XMM-Newton CCF Release Note

XMM-CCF-REL-189

EPIC-pn spectral response

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1 CCF components

Name of CCF	VALDATE	Blocks changed	XSCS flag
EPN_QUANTUMEF_0016.CCF	2000-01-01	FRACTION_ENERGY	NO
EPN_REDIST_0010.CCF	2000-01-01	PARTEVENT_PARAMS	NO

2 Changes

This release contains an improvement in the low-energy (below 1 keV) response function which has been made more peaked to better fit the spectra of continuum sources (Fig. 1).

These changes lead to a modification of the pattern fractions stored in the quantum efficiency file (EPN_QUANTUMEF_0016.CCF), otherwise there has been no material change to the quantum efficiency calibration.

3 Scientific Impact of this Update

An ensemble of blazar spectra have been individually fit, over the 0.15–1.5 keV energy band, with a single power-law plus galactic absorption model. The resulting residuals show a characteristic shape which is repeated across the sample (Fig. 2). While the spectral model employed may not be perfect for each individual source, due to uncertainties in the galactic absoption parameterisation or possible spectral breaks within the fitted band, the consistency of the results argues strongly for a problem with the modelling of the instrumental response. The reason for this is not currently understood in terms of physical effects in the detector. In this release an empirical tweak is applied to the redistribution function below 1 keV to flatten out the observed residuals (Fig. 2).

While this change has been made without reference to other instruments it is worth

noting that it brings the fits on continuum sources into better agreement with those of EPIC-MOS.

A long standing problem with fits to EPIC-pn spectra is that they tend to return absorption columns which are too low by $\sim 7 \times 10^{19}$ cm^{-2} compared with radio measurements and fits to Chandra and EPIC-MOS spectra. Perhaps the clearest example of this is the isolated neutron star RXJ 1856.5-3754, where Chandra LETG and HRC spectra are well fit by a 61 eV black-body model with an inter-stellar absorption $N_H = 9.5 \pm 1.5 \times 10^{19}$ cm^{-2} [1]. While EPIC-pn and EPIC-MOS both measure a similar temperature to Chandra and MOS returns a similar absorption value ($6.7 \pm 0.2 \times 10^{19}$ cm^{-2}), the pn spectra yields an N_H of $1.8 \pm 0.3 \times 10^{19}$ cm^{-2} [2]. A fit with the new calibration presented here gives $N_H = 7.1 \pm 0.3 \times 10^{19}$ cm^{-2} (Fig. 3) in much better agreement with the other instruments.

It should be noted that the change introduced here affects all pn observing modes.

4 Estimated Scientific Quality

Fits to continuum spectra now agree with the MOS from 0.2 to 5 keV to within 5% but show an excess of $\sim 10\%$ at the very lowest energies.

Gross errors in the pn returned absorption columns have been addressed. Remaining errors have not been quantified but are likely to be at the $1 - 2 \times 10^{19}$ cm^{-2} level.

Fits to low-energy spectral lines show an improved chi-squared but are still not perfect.

5 Expected Updates

6 Test procedures

Test 1: The response matrix generation task *rmfgen* has been tested against canned matrices produced by separate software running at MPE for single, double and single plus double pixel spectra.

7 Test results

Test 1: In all cases the matrices produced by SAS were nearly identical to the canned matrices.

