

spi_obs_response

User Manual

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Note to the user

This software has been written to analyse data of the SPI telescope onboard INTEGRAL. Particular care has been taken in making the software user friendly and well documented. If you appreciated this effort, and if this software and User Manual were useful for your scientific work, the author would appreciate a corresponding acknowledgment in your published work.

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1 Introduction

The executable `spi_obs_response` is part of the SPI imaging analysis software component (IA). It models the instrument response to a gamma-ray intensity distribution in the SPI data-space.

`spi_obs_response` is written in the ANSI C++ language and has been developed under ISDC support platform 6.3. It requires `spi_toolslib` version 4.10.6 or higher.

2 Getting started

Before installing `spi_obs_response`, make sure that the ISDC support platform 6.3 or higher is installed on your system, and that you have installed the library `spi_toolslib` version 4.10.6 or higher.

After downloading the `spi_obs_response.tar.gz` file, step into a directory that should hold the distribution, move the `spi_obs_response.tar.gz` file into this directory and type after the UNIX prompt `$` (don't type this prompt):

```
$ gunzip spi_obs_response.tar.gz
$ tar xvf spi_obs_response.tar
```

The first command uncompresses the distribution file, the second unpacks the files.

Before configuration, the distribution needs to be reset to a clean state. To do this, type

```
$ make distclean
```

Then, configure the distribution. It is assumed here that you have previously installed the ISDC support platform, thus you should type

```
$ ~/bin/ac_stuff/configure
```

Finally, build the distribution by typing

```
$ make global_install
```

To perform a unit test, type

```
$ make test
```

3 Parameter file

```
#####
#
#           Centre d'Etude Spatiale des Rayonnements           #
#           (in collaboration with ISDC)                       #
#
#           SPI response modelling                               #
#
# -----#
#
# File:      spi_obs_response.par                               #
# Version:   1.3.0                                             #
# Component: IA                                               #
#
# Author:    Juergen Knoedlseder                               #
#            knodlseder@cesr.fr                               #
#            CESR                                              #
#
# Purpose:   Parameter file for the SPI response modelling task #
#
#####
#
# The input DOLs/filenames
#=====
ingrpDOL, s,q,"og_spi.fits",,,"Input Observation Group DOL or filename"
inebdsDOL,s,q,"",,,"Energy boundary DOL or filename"
inpntDOL, s,q,"",,,"Pointing DOL or filename"
ingtdDOL, s,q,"",,,"Good Time Interval DOL or filename"
indtdDOL, s,q,"",,,"Deadtime DOL or filename"
inpefDOL, s,q,"",,,"PSD Efficiency DOL or filename"
inprfDOL, s,q,"",,,"PSD Response DOL or filename"
inirfDOL, s,q,"spi_irf_grp.fits",,,"Instrument Response Index DOL or filename"
#
# The output DOLs/filenames
#=====
outgrpDOL,s,q,      "og_spi.fits",,,"Output Observation Group DOL or filename"
outidxDOL,s,q,"response_idx.fits",,,"Result Spectra Index DOL or filename"
outspeDOL,s,q,      "response.fits",,,"Result Spectra filename"
#
# Task parameters
#=====
skymapDOL,  s,q,"dir240.fits[0]",,,"Sky-map to convolve"
skymapEmin, r,q,      "1809.0",,,"Sky-map energy band minimum (keV)"
skymapEmax, r,q,      "1809.0",,,"Sky-map energy band maximum (keV)"
skymapScale, r,q,      "3.0",,,"Sky-map scaling factor"
selDataSpace,b,h,      no,,,"Store only selected energy bins ?"
sumDataSpace,b,h,      no,,,"Sum energy bins ?"
#
# Response parameters
#=====
srcGamma,   r,h,      "2.0",,,"Power-law E^-gamma exponent gamma"
rspIntdlogE,r,h,      "0.03",,,"Response interpolation log10 step size"
```

```
#
# Standard parameters
#=====
clobber,b,h,yes,, "Overwrite existing output data ?"
verbose,i,h,3,0,3, "Information logging level"
```

Instead of specifying complete DOLs (Data Object Locations), which are composed of a filename plus the data structure extension (HDU), `spi_obs_response` accepts also simple filenames and adds the appropriate data structure extensions. This means that **specified data structure extensions are ignored**. The only exception is the `skymapDOL` parameter which needs an extension to specify which image should be loaded from the FITS file.

