emdiag

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Abstract

Analyse EPIC-MOS diagnostic images. Compute line and column offsets and event lists.

1 Instruments/Modes

Instrument	Mode
EPIC MOS	DIAGNOSTIC

2 Use

pipeline processing	no
interactive analysis	yes

3 Description

emdiag emulates the on-board computation of the line and column offsets. It also emulates event analysis, and provides a masked CCD map, suitable to build a reference dark frame. Window keywords are accepted allowing to restrict the whole line of analysis to a part of the CCD map.

Two different coordinate systems are used in **emdiag**:

- The on-board coordinate system, used also in the ODF, runs from 0 to 609 (along `RAWX`) and 0 to 601 (along `RAWY`). It includes under and overscans. All ODF files (diagnostic map, offset/variance table, event list) refer to this system. In addition event coordinates (in the event list) are offset by (+2,+2).
- The CCD coordinate system used in the SAS (PIXCOORD in **cal**), runs from 1 to 600 along both `RAWX` and `RAWY` and does not include the under/overscans. All output maps (masked CCD map, bright pixels map), the bad pixels and the input window parameters refer to that system.

emdiag calls (in order) the following subroutines, all of which can be individually switched off:

- OFFSET emulates the on-board algorithm calculating the line and column offsets. It analyses the CCD locally to mask out high pixels (bad pixels, X-rays, cosmic-rays) standing out by more than `nsigmas` times the local dispersion above the local median, and works only on that part of the CCD in view of the sky. The reference distribution to check each pixel is taken from the 16 pixels at distance 2 (in `RAWX` or `RAWY`) from the current pixel.
  If `selectfov` is set, a second pass will be performed, removing all pixels outside the field of view. This provides a better estimate of the offsets for the lines/columns within the field of view.
  The variance of the resulting map (with respect to that constructed from the line and column offsets, and limited to the field of view if `selectfov`=yes) is written in the `CCDVAR` keyword.
  The emulation also accepts as input a masked CCD map (with high pixels set to 0, output of a first run of **emdiag**). Pixels bad or set to 0 are then not used to compute the offsets. Because the on-board offset computation does not efficiently remove cosmic-ray patches, thhis is the way to get good offsets and variance.
- EDUSOFT performs on the ground the same pattern recognition performed in flight in IMAGING (or TIMING) mode, and outputs the same information (`RAWX`, `RAWY`, `ENERGYE1`, `ENERGYE2`, `ENERGYE3`, `ENERGYE4`, `PATTERN` and `PERIPIX`). If the diagnostic map was obtained in window mode (no overscan), no event may be found in the last two lines and columns (as in flight). The line and column offsets are taken either from an offset/variance file (if `offsets` is "read") or from the result of the OFFSET subroutine. Beyond that, EDUSOFT rejects events with `ENERGYE1` + `ENERGYE2` above the upper EMDH threshold or below the lower EMDH threshold. In output, all pixels of the map belonging to events recognized by EDUSOFT are masked out (*i.e.* set to 0, not a valid value because of the electronic offset), except patterns 30 and 31 (usually associated with cosmic-rays).
- THRESH subtracts from the map the line and column offsets taken either from an offset/variance file or from the OFFSET result (like EDUSOFT). Then it looks for all events above the EMDH lower threshold. It creates optionally a map of all selected pixels (offset subtracted). If EDUSOFT was run before, this map will not contain any valid X-ray event. In output, all selected pixels are set to 0 in the masked CCD map (not offset subtracted).

4 Parameters

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

Parameter	Mand	Type	Default	Constraints
diagnosticset	yes	dataset	' '	none

name of input file holding the CCD map(s)

eduthreshold	no	integer	1	> 0

EDU threshold for event detection

emdhlowerthreshold	no	integer	0	≥ 0

EMDH lower threshold for event detection

emdhupperthreshold	no	integer	4095	> 0

EMDH upper threshold for event detection

windowx0	no	integer	1	1-600

first column in the window

windowy0	no	integer	1	1-600

first line in the window

windowdx	no	integer	600	1-600

horizontal width of the window

windowdy	no	integer	600	1-600

vertical width of the window

findevents	no	boolean	yes	yes/no

activate EDUSOFT ?

cutabovethreshold	no	boolean	yes	yes/no

activate THRESH ?

offsets	no	string	compute	compute/read

compute the offsets or read them from a file

nsigmas	no	real	10.	$\geq 1.$

threshold for pixel rejection in OFFSET

selectfov	no	boolean	yes	yes/no

select area within the field of view in OFFSET ?

maskbadpix	no	boolean	no	yes/no

mask out the bad pixels from the CCF in OFFSET (not implemented) ?

inoffvarset	no	dataset	' '	none

name of input offset/variance file. If this parameter is set, then `offsets`=read is automatically set

writeoffvarset	no	boolean	no	yes/no

write offset/variance file ?

outoffvarset	no	dataset	'offvar.out'	none

name of output offset/variance file

writemaskedccdset	no	boolean	no	yes/no

write masked CCD map ?

maskedccdset	no	dataset	'masked.out'	none

name of output image file for masked CCD map

writeeventset	no	boolean	no	yes/no

write event file ?

eventset	no	dataset	'event.out'	none

name of output event file

writebrightpixset	no	boolean	no	yes/no

write map of other pixels above threshold ?

