pnspectra

April 16, 2023

Abstract

This task processes the cleaned event file output from *espfilt* to produce intermediate files for the creation of model particle background spectra and images by the task *pnback*. This task was originally a perl subtask of the SAS *esas* task named *pn-spectra* prior to SAS-21 and retains all of its functionality.

1   Instruments/Modes

Instrument	Mode
EPIC	Imaging

2   Use

pipeline processing	no
interactive analysis	yes

3   Description

pnspectra processes the cleaned event file output from *espfilt* to produce intermediate files for the creation of model particle background spectra and images by the task *pnback*.

Warning and requirements: *pnspectra* was part of the package *esas*, integrated into SAS. It is now standalone, but (still) limited to work within *esas*' data reduction scheme (c.f. esas cookbook and/or esas flowchart). This is especially true with respect to input files structure and names. In particular, *pnspectra* assumes that other tasks from the package, *espfilt* for filtering and `cheese` for point source exclusion have been successfully run for the exposures to be used. However, modularization for SAS-19 allows user-chosen filenames as optional parameters, with code-derived names that follow the esas schema created if the user chooses not to enter their own filenames.
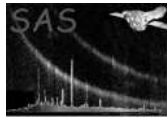
4 Parameters

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

Parameter	Mand	Type	Default	Constraints
eventfile	yes	dataset		

EPN event file (cleaned, created by espfilt from epchain output).

Parameter	Mand	Type	Default	Constraints
ootevtfile	no	dataset	default	

EPN OOT event file (cleaned, created by espfilt from epchain output).

Parameter	Mand	Type	Default	Constraints
cornerfile	no	dataset	default	

Corners-only eventlist (cleaned, created by espfilt from epchain output).

Parameter	Mand	Type	Default	Constraints
ootcornfile	no	dataset	default	

Corners-only OOT eventlist (cleaned, created by espfilt from epchain output).

Parameter	Mand	Type	Default	Constraints
imagefile	no	dataset	default	

Entire EPN FOV image.

Parameter	Mand	Type	Default	Constraints
ootimagefile	no	dataset	default	

Entire EPN FOV OOT image.

Parameter	Mand	Type	Default	Constraints
expmap	no	dataset	default	

Exposure map in DET coords.

Parameter	Mand	Type	Default	Constraints
spmask	no	dataset	default	

Mask for calculating SP scaling.

Parameter	Mand	Type	Default	Constraints
specfile	no	dataset	default	

Output EPN FOV Full band spectrum.

Parameter	Mand	Type	Default	Constraints
ootspecfile	no	dataset	default	

Output EPN FOV Full band spectrum OOT.

Parameter	Mand	Type	Default	Constraints
mask	no	dataset	default	

File to mask out point sources (from cheese).

Parameter	Mand	Type	Default	Constraints
withregion	no	boolean	true	false|true

Provide region (ASCII) file for evselect expression?

Parameter	Mand	Type	Default	Constraints
regionfile	no	string	reg.txt	

A selection expression in a text file. The selection expression for the desired region for the generation of the model background spectrum. If no file with the input name exists, or if the file is empty, then the default is to model the data from the entire field of view. If a specific region is desired, the region expression must be in detector coordinates. For example, a file containing `&&((DETX,DETY) IN circle(201,-219,3600))` would extract the central 3′ of the cluster Abell 1795. Note that the leading "`&&`" are required as the selection expression is added to other constraints.

Parameter	Mand	Type	Default	Constraints
withsrcrem	no	boolean	F	false|true

Perform source exclusion?

masksky	no	dataset	default	

SKY coord mask FITS file name.

maskdet	no	dataset	default	

DET coord mask FITS file name.

rmffile	no	dataset	default	

Redistribution matrix file name (will construct name if none given).

arffile	no	dataset	default	

Auxillary response matrix file name (will construct name if none given).

quads	no	boolean	TTTT	false|true

Quads to be analyzed. Unselected quads will be masked out.

elow	no	integer	400	

The energy low limit (in eV) for the band for images created.

ehigh	no	integer	7200	

The energy high limit (in eV) for the band for images created.

pattern	no	int	4	

QUAD event pattern upper limit. Pattern=0 for single pixel events and pattern=4 for two-pixel events. Pattern=0 is recommended when using the lowest energy bands.

keepinterfiles	no	boolean	true	false|true

Keep intermediary files created?

badpixelresolution	no	16	real	

Bad pixel resolution to pass to backscale (higher values lower pnspectra runtime).

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.