The parameters have the following meaning:

- `ingrpDOL` (optional) specifies the DOL or filename of the input Observation Group (HDU [GROUPING]) for which a response model should be derived. The input group has to be of level `BIN_I`.
If an output Observation Group has been specified (parameter `outgrpDOL`), the specification of this parameter is optional. If the parameter is left blank, the output Observation Group will then be used as input Observation Group. Otherwise, the input Observation Group will be copied into the output Observation Group.
- `inebdsDOL` (optional) specifies the DOL or filename of an energy boundary definition (HDU [SPI.-EBDS-SET]). This data structure specifies the energy boundaries of the binned data.
If a [SPI.-EBDS-SET] element exists already in the input Observation Group, this element will be replaced by the specified DOL in the output Observation Group. Otherwise, the specified DOL will be attached to the output Observation Group. If left blank, it is assumed that a [SPI.-EBDS-SET] element exists already in the input Observation Group. If no such element is found, however, the task execution is aborted with an error message.
- `inpntDOL` (optional) specifies the DOL or filename of a Pointing definition (HDU [SPI.-OBS.-PNT]). This data structure specifies the SPI pointings during data taking.
If a [SPI.-OBS.-PNT] element exists already in the input Observation Group, this element will be replaced by the specified DOL in the output Observation Group. Otherwise, the specified DOL will be attached to the output Observation Group. If left blank, it is assumed that a [SPI.-OBS.-PNT] element exists already in the input Observation Group. If no such element is found, however, the task execution is aborted with an error message.
- `ingtiDOL` (optional) specifies the DOL or filename of a Good Time Interval definition (HDU [SPI.-OBS.-GTI]). This data structure specifies the time intervals that have been used for data taking.
If a [SPI.-OBS.-GTI] element exists already in the input Observation Group, this element will be replaced by the specified DOL in the output Observation Group. Otherwise, the specified DOL will be attached to the output Observation Group. If left blank, it is assumed that a [SPI.-OBS.-GTI] element exists already in the input Observation Group. If no such element is found, however, the task execution is aborted with an error message.
- `indtiDOL` (optional) specifies the DOL or filename of a Deadtime data structure (HDU [SPI.-OBS.-DTI]). This data structure contains the livetime and the deadtime ratio for the binned data.
If a [SPI.-OBS.-DTI] element exists already in the input Observation Group, this element will be replaced by the specified DOL in the output Observation Group. Otherwise, the specified DOL will be attached to the output Observation Group. If left blank, it is assumed that a [SPI.-OBS.-DTI] element exists already in the input Observation Group. If no such element is found, however, the task execution is aborted with an error message.

