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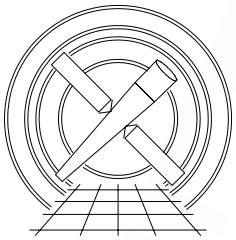

Data Product Interface Document: Level 1 aspect offset products

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Submitted: _____ _____
Jonathan McDowell — Date
Scientist, ASC Science Data Systems

Concurred: _____ _____
Arnold Rots — Date
Archive Scientist, ASC Archives

Concurred: _____ _____
Janet De Ponte — Date
ASC Data Systems Group Leader, Tools

Concurred: _____ _____
Fred Seibel — Date
Manager, ASC Data Systems

Concurred: _____ _____
Martin Elvis — Date
Manager, ASC Science Data Systems

Approved: _____ _____
Harvey Tananbaum — Date
Director, ASC

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09/27/98	1.0	all	Initial pre-release draft

Unresolved issues

The following is the list of the most important unresolved issues, as of October 7, 1998:

1. Need to verify how SIM offsets are calculated in case when aspect sol. is not KALMAN.
2. Need to schedule changes to code.

Contents

List of Tables

Chapter 1

Summary

This document describes the aspect related data products to be generated by the ASC Level 1 science instrument pipelines. These products are derived from the fundamental Level 1 aspect products made by the aspect pipeline. Tool requirements are from Applicable Document 1 and design from Applicable Document 2. Data product requirements are from Applicable Document 3. Data products will conform to FITS standards and conventions described in Applicable Documents 4, 5, and 6, and coordinate conventions as described in Applicable Document 7.

FITS files consist of one or more HDUs (Header Data Units). They contain one principal HDU and, optionally, multiple auxiliary HDUs. They are either images, with an IMAGE HDU as the first and possibly only HDU, or tables, in which case the first HDU in the file is a null HDU, with the principal BINTABLE HDU in a later section of the file.

Chapter 2

Applicable Documents

1. ASC AMO-2400 (SE03)
   ASC Data System Requirements (ASC.302.93.0008)
2. ASC AMO-2401 (DS01)
   ASC Data System Software Design (ASC.500.93.0006)
3. SDS02
   AXAF Data Products Guide
   `http://hea-www.harvard.edu/asclocal/sds/CDR2/dp.ps`
4. NOST 100-1.1, Definition of the Flexible Image Transport System (FITS)
   `http://www.cv.nrao.edu/fits/`
5. HEASARC FITS Standards:
   `http://legacy.gsfc.nasa.gov/docs/heasarc/ofwg/ofwg_intro.html`
   `ftp://legacy.gsfc.nasa.gov/fits_info/ofwg_recomm/recomm.txt`
6. ASC FITS File Designers' Guide
   `http://hea-www.harvard.edu/~arots/asc/fits/ascfits.ps`
7. SDS01-4.2
   AXAF Coordinate Systems
   `http://hea-www.harvard.edu/~jcm/asc/coords`

Chapter 3

Data products

ASC will generate two Level 1 OBI processing aspect products:

aspect offsets: Aspect relative to nominal versus time.

sim offsets: Science instrument module offsets versus time.

3.1 Aspect Offsets

3.1.1 Algorithm

The new plan for aspect offsets is as follows.

We will store the sky aspect offsets Ax, Ay, Ar defined as follows:

- nominal aspect $(\alpha_n, \delta_n, \theta_n)$
- instantaneous aspect (α, δ, θ).
- plate scale (degrees per pixel) Δ
- FPSYS plane center coords x_0, y_0.
- Sky coords of a photon, x, y
- FP coords of a photon, dx, dy.
- Sky aspect offsets A_x, A_y (pixels) and roll offset A_r (deg).

Then

$$\begin{pmatrix} A_x \\ \\ A_y \end{pmatrix} = \begin{pmatrix} (-1/\Delta)(\alpha - \alpha_n)\cos\delta_n \\ \\ (+1/\Delta)(\delta - \delta_n) \end{pmatrix}$$

where the minus sign in the expression for A_x is because RA decreases with sky X coordinate. Also

$$A_r = \theta - \theta_n$$

but A_r is forced to lie in the range (-180,180) by adding 360n as needed.

The expression to apply the aspect offsets is

$$\begin{pmatrix} x \\ \\ y \end{pmatrix} = \begin{pmatrix} x_0 \\ \\ y_0 \end{pmatrix} + R(-\theta_n - A_r) \begin{pmatrix} dx - x_0 \\ \\ dy - y_0 \end{pmatrix}$$

where $R(\theta)$ is a rotation $\begin{pmatrix} \cos\theta & -\sin\theta \\ \sin\theta & \cos\theta \end{pmatrix}$.