brightpixset	no	dataset	'bright.out'	none

name of output image file for map of other pixels above threshold

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.

readmap02 *(error)*
input CCD map is not a 2-D array

readmap03 *(error)*
input CCD map has too large dimensions

readmap04 *(error)*
`WINDOWDX` keyword incompatible with array size

readmap05 *(error)*
`WINDOWDY` keyword incompatible with array size

readmap06 *(error)*
no `WINDOWX0` keyword in CCD file

readmap07 *(error)*
no `WINDOWY0` keyword in CCD file

readmap08 *(error)*
input CCD map has non-standard dimensions

readmap09 *(error)*
window chosen by parameters outside the actual window in the data

getoffvar02 *(error)*
offsets have wrong dimensions

getoffvar03 *(error)*
offsets file incompatible with CCD file

readmap10 *(warning)*
general ODF keywords not present
corrective action: continue

getOffsets10 *(warning)*
no good pixels in some rows/columns. The corresponding offsets are set to 0
corrective action: set offsets manually in output offsets file

getOffsets12 *(warning)*
less good pixels than there are offsets. Unreliable result
corrective action: try using another diagnostic image file

thresh10 *(warning)*
Events larger than bipixels but below the EMDH lower threshold exist. They will be masked in the masked CCD map anyway
corrective action: Setting the EMDH lower threshold to more than twice the EDU threshold is non-standard. Unless this is voluntary, try lowering `emdhlowerthreshold` or increasing `eduthreshold`

readmap11 *(warning)*
NPIXEL is not equal to the number of pixels in the image. Proceeding anyway
corrective action: This should not happen with a proper diagnostic image file. Check input image is not corrupted

readmap12 *(warning)*
the EMDH upper threshold is lower than the EMDH lower threshold. EDUSOFT cannot find any event
corrective action: check this was intended

6 Input Files

1. EPIC MOS diagnostic mode image file (from ODF/SDF). Uses keywords WINDOWXO, WINDOWYO, WINDOWDX, WINDOWDY, EDUTHR, FRMTIME.
2. EPIC MOS offset/variance file for that CCD/node (from ODF/SDF)

The structure of files in the ODF is described in [1].

7 Output Files

1. offset/variance file for that CCD/node in ODF format (for calibration purposes, [1])
2. masked CCD map(s) as a 600x600 image FITS file with additional EMDHLOW, EMDHUPP, MASKED and CCDMAP keywords (for calibration purposes)
3. event file simulating on-board processing in ODF format (for calibration purposes), with the additional CCDMAP keyword and an extension holding the auxiliary (frame) information (replaced by keywords if there is only one input map). In this format the event coordinates are as in the ODF, *i.e.* offset by (+6,+1) from the coordinates in the output maps (and the input window parameters).
4. map(s) of pixels above threshold outside events as a 600x600 image FITS file with additional EMDHLOW, EMDHUPP, BRIGHT and CCDMAP keywords (for calibration purposes)

Applicable keywords are propagated from the input diagnostic image file. The window keywords in the input file are converted to [1-600]x[1-600] and clipped following the window parameters set by the user. The EDUTHR keyword may be modified by the user (eduthreshold parameter). The offsets used to analyse the data are incorporated as an offset/variance OFFSETS0 extension in ODF format in the output map and event files.

8 Algorithm

```
subroutine emdiag

Read the file names of input and output files

Open files
```

```
   Get keyword values

   parameters read : choice of sub_tasks to execute
   Loop over input task parameters
      Read the task parameter / yes to perform the procedure,
                                no  not to perform it  /
   End loop

   Read CCD map

SUBROUTINE OFFSET
   if offset requested  then
      mask out pixels with significant signal
      compute mean over rows and columns
      if selectfov then
         mask out pixels outside the field of view
         for all rows/columns with more than 4 pixels left
             recompute offset
      endif
      compute variance
   else
      read offsets from offset/variance file
   endif

SUBROUTINE EDUSOFT
   if edusoft requested  then
      simulate EDU action
      simulate EMDH thresholding
      mask out pixels belonging to valid events
   endif

SUBROUTINE THRESH
   if thresh requested  then
      subtract offsets
      identify pixels above EMDH lower threshold
      mask them out in map
   endif

   Write output files
   Close files

   end subroutine  emdiag
```

9 Comments

- To avoid contamination of the masked CCD map by leakage in pixels next to charge deposits, a more conservative approach would also mask out all neighbouring pixels.
- The reanalysis of events in EDUSOFT (and THRESH) calls a C routine (edusoft) which interfaces to the C routine (edu_simu, written by M. Lortholary of the EPIC/Saclay team) which simulates the EDU recognition. This is described in **emsaplib**.

10 Future developments

- It could be a good idea to allow analysing several CCD maps together.
- It could be useful to allow masking out the bad pixels in the CCF.

References

[1] ESA. XMM Interface Control Document: Observation and Slew Data Files (XSCS to SSC) (SciSIM to SOCSIM). Technical Report XMM-SOC-ICD-0004-SSD Issue 2.5, ESA/SSD, June 2000. Found at the URL: `ftp://astro.estec.esa.nl/pub/XMM/documents/odf_icd.ps.gz`.