XMM-Newton CCF Release Note

XMM-CCF-REL-no-number-assigned

EPIC Spectral Response Distribution

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1 CCF components

Name of CCF	VALDATE	CAL VERSION	XSCS flag
EMOS1_QUANTUMEF_0010.CCF	2000-01-01		NO
EMOS2_QUANTUMEF_0010.CCF	2000-01-01		NO
EPN_QUANTUMEF_0010.CCF	2000-01-01		NO

2 Changes

Four new extensions, FRACTION_CHANNEL, FRACTION_ENERGY, QE_TOTAL and EBINS_FRACTION have been added. These have been added to allow the response generation routines, rmfgen and arfgen, to produce matrices which duplicate those of the instrument teams. This new method of calculating the RMF was instigated at MPE to create response matrices which gave less weight to double-pixel events at low energies [1].

The new RMF matrix generation scheme is as follows:

```
For each energy
{
  For each event grade (single, double, triple or quad)
  {
     create the redistribution function (rmf) as normal

     multiply the rmf with the pattern fractions for this
     event grade [FRACTION_CHANNEL]
  }

  Add together the rmfs for each grade

  Normalise the total rmf to 1.0
```

```
}
```

The new quantum efficiency (QE) part of the ARF generation is:

```
For each energy
{
    get the QE of the detector in all patterns [QE_TOTAL]

    multiply the QE by the pattern fraction for the event grades
    in the spectrum [FRACTION_ENERGY]
}
```

2.1 Structure of the new extensions

The new extensions have the following columns:

FRACTION_CHANNEL

MODE_ID: The observing mode of the instrument
THRESH: The thresholding used within the detector in ADU channels.
REGION: The spatial region over which these fractions apply
FRAC_S: The fractions in each channel for single-pixel events
FRAC_D: The fractions in each channel for double-pixel events
FRAC_T: The fractions in each channel for triple-pixel events
FRAC_Q: The fractions in each channel for quadruple-pixel events
FRAC_SD: The fractions in each channel for single and double-pixel events
FRAC_SDTQ: The fractions in each channel for single,double,triple and quadruple-pixel events

FRACTION_ENERGY

MODE_ID: The observing mode of the instrument
THRESH: The thresholding used within the detector in ADU channels.
REGION: The spatial region over which these fractions apply
FRAC_S: The fractions in each energy for single-pixel events
FRAC_D: The fractions in each energy for double-pixel events
FRAC_T: The fractions in each energy for triple-pixel events
FRAC_Q: The fractions in each energy for quadruple-pixel events
FRAC_SD: The fractions in each energy for single and double-pixel events FRAC_SDTQ: The fractions in each energy for single,double,triple and quadruple -pixel events

QE_TOTAL

QE_TOTAL: The total quantum efficiency, over all patterns, for each energy.

EBINS_FRACTION

ENERGY: The energies used to define the QE_TOTAL array.

3 Scientific Impact of this Update

This update allows the SAS to produce matrices which give a response which is within 1% of the equivalent files produced by the instrument teams.

4 Estimated Scientific Quality

The pattern fractions in this release have been calculated from in-orbit data. The PN values were calculated from a rev 0082 observation of MS1229.2+6430 for the Full Frame mode, from merged observations of the Coma cluster for Extended Full Frame mode, from observations of Mkn421 (rev 0171) for Small Window mode, from a rev 0075 observation of Mkn 205 for Large Window mode and from an observation of GX13+1, rev 0057, for Timing mode.

The fractions are not expected to be significantly mode or position dependent for the MOS detectors and so have been calculated from a Full Frame mode, rev 0082, observation of MS1229.2+6430. These values are used for all modes and at all detector positions in the current release.

The total QE values in this release, for the PN, are an extrapolation of the current QE_0, QE_1 values calculated from the initial ground calibration runs, so there has been no change here. The values for the MOS have been taken directly from the total QE used to generate the standard instrument matrices by LUX. These numbers are expected to be superceded within days so no more details will be given here.

The number of energy bins in the standard PN matrices has been increased from 972 to 1319. These new energies are contained in the EBINS_FRACTION extension.

5 Expected Updates

The MOS QE is under intense review at the moment. A new QE curve for MOS-1 and MOS-2, which will be used by the SAS and LUX, is expected to be released shortly.

6 Test procedures

The changes introduced here are only used within arfgen, rmfgen and calview. The whole point of it is to produce a response which is the same as the instrument standard responses and so this is the check which needs to be applied.

The routines, eexpmap and lccorr use extensions in this file which should not have changed in this release.

7 Test results

The difference between the MOS and PN standard responses and the SAS responses generated using these new CCF elements are shown in Figures 1 and 2. The agreement is very good except at the extremes of the spectrum.

References

[1] Haberl, F., Briel, U.G., Dennerl, K. and Zavlin, V.E., "Spectral response of the EIC-PN detector: Basic dependencies", Proceedings of the symposium 'New visions of the X-ray Universe in the XMM-Newton and Chandra era'.

