# AIA/SDO FITS Keywords for Scientific Usage and Data Processing at Levels 0, 1.0, and 1.5

(A document in progress; This Version for Level 0 & 1 at SDO Launch)

Keyword Nomenclature:

(Telemetry keywords are ***bold italic***; derived keywords are **bold**; potential keywords are *italic*)

{# = Integer (~ 0-999); @ = Optional single character A-Z; & = Alpha-numeric}

| | |
|---|---|
| *LL@#* | Lower Left corner pixel for row (X) / column (Y) for Region of Interest (ROI) # on CCD |
| *NAXIS@#* | Dimension (in pixels) along row (X) / column (Y) for ROI # on CCD |
| A@&&&&&& | Originating from telemetry data (@: H = HDR, F = FDB, I = ISP) |

(Note: The definitions of the output data levels included below have been extracted in part from the current Stanford SDO DRMS and SUMS computer database. Phil Scherrer's "JSOC Keywords used for metadata" document [current update 5/8/09] will be used to define and explain the keyword usage.)

## 1. Level-0 Keywords

### 1.1 Basic Image Configuration Keywords and Information for Level-0

Definition of Level-0 Metadata for the Image Header (Note: The only intended external use of this level is for JSOC-OPS quick-look viewing in near-real time.)

Metadata for Level-0, when the image comes down, consists of keywords derived directly from the image camera header data and those stored in a ground database containing the image characteristics, such as image size, date of observation, telescope, instrument, etc., plus that generated from the associated image status packet (ISP), including the status of mechanisms, the camera itself, the image stabilization system (ISS), and the guide telescope (GT). (See image status packet list in Section 1.2 below.)

Metadata for Level-0 may be updated further in the next 24 hours as the final versions of SDO roll information and Flight Dynamics System data are received.

Data Image for Level-0

Decompressed raw data recompressed using non-lossy compression, such as rice.

The following keywords come from science data packet image header (HDR) information (definition in Doc. AIA02019):

***AHAPID*** = Packet APID (11b; from HDR)
***AHTCS*** = Packet Time Code Seconds (32b; from HDR)
***AHTCSS*** = Packet Time Code Sub Seconds (32b; from HDR)
***AHTLFSN*** = Camera/Frame Serial Number (32b; from HDR)
***AHTAPC*** = TAP Code (4b; from HDR)
***AHBITID*** = Bit Select ID (4b; from HDR)
***AHCPIDN*** = Compression parameter *n* (4b; from HDR)
***AHCPIDK*** = Compression parameter *k* (4b; from HDR)
***AHLUTID*** = Lookup Table ID (8b; from HDR)

The 9 keywords above will be useful in identifying and reconstructing the acquired image, as indicated below.

**NAXIS** = the number of axes of the overall image, int, (nominally = 2) {Level-1 also}
**NAXIS1** = the total number of pixels along axis 1 of overall image, int, (nominally = 4096 for X axis) {Level-1 also}
**NAXIS2** = the total number of pixels along axis 2 of overall image, int, (nominally = 4096 for Y axis) {Level-1 also}
**CAMERA** = the most significant 2b of ***AHTLFSN*** +1 = [1, 2, 3, 4] and the AIA camera (telescope) number associated with the image (int) {Level-1 also}
**FSN** = the least significant 30b of ***AHTLFSN*** and is the Frame Serial Number (int) {Level-1 also}
**FID** = the Frame Definition Block (FDB) ID (int) found in the crop/de-crop tables for this image {Level-1 also}
**TLMDSNAM** = Telemetry data series name (string) with first packet of image
**IMGFPT** = the first packet time in "ISO" units constructed from ***AHTCS*** and ***AHTCSS***.
**IMGAPID** = ***AHAPID***, Image Application ID (int)
**TAPCODE** = ***AHTAPC***, "Take a Picture code" (int)
**BITSELID** = ***AHBITID***, Bit select id, r (int)
**COMPID** = the compression id; n, k; constructed from ***AHCPIDN*** and ***AHCPIDK***. (int)
**CROPID** = Crop Table ID
**LUTID** = ***AHLUTID***, Lookup table id (int)
**NPACKETS** int, Number of packets in image
**NERRORS** int, Number of decompression errors
**EOIERROR** short, Last pixel error; End Of Image Error
**HEADRERR** short, Header error in image
**OVERFLOW** short, Data overflow error in image

