XMM-Newton CCF Release Note

XMM-CCF-REL-84

EPIC Spectral Response Distribution

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August 6, 2001

1 CCF components

Name of CCF	VALDATE	List of Blocks changed	CAL VERSION	XSCS flag
EMOS1_REDIST_0011.CCF	2000-01-01	EBINS		NO
EMOS2_REDIST_0011.CCF	2000-01-01	EBINS		NO
XRT1_XAREAEF_0008.CCF	2000-01-01	ONAXISAREAEF,		NO
		VIGNETTING		NO
XRT2_XAREAEF_0009.CCF	2000-01-01	ONAXISAREAEF,		NO
		VIGNETTING		NO
XRT3_XAREAEF_0008.CCF	2000-01-01	ONAXISAREAEF,		NO
		VIGNETTING		NO
XRT1_XENCIREN_0003.CCF	2000-01-01	XENCIREN		NO
XRT2_XENCIREN_0003.CCF	2000-01-01	XENCIREN		NO
XRT3_XENCIREN_0003.CCF	2000-01-01	XENCIREN		NO
EMOS1_QUANTUMEF_0007.CCF	2000-01-01	QE_CCDn, EBINS		NO
EMOS2_QUANTUMEF_0007.CCF	2000-01-01	QE_CCDn, EBINS		NO
EPN_QUANTUMEF_0009.CCF	2000-01-01	QE_CCDn, EBINS		NO

2 Changes

These changes have been made to support the release of the *rmfgen* and *arfgen* tasks for SAS v5.1.

2.1 Redistribution

The EMOSn_REDIST files have an increased density of energy channel spacing which especially at low energies seems necessary to match the response available from the existing *fixed* on-axis response matrices (e.g. m1_thin1v9q19t5r5_all_15.rsp) previously distributed.

2.2 Mirror Area

The XRT_XAREA files have an increased density of energy points in the VIGNETTING extension, in order to overcome limitations with interpolation in energy which resulted in an underprediction in off-axis area loss with energy.

The XRT_XAREA files have a modified on-axis area that includes a modification to the gold M edge region, which reduces the residuals in fitting MOS and PN spectra simultaneously.

2.3 The encircled energy CCF

These have been created from a PSF parameterisation based on a King profile developed in IFCTR-Milan. The Milan calibration team have analysed MOS observations of point sources and have formulated the PSF as a function of energy and off-axis angle [1]. This work has been separately extended to the EPIC-PN [2]. The formulation differs in detail from previous parameterisations based on ground calibration data but gives broadly similar FWHM and HEW values.

The King profile provides an excellent fit to the in-orbit PSF (Figure 1). It is slightly energy dependent and at high energies has a narrower core and flatter wings than at the lower energies. This leads to the encircled energy fraction being noticeably greater for higher energies for extraction radii smaller than $\sim$ 1 arcminute (Figures 2–4).

A paucity of good off-axis data has delayed the determination of the relationship of the PSF with off-axis angle. The work has been completed for MOS-1 and there it shows a gradual decrease of encircled energy with distance from the optical axis (Figure 5). The relationship to off-axis angle of the MOS-2 and PN encircled energy functions (EEF) has still to be calculated. For these instruments the on-axis function is used everywhere. If these telescopes follow the patten of XRT-1 then this will introduce a normalisation error for sources at large off-axis angles but the spectral effect will be small. Due to the format of these CCF files the extrapolation of the EEF to off-axis angles is done independently of energy. As we have seen the effect on the spectrum will be small.

2.4 Quantum Efficiency

The MOS detection efficiencies were changed to match those used in the existing Leicester-supplied on-axis response matrices. Changes for the off-axis efficiencies were introduced based on measurements taken on the ground at Orsay synchrotron, where we believe a batch-dependent detection depth scales the high energy detection efficiency a few % from CCD to CCD.

The new knowledge of the PN CCD pattern ratios and better estimates of overall QE are ingested to provide a better match to the arfgen generation to the supplied instrument matrices. Note there