Pre42 *(error)*
    Observation was before Rev 42. Cannot analyze (lack CAL files

notPN *(error)*
    Input event list INSTRUME must be EPN

unsupportedSMODE *(error)*
    SUBMODE must be PrimeFullWindowExtended or PrimeFullWindow

noEVENTS *(error)*
    Input event file has no EVENTS block

noEXPOSURE *(error)*
    Input event file has no EXPOSURE attribute

noLIVETIMnn *(error)*
    Input event file has no LIVETIMnn attribute

noOPEN *(error)*
    Cannot OPEN region file, iostat=N

noREAD *(error)*
    Cannot READ region file, iostat=N

noREGIONfile *(error)*
    Chosen region file does not exist

6   Input Files

  1. Cleaned event file as processed by *espfilt*.

  2. Cleaned OOT event file as processed by *espfilt*. Auto-derived and/or created by default.

  3. Cleaned corner-only event file as processed by *espfilt*. Auto-derived and/or created by default.

  4. Cleaned corner-only OOT event file as processed by *espfilt*. Auto-derived and/or created by default.

  5. Image file as processed by *espfilt*. Auto-derived and/or created by default.

  6. OOT Image file as processed by *espfilt*. Auto-derived and/or created by default.

  7. Exposure map as processed by *eexpmap*. Auto-derived and/or created by default.

  8. Mask as processed by *cheese*. Auto-derived and/or created by default.

  9. Full band FOV spectrum. Auto-derived and/or created by default.

 10. Mask for calculating SP scaling Auto-derived and/or created by default.

 11. Redistribution Matrix File (RMF). Auto-derived and/or created by default.

 12. Auxiliary response File (ARF). Auto-derived and/or created by default.

 13. Region (text) file for evselect expression.

 14. Sky coord mask for evselect expression.

15. Det coord mask for evselect expression.

Notes: in previous versions of pnspectra many of the above files were derived from the 'prefix' input parameter. This has changed. A mandatory input event list is entered and the prefix derived from the INSTRUME and EXPIDSTR attributes within that file. All of the other input files have 'default' as their actual default filename and are optional. If the user does not enter a file name it will be derived from prefix and in most cases if it does not exist, it will be created with the default name. E.g. if the FOV image is not given on the command line, the filename *pn+expidstr+fovim.fits* will be created, checked for existence, and either used (if clobber not set), or created and overwritten (if clobber is set).

7 Output Files

- pn*prefix*-`fovt.pi` – The observation data spectrum from the FOV, full band.

- pn*prefix*-`fovqN.pi` – The observation data spectrum from the selected region from the individual quads. The quad number, "N" in the file name, runs from 1 to 4 including only the selected PN quads.

- pn*prefix*-`fovfwcqN.pi` – The filter-wheel-closed data spectrum from the selected region from the individual quads. The quad number, "N" in the file name, runs from 1 to 4.

- pn*prefix*-`fovfwcimqN*-`*elow*-*ehigh*`.fits` – The image of the filter-wheel-closed data from the selected region from the individual quads for the selected band. The quad number, "N" in the file name, runs from 1 to 4 and the band limits, `elow` and `ehigh` indicate the energy band.

- pn*prefix*-`corqN.pi` – The corner spectrum from the observation data from the individual quads. The quad number, "*" in the file name, runs from 1 to 4.

- pn*prefix*-`corfwcqN.pi` – The corner spectrum from the filter-wheel-closed data from the individual quads. The quad number, "N" in the file name, runs from 1 to 4.

- pn*prefix*`.arf` – The ARF file for the pn*prefix*-`obj.pi` spectrum.

- pn*prefix*`.rmf` – The RMF file for the pn*prefix*-`obj.pi` spectrum.

- pn*prefix*-`expimt.fits` – The exposure image for the observation data in sky coordinates from the field-of-view for all selected quads for the total energy band.

- pn*prefix*-`expim-`*elow*-*ehigh*`.fits` – The exposure image for the observation data from the selected region for all selected quads for the selected band. `elow` and `ehigh` indicate the band limits.

- pn*prefix*-`expimdet-`*elow*-*ehigh*`-ccd1.fits` – The exposure image for the observation data from the selected region for quad #1 for the selected band. `elow` and `ehigh` indicate the band limits.

- pn*prefix*-`maskimdet.fits` – The mask image for the observation data from the field-of-view for all selected quads for the full energy band.

- pn*prefix*-`maskimdet-`*elow*-*ehigh*`.fits` – The mask image for the observation data from the selected region for all selected quads for the selected band. `elow` and `ehigh` indicate the band limits.

- pn*prefix*-`maskimdet-`*elow*-*ehigh*`-qN.fits` – The mask image for the observation data from the selected region for quad "N" for the selected band. `elow` and `ehigh` indicate the band limits.

- pn*prefix*-`fovt.pi` – The observation data spectrum from the selected region.

- pn*prefix*-`fovimt.fits` – The image of the observation data in sky coordinates from the full field-of-view for all selected quads for the full energy band.

