

# epxrlcorr

April 16, 2023

## Abstract

A routine to correct a raw EPIC-pn event file for the effects of X-ray loading.

## 1 Instruments/Modes

Instrument	Mode
EPIC-pn	IMAGING

## 2 Use

pipeline processing	no
interactive analysis	yes

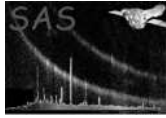
## 3 Description

Reconstruction of X-ray event energies requires a knowledge of the level of dark-current present in each CCD pixel. This is estimated on-board, for the EPIC-pn camera<sup>1</sup>, by making a special reading of the first 50 or 100 exposed frames. An offset map is then calculated by taking the average charge in each pixel, after discarding the highest three and lowest three charges. The resulting map is important for removing the effect of optical loading, where many optical photons can bias upwards the apparent energies of X-ray photons.

A problem occurs when the X-ray source is bright and, for a given pixel, more than three of the first 50 (or 100) frames contain X-ray photons. This leads to an effect known as *X-ray loading* where the dark-current is over-subtracted from events falling in affected pixels and hence energies appear artificially low. The flux level where this becomes important is roughly the same as that when pile-up effects occur.

This task, **epxrlcorr**, attempts to correct event energies by statistically estimating deviations in the offset map caused by X-ray loading. For a more complete description of X-ray loading in the EPIC-pn camera please see XMM-SOC-CAL-TN-0050.

<sup>1</sup>The EPIC-MOS cameras do not suffer from X-ray loading as they use a fixed offset map



### 3.1 The correction procedure

- Produce a map of the X-ray loading, from the original offset map, by removing the median of the columns and then the median of the rows from each pixel. Any peaks in the resulting map are due to loading.
- Loop over each charge in the EPIC-pn raw event file and **increase** its charge by the value in the X-ray loading map.

NB: **epxrlcorr** cannot distinguish between X-ray and optical loading. The task should not be used on optically bright sources (see the XMM-Newton user handbook for more details).

### 3.2 Input

An EPIC-pn raw event file from an imaging mode observation or an EPIC-pn event file produced by **epframes**.

### 3.3 Output

A new file, identical to the input file but with the X-ray loading correction applied to the ENERGY (or PHA) column. The original energy of the charges is stored in a new column called ENERGY\_ORIG.

## 4 Examples

```
epxrlcorr eventset=2384_0691100201_PNS00301IME.FIT outset=eventsXRLC01IME.FIT
```

corrects the events from the input raw event file, 2384\_0691100201\_PNS00301IME.FIT, for X-ray loading and writes the corrected events into the file eventsXRLC01IME.FIT

```
epxrlcorr eventset=rawevents04.dat
```

corrects the events from the input event file, rawevents04.dat, and writes the corrected energies back into the same file.

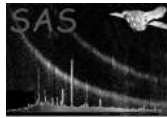
```
epxrlcorr eventset=rawevents04.dat xrlimage=xrlimage04.ds
```

corrects the events from the input event file, rawevents04.dat, and produces an image, xrlimage04.ds, that contains the correction which has been applied in each raw pixel.

## 5 Parameters

This section documents the parameters recognized by this task (if any).

Parameter	Mand	Type	Default	Constraints
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<b>eventset</b>	yes	dataset		
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The name of the input event file.

<b>withoutset</b>	no	boolean	no	
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Write output to a new file ? If set true then a new file is created with filename determined by the **outset** parameter. If set false then the input file is overwritten.

<b>outset</b>	no	dataset	eventsxrd.ds	
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The name of the output event file.

<b>offsetmap</b>	no	dataset		
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The name of an input offset map. If an offset map is not supplied on the command line then the task will attempt to find the appropriate offset map for the input event file from the directory pointed to by the environment variable SAS\_ODF.

<b>withxrlimage</b>	no	boolean	no	
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Produce a diagnostic image, **xrlimage**, containing the X-ray loading corrections which have been applied.

<b>xrlimage</b>	no	dataset	xrlimage.ds	
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The name of the output diagnostic X-ray loading corrections image.

## 6 Errors

This section documents warnings and errors generated by this task (if any). Note that warnings and errors can also be generated in the SAS infrastructure libraries, in which case they would not be documented here. Refer to the index of all errors and warnings available in the HTML version of the SAS documentation.

### **UnsuportedObservingMode** (*error*)

Only imaging modes are supported by this task

### **NoEventBlock** (*error*)

The input event file has not got a block called PNIME1 or EVENTS

### **XRLCorrected** (*error*)

The input file has already been corrected for X-ray loading. It knows this because the header contains the keyword XRL\_CORR set to true.

### **NoEventSet** (*error*)

The input event file was not found or is in an unrecognised format.

### **MissingKeyword** (*error*)

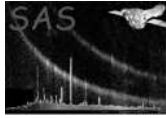
The input event file does not contain an essential keyword.

### **NoOffsetMap** (*error*)

An offset map could not be found corresponding to the input event file.

### **NoOffsetData** (*error*)

The offset map did not contain a block called PNODI1.



## 7 Input Files

- an EPIC-pn raw event file or an EPIC-pn event file produced by **epframes**.

## 8 Output Files

An EPIC-pn raw event file corrected for X-ray loading

Optionally, a FITS image giving the correction which has been applied in each EPIC-pn detector pixel.

## 9 Algorithm

Takes the median in the row direction and subtracts it from the whole map. Then it takes the median in the column direction and subtracts it from the offset map. Remaining values, in each pixel, are added onto each event.

NB: This task should not be used for sources which suffer from optical loading.

## 10 Comments

## References