**QUALITY** int, Level-0 and -1 quality word (QUALITY = 0 means OK; see Appendix 2) {Level-1 also}
**INSTRUME** = "AIA_i" string, name of instrument (within telescope package) where i = camera number = 1, 2, 3, or 4

The following lower case keywords appear only in the JSOC Level-0 Lookdata keywords:

| | |
|---|---|
| **cparms_sg000** | DRMS segment 0 |
| **image_bzero** | multiplier for data values |
| **image_bscale** | offset for data values |
| **cparms_sg001** | DRMS segment 1 |
| **image_sm_bzero** | multiplier for data values in small image |
| **image_sm_bscale** | offset for data values in small image |

(Note: Compressed files may have extra and/or different key words.)

## 1.2 FITS, JSOC, and Image Statistics Keywords for Level-0 and Level-1

**SIMPLE** = "T" Boolean, always T for True, if conforming FITS file
**BITPIX** = "16" integer, Bits/pixel: 16, 32, -32, or -64 (negative for floating point) (HMI uses as 16 in L0)

**EXTEND** FITS file may contain extensions
**BLD_VERS** string, JSOC build version
**ORIGIN** string, location where file was made, e.g., "SDO/JSOC-SDP"
**DATE** string, date and time of file creation in format: yyyy-mm-ddThh:mm:ss[.sss] in UTC (FITS- and iso-standard)

**DATE_OBS = T_OBS – (EXPTIME**/2.0) string, UTC, date when image observation started
**= DATE_D$OBS = DATE__OBS** other forms of this keyword in the database or in printouts
**T_OBS** time**,** UTC**,** middle of the exposure time (shutter open start time + exposure time / 2.

**EXPTIME** floating point, calculated in double precision, exposure time in seconds

**EXPSDEV** float, calculated in double precision, standard deviation of the exposure time (see Appendix 1: AIA Camera Exposure Time Calculation for details on the 4 keywords above.)

**IMG_TYPE** string, shutter image type: 'LIGHT' or 'DARK'

| | |
|---|---|
| **TELESCOP** = "SDO/AIA" | string, name of source telescope package |
| **INSTRUME** = "AIA" (TBD) | string, name of instrument {Level-1 only} |
| **INT_TIME** = ***AICFGDL4*** **-** ***AICFGDL3*** (+ rollover) | double, interval time between readout delay and shutter operation delay plus rollover (i.e., CCD integration duration) |
| **WAVELNTH** = ***AIAWVLEN*** = AIA_IMG_WAVELENGTH | integer, wavelength of this observation in angstroms, with 2 each for camera (telescope) 1, 2, 4, and 4 each for camera 3 with mapping reference number of each wavelength |
| = 335 (0), 131 (1) | for camera 1 |
| = 211 (2), 193 (3) | for camera 2 |
| = 1600 (4), 1700 (5), 4500 (6), 171 (7) | for camera 3 |
| = 304 (8), 94 (9) | for camera 4 |
| **WAVEUNIT** = "angstrom" | wavelength unit: angstrom |
| **WAVE_STR** = string(**WAVELNTH+'_'+*AIFILTYP***) | wavelength Filter Position |
| **TOTVALS** | int, Expected number of data values (pixels) |
| **DATAVALS** | int, Actual number of data values in image |
| **MISSVALS** | int, Missing values: **TOTVALS – DATAVALS** |
| **PERCENTD** | int, Actual number of data values in image as percent of the total: (**DATAVALS/TOTVALS**) *100.0 |
| **DATAMIN** | short, minimum value from all pixels (pixel units are in "DN") |
| **DATAMAX** | short, maximum value from all pixels |
| **DATAMEDN** | short, median value from all pixels |
| **DATAMEAN** | float, mean value for all pixels |
| **DATARMS** | float, RMS deviation from the mean value of all pixels |
| **DATASKEW** | float, Skewness from the mean value of all pixels |
| **DATAKURT** | float, Kurtosis of all pixels |
| **BLANK** = "-32768" | value signaling undefined integer data |
| **COMMENT** | Comment |
| **HISTORY** | ASCII history record, one or more, usually by SSW |
| **END** | {FITS required; not at end of current Level-0 files (TBD)} |

