Title : **System offsets using diagnostics images**

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1 Introduction

At this moment, SAS default processing uses a constant system peak offset for each CCD node. However, it was noted that warm pixels can often be characterized by having a different (higher) system peak. Therefore it can be expected that data quality can improve by using individual system peak offsets for each pixel. These pixel offsets can be retrieved by averaging diagnostics images.

This short report investigates the possible improvement in data quality by using these diagnostics offsets.

2 Data and reduction

The data used was observation 0153950601 on Mkn421 in revolution 440. Mkn421 offers a bright source with sufficient statistics in a single observation with a relatively simple smooth power law spectrum. Rev 0440 is the last Mkn421 observation prior to cooling, suffering from considerable number of warm/hot pixels due to radiation damage.

For the diagnostics offsets, to get sufficient statistics, the diagnostics images from 3 orbits around revolution 440 were used: revolutions 339, 440, 441. For each pixel an average PHA value was fitted, throwing away outlier values due to cosmic events and real X-rays.

The data were both processed in the default way (single system peak value) and using the diagnostics averages. These results were compared by fitting absorbed power law spectra in XSPEC using a fixed absorption of $N_{\rm H} = 1.66 \times 10^{20}\ {\rm cm}^{-2}$.

3 Analysis

Fig 1 shows the result of the default processing. Fig 2 shows the diagnostics average processing result. It is clear that the 'outliers', especially concentrated towards lower energies, are much less frequent in the diagnostics averaging processing result.

The total χ^2 of the fit residues is dominated by possible large scale errors in the effective area and deviations of the real source spectrum from a perfect single power law. To remove these effects and to quantify the reduction in outliers and systematic noise, the fit residues were subtracted from a running average of 9 wavelength bins. The result is visualized in fig 3.

This figure shows the histogram of remaining fit residues. Clearly in the case of default processing the histogram shows much more extended tails, which consist of the 'outliers' mentioned before. The total χ^2 of these fit residues is:

- Default processing: $\chi^2 = 1.6$
- Diagnostics processing: $\chi^2 = 1.1$

As can be seen from the Gaussian fits, which are mainly sensitive for the bulk of bins in the histogram center and hardly for the tails, the majority of wavelength bins which do not suffer from bad pixels is not affected by the diagnostices processing, as can be expected.

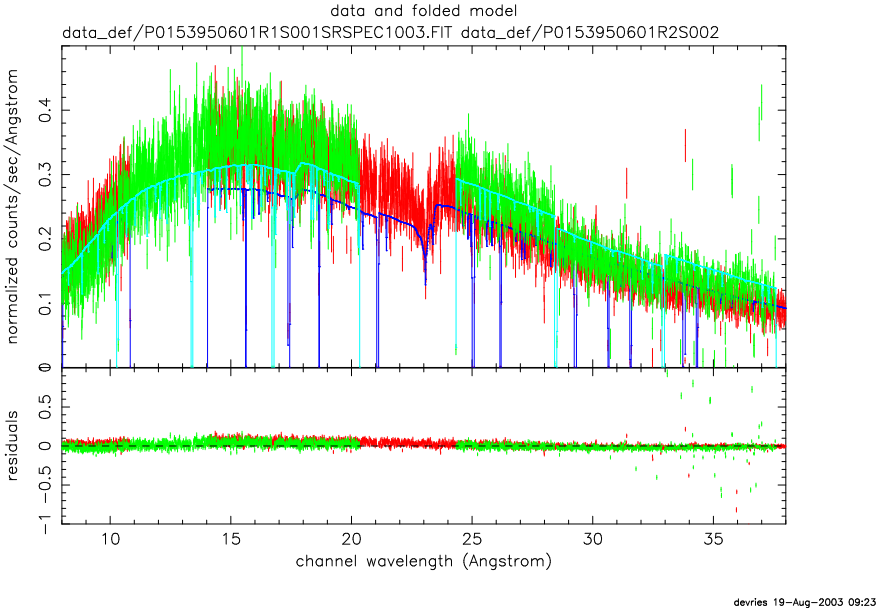

Figure 1: Default processing using a single system-peak offset for all pixels. ‘Outliers’ occur especially towards lower energies.

