ROSAT Results Archive (RRA)

PSPC Software Documentation

Issue 1.3

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Change Record

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Reason, Remarks: new program ARCHIVE/RRA, improved GUI

1 Introduction

1.1 Purpose

This document describes the Analysis System to produce the ROSAT Results Archive (RRA) of PSPC pointed observations. The primary goal is the production of a high quality source catalogue from the SASS processing. During meetings since the summer of 1994 it was decided to use two sorts of flags to perform the quality control: those which describe the reliability of the SASS processing of individual sources (Source flags) and those which describe conditions of the whole field (Sequence flags). A second document "Operator's Instructions −− PSPC flag setting" contains all necessary information how and when to set the flags.

1.2 Scheme for Construction of the RRA

The suggested flow diagram to construct the RRA is given below. The corresponding MIDAS/EXSAS command names are given on the right side.

Extraction of SASS products for given Sequence	intape/rdf
Automatic flag setting Data structure changes in table with source detections Creation of sub-images for visual inspection	prepare/rra
Visual inspection • operator decision on source flag setting • operator decision on sequence flag setting Verification log	gui/rra
Archive checking results Fits conversion of the results	archive/rra

1.3 Software requirement

The fits files had to be produced with RDF version 3.3. MIDAS version 94NOV and EXSAS 95JAN_EXP should be installed. The use of the graphical interface (gui/rra) requires installation of Tcl Version 7.3, **Tk Version 3.6** (please do not use Tk Version 4.0 with the actual PSPC software). **IDL must be installed.** Users should make sure that the IDL RRA software is enabled. In particular, the $IDL_PATH and $IDL_STARTUP environment variables must be set. For example, if the IDL RRA software is in the directory
$HOME/rra/idl/idl_vi then
setenv IDL_VI $HOME/rra/idl/idl_vi
Define IDL_STARTUP as
setenv IDL_STARTUP $IDL_VI/hvi2.5.2/startup

1.4 Installation guide

In order to copy and install the new software do the following:

```
% cd $XEXSAS/..
% ftp rosat_svc.rosat.mpe-garching.mpg.de
user anonymous
pass <your-address>
ftp> cd exsas/rra
ftp> bin
ftp> get 95JAN_rra.tar.Z
ftp> bye
% uncompress 95JAN_rra.tar.Z
% tar xvf 95JAN_rra.tar
% cd 95JAN_EXP/spatial/dl/distrib
% make
% cd $XEXSAS/tcltk
% make
% chmod a+x *
% cd $XEXSAS/cal
% exsas
Midas 001> @@ getmask
Midas 002> bye
% cd $XEXSAS/tcltk/prg
% cp dist*.prg $XEXSAS/prg/.
```

Edit the file `$XEXSAS/tcltk/tk_learn.tk` and modify the path given in the first line, to find `wish` in your machine.

Edit the file `$XEXSAS/exsas.prg`, and add the following new command definition (soon after the previous command definitions):

```
CREA/COM PREPARE/RRA @@ TCLTK_PRG:prepare_1
CREA/COM ARCHIVE/RRA @@ TCLTK_PRG:t_archive
CREA/COM GUI/RRA $ $XEXSAS/tcltk/tk_learn.tk {MID$SESS(11:12)} &
```

(don't forget the & at the end!).

Edit the file `$XEXSAS/EXSAS.csh`, and add the new definition (e.g. soon after the command definition: `setenv EXSAS_PRG $XEXSAS/prg`):

```
setenv TCLTK_PRG $XEXSAS/tcltk/prg
```

1.5 Getting started

The working directory should contain the files of only one sequence. The following scheme is suggested to test the RRA PSPC software.

1. Create a working directory which will contain the data for one sequence
   e.g. `mkdir testdata1`

2. Copy the basic data to your working directory
   the files which are needed by subsequent actions are:
   r*_anc.fits, r*_bas.fits, r*_im1.fits, r*_im2.fits, r*_im3.fits, r*_src.fits
3. start EXSAS
4. Convert ROD data from RDF format to EXSAS-MIDAS format
   `intape/rdf disk r anc,bas,im1,im2,im3,src` if you have EXSAS 95JAN_EXP
   otherwise use the help on intape/rdf
5. prepare your sequence for checks
   prepare/rra
6. Visual inspection
   gui/rra
7. archive the files r*_qsrc.fits and r*_mis.fits containing the results of the validation process
   archive/rra

2 Preparing the sequence for checking - PREPARE/RRA

The MIDAS/EXSAS command `prepare/rra` produces data structures necessary to run `gui/rra`. As long as the source flags can be set automatically, by considering the values of the SASS output, this is done with `prepare/rra` as well as the creation of sub-images (gaussian filtered images for the broad, soft and hard ROSAT band; bin size 10 images in the three energy bands and subsequent gaussian filtering). `Prepare/rra` creates a new table `qsource.tbl`. This table contains the original descriptors and columns of the table with source detections `source.tbl` and additionally new columns for the source and sequence flags and new descriptors as described below. The command `gui/rra` also uses `qsource.tbl` so that `source.tbl` will not be changed during the checking procedure.