## 1.3 Image Status Packet (ISP) Keywords [from APID 027, as of May 2008] to be included in Level-0 and Level-1

| | |
|---|---|
| **ISPSNAME** | ISP Series Name |

**ISPPKTIM** Packet time from the following two ISP keywords, Prime key value for the ISP record

***ATCS027*** = APID027_TIMECODE_SECONDS, APID027 timecode in seconds
***ATCSS027*** = APID027_TIMECODE_SUBSECS, APID027 timecode in subseconds, [Quality/Sanity Check time]
**ISPPKTVN** Packet version number
***AIVNMST*** = AIA_VER_NUM_IMAGE_STATUS, ISP version number
***AIMGOTS*** = AIA_IMG_OBT_TIME_SH_SEC, seconds time tag read from OBC shutter time tag register for the shutter operation making this image

***ASQHDR*** = AIA_SEQ_HEADER, a combination of the camera number and the frame serial number, both of which have their own keywords, as follows

***ASQTNUM*** = AIA_SEQ_TEL_NUM, from which the camera (telescope) number that took this image, **CAMERA** (= ***ASQTNUM*** + 1), can be sanity checked

***ASQFSN*** = AIA_SEQ_FRAME_SN from which the frame serial number of this image, ***AHFSN***, can be sanity checked (independent of the camera number)

***AIAHFSN*** = AIA_IMG_HIST_FSN, the FSN of the image from which the histogram data was obtained
***AECDELAY*** = AIA_IMG_AEC_DELAY, time since image used for AEC
***AIAECTI*** = AIA_IMG_AEC_TABLE_ID, Automatic Exposure Control (AEC) table used with image
***AIASEN*** = AIA_IMG_AS_ENCODER aperture selection encoder reading{TBD, Level-1 as **APER_SEL**}
***AIFDBID*** = AIA_IMG_FDB_ID, frame definition block id, [Quality/Sanity Check ***AFDBID*?**]
***AIMGOTSS*** = AIA_IMG_OBT_TIME_SH_SS, subseconds time tag read from OBC shutter time tag register for the shutter operation making this image

***AIFCPS*** = AIA_IMG_FC_POSITION currently loaded target value for the focus position mechanism {TBD, Level-1 as **FOCUSPOS**}

***AIFTSWTH*** = AIA_IMG_FLT_TYPE_SW_TH, filter switch threshold for 131A wavelength (exposure)
***AIFRMLID*** = AIA_IMG_FRMLIST_ID, framelist id for this image
***AIFTSID*** = AIA_IMG_FTS_ID, framelist timeline schedule (FTS) id for this image
***AIHISMXB*** = AIA_IMG_HIST_MAX_BIN, bin number of maximum of standard histogram for previous image in this wavelength used for the current AEC

***AIHIS192*** = AIA_IMG_HISTC_BN_192, cumulative histogram value at bin #192
***AIHIS348*** = AIA_IMG_HISTC_BN_348, cumulative histogram value at bin #348
***AIHIS604*** = AIA_IMG_HISTC_BN_604, cumulative histogram value at bin #604
***AIHIS860*** = AIA_IMG_HISTC_BN_860, cumulative histogram value at bin #860
***AIFWEN*** = AIA_IMG_FW_ENCODER filter wheel selector encoder reading (0-255) for this image

