XMM-Newton CCF Release Note

XMM-CCF-REL-2

Point Spread Function of the X-ray telescopes

P. Gondoin

October 4, 2000

1 CCF components

Name of CCF	VALDATE	Blocks changed	CAL VERSION	XSCS flag
XRT1_XPSF_0006	2000-01-13T00:00:00	ALIGNMENT, FIT_PAR, 3GAUSS_PAR, IMAGE	sas_20000903_1900	NO
XRT2_XPSF_0002	2000-01-13T00:00:00	ALIGNMENT, FIT_PAR, 3GAUSS_PAR, IMAGE	sas_20000903_1900	NO
XRT3_XPSF_0002	2000-01-13T00:00:00	ALIGNMENT, FIT_PAR, 3GAUSS_PAR, IMAGE	sas_20000903_1900	NO

2 Changes

The files describe the PSFs of the flight x-ray telescopes XRT1, XRT2 and XRT3 vs energy and field angle. The XRT1, XRT2 and XRT3 telescopes are respectively associated with the MOS1, MOS2 and PN EPIC cameras. Each file consists of a header, three table sections and an image library section [1].

- the alignment table contains coefficients which describe the EPIC defocus and decenter with respect to the average focal point of the mirror modules.
- a second table section contains a three dimensional table of 6 fitting coefficients provided as a function of 6 energies and 6 field angles. These coefficient are used by the CCF access layer to generate analytical PSF descriptions using a simple bi-dimensional Gaussian fit.

- a third section contains a table of 21 fitting coefficients. These coefficient are used by the CCF access layer to generate analytical PSF descriptions using a bi-dimensional multi-Gaussian fit.
- the image section contains a collection of FITS images obtained at different energies and field angles. Theses images are interpolated by the CCF access layer to any energy and field position.

3 Scientific Impact of this Update

The released CCF sections update the previous Pearson_VII model which provided a PSF description limited to the center of the field of view and to low energies.

4 Estimated Scientific Quality

- The simple bi-dimensional Gaussian model of the x-ray telescope PSFs provides an effective way to construct representative XMM-Newton PSFs for applications (e.g source detections) which do not require high spatial or photometric accuracies.
- The validity range of the bi-dimensional multi-Gaussian fit of the telescope PSF is limited to the central 10 arcmin of the field of view and to energies lower than 4.5 keV. Within this domain, the encircled energy funtion is estimated to be accurate to better than 5 % for extraction window radii included between 20 arcsec and 2 arcmin (see Fig.3)
- The image section of the CCF files contains a library of FITS images which were generated using scisim in combination with a numerical model of the x-ray telescopes [2]. In-orbit calibration verifications (see fig.1) indicates that the in-orbit telescope PSFs are identical to the on-ground measurements [3] [4]. Hence, the accuracy of the FITS files provided in the CCF image library can be estimated by comparing on-ground calibration test measurements with simulation results. Figure 2 indicates that simulated encircled energy functions at 1.5 keV agree with on-axis PANTER measurements to an accuracy better than 3 % accuracy. The accuracy at 8 keV then degrades to about 5 % for a 30 arcsec radius of the extraction window. The PSF core of the XRT1 and XRT3 telescopes at low energies exhibit a triangular shape which is not describe by the numerical model. A more accurate description of the core of the telescope PSFs is provided by the multi-Gaussian fit.

References

[1] Christian Erd, Phillipe Gondoin, David Lumb, Rudi Much, Uwe Lammers, and Giuseppe Vacanti. *Calibration Access and Data Handbook*. XMM-PS-GM-20, issue 1.0, ESA/SSD, September 2000.

[2] Ph. Gondoin, B. Aschenbach, H. Brauninger, D. de Chambure, J.P. Colette, R. Egger, K. van Katwijk, D. Lumb, A. Peacock, Y. Stockmann, J.P. Tock, and R. Willingale. *Simulation of*

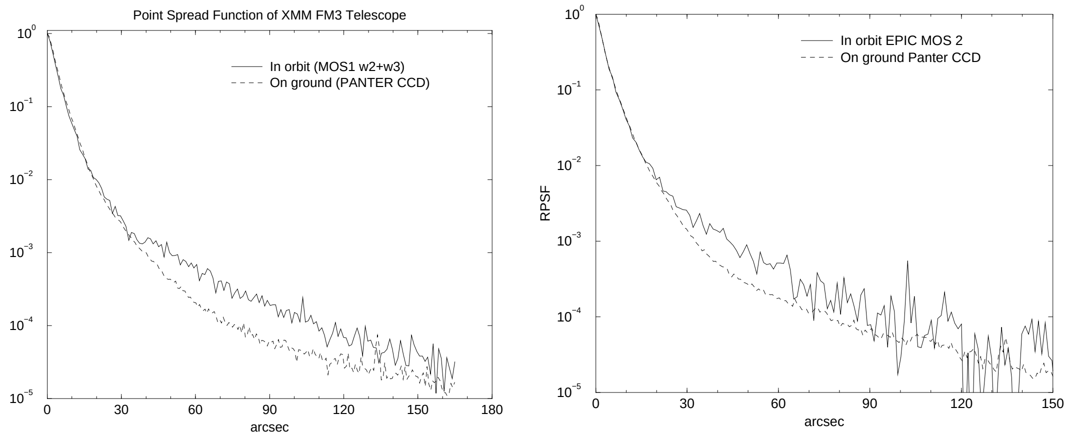

Figure 1: PSF of the XRT1 (left) and XRT2 (right) telescope measured with the MOS1 and MOS2 camera operating respectively in window and full frame mode. The radial energy distributions of the PSFs measured in-orbit are identical to on-ground measurements within the accuracy limit of background substraction.