2.1 New columns created by `prepare/rra`

X_SKY,Y_SKY
sky coordinates

a,m,d,e,n,v,l,s,i,p,f,c,w
Source flags as defined in the February meeting. The flags a,m,d,n,p,f,c,w can be changed in gui/rra by operator action

commentline
comment on a source

LABEL
Point-spread-function 68 per cent radius of extract circle for an analytic model for ROSAT,PSPC. Input parameters are the off-axis distance of the source and the mean energy channel. The mean energy channel is determined from the hardness ratio 1 (HR) by: mean channel = $14\ HR^3 + 46\ HR^2 + 50\ HR + 30$

LABEL10
Point-spread-function 68 per cent radius of extract circle for an analytic model for ROSAT,PSPC for bin size 10 images (standard bin size is 30).

broad1,broad2,broad3 hard1,hard2,hard3,soft1,soft2,soft3
detections in broad,soft or hard band, will be deleted after prepare/rra (not yet done)

dist_scr_new
distance to the next source

dist_rib_new
distance to rib or edge structure

neigh_row
source number of the next source

ac,mc,dc,ec,nc,vc,lc,sc,ic,pc,fc
copy of the automatic source flag setting

2.2 New images created by `prepare/rra`

imagegauss,imagesoftgauss,imagehardgauss
Gaussian filtering for broad, soft and hard images. The amplitude channels used are 7-240 (broad), 11-41 (soft) and 52-201 (hard)

imagebin10,imagebin10soft,imagebin10hard
bin size 10 images of broad, soft and hard images

imagebin10gauss,imagebin10softgauss,imagebin10hardgauss
Gaussian filtering for broad, soft and hard images for bin size 10 images

2.3 New tables created by `prepare/rra`

missed
Table which will contain sources probably missed by the detection algorithm. The table can be filled in gui/rra by operator action

sourcebroad,sourcesoft,sourcehard
Tables containing sources detected in the either in the broad, soft or hard ROSAT band

q_unflag,q_flag,q_not,q_false
Table q_unflag contains all sources which remain unflagged in the automatic flag setting (color code green in `gui/rra`).
Table q_not contains sources with flag setting `not checked` (color code magenta in `gui/rra`). Table q_false contains sources with flag setting `false detection` (this flag can be given in `gui/rra` by visual inspection with color code blue). Table q_flag contains all sources with any other flag setting (cyan).

q_selnum
Table for use in `gui/rra` to use the faster `copy/tt` command instead of `copy/table`. This table will be deleted after `gui/rra` (not yet done).

2.4 Automatic flag setting

The following description of source flag setting gives the current implementation. The definition can be changed during the testing phase.

2.4.1 Flag a - associated with nearest neighbour

Flag a is set to `T` if the sum of the Point-spread-function `LABEL` and the source extent `EXT` (converted from arc sec to image pixels) is greater or equal to the distance of the next source `dist_scr_new`. The likelihood of source extend `EXT_ML` has to be greater than 10 to consider a source as extended.
subsequent flag setting: i,s,l,v

2.4.2 Flag m - complex emission split into individual sources

Flag m is set for all sources within 2.1 times the sum of the source PSF and extent if at least two sources are found within that region. The likelihood of source extend `EXT_ML` has to be greater than 10 to consider a source as extended. The source with the highest detection priority `PRIO` (using the sum of the individual digits, e.g. 5 if PRIO is 111011) is defined as `mother source`. If more sources have the same detection priority, the source with the highest count rate is defined as `mother source`.
subsequent flag setting: i,s,l,v,p,f
The flag f is not given to the `mother source`.

