emtaglenoise

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Abstract

Task to identify and tag low-energy noise in the MOS CCDs in anomalous states according to Kuntz and Snowden (2008).

1 Instruments/Modes

Instrument	Mode
EPIC MOS	Imaging

2 Use

pipeline processing	yes
interactive analysis	yes

3 Description

The task **emtaglenoise** writes a new attribute called LENOISnn, for each of the MOS CCDs nn = 02–07, to an EPIC MOS calibrated event list generated by **emchain** or **emproc**, or from the Pipeline Processing Products; the value of this attribute is 1 if the corresponding CCD is in an anomalous state, and 0 otherwise. The current version of this task does not consider the central CCD (nn = 01) at all; see Section 9 for details.

An 'anomalous state' (Kuntz and Snowden, 2008 [1]), aka the 'MOS2CCD5 effect' (Stuhlinger, 2008 [2]), or 'electron noise in CCD 5 bands 1 and 2' (SSC data screening team), manifests itself as elevated event rates between 0 and 1 keV, forming a plateau in the event spectrum. This effect appears most frequently, but not exclusively, in MOS 2 CCD 5. It has been present in short phases since the beginning of the mission, but became continuous since Revolution 874. No switch-on/off has been detected within an observation; the event times are consistent with Poisson statistics, and the spatial distribution is fairly (but not entirely) homogeneous both within and outside the field of view. Events rarely repeat at the same pixels in the same observation. Patterns 0, 2 and 4 occur more frequently than in ordinary events.

Both Kuntz and Snowden and Stuhlinger have proposed ways to identify the presence of this effect given an EPIC MOS observation. As of January 2009, the true cause of the effect is as yet unknown, and there has not been an effective method for its correction. We implement Kuntz and Snowden's method of identification with this SAS task.

The optional parameter `filterbadccds`, if set, allows the user to filter all events in all CCDs tagged as noisy out of the input DataSet. The optional parameter `filteredset` specifies the output filename.

4 Parameters

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

Parameter	Mand	Type	Default	Constraints
eventset	yes	table	—	Valid DataSet containing an EVENTS Table

FITS MOS event list to be analysed and tagged for anomalous state.

filterbadccds	no	boolean	no	yes—no

If yes, filter the input eventset to remove all events at CCDs tagged as in the anomalous state. The filtered DataSet is written to the file specified by the `filteredset` parameter.

filteredset	no	string	filtered.fits	valid filename

Name of the output file to contain the filtered event list with all events at noisy CCDs removed. If the boolean parameter `filterbadccds` is set, but `filteredset` is not, the default output filename is used. Explicitly setting this parameter automatically sets `filterbadccds`=yes.

5 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.

unrecognisedInstrument *(error)*
Value of the INSTRUME attribute of input eventset is neither EMOS1 nor EMOS2.

noGTI *(error)*
The GTI length from the input eventset is determined to be zero.

LENOISnn mismatch *(error)*
This attribute already exists in the input DataSet, and the value in file does not agree with the newly calculated value.

Task not found *(error)*
Failed to call **evselect** for filtering.

invalidSelectionExpression *(error)*
Selectlib expression contains variable(s) other than DETX and DETY. This indicates a bug; please raise an SPR.

CCDNRoutOfRange *(error)*
This indicates a bug; please raise an SPR.

unrecognisedEnergyBand *(error)*
This indicates a bug; please raise an SPR.

noEVENTSextension *(warning)*
The input eventset does not contain an `EVENTS` table.
corrective action: Note that this task cannot tag anything without an event list.

noSTDGTIextension *(warning)*
The input eventset does not contain an `STDGTI` table for at least one CCD.
corrective action: Create `STDGTI` table(s) in the input eventset.

6 Input Files

1. A MOS event list produced by **emchain** or **emproc**, to be tagged, or a MOS event list from the Pipeline Processing Products.

7 Output Files

1. New attributes LENOISnn, nn=02–07, are written to the input eventset.
2. A tagged and filtered DataSet is written to an output file specified by the parameter `filteredset` if `filterbadccds` is set.

8 Algorithm

1. Open the input DataSet, determine if it comes from MOS1 or MOS2, check input errors, initalise counters, and etc.
2. Read the `EVENTS` table extension.
3. Check if each event:
   (a) lies outside the field of view (as defined in Kuntz and Snowden, 2008 [1], Table 3), and
   (b) falls within:
      i. the 2.5– 5.0 keV 'hard' band,
      ii. the 0.4– 0.8 keV 'soft' band, and/or
      iii. the 0.3–10.0 keV count-rate band.
4. For each event that satisfies the conditions above, increment by one the corresponding event counter(s) for the corresponding CCD.
5. For each CCD nn,
   (a) Read the `STDGTInn` table extension.
   (b) Calculate the sum of all GTIs.
   (c) Calculate the hardness ratio H as the ratio of the hard- to soft-band event counts.
   (d) Calculate the event rate R from the event-rate band counter and the GTI sum.
   (e) Test if the values of H and R meet the anomalous criteria as stated in Kuntz and Snowden, 2008 [1], Table 1.

(f) If the CCD is in an anomalous state, set the corresponding bit of the anomalous bit flag.

6. Write the keywords LENOISnn, nn=02–07, to the header of the input DataSet.
7. If parameter `filterbadccds` is set, call **evselect** to filter the input Dataset and write the output to the file specified by `filteredset`.

9 Comments

- Note that Kuntz and Snowden's identification method is applicable only to CCDs 2–7, namely, not the central CCD. Accordingly, this task currently only adds attributes LENOIS02 to LENOIS07 to the input DataSet, emphasizing that CCD 1 is not checked.
- If the good-time-interval extension STDGTInn is missing from the input event list for some CCD nn, then this task skips writing the attribute LENOISnn to the output event list. This feature is for handling user-generated input that may not comply completely with the format of standard SAS event lists. Event lists generated by **emchain**, **emproc** or the Pipeline Processing Products all contain STDGTInn extentions for all CCDs, nn=01–07, regardless of filtering. Thus, no LENOISnn attribute will be skipped.

10 Known bugs and side effects

Version 1.0 of **emtaglenoise** included in SAS 9.0.0 contains two run-time bugs that halt the task with errors. The first appears in low-memory mode only (ie, when the environment variable `SAS_MEMORY_MODEL` is set to 'low'), and affects all platforms (linux, OS/X and solaris). It halts the task with either a segmentation fault or the following error:

```
 ** emtaglenoise: error (FITSIO), FITS error 112 while accessing file '<F4>^Q':
cannot write to readonly file
```

The second affects Mac OS/X, regardless of memory mode, and solaris in low-memeroy mode only. It halts the task with the following error:

```
 ** emtaglenoise: error (NoData), The CCF does not contain a ScreenThreshold data
for CCD 1 node 0 [PRIMARY]
```

Both bugs have been fixed in Version 1.0.1 of **emtaglenoise**, included in SAS 9.0.1 .

In low-memory mode, this task overwrites the keyword `BITPIX` in the primary header of the input data set with the value 16, regardless of the original value. This behaviour is propagated from the HiLow-mode implementation of the SAS data access library **dal**.

References

[1] K. D. Kuntz and S. L. Snowden. The EPIC-MOS particle-induced background spectra. *Astron. Astrophys.*, 478(2):575–596, February 2008.

[2] M. Stuhlinger. Increased low energy noise below 1 keV or the MOS2CCD5 effect. Technical Report XMM-SOC-INST-TN-0033, Issue 1.1, ESA ESOC, January 2008.