the XMM Mirror Performance based on Metrology Data. In *SPIE Proc.*, volume 2808, pages 390–401, 1996.

[3] Ph. Gondoin, B. Aschenbach, M. Beijersbergen, R. Egger, F. Jansen, Y. Stockman, and J.P. Tock. *Calibration of the first XMM flight mirror module: I. Image Quality.* In *SPIE Proc.*, volume 3444, page 278, 1998.

[4] Ph. Gondoin, B. Aschenbach, C. Erd, D.Lumb, S. Majerowicz, D. Neumann, and J.L.Sauvageot. *In-orbit calibration of the XMM-Newton telescopes.* In *SPIE Proc.*, 2000.

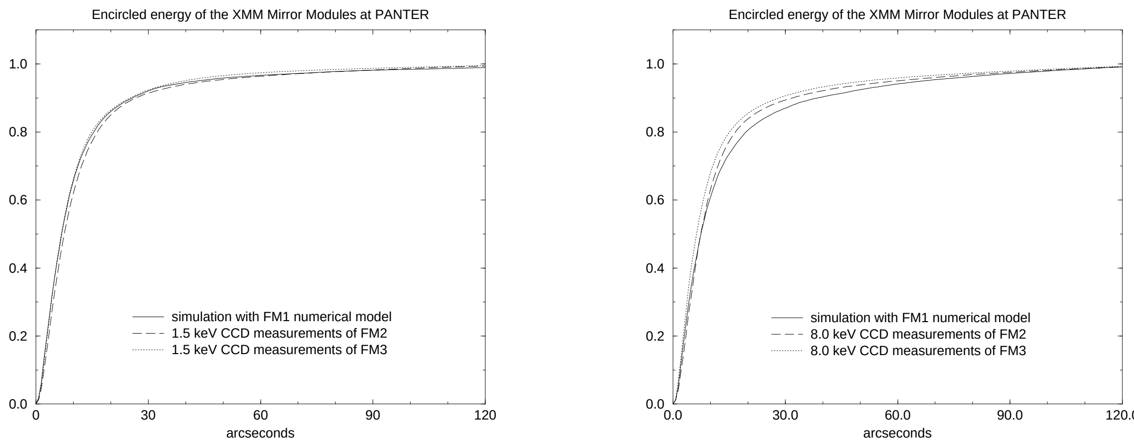

Figure 2: Encircled energy functions of the XRT3 (FM2 module) and XRT1 (FM3 module) telescopes measured at Panter respectively at 1.5 keV (left) and 8 keV (right). The measurements are compared with simulation results using the numerical model which was used to build the PSF image library in the CCF files.

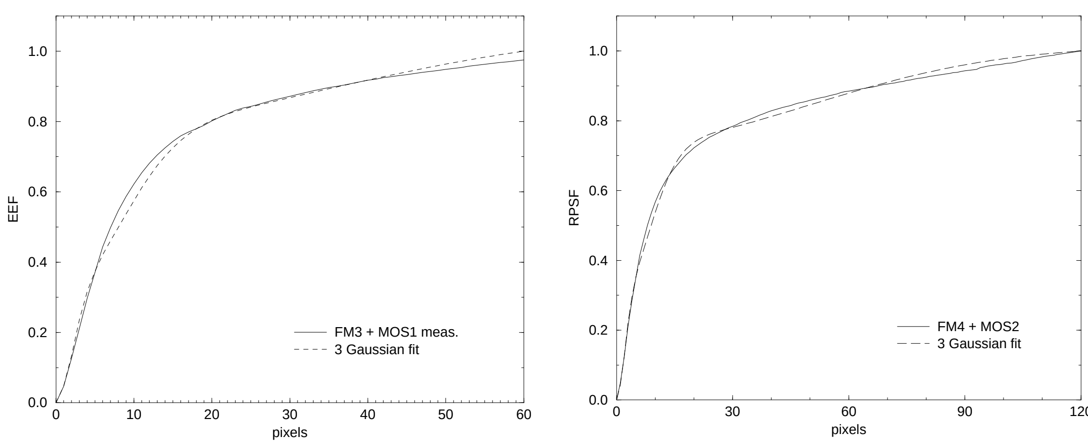

Figure 3: Encircled energy functions of the XRT1 and XRT2 telescopes measured in-orbit. The measurements are compared with the multi-Gaussian analytical fit which parameters are provided in the CCF files.