References

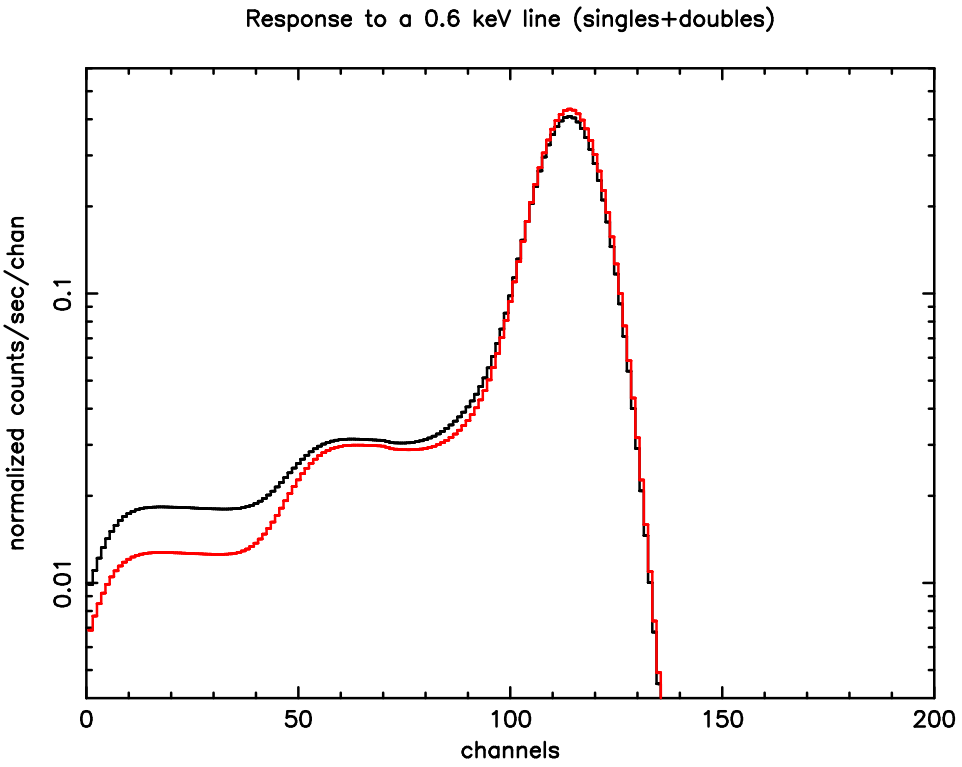

Figure 1: The change in the shape of the pn redistribution function at 0.6 keV. An increase in the peak height of 6% is visible in the new (red) curve compared with the old one (black).

[1] Drake et al. 2002, ApJ, 572, 996

[2] Burwitz et al. 'The thermal radiation of the isolated neutron star RX J1856.5-3754 observed with Chandra and XMM-Newton' (in prep.)

