XMM-Newton CCF Release Note

XMM-CCF-REL-183

EPIC-pn spectral response

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11 November 2004

1 CCF components

Name of CCF	VALDATE	Blocks changed	XSCS flag
EPN_QUANTUMEF_0015.CCF	2000-01-01	FRACTION_CHANNEL, FRACTION_ENERGY QE_TOTAL, EBINS_FRACTION	NO
EPN_REDIST_0009.CCF	2000-01-01	NOISE_PARAMS, PARTEVENT_PARAMS THRESH_LOSS	NO

2 Changes

Recent calibration work has shown that the Epic-pn redistribution function is in practice narrower than that represented in the current matrices. In this release the redistribution, especially at low energies, has been sharpened and is now in better agreement with the results from ground calibration.

The number of energies has been increased from 1319 to 2067 to provide a better description of the redistribution function around sharp features.

A technical change has been introduced in this release with some hard-coded redistribution parameters being moved from the code into the EPN_REDIST CCF file. This will allow the redistribution matrices to be modified between releases of the SAS software by CCF upgrades. In detail the EPN_REDIST CCF now contains an extension NOISE_PARAMS which contains a 6 element vector for each observing mode, and independently for single and double-pixel events, that can be used to calculate the width and height of the main redistribution peak. It also contains the extension PARTEVENT_PARAMS that holds the arrays TAU_IN, S_IN and L_IN as a function of photon energy. A placeholder extension THRESH_LOSS has been added which may eventually be used to hold the thresholding parameters for each detector mode. This is currently not used in the code and is set to zero in this release. The normalisation of the shelf is contained in the attribute FLATSHLF in the header of the primary array and the Silicon escape fraction in the keyword SIESCFRN. The constant, C, used in the redistribution calculation is held in the keyword C_IN within

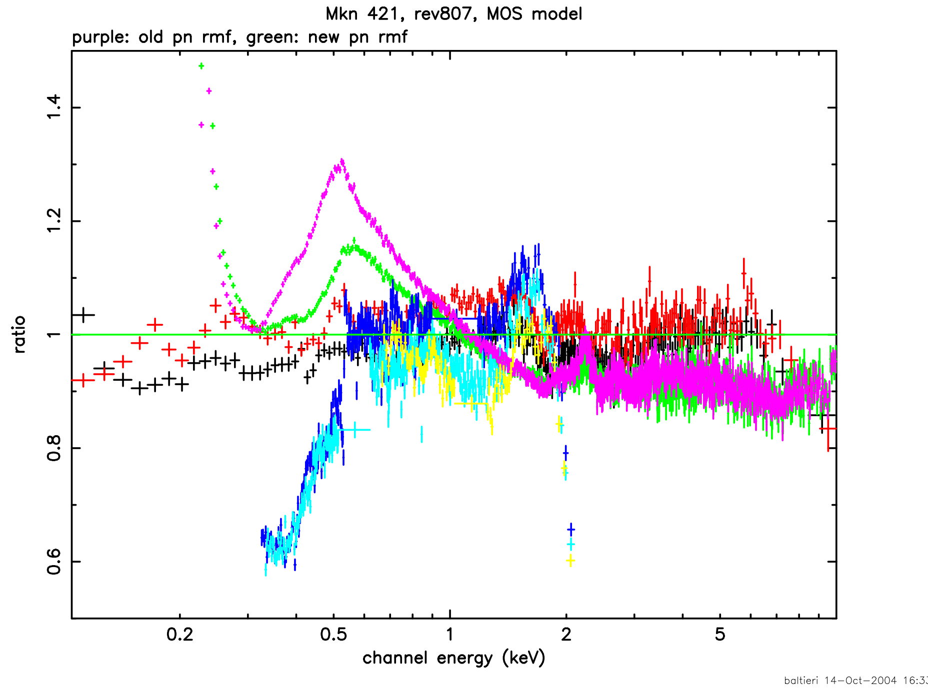

Figure 1: Residuals from a simultaneous fit to an observation by Epic-pn, MOS and RGS of the blazar MKN 421. The difference between the MOS and pn spectra has reduced from a peak of 30% at 0.5 keV with the current pn redistribution function to 15% with the new one.

the header of the PARTEVENT_PARAMS extension.