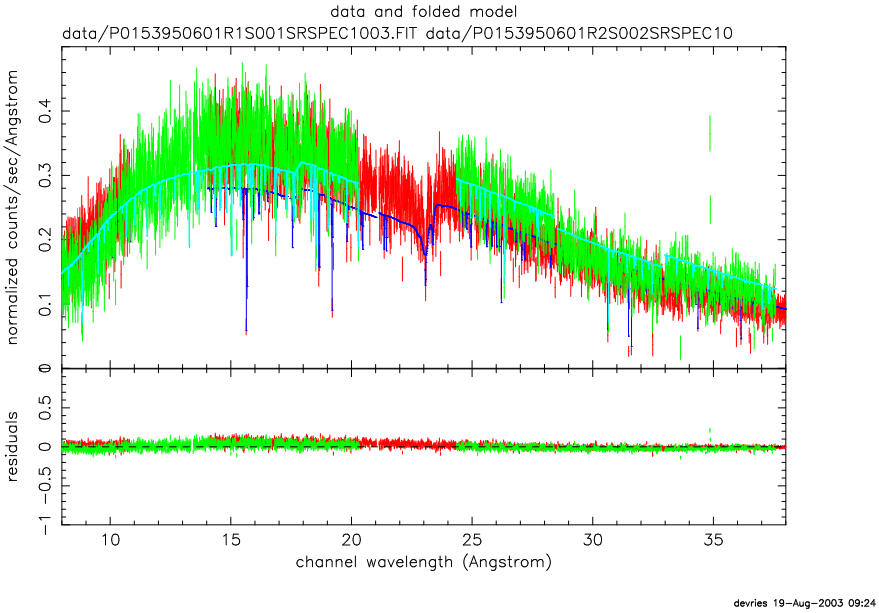

Figure 2: Processing using system-peak offsets per pixel from the diagnostics averages. ‘Outliers’ are very much reduced (compare fig 1).

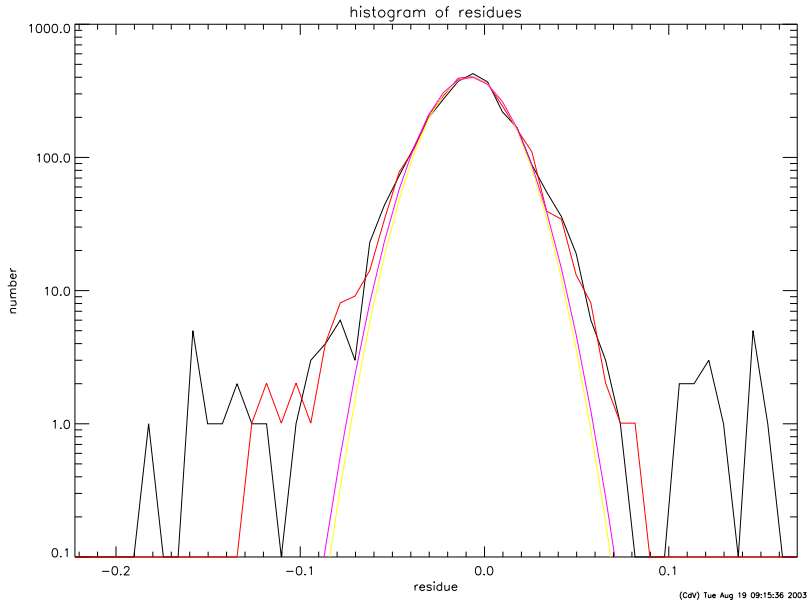

Figure 3: Histogram of residues for the default processing (black line) and the diagnostics averages system peaks (red line). Gaussian fits to these histograms are shown by the yellow line (default processing) and purple line (diagnostics processing). It follows that the main difference between default and diagnostics processing is the reduction of the number of ‘outliers’ in the tails of the distribution, for the diagnostics processing.

4 Conclusions

It can be concluded that the ‘diagnostics processing’ does offer clear advantages. ‘Outliers’ from warm pixels are clearly removed and notably the quality of the long wavelength area of the spectrum is improved. In order to offer this processing option in the SAS, task “rgsenergy” must be changed and averaged diagnostics files be made available, or all diagnostics data combined with a new SAS diagnostics averaging task.