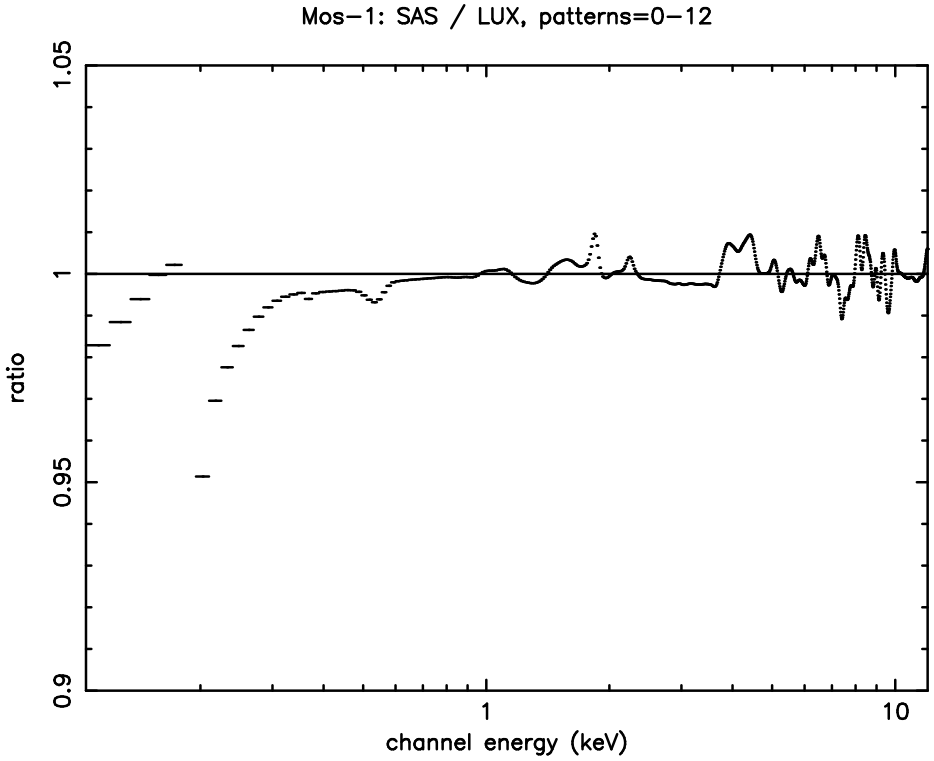

Figure 1: Comparison of MOS-1 response to a slope=1.5 power-law spectrum using event paterns 0–12

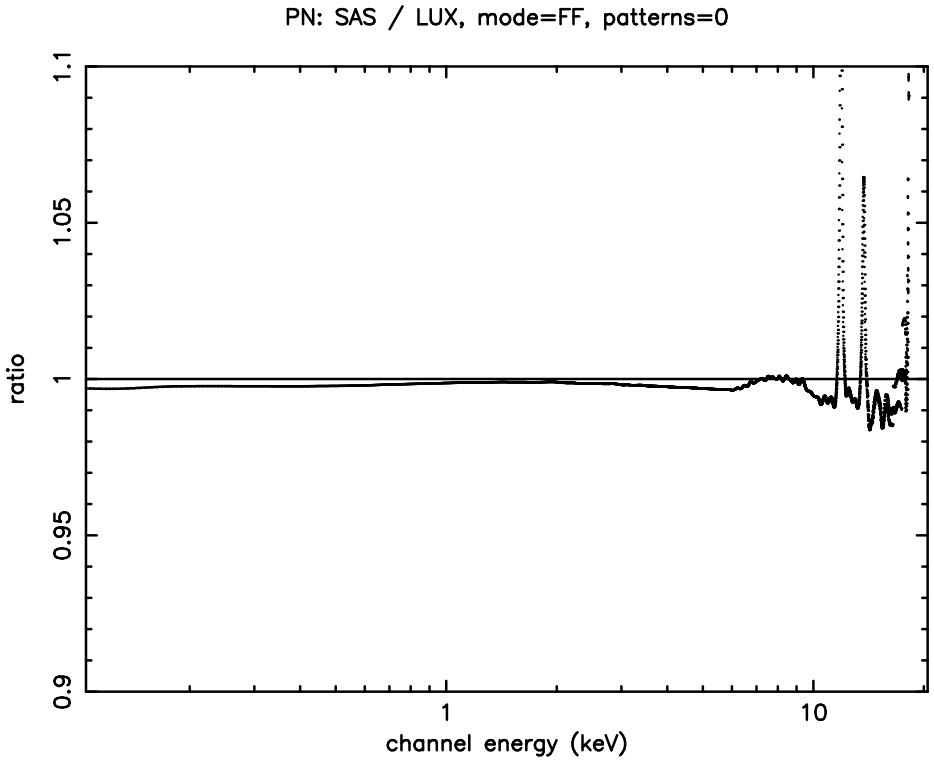

Figure 2: Comparison of PN response to a slope=1.5 power-law spectrum using a spectrum in FF mode and pattern 0 only