{TBD, Level-1 as **FILWLSEL**}

| | | |
|---|---|---|
| ***AIMGSHCE*** | = AIA_IMG_SH_CMDED_EXPOSURE | commanded exposure for image {TBD, Level-1 as **CMDEXPT**} |
| ***AECTYPE*** | = AIA_IMG_AEC_TYPE, | AEC table for current wavelength (4 tables per wavelength) |
| ***AECMODE*** | = AIA_IMG_AEC_MODE, | mode of AEC (on/off) |
| ***AISTATE*** | = AIA_IMG_ISS_LOOP, | ISS on/off |
| ***AIAECENF*** | = AIA_IMG_AEC_ENA_FLAG, | AEC enable flag for this image |
| ***AIFILTYP*** | = AIA_IMG_FILTER_TYPE | filter type, “thick”, “thin” (used for 131 A only), or “open” {TBD, Level-1 as **FILT_TYP**} |
| ***AIMSHOBC*** | = AIA_IMG_SH_OPEN_BOT_CENTR, | shutter timer register value for this position of this image |
| ***AIMSHOBE*** | = AIA_IMG_SH_OPEN_BOT_EDGE, | (same as above) |
| ***AIMSHOTC*** | = AIA_IMG_SH_OPEN_TOP_CENTR, | (same as above) |
| ***AIMSHOTE*** | = AIA_IMG_SH_OPEN_TOP_EDGE, | (same as above) |
| ***AIMSHCBC*** | = AIA_IMG_SH_CLOSE_BOT_CENTR, | (same as above) |
| ***AIMSHCBE*** | = AIA_IMG_SH_CLOSE_BOT_EDGE, | (same as above) |
| ***AIMSHCTC*** | = AIA_IMG_SH_CLOSE_TOP_CENTR , | (same as above) |
| ***AIMSHCTE*** | = AIA_IMG_SH_CLOSE_TOP_EDGE, | (same as above) |
| ***AICFGDL1*** | = AIA_IMG_CFG_DELAY_1, | mechanism delay 1 for this image |
| ***AICFGDL2*** | = AIA_IMG_CFG_DELAY_2, | clear table delay for this image |
| ***AICFGDL3*** | = AIA_IMG_CFG_DELAY_3, | shutter operation delay for this image |
| ***AICFGDL4*** | = AIA_IMG_CFG_DELAY_4 , | readout delay for this image |
| ***AIFOENFL*** | = AIA_IMG_FOCUS_ENA_FLAG, | flag to indicate if focus table used or not |
| ***AIMGFSN*** | = AIA_IMG_FRLIST_POS, | position within framelist of this frame |
| ***AIMGTYP*** | = AIA_IMG_IMAGE_TYPE | software logic shows “dark” (0) only, {replaced by **IMG_TYP**} |
| ***AIAWVLEN*** | = AIA_IMG_WAVELENGTH | |
| ***AIAGP1*** | = AIA_IMG_GP1, | general purpose register word 1 |
| ***AIAGP2*** | = AIA_IMG_GP2, | general purpose register word 2 |
| ***AIAGP3*** | = AIA_IMG_GP3, | general purpose register word 3 |
| ***AIAGP4*** | = AIA_IMG_GP4, | general purpose register word 4 |
| ***AIAGP5*** | = AIA_IMG_GP5, | general purpose register word 5 |
| ***AIAGP6*** | = AIA_IMG_GP6, | general purpose register word 6 |
| ***AIAGP7*** | = AIA_IMG_GP7, | general purpose register word 7 |
| ***AIAGP8*** | = AIA_IMG_GP8, | general purpose register word 8 |
| ***AIAGP9*** | = AIA_IMG_GP9, | general purpose register word 9 |
| ***AIAGP10*** | = AIA_IMG_GP10, | general purpose register word 10 |

| | | |
|---|---|---|
| ***AGT1SVY*** | = AIA_IMG_GT1_SUNVECTOR_Y, | Guide Telescope (GT) 1 Sun vector in y direction |
| ***AGT1SVZ*** | = AIA_IMG_GT1_ SUNVECTOR _Z, | Guide Telescope (GT) 1 Sun vector in z direction |
| ***AGT2SVY*** | = AIA_IMG_GT2_SUNVECTOR_Y, | Guide Telescope (GT) 2 Sun vector in y direction |
| ***AGT2SVZ*** | = AIA_IMG_GT2_ SUNVECTOR _Z, | Guide Telescope (GT) 2 Sun vector in z direction |
| ***AGT3SVY*** | = AIA_IMG_GT3_SUNVECTOR_Y, | Guide Telescope (GT) 3 Sun vector in y direction |
| ***AGT3SVZ*** | = AIA_IMG_GT3_ SUNVECTOR _Z, | Guide Telescope (GT) 3 Sun vector in z direction |
| ***AGT4SVY*** | = AIA_IMG_GT4_SUNVECTOR_Y | Guide Telescope (GT) 4 Sun vector in y direction |
| ***AGT4SVZ*** | = AIA_IMG_GT4_ SUNVECTOR _Z, | Guide Telescope (GT) 4 Sun vector in z direction |
| ***AIMGSHEN*** | = AIA_IMG_SH_ENCODER, | shutter selector encoder reading (0-255) for this image |

## 2. Level-1 Keywords

More level definitions

Definition of Level-1.0 (Note: This temporary level is generated on demand from Level-0 and is held for up to 60 days.)