- pn*prefix*-fovimt-*elow*-*ehigh*.fits – The image of the observation data in sky coordinates from the selected region for all selected quads for the selected band. elow and ehigh indicate the band limits.

- pn*prefix*-fovim-*elow*-*ehigh*-qN.fits – The image of the observation data from the selected region for quad "N" for the selected band. elow and ehigh indicate the band limits.

- pn*prefix*-fovspimdet.fits – Image of the selected region in detector coordinates. This image is used in the task *proton-scale*.

- pn*prefix*-fovimdet-*elow*-*ehigh*.fits – The image of the observation data in detector coordinates from the selected region for all selected quads for the selected band. elow and ehigh indicate the band limits.

8   Algorithm

```
Read in params

read submode from cleaned PN event list
set scaling factor (scale) based on submode

set ccddef evselect expression based on quads chosen by user

set cornerdef evselect expression for corner-only selections

set quaddef(4) evselect expression for chosen-quads selections

set fulldef evselect expression for full FOV selections

set ruffovdef evselect expression for FOV open to sky selections

if maskitsky, set maskitsky filename add bkg-reg to selections

if maskitdet, set maskitdet filename add bkg-reg to selections

if withregion open, read region selection from input reg text file

run atthkgen to create atthk.fits unless it already exists

create corner only event file with evselect from cleaned event file

create corner only OOT event file with evselect from cleaned event file

create FOV image file with evselect from cleaned event file

create FOV OOT image file with evselect from cleaned event file

create FOV exposure map with eexpmap from cleaned event file,
atthk.fits, and FOV image

create FOV mask with emask from FOV image

create FOV SP scaling image with evselect from cleaned event file
in DET coords
```

```
if (withbands) then

 create FOV image in region in selected band (elow-ehigh) with evselect

 create FOV exposure map with eexpmap from cleaned event file

 create FOV mask with emask from FOV image

 create FOV OOT image in region in selected band (elow-ehigh) with evselect

end if (withbands)

create spectrum from FOV region, run backscale, generate response

create spectrum from FOV OOT region, run backscale, generate response

create response from FOV spectrum with rmfgen

create response from FOV spectrum with arfgen

if (withbands) then
 create FOV image in region in selected band (elow-ehigh) with evselect

 create FOV exposure map with eexpmap from cleaned event file

 create FOV mask with emask from FOV image

 create FOV OOT image in region in selected band (elow-ehigh) with evselect

endif

foreach quadrant selected (1-4)
 create spectrum for FOV of region
 backscale spectrum

 create spectrum for FOV OOT of region
 backscale spectrum

 create spectrum for corner-only data
 backscale spectrum

 create spectrum for corner-only OOT data
 backscale spectrum

 create temp eventlist from corner-only data (temp_events.fits)
 extract cnts and livetimNN

 rm temp_events.fits

 create temp eventlist from corner-only OOT data (temp_events.fits)
 extract cntsoot

 rate = (cnts-(scale*cntsoot))/((1.0-scale)*expo)
```
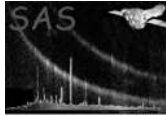
```
rate = rate*100. [why???]

rm temp_events.fits

create temp eventlist from corner-only data (temp_events.fits)
PI in 600-1300
extract lowe

rm temp_events.fits

create temp eventlist from corner-only data (temp_events.fits)
PI in 1650-7200
extract hige

rm temp_events.fits

create temp eventlist from corner-only OOT data (temp_events.fits)
PI 600-1300
extract loweoot

rm temp_events.fits

create temp eventlist from corner-only OOT data (temp_events.fits)
PI 1650-7200
extract higeoot

calculate hardness ratio:
hard=(hige-(scale*higeoot))/(lowe-(scale*loweoot))

create spectrum from the region from the FWC data
backscale spectrum

create spectrum from the region from the FWC OOT data
backscale spectrum

create spectrum from the corners from the FWC data
backscale spectrum

create spectrum from the corners from the FWC OOT data
backscale spectrum

if (withbands) then
 create image of FWC data for the region and the band

 create FWC mask with emask from FWC image

 mask FWC image with farith

 rename FWC image:
 mv pnS002-im2-350-1100-mask.fits pnS002-im2-350-1100.fits

 create image of FWC OOT data for the region and the band

 create FWC mask with emask from FWC OOT image
```

```
  mask FWC OOT image with farith

  rename FWC OOT image:
  mv pnS002-im2-350-1100-mask-oot.fits pnS002-im2-350-1100-oot.fits

 end withbands
end foreach quadrant

rm intermediary files

end pnspectra
```

9 Comments

The original code for this task appeared in the *esas* task 2009-2021 as the perl subtask *pn-spectra*. It was removed from the task *esas*, converted to f95, and modularized as a single task for SAS-21. The *esas* task was removed in SAS-21.

References