XMM-Newton CCF Release Note

XMM-CCF-REL-202

EPIC MOS response

S.F. Sembay, R.D. Saxton

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1 CCF components

Name of CCF	VALDATE	EVALDATE	Blocks changed	XSCS flag
EMOS1_REDIST_0065.CCF	1999-12-10	2000-07-15	CCD_REDISTRIBUTION-n	NO
EMOS1_REDIST_0066.CCF	2000-07-15	2000-11-09	CCD_REDISTRIBUTION-n	NO
EMOS1_REDIST_0067.CCF	2000-11-09	2001-04-18	CCD_REDISTRIBUTION-n	NO
EMOS1_REDIST_0068.CCF	2001-04-18	2001-08-18	CCD_REDISTRIBUTION-n	NO
EMOS1_REDIST_0069.CCF	2001-08-18	2001-09-26	CCD_REDISTRIBUTION-n	NO
EMOS1_REDIST_0070.CCF	2001-09-26	2001-11-25	CCD_REDISTRIBUTION-n	NO
EMOS1_REDIST_0071.CCF	2001-11-25	2002-05-01	CCD_REDISTRIBUTION-n	NO
EMOS1_REDIST_0072.CCF	2002-05-01	2002-11-07	CCD_REDISTRIBUTION-n	NO
EMOS1_REDIST_0073.CCF	2002-11-07	2004-01-01	CCD_REDISTRIBUTION-n	NO
EMOS1_REDIST_0074.CCF	2004-01-01	-	CCD_REDISTRIBUTION-n	NO
EMOS2_REDIST_0065.CCF	1999-12-10	2000-07-15	CCD_REDISTRIBUTION-n	NO
EMOS2_REDIST_0066.CCF	2000-07-15	2000-11-09	CCD_REDISTRIBUTION-n	NO
EMOS2_REDIST_0067.CCF	2000-11-09	2001-04-18	CCD_REDISTRIBUTION-n	NO
EMOS2_REDIST_0068.CCF	2001-04-18	2001-08-18	CCD_REDISTRIBUTION-n	NO
EMOS2_REDIST_0069.CCF	2001-08-18	2001-09-26	CCD_REDISTRIBUTION-n	NO
EMOS2_REDIST_0070.CCF	2001-09-26	2001-11-25	CCD_REDISTRIBUTION-n	NO
EMOS2_REDIST_0071.CCF	2001-11-25	2002-05-01	CCD_REDISTRIBUTION-n	NO
EMOS2_REDIST_0072.CCF	2002-05-01	2002-11-07	CCD_REDISTRIBUTION-n	NO
EMOS2_REDIST_0073.CCF	2002-11-07	2004-01-01	CCD_REDISTRIBUTION-n	NO
EMOS2_REDIST_0074.CCF	2004-01-01	-	CCD_REDISTRIBUTION-n	NO

2 Changes

In August 2005 a set of MOS CCFs were released to describe the spatial dependence of the redistribution function for revolution 360 and onwards [1]. The calibration has now been extended back to the beginning of the mission and this note describes the first release of MOS redistribution files which contains spatial dependency for all epochs.

The algorithm identifier has been set to two in the file headers, which makes the files incompatible with SAS releases earlier than SAS V6.5 with the patch *cal3.177_patch*. Users of SAS V6.5 (without the patch) and earlier versions will receive an error message, instructing them to upgrade their SAS to the latest version, if they try to use these new

CCF elements.

In the release the redistribution parameters have been tuned using observations of a variety of line- and continuum-dominated sources. For example, the O star Zeta Puppis has a line dominated spectrum with strong Nitrogen (440 eV) emission which is useful for constraining the shape of the line response at this energy. Soft continuum sources with reasonably well constrained low energy column densities, such as the isolated neutron stars RXJ 1856-3754 and RXJ 0720.4-3125, have been used to constrain the response at lower energies.

Epochs up to revolution 360 (files 0065–0070) have spatial dependence built in for the first time in this release. Files for the last four epochs (0071-0074) represent a small tweak to the existing calibration described in [1].