1. Header
   Metadata for Level-0 reduced to those scientific FITS keywords needed for analysis at Level-1, updating the image coordinate mapping keywords to meaningful and nearly correct values, plus other keywords needed for Level -1 and above.
2. Data
   Decompressed raw data (level 0) with overscan pixels removed, dark pedestal and current, as well as flat field, corrections applied, bad pixel and cosmic-ray spike maps created and used to fix bad pixels and despike the cosmic-rays, image flipped to align with Solar North, and, finally, image rescaled to integer.

Definition of Level-1.5 (Note: The output from this level will be used to generate the permanently stored data.)

1. Header
   Metadata for Level-1.0 updated for the applied calibrations below (that will irreversibly modify the data).
2. Data
   Floating-Point Level-1.0 data images that are adjusted for plate scale, rotation, and sub-pixel registration; roll corrected; and finally rescaled to integer.

Note: Level-1 keywords include those identified as such above plus those following.

## 2.1 Level-1 Image, Scale, and Processing Keywords

The following lower case keywords appear only in the JSOC Level-1 Lookdata keywords:

| | |
|---|---|
| **cparms_sg000** | DRMS segment 0 |
| **image_lev1_bzero** | multiplier for data values |
| **image_lev1_bscale** | offset for data values |
| **cparms_sg001** | DRMS segment 1 |
| **bad_pixel_bzero** | multiplier for data values in bad pixel list |
| **bad_pixel_bscale** | offset for data values in bad pixel list |
| **cparms_sg002** | DRMS segment 2 |
| **spikes_bzero** | multiplier for data values in spikes list |
| **spikes_bscale** | offset for data values in spikes list |

The following lower case keywords appear only in the JSOC Level-1.5 Lookdata keywords:

| | |
|---|---|
| **cparms_sg000** | DRMS segment 0 |
| **image_lev1p5_bzero** | multiplier for data values |
| **image_lev1p5_bscale** | offset for data values |

| | | |
|---|---|---|
| **T_OBS_step** | T_OBS step (seconds) | |
| **T_OBS_epoch** | epoch date | |
| **T_OBS_round** | center of slot | {Level-1.0 only} |
| **QUALLEV0** | int, Level-0 quality word in Level-0 | (see Appendix 2) |
| **QUALITY** | int, Level-1 quality word | (see Appendix 3) |

**ROI_NWIN** = Number of Windows (4b; from FDB) for number of Region Of Interest(s) (ROI) (int) (= 0, 1, 2)
**ROI_SUM** = SummingMode (4b; from FDB) for summing (int): 1x1, 2x2, 4x4 (= 0, 1, 2)
**ROI_NAX1** = Number of CCD Columns (from FDB and de-crop table) for width of ROI 1 in pixels (int)
**ROI_NAY1** = Number of CCD Rows (from FDB and de-crop table) for height of ROI 1 in pixels (int)
**ROI_LLX1** = CCD X-variable location of lower left corner pixel of ROI 1 (int)
**ROI_LLY1** = CCD Y-variable location of lower left corner pixel of ROI 1 (int)
**ROI_NAX2** = Number of CCD Columns (from FDB and de-crop table) for width of ROI 2 in pixels (int)
**ROI_NAY2** = Number of CCD Rows (from FDB and de-crop table) for height of ROI 2 in pixels (int)
**ROI_LLX2** = CCD X-variable location of lower left corner pixel of ROI 2 (int)

**ROI_LLY2** = CCD Y-variable location of lower left corner pixel of ROI 2 (int)

Currently the following 5 keywords are still listed by their ISP names, which start with "**AI**" (second column of 5 keywords below. The preferred first column names should be used if the ISP keywords are eliminated from a level.)

