ROSAT boresight correction

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In the following a procedure is outlined with which source positions can be improved for ROSAT pointing data processed with those of the earlier versions of SASS (Standard Analysis Software System) that did not use optimum boresight values.

However, we would like to begin this note with a word of caution as to the use of such data. In general, users should always attempt to use data processed with the latest SASS reprocessing (version SASS 7_0 or higher) which are the most reliable in several respects. For these data no further boresight correction needs to be applied. In the ROSAT data archive earlier data products are continuously replaced by the latest versions so that only a small number of data sets with deviating boresight values remain presently in the archive.

A second warning regards the use of the presented correction procedure itself. In a number of cases an observation that consists of several OBIs (observation intervals) contains data processed with different SASS versions (different versions for different OBIs). This may require different boresight corrections for each OBI. A detailed history of the processing can be found in the ROSAT Service Area (files pspc_obi.sassvrs, pspc_seq.sassvrs, hri_obi.sassvrs and hri_obi.sassvrs in directory processing). Be sure to identify the SASS version(s) used to process your OBI data before attempting any correction. The history files mentioned above provide the required information on the start and end times of each OBI and the respective SASS version.

In order to improve source positions in ROSAT data processed with SASS versions below 7_0, the following *additive* corrections should be applied to the individual photons of an observation (for practical purposes it may suffice to apply this correction directly to the source positions):

- Δx: value to be added to detector–x coordinates;
- Δy: value to be added to detector–y coordinates;
- $\Delta\rho$: angle by which an image needs to be rotated in a counterclockwise fashion (roll angle correction).

Correction values appropriate for the respective SASS versions are listed in Table 1 for PSPC(B), and for the HRI. The pair (Δx, Δy) corresponds to a spatial shift of the detector in the plane tangential to the celestial sphere (an approximation valid for small shifts), $\Delta\rho$ corresponds to a rotation of the detector. In general the correction of erroneous boresight values must be done in detector coordinates as follows:

1) Transform sky coordinates (RA, DEC) to detector coordinates $(x_{\rm det}, y_{\rm det})$ via:

$$x^{\rm det} - x_{\circ}^{\rm det} = -(RA - RA_{\circ})\ \cos DEC\ \cos\rho - (DEC - DEC_{\circ})\ \sin\rho$$
$$y^{\rm det} - y_{\circ}^{\rm det} = +(RA - RA_{\circ})\ \cos DEC\ \sin\rho - (DEC - DEC_{\circ})\ \cos\rho$$

Table 1: Boresight correction values

Detector	SASS version	Δx [arcsec]	Δy [arcsec]	$\Delta\rho$ [arcmin]
PSPC(B)	earlier than SASS6_2	1.0	−10.0	−12.0
PSPC(B)	from SASS6_2 until before SASS7_0	0.0	−4.0	−12.0
PSPC(B)	SASS7_0 and later	0.0	0.0	0.0
HRI	earlier than SASS7_0	0.0	0.0	−24.0
HRI	SASS7_0 and later	0.0	0.0	0.0

where $(RA_\circ,\ DEC_\circ)$ and $(x_\circ^{\rm det},\ y_\circ^{\rm det})$ are, respectively, the equatorial and detector coordinates of the pointing direction (detector center), and ρ is the roll angle.

2) Apply the additive corrections by substituting

$$x^{\rm det} \longrightarrow x^{\rm det} + \Delta x, \qquad y^{\rm det} \longrightarrow y^{\rm det} + \Delta y, \qquad \rho \longrightarrow \rho + \Delta\rho.$$

3) Transform detector coordinates back to sky coordinates via:

$$(RA - RA_\circ)\ \cos DEC = -(x^{\rm det} - x_\circ^{\rm det})\ \cos\rho + (y^{\rm det} - y_\circ^{\rm det})\ \sin\rho$$
$$DEC - DEC_\circ = -(x^{\rm det} - x_\circ^{\rm det})\ \sin\rho - (y^{\rm det} - y_\circ^{\rm det})\ \cos\rho$$

See Table 1 for the appropriate correction values. The values of the roll angle ρ must be taken from the attitude file. It is important to note that different OBIs may have been carried out with different roll angles. The correction for these must be done separately.