3 Scientific Impact of this Update

Figure 1 shows MOS-1 spectra of the isolated neutron star RXJ 0720.4-3125 from 0.1 to 1.0 keV from an observation taken in orbital revolution 175. Two spectra have been extracted, one from the inner core (0-15") and one from the outer wings (15-40"). The plot shows a comparison model fit using responses generated by rmfgen (SAS V6.5) from REDIST CCF 46 and REDIST CCF 67. The difference in the shape of the extracted spectrum between the core and wings is clearly evident. This difference is due to the spatial change in the response properties of the CCD. The new CCFs provide a much improved consistency between the core and wings model fit.

Figure 2 shows MOS-2 spectra of the O star Zeta Puppis from revolution 795. As with Figure 1, two spectra have been extracted from the inner core and outer wings regions. The plot shows a comparison model fit using responses generated by rmfgen (SAS V6.5) from REDIST CCF 51 and REDIST CCF 74. As with the previous plot the new CCFs provide a much improved consistency between the core and wings model fit.

Taken together these plots illustrate the improved spatial and epoch-dependant modelling of the MOS response.

4 Estimated Scientific Quality

This update improves the agreement between the EPIC-MOS and pn cameras to $\sim$5–10% at low energies (< 1 keV) for all epochs.

5 Expected Updates

The redistribution function from the core part of the bad patch at the centre of each MOS camera seems to have stabilised now and further epoch-dependent implementations may not be necessary. The wings of the bad patch and the outer CCD area are expected to evolve and it can be anticipated that more files will be needed to parameterise these changes.

Further scientific testing of the Timing mode redistribution function is ongoing and small changes may also be necessary here.

6 Test Procedures

Redistribution matrices generated by *rmfgen* from the 20 new CCF elements have been tested against canned matrices produced at the University of Leicester.

- Test 1: Imaging mode observations, for all ten epochs, for both MOS cameras, using patterns 0–12 and individually for the core, wings and outer regions.
- Test 2: Imaging mode observations, using pattern 0 only for the core region, for one epoch and both cameras.
- Test 3: Timing mode observations using pattern 0 only for both cameras for one epoch.

7 Test Results

- Test 1: The produced matrices were identical to the canned matrices, within the numerical errors expected from different software codes, in all cases.
- Test 2: The produced matrices were identical to the canned matrices, within the numerical errors in all cases.
- Test 3: The SAS-generated timing mode matrices show small differences from the canned matrices (Fig. 3)

Timing mode spectra nominally made with pattern zero events actually contain patterns 0,1 and 3, i.e. the single-pixel and about 50% of the double-pixel events. The canned matrices were generated using the simplification that all the events are single-pixel events whereas the SAS (*rmfgen*) assumes that the events are singles plus all of the doubles. Work needs to be done to decide whether this simplification makes any practical difference to spectral fits. If it does then a SAS change will be required to average the redistribution function for each pattern type in the correct ratio.