| | | |
|---|---|---|
| **APER_SEL** | = ***AIASEN*** | long int, Aperture selection encoder reading |
| **FILWLSEL** | = ***AIWEN*** | int, Filter wheel selector encoder reading (0-255) |
| **FILT_TYP** | = ***AIFILTYP*** | string, filter type of 'thick', 'thin', or 'open' |
| **CMDEXPT** | = ***AIMGSHCE*** | float, Commanded exposure |
| **FOCUSPOS** | = ***AIFCPS*** | long int, Focus position, i.e., currently loaded focus target value |
| **FLAT_REC** | | is a pointer to the calibration file containing information on the dark processed image and processed flat field image used to correct the current image. |
| **BLD_VERSN** | | gives the JSOC build version by pointing to jsoc_version.h |
| **LVL_NUM** | | Level number of image |
| | | In a histogram of image values: |
| **DATAP01** | | pixel value corresponding to lowest 1 percentile |
| **DATAP10** | | pixel value corresponding to lowest 10 percentile |
| **DATAP25** | | pixel value corresponding to lowest 25 percentile |
| **DATAP75** | | pixel value corresponding to lowest 75 percentile |
| **DATAP90** | | pixel value corresponding to lowest 90 percentile |
| **DATAP95** | | pixel value corresponding to lowest 95 percentile |
| **DATAP98** | | pixel value corresponding to lowest 98 percentile |
| **DATAP99** | | pixel value corresponding to lowest 99 percentile |
| **OSCNMEAN** | ;not used at present by AIA - to be removed | mean value of overscan rows |
| **OSCNRMS** | ;not used at present by AIA - to be removed | rms deviation from the mean value of overscan rows |

Temperatures measurements at CCD, common electronics box, primary mirror, and secondary mirror will be found here when all of the data are in the JSOC and time-averaged from the time-averaged series (mean, maximum, and variation smoothed over 300 sec). Camera attitude pointing information can be found in **MPO_REC**. DN per electron gain factor and effective area in $cm^2$ pointer will later be found here pointing to the Intensity Through-Put Series for these values.

Currently the following keywords are not in Level-1:

| | | |
|---|---|---|
| **BSCALE** | (?) | Multiplier for data values |
| **BZERO** | **(?)** | Offset for data values |
| **PIXLUNIT** | (TBD) | string, pixel value units are in "DN" |
| **KEYWDDOC** | (TBD) | string, web pointer in FITS header: "www.lmsal.com/sdodocs/…AIA02840" full document title: "www.lmsal.com/sdodocs/AIA_FITS_Keywords_AIA02840" |
| **CUT_OUT** | (to be defined) | int, Is this a cut out?, 0 = no, 1=yes |
| **TEMPCCD** | (to be defined) | Temperature at CCD |
| **TEMPCEB** | (to be defined) | Temperature at common electronics box |
| **TEMPSMIR** | (to be defined) | Temperature at secondary mirror |
| **TEMPPMIR** | (to be defined) | Temperature at primary mirror |
| **DN_GN_V** | (to be defined) | pointer to DN gain value in Intensity Through-Put Series |
| **EFF_AR_V** | (to be defined) | pointer to effective area value in Intensity Through-Put Series |
| **BADPIXEL** | (to be defined) | segment pointer containing the list of bad pixels corrected in image |
| **NUMSPIKE** | (to be defined) | number of spikes in image |
| **SPIKELST** | (to be defined) | segment pointer containing the list of spikes, as well as old and new values corrected in image |

## 2.2 Level-1 Coordinate Mapping Keywords

These keywords are to be populated separately for each instrument in Level-1.0, and above, when information becomes available following the definitions, assumptions, and guidelines in Phil Scherrer's "JSOC Keywords used for metadata" document [current update 2/19/10 or later], which can be found on the web at http://jsoc.stanford.edu/doc/keywords/JSOC_Keywords_for_metadata . Please consider Phil's document as another appendix to the present document, because it presents a full description of the following image coordinate mapping keywords, discussing the FITS standards, including instrument and spacecraft pointing. Below the keywords and a brief description are presented. For AIA it is assumed: 1) there is a fixed value for each telescope plate scale, **IMSCL_MP**: 2) the center of the solar disk is the origin. The spacecraft pointing keywords are now included below. Note in the following that the lower case, Italicized, letters specify mapping from array axes (j) to image axes (i).