We also calculate the mean values of RA, Dec and Roll in the header.

Table 3.1 lists the keywords added to the principal HDU header of the Aspect Offsets file. The CENTER keyword records the centering method used in the aspect solution, usually 'KALMAN'. The DTASPSOL keyword records the time step in the aspect solution. These keywords are copied from the input aspect solution.

The ROLL_RMS keyword describes the RMS variation in the aspect roll offsets, in units of degrees. X_OFFSET_MIN, X_OFFSET_MAX, Y_OFFSET_MIN, Y_OFFSET_MAX, ROLL_OFFSET_MIN, ROLL_OFFSET_MAX give the actual range in the data of the X_OFFSET, Y_OFFSET and ROLL_OFFSET columns. These keywords should be written as double precision values.

PROPOSED REVISION: We propose changing some names and adding the following new keywords: RA_PNT DEC_PNT and ROLL_PNT as the mean values of RA and DEC and Roll during the observation.

The contents of the primary HDU binary table for the Aspect Offsets algorithm are described in Table **??**. Each row contains the information on one aspect time readout.

```
EXTNAME = 'ASPOFF  '            / Same as HDU name
CONTENT = 'ASPOFFS '            / What data product
HDUSPEC = 'Data Products ICD: Level 1 aspect offset products'
HDUDOC  = 'ASC-FITS-1.2: McDowell, Rots: ASC FITS File Designers Guide'
HDUVERS = '1.0.0   '
HDUNAME = 'ASPOFF '            / HDU name
HDUCLASS= 'ASC     '
HDUCLAS1= 'TEMPORALDATA'
HDUCLAS2= 'ASPOFF'
CENTER  = 'KALMAN'             / Centering used in solution
DTASPSOL=          1.0         / [sec] Delta readout time
ROLL_RMS=                     / [deg] RMS of roll offsets
X_OFFSET_MIN=
X_OFFSET_MAX=
Y_OFFSET_MIN=
Y_OFFSET_MAX=
ROLL_OFFSET_MIN=
ROLL_OFFSET_MAX=
RA_PNT=                 [deg] Mean RA of optical axis
DEC_PNT=                [deg] Mean Dec of optical axis
ROLL_PNT=               [deg] Mean Roll of optical axis
```

Table 3.1: Keywords specific to ASPECT OFFSETS

#	TTYPE	TUNIT	TFORM	TLMIN	TLMAX	Comment
1	TIME	s	1D	-	-	Mission time
2	X_OFFSET	pixel	1E			ASPX
3	Y_OFFSET	pixel	1E			ASPY
4	ROLL_OFFSET	deg	1E	-180.0	180.0	ASPR
5	STF_Y	mm	1D			SIM offset
6	STF_Z	mm	1D			SIM offset
7	STF_ROLL	deg	1D	-180.0	180.0	SIM roll

Table 3.2: List of columns in aspect offsets file

3.2 SIM Offsets

Table 3.3 lists the keywords added to the principal HDU header of the SIM Offsets file. The CENTER keyword records the centering method used in the aspect solution, usually 'KALMAN'.

```
EXTNAME = 'ALIGN  '           / Same as HDU name
CONTENT = 'ALIGNMOFFS '           / What data product
HDUSPEC = 'Data Products ICD: DETECT tools, V. xxxx'
HDUDOC  = 'ASC-FITS-1.2: McDowell, Rots: ASC FITS File Designers Guide'
HDUVERS = '1.0.0   '
HDUNAME = 'ALIGN  '           / HDU name
HDUCLASS= 'ASC     '
HDUCLAS1= 'TEMPORALDATA'
HDUCLAS2= 'ALIGNMENT'
CENTER  = 'KALMAN'           / Centering used in solution
STF_Y_TOL=        / STF tolerance
STF_Z_TOL=        / STF tolerance
STF_ROLL_TOL=        / STF tolerance
```

Table 3.3: Keywords specific to ASPECT OFFSETS

The contents of the primary HDU binary table for the SIM alignments file are described in Table 3.4. Each row contains the information on one SIM position that differs by more than the tolerance from the previous row.

#	TTYPE	TUNIT	TFORM	TLMIN	TLMAX	Comment
1	START	s	1D	-	-	Mission time
2	STOP	s	1D	-	-	Mission time
3	STF_Y	mm	1D			SIM offset
4	STF_Z	mm	1D			SIM offset
5	STF_ROLL	mm	1D			SIM roll

Table 3.4: List of columns in aspect offsets file