- `inpefDOL` (optional) specifies the DOL or filename of a PSD efficiency data structure (HDU [SPI.-OBS.-PEF]). This data structure contains the PSD efficiencies for the binned data.
If a [SPI.-OBS.-PEF] element exists already in the input Observation Group, this element will be replaced by the specified DOL in the output Observation Group. Otherwise, the specified DOL will be attached to the output Observation Group. If left blank, it is assumed that a [SPI.-OBS.-PEF] element exists already in the input Observation Group. If no such element is found, however, the task execution is aborted with an error message.
- `inprfDOL` (optional) specifies the DOL or filename of a PSD response data structure (HDU [SPI.-OBS.-PRF]). This data structure contains the PSD response for the binned data.
If a [SPI.-OBS.-PRF] element exists already in the input Observation Group, this element will be replaced by the specified DOL in the output Observation Group. Otherwise, the specified DOL will be attached to the output Observation Group. If left blank, it is assumed that a [SPI.-OBS.-PRF] element exists already in the input Observation Group. If no such element is found, however, the task execution is aborted with an error message.
- `inirfDOL` (optional) specifies the DOL or filename of a Instrument Response Function (IRF) index (HDU [SPI.-IRF.-RSP-IDX]). This data structure contains an index to the response functions that should be used for response calculation.
If a [SPI.-IRF.-RSP-IDX] element exists already in the input Observation Group, this element will be replaced by the specified DOL in the output Observation Group. Otherwise, the specified DOL will be attached to the output Observation Group. If left blank, it is assumed that a [SPI.-IRF.-RSP-IDX] element exists already in the input Observation Group. If no such element is found, however, the task execution is aborted with an error message.
- `outgrpDOL` (optional) specifies the DOL or filename of the output Observation Group (HDU [GROUPING]). The output Observation Group will be a copy of the input Observation Group plus the resulting Response Model Index data structure [SPI.-SDET-SPE-IDX] attached.
If an input Observation Group has been specified (parameter `ingrpDOL`), the specification of this parameter is optional. If the parameter is left blank, the input Observation Group will then be used as output Observation Group.
- `outidxDOL` specifies the DOL or filename of the Response Model Index (HDU [SPI.-SDET-SPE-IDX]). After execution of the task, this index will contain a pointer to the response model.
This index will be attached to the output Observation Group. Any index of the same type that may already exist in the output Observation Group will be detached before. If the specified DOL is identical to an already existing DOL, this DOL will be deleted if the `clobber` parameter is `yes` (otherwise the task will abort with an error).
- `outspeDOL` specifies the filename of the Response Model data structure (HDU [SPI.-SDET-SPE]). **Note that this filename is relative to the Background Model Index (parameter `outidxDOL`), and that no HDU extension should be provided for this parameter.** After execution of the task, this file will contain the response model.
- `skymapDOL` specifies the DOL of the skymap that should be convolved with the instrument response. **Note that here a DOL is required.**
- `skymapEmin` specifies the lower source photon energy boundary of the skymap in units of keV.
- `skymapEmax` specifies the upper source photon energy boundary of the skymap in units of keV. If the response to a gamma-ray line should be calculated, the upper boundary has to be identical to the lower boundary.

- `skymapScale` specifies a scaling factor with which the input skymap will be multiplied before convolution. This allows to scale the response model to arbitrary flux values.
- `selDataSpace` specifies if the response model should only be created for the energy bins that overlap with the skymap energy interval (`yes`) or if the convolution should be done for all energy intervals (`no`). The default option is `no` and results in a response model that has the same number of energy bins as the detector spectra and background model of the corresponding observation group. If `yes` is specified, only the overlapping energy bins (which contain a non-zero response) will be saved, and in general the number of energy bins will be less than in the input data.
- `sumDataSpace` specifies if the data-space energy intervals should be summed (`yes`) or not (`no`). The default option is `no` and results in a response model for each of the data-space energy bins. If `yes` is specified, all selected data-space energy bins will be combined into a single bin before response calculation, and only a single energy bin will be written in the resulting model data structure.
- `srcGamma` specifies the gamma-ray source power-law $E^{-\gamma}$ slope γ for response calculation of continuum sources. A default value is `srcGamma = 2.0`.
- `rspIntdlogE` specifies the number of logarithmic integration steps for response calculation of continuum sources. A default value is `rspIntdlogE = 0.03`.
- `clobber` specifies if existing output data structures should be overwritten or not. If `yes` is specified, the executable will notify the user about the deletion of any file. If `no` is specified and the executable attempts to overwrite existing data (e.g. an existing output Observation Group or response model index), the task will exit with an error message.
- `verbose` specifies the verbose level of the executable. For `verbose=0`, no information will be logged in case of an error. For `verbose=1`, only errors will be logged, while for `verbose=2` also actions (such as DOL detachments and attachments and DOL deletion) will be logged. `verbose=3` provides a detailed report about the response model generation.

4 Interface definition

`spi_obs_response` attaches an response model index of type `SPI.-SDET-SPE-IDX` to the observation group. This index points to the response model that is stored in data structure of type `SPI.-SDET-SPE`.

5 Error codes

TBW