| | | |
|---|---|---|
| **CTYPE*i*** | | Text, type of image coordinate axis ***i*** for other Cxxxx keywords, where **CTYPE1 = HPLN-TAN (SOLARX), CTYPE2 = HPLT-TAN (SOLARY),** for longitude and latitude, respectively. (see Phil's document for coordinate mapping descriptions). |
| **CUNIT*i*** | | Physical units for position on image axis ***I***, where **CUNIT1 = CUNIT2 =** "arcsec" |
| **CRVAL*i*** | | Physical value along image axis ***i*** at the center of the pixel, where **CRVAL1 = CRVAL2 = 0.0** |
| **CDELT*i*** | | Pixel spacing per index value along image axis ***I***, equal to **IM_SCALE** except at higher levels when the image has been rescaled (**CDELT1, CDELT2** in x, y directions, respectively) |
| **CRPIX*j*** | | Reference pixel along array axis ***j***, with the center of the lower left pixel numbered 1 (not 0), i.e., location of disk center in x and y directions on image, where **CRPIX1 = X0_MP + 1, CRPIX2 = Y0_MP + 1** (see **X0_MP**, **Y0_MP** below). |
| **CROTA*j*** | | Rotation needed for array axes to get to image axes (in degrees), where **CROTA2 = SAT_ROT** + **INST_ROT** (see below) Note: No **CROTA1** |
| CRDER*i* | (TBD, to appear in **MPO_REC**) | Estimate of random error in coordinate ***i*** expressed in **CUNIT*i***. |
| CSYSER*i* | (TBD, to appear in **MPO_REC**) | Estimate of systematic error in coordinate ***i*** expressed in **CUNIT*i***. |
| **R_SUN** | | Radius of the Sun's image in pixels on the CCD detector, for the visible light (float) |
| **MPO_REC** | | is the Master Pointing series record pointer to the Science reference bore sight information (See Appendix 4) and replaces **SCIRFBSV**, the science reference bore sight version number |
| **INST_ROT** | | Master pointing CCD rotation wrt SDO Z (float, degrees) |
| **IMSCL_MP** | | Master pointing image scale in arc-sec per CCD pixel (float), replacing **IM_SCALE**; This value will be used for the estimate of CDELT for AIA |
| **X0_MP** | | Master pointing X0 sun center in CCD frame in pixels, start 0.0 (float) for raw image |
| **Y0_MP** | | Master pointing Y0 sun center in CCD frame in pixels, start 0.0 (float) for raw image |

| | |
|---|---|
| **RSUN_LF** | Limb fit Solar radius in pixels (float) |
| **X0_LF** | Limb fit X0 sun center in CCD frame in pixels (float) |
| **Y0_LF** | Limb fit Y0 sun center in CCD frame in pixels (float) |
| **ASD_REC** | Ancillary Science Data series record pointer (string) |
| **SAT_Y0** | Position of solar center wrt the SDO -Y axis in arcsec (float) |
| **SAT_Z0** | Position of solar center wrt the SDO Z axis in arcsec (float) |
| **SAT_ROT** | Position angle of solar pole wrt the SDO X axis (float, degrees) |
| **ACS_MODE** | ACS pointing mode (ACS are strings)- ACS_AN_ACS_MODE |
| **ACS_ECLP** | ACS eclipse flag - ACS_AN_FLAG_CSS_ECLIPSE |
| **ACS_SUNP** | ACS sun presense flag - ACS_AN_FLAG_DSS_SUNPRES |
| **ACS_SAFE** | ACS safe hold flag - ACS_AN_FLAG_ACE_INSAFEHOLD |
| **ACS_CGT** | ACS ID of Controlling Guide Telescope - ACS_AN_NUM_CGT |
| **ORB_REC** | Orbit vector series record pointer (string) |
| **DSUN_REF** | Reference distance to Sun: 149,597,870,691.0 m (double) |
| **DSUN_OBS** | Distance from Sun center to SDO in m (double) |
| **RSUN_REF** | Reference radius of the Sun: 696,000,000.0 m (double) |
| **RSUN_OBS** | Apparent radius of the Sun seen by SDO (arcsec, double) |
| **GCIEC_X** | Geocentric Inertial X position in m (double) |
| **GCIEC_Y** | Geocentric Inertial Y position in m (double) |
| **GCIEC_Z** | Geocentric Inertial Z position in m (double) |
| **HCIEC_X** | Heliocentric Inertial X position in m (double) |
| **HCIEC_Y** | Heliocentric Inertial Y position in m (double) |
| **HCIEC_Z** | Heliocentric Inertial Z position in m (double) |
| **OBS_VR** | Speed of observer in radial direction in m/s (double) |
| **OBS_VW** | Speed of observer in solar-west direction in m/s (double) |
| **OBS_VN** | Speed of observer in solar-north direction in m/s (double) |
| **CRLN_OBS** | Carrington longitude of the observer in degrees (float) |
| **CRLT_OBS** | Carrington latitude of the observer in degrees (float) |
| **CAR_ROT** | Carrington rotation number of CRLN_OBS(integer) |