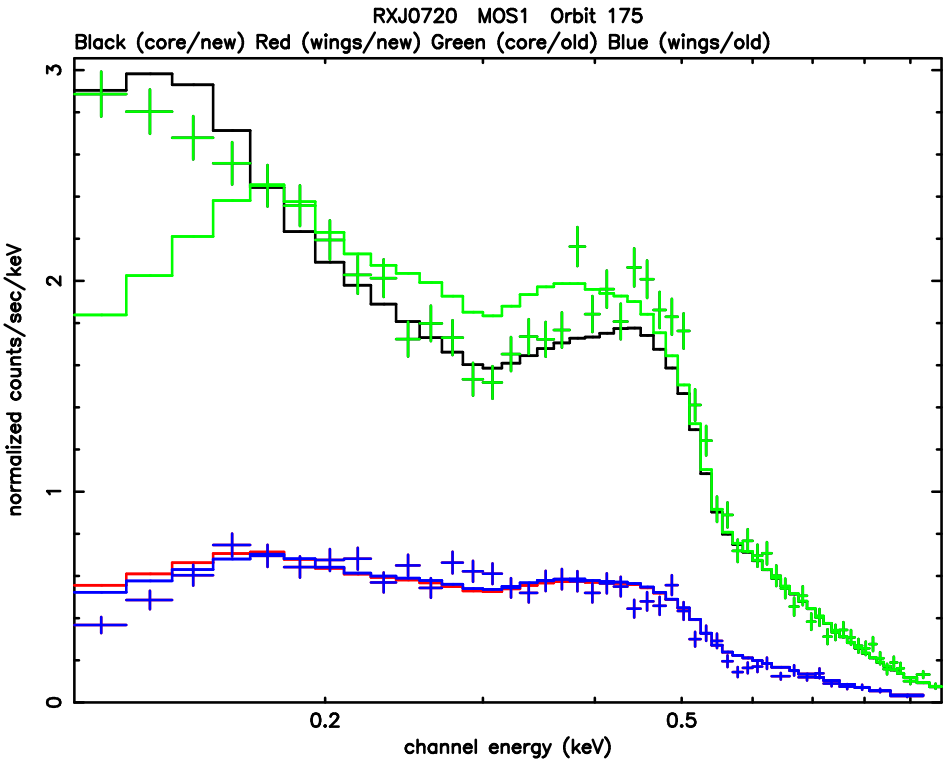

Figure 1: Fits to an on-axis, early-orbit MOS-1 observation of the isolated neutron star RXJ 0720.4-3125. The responses have been generated using the current (EMOS1_REDIST_0046.CCF) and new (EMOS1_REDIST_0067.CCF) calibration elements. At this early epoch the response at the core of the point spread function (PSF; top curve) shows a significantly better fit to the data with the new file, whereas in the wings (lower curve) the response is essentially unchanged.

