 3 (1.0-2.0 keV), 4 (2.0-4.5 keV) there seems to be a MOS/pn flux ratio discrepancy ~7-8%, consistent with the results of the cross-calibration archive. There is some trend for larger differences at larger off-axis
- in Band 1 (0.2-0.5 keV) the overall agreement between pn and MOS is better. However, this is due to a large dependency with offset angle. At small offset angle the pn/MOS ratio is +7%, whereas beyond 2 arc minutes the difference is ~1-2%. This is due to the usage of ECFs based on the same redistribution matrix for all sources. Ignoring the sources potentially affected by the MOS patches, the agreement between MOS1 and pn is 10-12%, MOS2 and pn 2-7%
- For band 5 (4.5-12 keV) the difference is the largest, and it has also a strong azimuthal effect.

The maximum (minimum) flux ratio correspond to the quadrant where the RGS obscuration is smallest (largest). The conclusions is that there is too much RGA obscuration, and needs re-calibration

SSC should be recommended to use the a proper ECF library in the generation of 3XMM..

H.Marshall, The Chandra mirror effective area

A new Chandra effective area correcting for the observed differences in galaxy cluster temperatures between ACIS and EPIC will be released shortly.

Future calibration plans - discussion:

Objective 1: pn CTI

1. Rate dependent CTI should also work for bright sources in Timing and Burst mode (MG)
 - MK has analysed the effect
 - `epfast` can perform the correction (will be implemented in SAS 8.0)
 - burst mode special gain calibration is affected and need to be reset to ground values
 - final scientific evaluation pending

Objective 2: OFF axis calibration

- a) 2-D parametrization of the PSF (AR)
 - code for elliptical PSF will be implemented in SAS 8.0
 - usage of the elliptical parametrization of the PSF will be prompted by the user's choice of the shape of the extraction region
 - AR will send to the SOC CCF numbers for the spectral testing by **May 9**
- b) RGS obscuration refinement (RS)
 - Plans to be defined after the release of SASv8.0

Objective 3: MOS patch (SS)

Further analysis needed. The goal to deliver first improved version by **October 2008**

Objective 4: Low energy noise reduction (KD)

A proposal for implementation will be delivered by **September 2008**

Objective 5: Spatial exposure corrections for pn

MG will contact MJF to verify the status of this objective by **April 27 2008**

Objective 6: CTI/contamination monitoring (ESAC)

- MOS-CTI (MSt): MSt has started to port the software at ESAC. Support from D.Baskell is being arranged through a for 1 week visit at ESAC as soon as possible
- PN-CTI (MS): development is on going, first results broadly reproduce the results of KD.

- Some residual differences are to be investigated
- RXJ1856 pn contamination monitoring should be done at ESAC using the cross-calibration archive. The goal is to have it implemented **by mid-2008**

Objective 7: SNR Gain calibration (AT)

Study of the gain calibration of the MOS/pn using SNR 1E0102, N132D CAS-A. It should lead to a scheme to improve gain/redistribution calibration. Plans to be defined later

Objective 8: 3x3 mode calibration (SS)

- useful independently of implementation of Slow Slew mode
- SAS update needed (for 9.0)
- CCF needed
- first test versions should be provided by **October 2008**

Objective 9: Invalid pattern influence on pn normalization (FH)

A report is expected at the **next BOC meeting** (FH)

Objective 10: refinement pn redistribution (FH)

Further investigation on the on redistribution using 1E0102 in collaboration with the IACHEC working group.

List of open actions

14/1 on RD, MK, MJD: Additional time column with other 0 point for OHL

17/8 on SS: Calibrate Pattern 0 for 3x3 mode

19/1 on MJF: implement warning for very bright sources with respect to non perfect FIFO reset correction

20/1 on MG: prepare a update of the pn CTI CCF with a new extension for the parameters of the special FF gain correction

20/2 on MG: write a SAS SCR describing MK software to identify time jumps not detected by the SAS, with the ultimate goal to correct for all of them

20/3 on CG: contact MJF to clarify whether any strong reasons exists, vetoing the extension of time randomization in SAS to the pn

20/4 on MJF and E.Kendzorra: to provide comments to the draft document on the time jumps, and (MJF only) a specific section of the document under his responsibility

20/5 on MG: modify the NRCO procedure to include the notification to the Instrument Team by the Calibration Scientist of the scheduling of an NRCO observation

20/6 on UB: review the pn configuration of the Tycho observations in the routine calibration plan

20/7 on SS and UB: review the sources in the routine calibration plan to see whether for any of them observations in source+calibration source mode would be advisable

20/8 on MSt: investigate on the possible effect of the change of BRAT table to the relative flux normalization between MOS and pn for MOS Timing Mode observations

20/9 on MG: change the MOS cameras instrumental mode of the Crab routine calibration plan to Timing mode

Next meeting: in ~11 months time – venue to be decided.