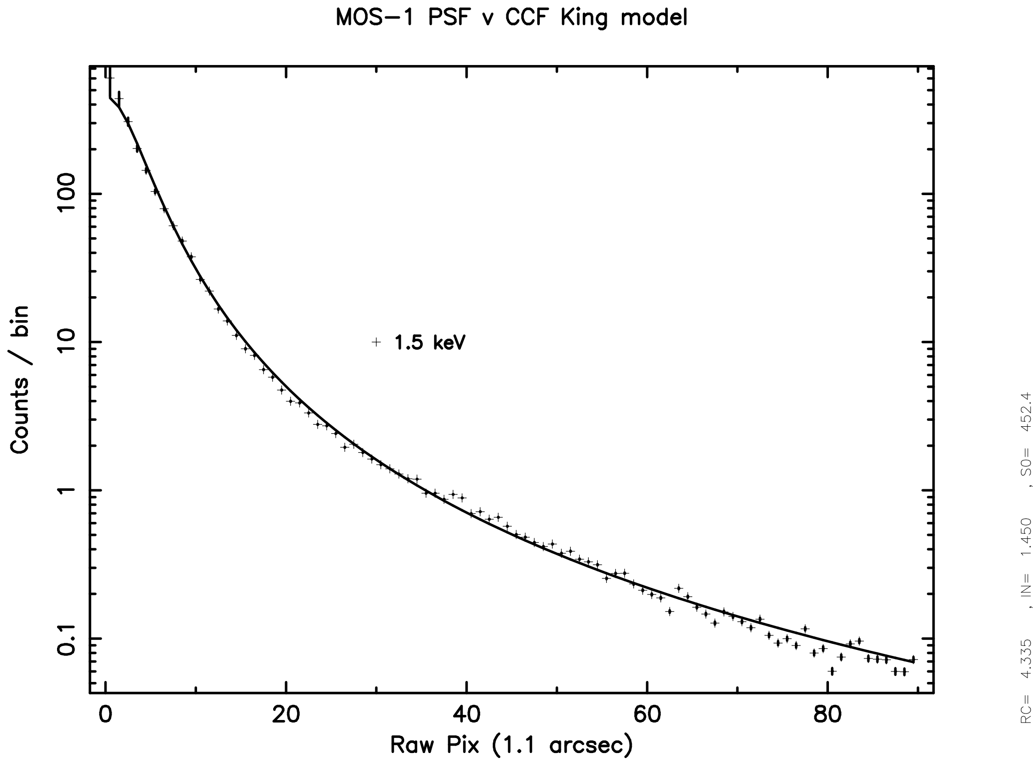

Figure 1: The radial profile of Zeta-Puppis modelled with a King profile

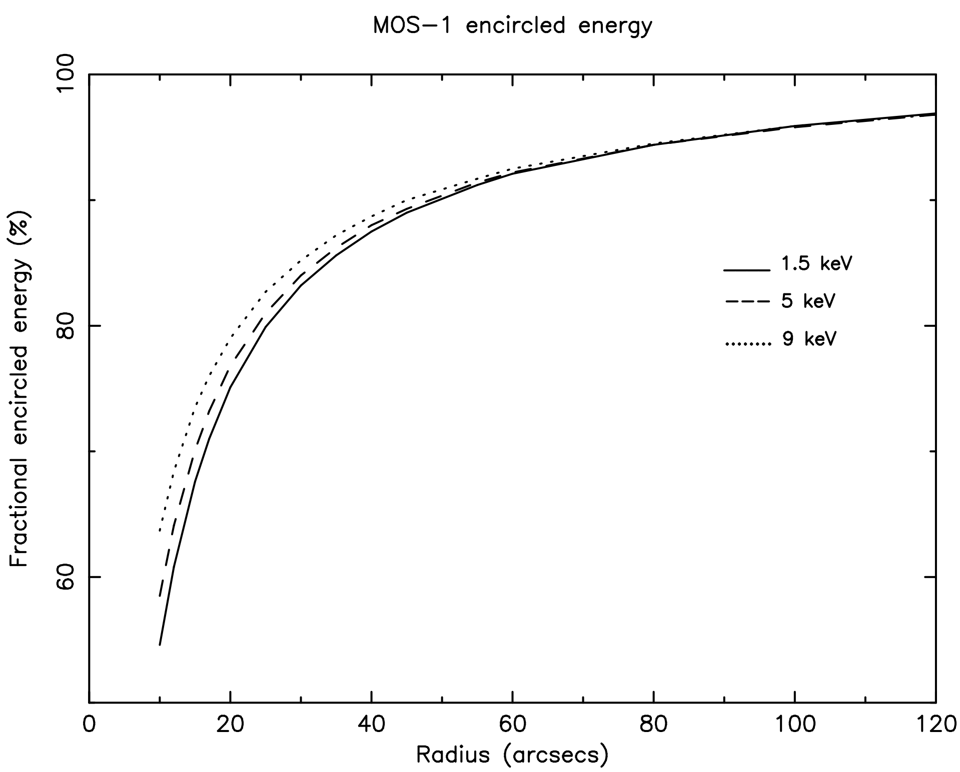

Figure 2: The encircled energy for MOS-1

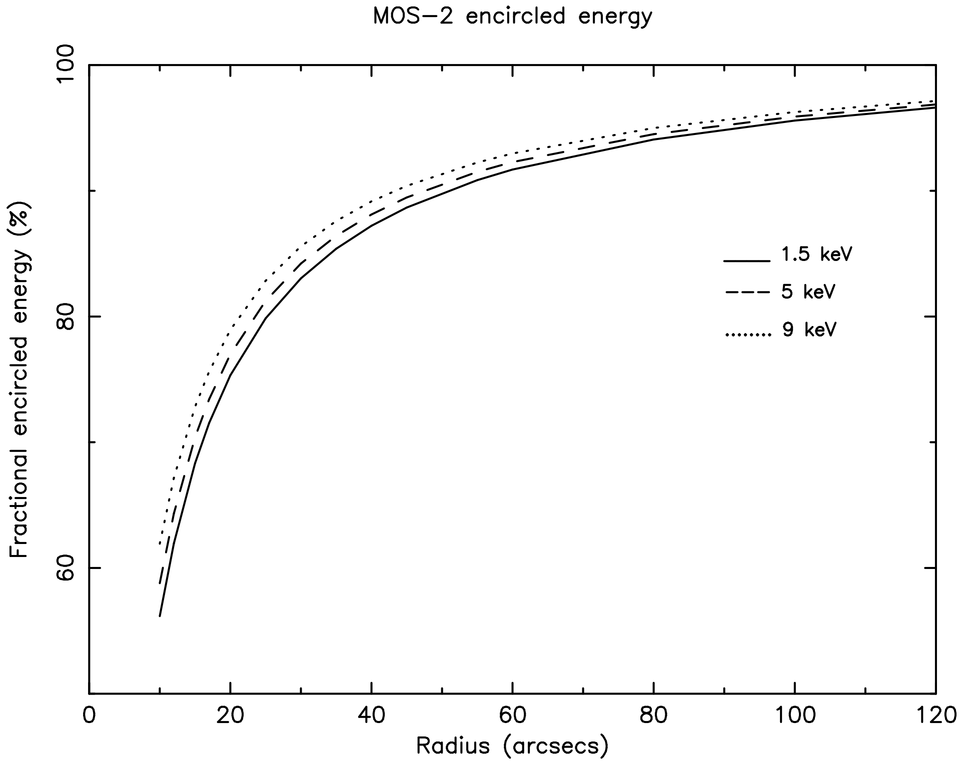

Figure 3: The encircled energy for MOS-2

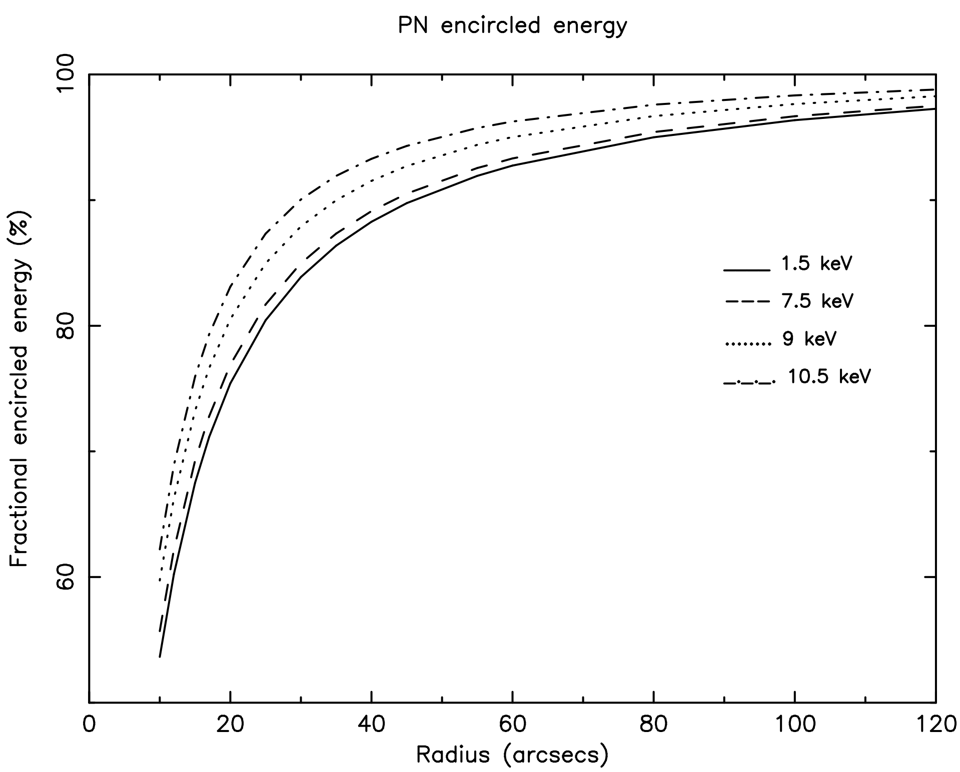

Figure 4: The encircled energy for EPIC-PN

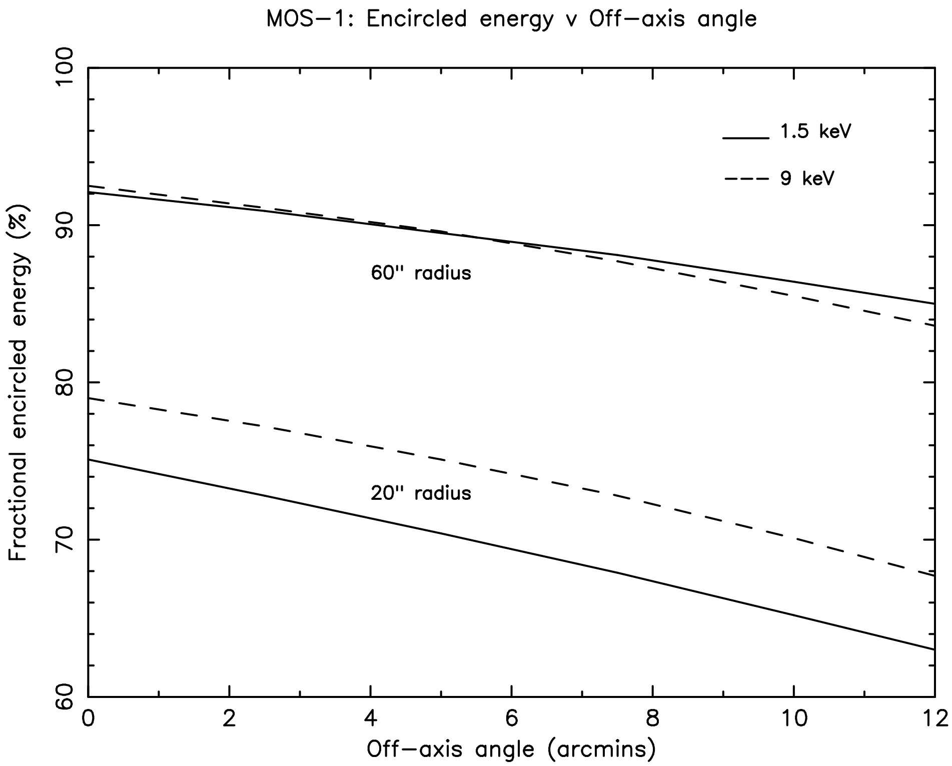

Figure 5: The relationship between encircled energy fraction and off-axis angle for MOS-1

are still problems at energies ≤500eV that will need to be fixed by working in PHA space and not PI domain. This is still to be addressed in future releases.

3 Scientific Impact of this Update