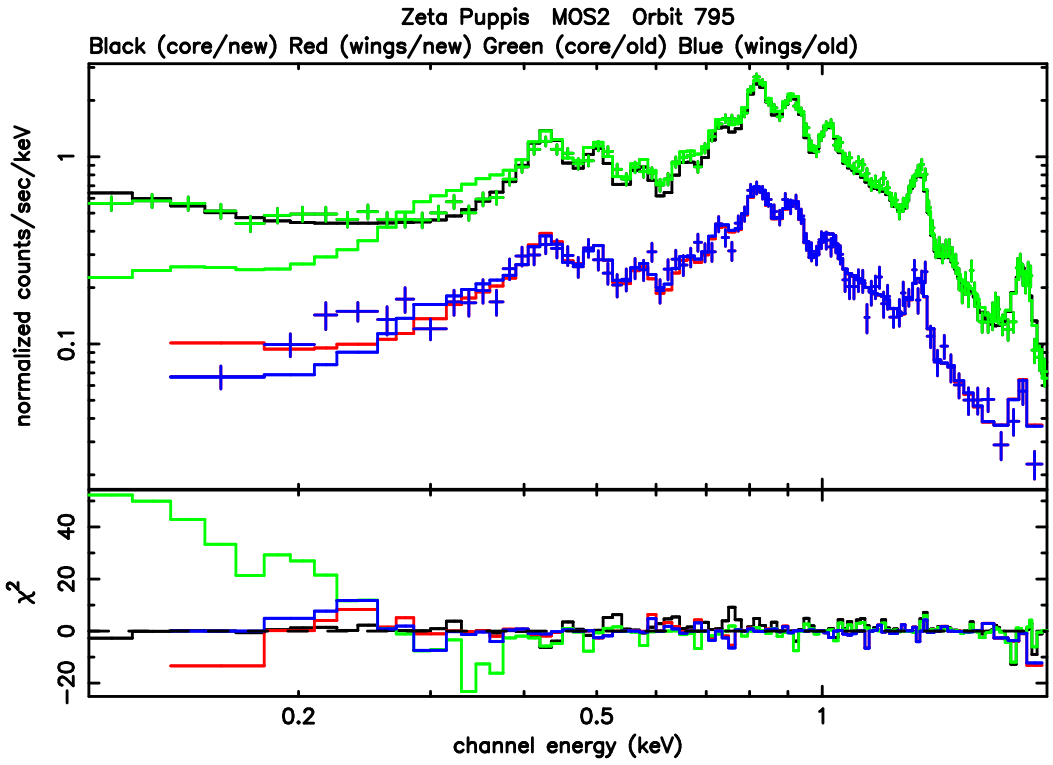

Figure 2: Fits to a revolution 795 MOS-2 observation of Zeta Puppis. The responses have been generated using the old (EMOS2_REDIST_0051.CCF) and new (EMOS2_REDIST_0074.CCF) calibration elements to illustrate the improvement given by the spatial modelling of the redistribution function. The upper fit to the data from the core of the PSF shows a marked improvement with the new calibration. The fit to the wings of the PSF (lower) is only marginally improved by the new response which models a little better the broader redistribution.

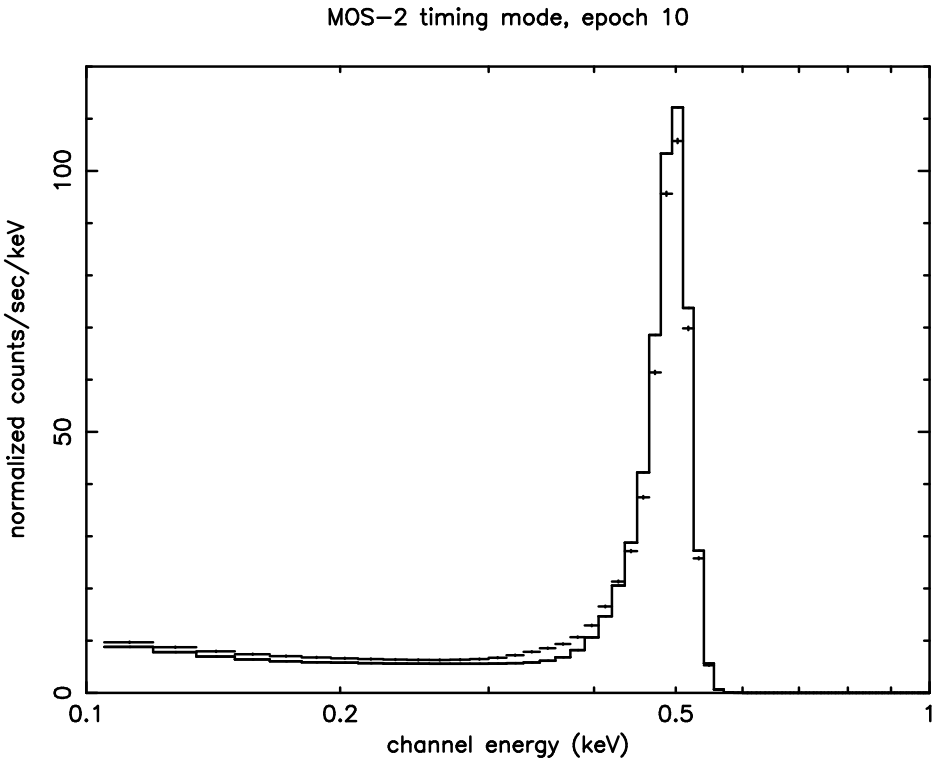

Figure 3: A comparison of the canned and SAS-generated timing-mode response functions at 0.5 keV. In both cases the response has been averaged spatially using a ratio of 67% core, 19% wings and 14% outer, which is the expected point spread function contribution from a well-centred timing mode observation. The canned matrix (crosses) assumes that all the pixels are pattern zero whereas the SAS matrix (solid line) averages over the single-pixel and double-pixel event response functions.

References

[1] Sembay, S.F. & Saxton, R.D., 2005, "EPIC MOS response", XMM-SOC-CAL-SRN-0192