2.4.3 Flag d - source near rib

We have improved the calculation of the rib and edge distance. The current implementation uses the new `DIST_RIB_NEW` value of `qsource.tbl`.
Flag d is set to "T" if the sum of the source PSF `LABEL` and extent EXT is greater or equal to the distance of the rib `DIST_RIB`. The likelihood of source extend `EXT_ML` has to be greater than 10 to consider a source as extended.
subsequent flag setting: i,s,l,v,p

2.4.4 Flag e - source extended

The flag e is set to "T" if the source extent is larger than 50 arcsec and the likelihood of extent is larger than 10. This definition should be discussed again during the testing phase.
subsequent flag setting: i

2.4.5 Flag n - no visual inspection

The flag n is set to "T" if `EXI_ML` or `EXI_MD` are less or equal 15 and greater than 0.
no subsequent flag setting

2.4.6 Flags l and s - light curve extraction may be incorrect, spectrum suspect

The flags l and s are set to "T" if the sum of the extraction radii `RADEXTR` of a source and its nearest neighbour is greater or equal to the distance between these sources `dist_scr_new`. The extraction radius is given in units of arcsec in the table `qsource` and is converted to image pixel when comparing it with the source distance.
subsequent flag setting: v

2.4.7 Flag v - variability flag suspect

Flag v is set to "T" if flag `F_CSQ` is not equal flag `POS_KS`. The input columns are taken from the `sourceana` table. `F_CSQ` is a flag containing information if the chi-squared test is positive (T/F). `POS_KS` is a flag containing information if the Kolmogorov-Smirnov test is positive (T/F).
no subsequent flag setting

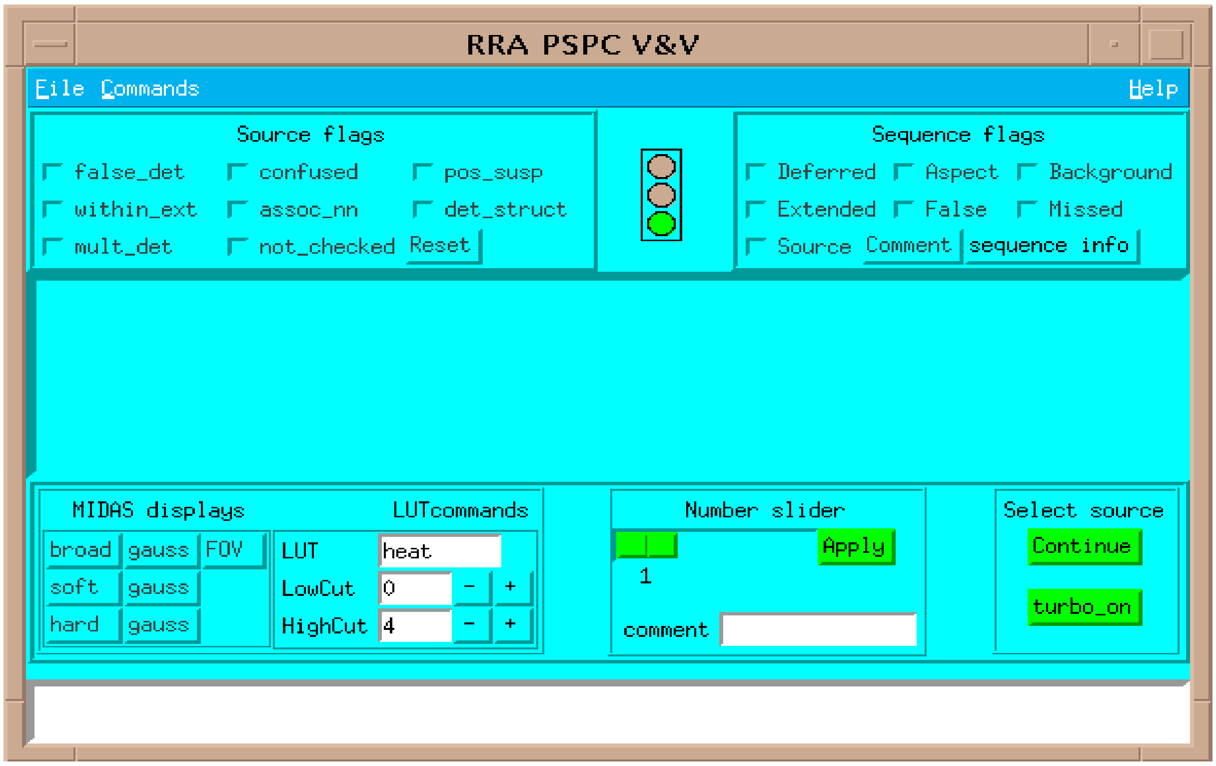

Figure 1: GUI Interface for RRA PSPC software

3 Visual inspection - `GUI/RRA`

3.1 Getting started

1. go to the directory where the results from `prepare/rra` are stored

2. exsas
   Start EXSAS

3. `gui/rra`
   A window is created where you have to give your `checking ID` and the `checking side`. Click on `Continue` and the window with the graphical user interface becomes active.