These updates should allow the SAS v5.1 tasks to return response matrices which are consistent to within 1 - 2 % of the response matrices supplied by the instrument teams for on-axis. However the tasks allow now the generation of responses for arbitrary off-axis angles and for arbitrary inclusion radii.

A more detailed description of the application is given in the reference [3]

4 Estimated Scientific Quality

There are remaining spectral residuals seen around the instrumental absorption edges such as O (0.5keV), Al (1.49keV), Si (1.84keV) and Au (2.1 keV) . Adjusting systematic errors in the region of these features to ∼5% in the spectrum files would be prudent. In addition at the extremes of the energy range (≤250eV and ≥8keV for example), the deviations between MOS and PN are noticeable at a few percent level.

5 Expected Updates

Future changes are expected to be real improvements in the physical data representing improved knowledge of the instrument

For example we continue to investigate the complex relationship between redistribution and CCD Quantum Efficiency, the off-axis encircled energy and CCD spatial efficiency variations all will contribute to the off-axis response, which thus needs further development.

We are carrying out detailed cross-calibrations between RGS and EPIC, and hope to use this work to obtain a more consistent set of data in time for the update of SAS in the Autumn 2001.

References

[1] EPIC-MCT-TN-008, Ghizzardi, S, Feb 8, 2001.

[2] Griffiths, G., Saxton, R., *in prep.*

[3] R Saxton, Status of the SAS spectral response generation tasks for XMM-EPIC, XMM-SOC-PS-TN-43