In the quantum efficiency CCF no calibration change has been introduced. The pattern fractions in energy space and total quantum efficiency have been extended to cover 2067 bins and the fractions in channel space have been recalculated to be consistent with the new redistribution function.

3 Scientific Impact of this Update

While the discrepancy between Epic-pn and MOS spectra continues to be a source of intense calibration activity this update demonstrably improves the agreement of the three cameras below 1 keV. Figure 1 shows the change observed on a revolution 807 observation of the blazar MKN 421.

The redistribution has been defined at finer energy intervals to enable spectral fitting software to more accurately calculate line centre positions. For instance around neutral Iron Kα (6.4 keV) the redistribution function is now stored at 15 eV intervals whereas it was previously tabulated only every 50 eV. This means that the best fit line energy may be found with `xspec` to the nearest 15 eV whereas previously the line energy was quantised to the nearest 50 eV.

Now that the important parameters of the redistribution function are contained within the CCF it will be easier to disseminate improvements in the calibration to the user base.

4 Estimated Scientific Quality

This update improves the agreement between the MOS and PN cameras at 0.5 to 1 keV to about 15%. However, this is a complicated subject with observations made at different times appearing to show varying levels of agreement between the cameras. The reader is urged to consult XMM-SOC-CAL-TN-0052 for a more in-depth analysis.

5 Expected Updates

6 Test procedures

Test 1: These changes have been tested within the response matrix generation task *rmfgen* by producing matrices for single, double and single plus double pixel event spectra for all the observing modes and comparing them against canned matrices produced by separate software at MPE.

7 Test results

Test 1: Figure 2 shows that the redistribution function for a single-pixel event spectra taken from a PrimeFullWindow mode observation is consistent with the canned matrix. The results for a double-pixel small window mode spectrum and a single plus double-pixel Timing mode observation are shown in Figures 3 and 4. In all cases the SAS generated matrix is nearly identical to the canned matrix.

8 Compatibility issues

The change introduced in the CAL and CALPNALGO code is not backwards compatible and so, while the new CCF files EPN_REDIST_0009 and EPN_QUANTUMEF_0015 can be used with earlier versions of the SAS, the new SAS, Version 6.1, can only be used with these or later CCF versions.

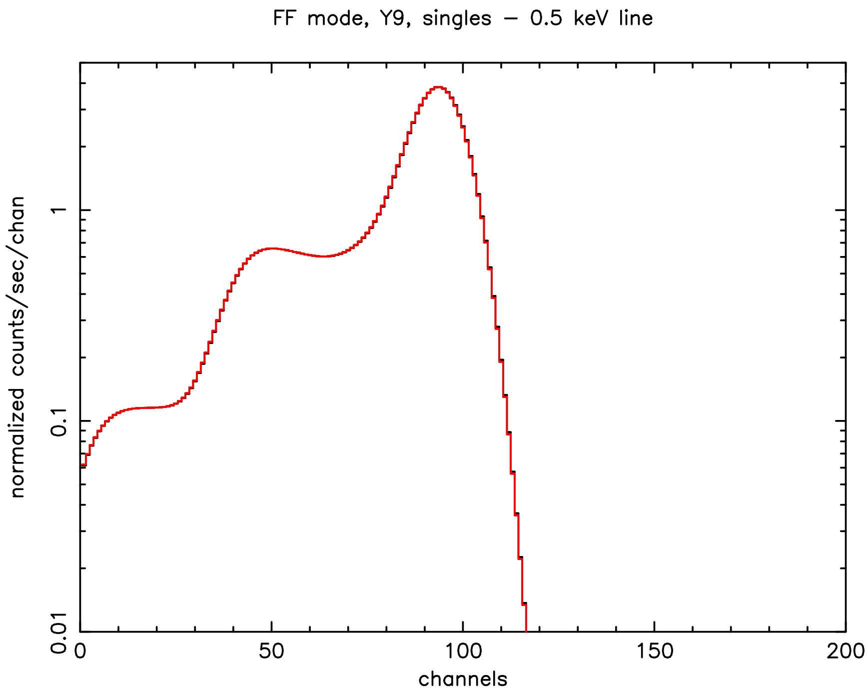

Figure 2: A comparison of the redistribution functions for a full frame, single-pixel-only event spectrum of a 0.5 keV emission line. The SAS-generated and canned matrices are indistinguishable.