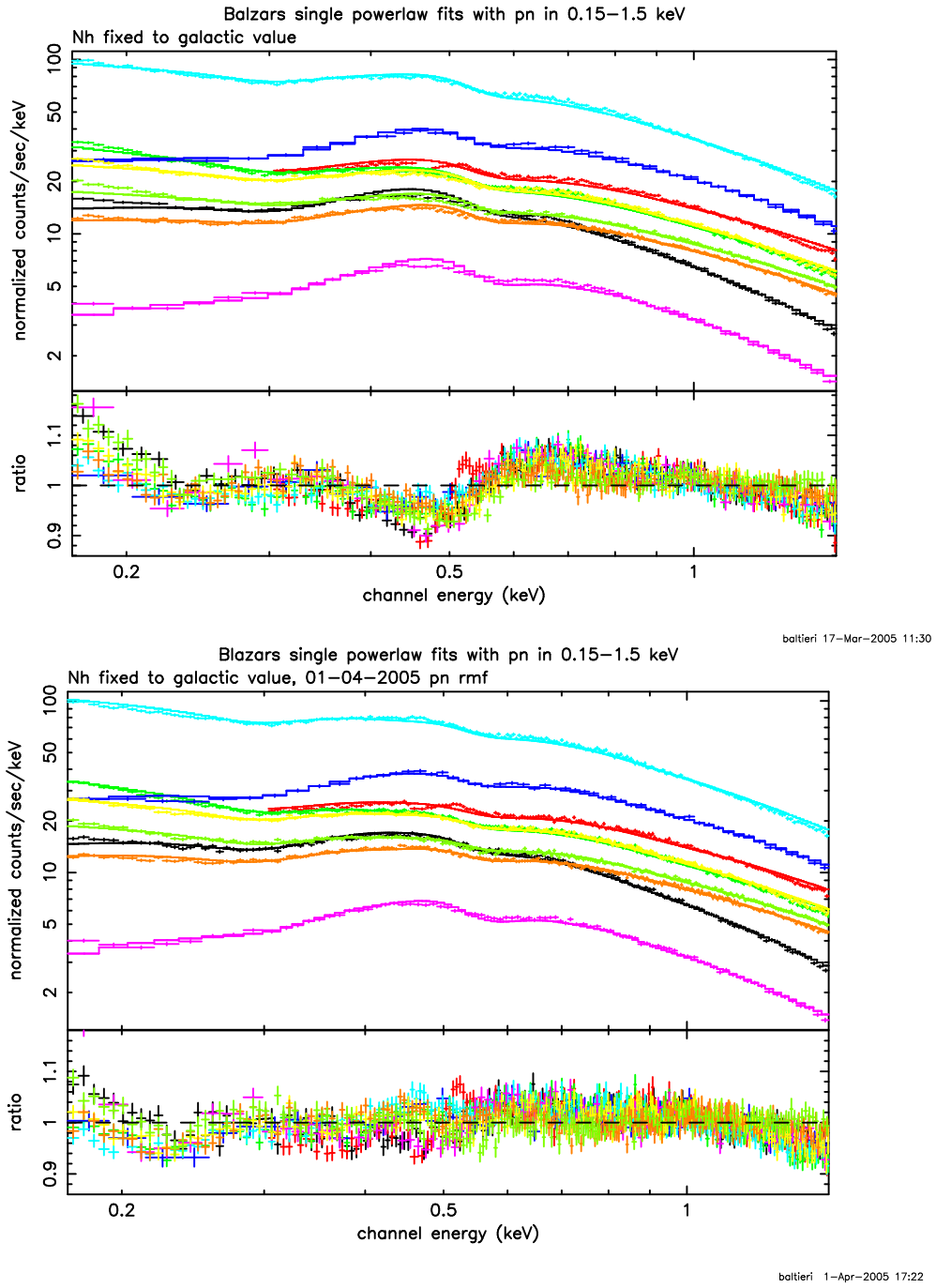

Figure 2: The best fit and residuals from a fit of an absorbed power-law to the 0.15 - 1.5 keV pn spectra of the blazars, MKN 421, PKS 2155, MKN 501, 1H 1219, PKS 0548, H 1426+428, MKN 180 and 1H 0414. Top panel: SAS 6.1 responses based on EPN_QUANTUMEF_0015.CCF and EPN_REDIST_0009.CCF; Bottom panel: Responses based on EPN_QUANTUMEF_0016.CCF and EPN_REDIST_0010.CCF.

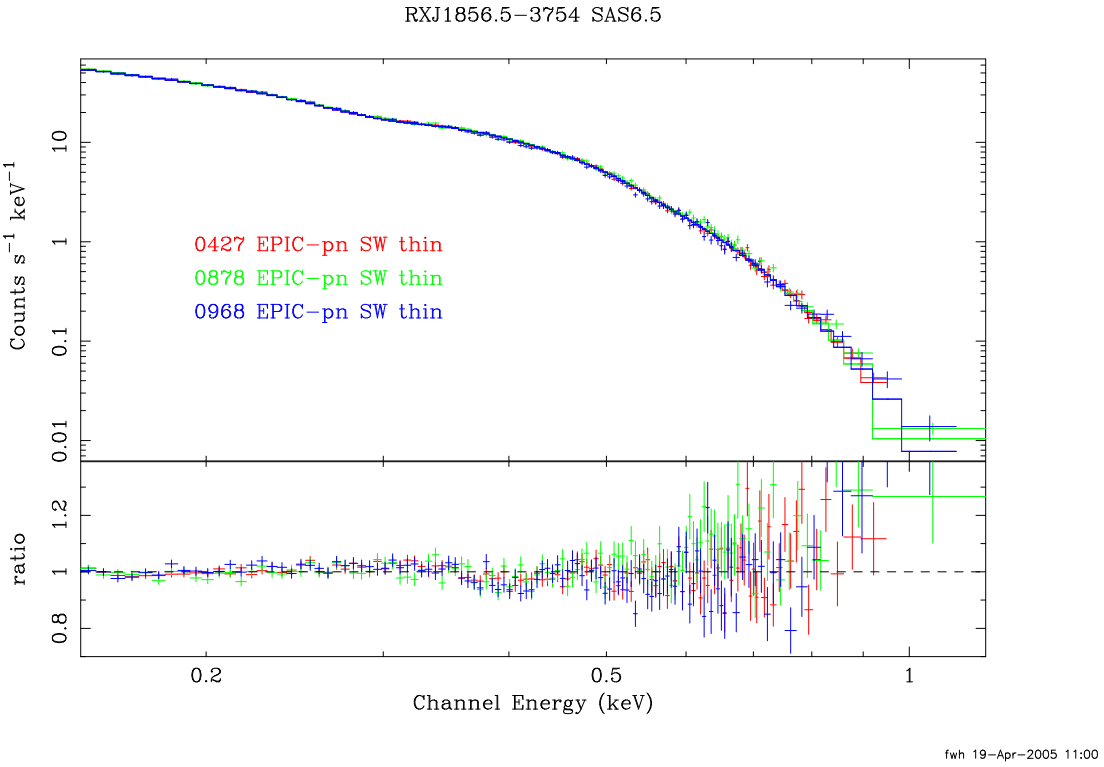

Figure 3: Black-body (kT=62.3 eV) fit to three thin filter observations of RXJ 1856-3754 taken at different epochs. The mean nH=7.1 $\times$ 10^{19} cm^{-2}.