

# XMM-Newton CCF Release Note

XMM-CCF-REL-337

## EPIC-pn Pattern Fraction

M.J.S. Smith, F. Haberl

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### 1 CCF Components

Name of CCF	VALDATE	EVALDATE	Blocks Changed	XSCS Flag
EPN_QUANTUMEF_0018.CCF	2000-01-01T00:00:00		FRACTION_CHANNEL FRACTION_ENERGY	NO

### 2 Changes

The event pattern fractions contained in the `FRACTION_CHANNEL` and `FRACTION_ENERGY` extensions of the `EPN_QUANTUMEF` CCF are used to properly weight the pattern-dependent responses when creating the RMF matrices in e.g. `rmfgen`. In addition, expected pattern fractions can be compared to those observed in order to evaluate data for potential pile-up; this may be done with the `epatplot` task.

This release note describes a modification to the EPIC-pn event pattern fractions following the introduction of the empirical doubles event energy correction in SAS 14.0 (Smith et al., 2014). The energy dependent shift applied by this correction to double events affects their energy dependent distribution. Although single event energies are not modified, for a given energy their pattern fraction will be affected. Therefore, both single and double event pattern fractions should be recalibrated with respect to the existing pattern fraction curves. As the empirical doubles event energy correction is only applied to imaging modes, Timing and Burst Mode fractions are not modified.

The existing pattern fractions are based on those originally derived empirically from in-orbit data, see e.g. Saxton (2002) for details. In the current release, these data were modified using the known energy dependence of the doubles energy shift.

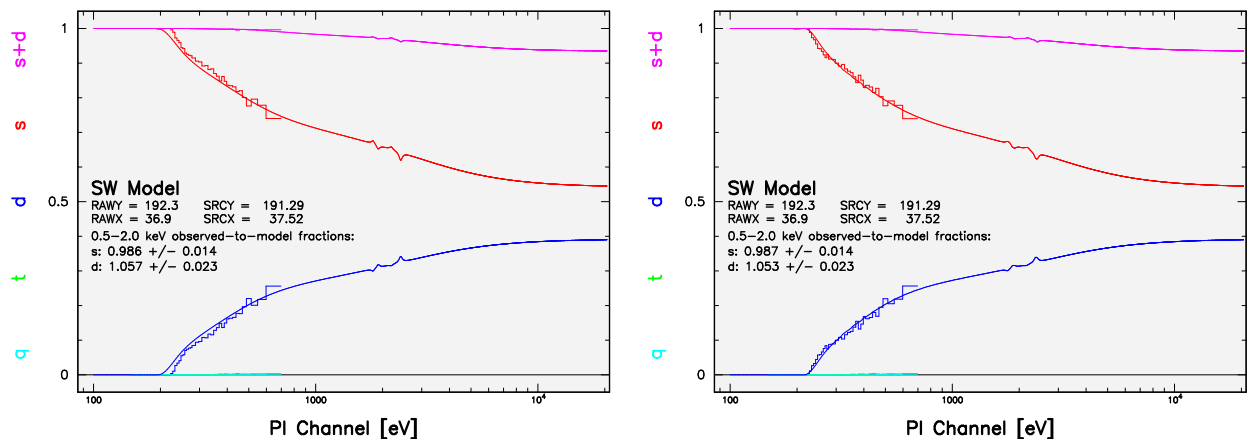


Figure 1: Comparison of expected (drawn line) with measured (histogram) pattern fractions versus energy, obtained with the `epatplot` task. Singles and doubles fractions are shown in red and blue, respectively. The left panel shows the situation with the current fraction models. The right panel shows the results obtained with the modified pattern fractions. Data were obtained from a Small Window Mode observation of RX J1856.5-3754 (ObsID 0412600401).

### 3 Scientific Impact and Estimated Quality

The change in pattern fraction will be most evident at low energies, where both the fractional shift in energy and the gradient in pattern fractions are large. The isolated neutron star RX J1856.5-3754, a soft source with a spectrum well described by a  $\sim 61$  eV black body emission, was used to evaluate the impact of the changes. The data used in the analysis were obtained from Small Window Mode where the source is not affected by pile-up.