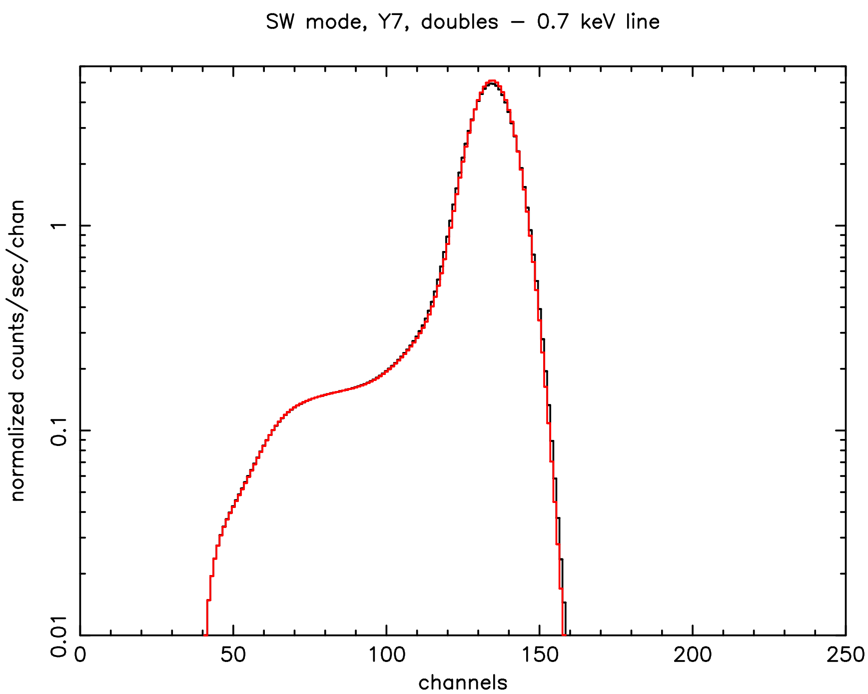

Figure 3: A comparison of the redistribution functions for a small window mode, double-pixel-only event spectrum of a 0.7 keV emission line. The differences between the SAS-generated and canned matrices are minimal.

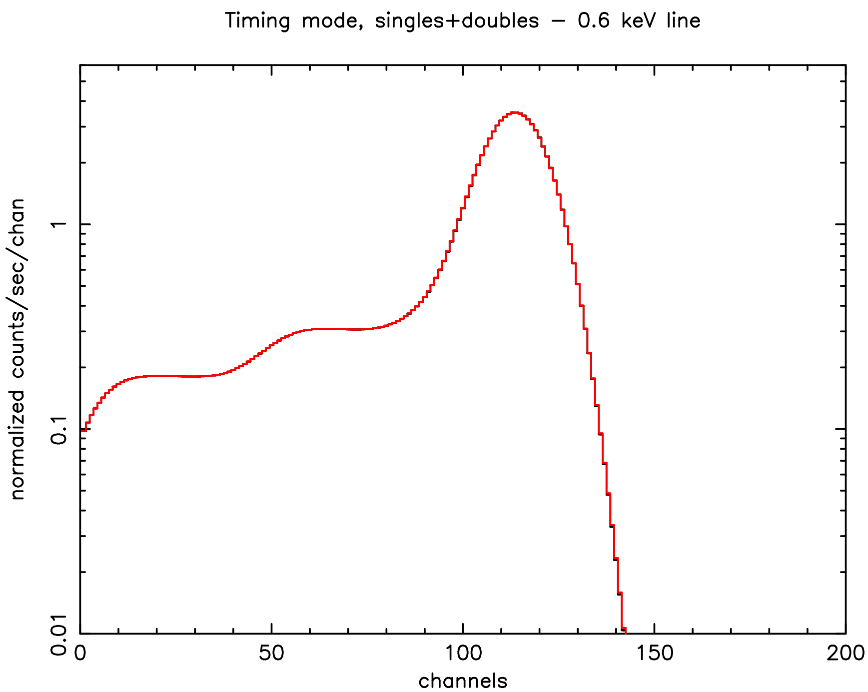

Figure 4: A comparison of the redistribution functions for a timing mode, single-plus-double-pixel event spectrum of a 0.6 keV emission line. The SAS-generated and canned matrices are indistinguishable.