4. It is recommended to click the window with the MIDAS/EXSAS session to the background, so that only the graphical user interface is on your screen. Please anchor the GUI at south-east of your screen. (The remaining space will be filled by MIDAS/EXSAS displays).

3.2 Basic Commands

3.2.1 Menu bar

In the menu bar you can select **File**, **Commands** or **Help**.
Within **File** you can select:

Print ...
produce a hardcopy of the main MIDAS display 0. The name of your printer has to be given to the the toplevel entry widget. The printer name is defaulted to `laser`.

Exit
The header of `qsource` is updated with the source and sequence flag statistic created during `prepare/rra` and `gui/rra`.
Additionally, we display an image of the mask indicating the rib structure of the PSPC. During the testing phase we check, if the mask is created correctly. Please click on `YES`, if the rib structure is clearly seen and click on `NO` in cases when additional structures outside the rib structure can be seen bye eye. Later we will remove this additional check.

Within **Commands** you can select:

Load Sequence
Select *One source *All Sources *Display inner ring *via number
Quick mode
Flag sequence

The selected mode is displayed on the right lower corner of the GUI, defaulted to `Select source`. Clicking on the green `Continue` button allows you to continue in the selected mode. If you want to change the mode goto `Commands` and select e.g. `Display inner ring`.

Load Sequence
to create a MIDAS display with the image in the broad band and an overlay of the sources found by SASS.

Select
Select causes a cascade of commands to select sources either via cursor click or via the number slider.

Select ONE source is used to select a source via cursor click in the MIDAS/EXSAS display 0. At the left side of your screen will appear 2 (if the "turbo mode" is set to `turbo_on` smaller MIDAS/EXSAS displays with the zoomed region around the selected source in the broad ROSAT energy band as well as the corresponding Gaussian filtered image. If the "turbo mode" is set to `turbo_off` additionally 4 smaller displays are shown in the soft and hard ROSAT energy band as well as the corresponding Gaussian filtered images.
Select ALL sources is used go through all sources detected by SASS for the sequence. After the first source is displayed you have the options to click on the "Continue button" or to use another mode (e.g. ONE SOURCE) to leave the "Select All Sources" mode.
Display INNER ring is used to display the inner 20 arcmin field around the on-axis position of the sequence. In all MIDAS/EXSAS displays images with bin size 10 blocking are shown.
Select via number is used to overplot in the MIDAS/EXSAS display 0 the source number on the image in the broad band. The subsequent action by the user should be to use the green number slider below to select the source. The selection with the number slider has to be confirmed with the green "Apply" button. Selection with the number slider causes that the full field of view is loaded to MIDAS/EXSAS display 0. The number slider is not working for bin size 10 images.

Quick mode
In the **Quick mode** the result of the source selection after cursor click in display 0 is displayed in only `three` smaller displays indicating the zoomed region in the broad, soft and hard ROSAT energy band (from top to bottom). The `Quick mode` is working on a Gaussian filtered image. If you follow the instructions in the middle text widget on the GUI you can increase or decrease the zooming factor, change lut's and itt's or toggle (press u when the cursor is inside display 0) the looking glass mode. Don't forget to untoggle (again with u) to select a source. Please always use the left mouse button to select a source. You have to confirm your source selection by cursor click on the middle mouse button in display

0.

Flag Sequence
Flag Sequence is used to show the results of the operators flag setting in the color code described above and to give Sequence flags. (If display 0 is loaded the Sequence flag checkbuttons become active so that at any time you can set or unset Sequence flags). Whenever you think that there is a reasonable source which is missed by the detect algorithm, click the "Missed" button and mark with mouse click(left) in display 0 the position of those sources, exit with mouse click(middle).

Help
Within **Help** there is a short on-line help on how to select sources as well on source and sequence flag setting. With clicking on "Help on source flag setting" you get the Operators manual describing how to give source flags via human decision. "Help on sequence flag setting" causes the appearance of the Operators manual on the Sequence flag setting.