Fig. 1 shows the comparison of expected with observed pattern fractions using the `epatplot` task. The model curve which is based on the currently implemented pattern fractions shows discrepancies with respect to the measured fractions below  $\sim 0.4$  keV. The deviations are consistent with those expected due to the empirical doubles event energy correction. The modified pattern fractions yield substantially reduced data-to-model deviations.

The spectral impact of the modified pattern fractions are illustrated in Fig. 2. Here singles-only and doubles-only data are compared to a spectral fit on the combined data. The model used is a photoelectrically absorbed black body emission. The current pattern fractions show significant spectral discrepancies between singles and doubles. The modified pattern fractions result in a much greater consistency between the two.

In comparing the current and new calibration it should be noted that, in terms of spectral parameters, significant differences will only be seen in doubles-only data. Owing to the dominance of singles at these low energies, singles-only (and even singles plus doubles) spectra will likely not show significant differences neither in parameter values nor in quality of fit.

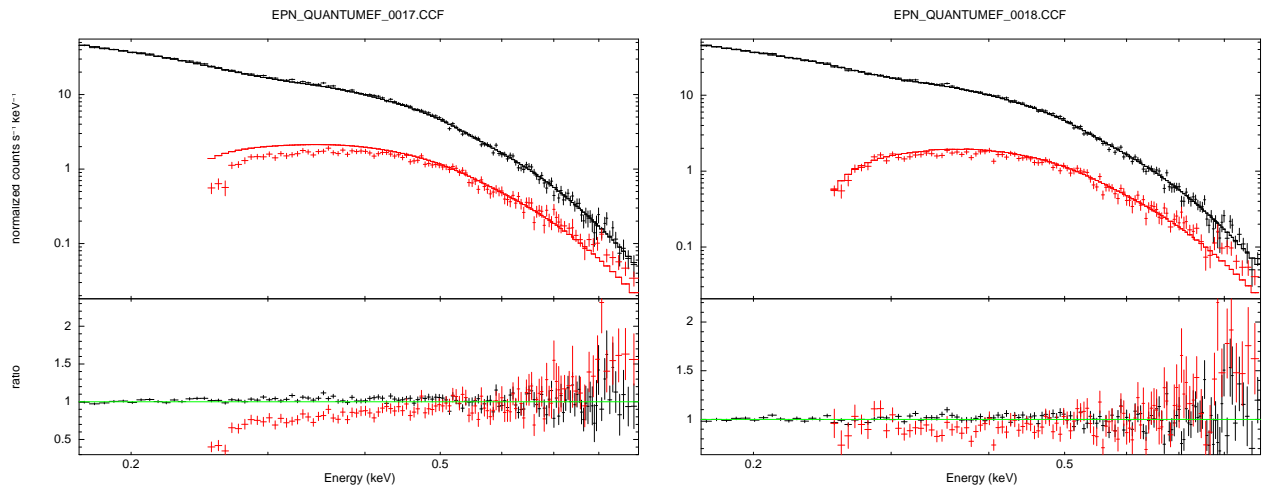


Figure 2: Data and spectral fits of a Small Window Mode observation of RX J1856.5-3754 (ObsID 0412600401) using single-only events (black) and double-only events (red). Results using the current and modified fractions are shown in the left and right panels, respectively. The spectral fits are obtained from the combined singles and doubles spectra.

## 4 Test Procedures

Verification of functionality of EPN\_QUANTUMEF\_0018.CCF with SAS 15.0: `cifbuild`, `epatplot`, `rmfgen`.

## 5 Expected Updates

No further updates are anticipated.

## 6 References

- Saxton, R.D., 2002, XMM-SOC-CAL-SRN-0112  
 (<http://xmm2.esac.esa.int/docs/documents/CAL-SRN-0112-1-0.ps.gz>)  
 Smith, M.J.S., et al., 2014, XMM-SOC-CAL-SRN-0323  
 (<http://xmm2.esac.esa.int/docs/documents/CAL-SRN-0323-1-1.ps.gz>)