3.2.2 Source flags widget

The Source flag widget contains the checkbuttons to set source flags. The checkbuttons are not active (grey text) if no source is selected (e.g. when you have started `gui/rra`). They become active (black text) when operators action is allowed. The "Reset" button can be used to start again flag setting with the results from the automatic flag setting in `prepare/rra`.
Some of the source flags which are set automatically and which do not require operator's action (e.g. "extended" or "intensity suspect") are not displayed. Their flag setting can be looked at in the text output widget, when the SASS results on a source are displayed.

3.2.3 Sequence flags widget

The Sequence flag widget contains the checkbuttons to set Sequence flags. The checkbuttons are active if display 0 is loaded. You can give a comment to the sequence by clicking on the `Comment` button. A new toplevel window will appear where you can give the comment (25 characters are stored). Basic information on the sequence (observation ID, observation date, pointing direction) can be looked at by clicking on `sequence info`.

3.2.4 Output text widget - below Source and Sequence flag widget

This text widget is used to display the SASS results for a selected source. You can scroll the text by press with the middle mouse button.

3.2.5 MIDAS displays

Below of MIDAS displays you find 7 buttons which correspond to the 7 MIDAS/EXSAS displays.
Please click one of these buttons to change the colour lookup tables or to change the cut values. The buttons are disabled when the corresponding displays are not loaded.
Please **avoid double clicks on the "+" or "-" buttons**, always first click one of the 7 buttons, which correspond to the 7 MIDAS/EXSAS displays, then click "+" or "-".

3.2.6 LUTcommands

Within the entry widget right of "LUT" you can change the colour lookup table for all displays. With the cursor on "LUT" there is an on-line help in the white text widget at the bottom of the GUI which lookup tables can be selected. Please avoid errors as this is currently not checked by the program.

You can change the lower and higher cuts values of each of the displays in two ways:
either click on the white entry widget right of "LowCut" or "HighCut", type in the value you want and give "Return". To correct please click again on the right side to the entry widget and delete from right to left. Please avoid errors as this is currently not checked by the program. You can also click the "minus" or "plus" buttons to decrease or increase by 1.

3.2.7 Number slider

The number slider (green slider) can be used to select sources via their numbers. Click the left mouse button and move the slider. Confirm source selection with the green "Apply" button. Selection with the number slider presently causes that the full field of view is loaded to MIDAS/EXSAS display 0. Please do not use the number slider when you are in the "Select ALL sources" mode.

3.2.8 comment widget

The comment widget (white widget above the green "incr" button) is active when a source is selected either with the cursor or the number slider. You can give your comment to a specific source by clicking the white entry widget and "Return".

3.2.9 Turbo mode

With the `turbo_on` or `turbo_off` mode you can decide if you wish to see the ROSAT images in the soft and hard band or not. Simply click on the button and work with any command you want to work in the "turbo_on" (only broad band images) or "turbo_off" mode.

3.2.10 Selection mode

The actual mode of source selection (one source, all sources, display inner ring, select via number or quick mode) is displayed on the right lower widget. Below you find the green `Continue` button. Click on it and continue in the selected mode. If you wish to change mode, goto `Commands` and select another mode.

4 Structure of the resulting FITS files

To convert the results of the V&V process run the program `archive/rra` in the directory, where the results from `prepare/rra` and `gui/rra` are stored.
The results of the verification process is stored in the fits files:
`r*_qsrc.fits`
`r*_mis.fits`
`r*_qsrc.init`
The `r*_qsrc.fits` is an extension of the `r*_src.fits` file. The extensions are:

- the source flags given to individual sources and the sequence flags via `prepare/rra` or `gui/rra`
- name and site of the checking person, checking date
- number of sources in the sequence
- the statistics of the source flag setting (e.g. flag `det_struc` was given to 5 sources in that sequence)
- information on whether the PSPC support mask was created correctly

The `r*_mis.fits` file contains the positions, marked by the checking person, of sources probably missed by the standard analysis software.
The `r*_qsrc.init` file contains the flags as set by `prepare/rra`.

Please let me know of any problems.
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References:

The RRA PSPC software is based on MIDAS/EXSAS and Tcl/Tk. A detailed description of the EXSAS system can be found in the EXSAS User's Guide (Zimmermann et al. 1994). The graphical user interface for MIDAS/EXSAS is based on Tcl/Tk (Welch 1994). The communication interface between MIDAS and Tcl/Tk was created by Banse (1994) and applied to MIDAS/EXSAS-Tcl/Tk communication by Carlo Izzo. The Standard Analysis Software (SASS) to evaluate data from the ROSAT satellite (Trümper 1983) is described by Voges et al. (1992).

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