The following non-keyword quantities can be calculated from the Level-1 keywords above:

| | |
|---|---|
| FOVX1 = **CDELT1 * ROI_NAX1** | ROI 1 X-Axis Field of View in arcsec |
| FOVY1 = **CDELT2 * ROI_NAY1** | ROI 1 Y-Axis Field of View in arcsec |

FOVX2 = **CDELT1 * ROI_NAX2** ROI 2 X-Axis Field of View in arcsec
FOVY2 = **CDELT2 * ROI_NAY2** ROI 2 Y-Axis Field of View in arcsec

## 3. Draft of Level 0 and 1 Headers with Sample Keywords

| Level 0 | | Level 1 | Brief Description | Sample Keyword | Section |
|---|---|---|---|---|---|
| **SIMPLE** | = | **SIMPLE** | | T | 1.2 |
| **BITPIX** | = | **BITPIX** | | 16 | 1.2 |
| **BLANK** | = | **BLANK** | | -32768 | 1.2 (definition) |
| **NAXIS** | = | **NAXIS** | | 2 | 1.1 |
| **NAXIS1** | = | **NAXIS1** | | 4096 | 1.1 |
| **NAXIS2** | = | **NAXIS2** | | 4096 | 1.1 |
| **EXTEND** | = | **EXTEND** | | T | 1.2 |
| | | **BSCALE** | multiplier for data values | | 2.1 |
| | | **BZERO** | offset for data values | | 2.1 |
| **ORIGIN** | = | **ORIGIN** | | 'SDO/JSOC-SDP' | 1.2 |
| **DATE** | = | **DATE** | | '2008-01-08T23:57:38' | 1.2 |
| **TELESCOP** | = | **TELESCOP** | | 'SDO/AIA' | 1.2 |
| **INSTRUME** | = | **INSTRUME** | | 'AIA' | 1.2 |
| **DATE__OBS** | = | **DATE__OBS** | | '2008-01-08T18:56:00.005' | 1.2, App. 1 |
| **T_OBS** | = | **T_OBS** | | **'**2008-01-08T18:56:03.005' | 1.2, App. 1 |
| **CAMERA** | = | **CAMERA** | | 3 | 1.1 (Header) |
| **IMG_TYPE** | = | **IMG_TYPE** | | 'LIGHT or DARK' | 1.2 |
| **EXPTIME** | = | **EXPTIME** | | 5.039 | 1.2, App. 1 |
| **EXPSDEV** | = | **EXPSDEV** | | 0.019 | 1.2, App. 1 |
| **INT_TIME** | = | **INT_TIME** | [= ***AICFGDL4*** - ***AICFGDL3*** (+ rollover), interval time between readout delay and shutter operation delay plus rollover] | | 1.2 |
| **WAVELNTH** | = | **WAVELNTH** | | 171 | 1.2 |
| **WAVEUNIT** | = | **WAVEUNIT** | | 'angstrom' | 1.2 |
| **WAVE_STR** | = | **WAVE_STR** | | '171_01' | 1.2 |
| **FSN** | = | **FSN** | Frame Serial Number | 75000 | 1.1 (Header) |
| **FID** | = | **FID** | Frame Definition Block ID | | 1.1 (Crop table) |

| | | | | |
|---|---|---|---|---|
| **TLMDSNAM** | | Telemety data series name with first packet of image | | 1.1 (Header) |
| **IMGFPT** | | First packet time | | 1.1 (Header) |
| **IMGAPID** | | Packet APID, "Image Application ID" | | 1.1 (Header) |
| **TAPCODE** | | “Take a Picture code” | | 1.1 (Header) |
| **BITSELID** | | Bit Select ID, r | | 1.1 (Header) |
| **COMPID** | | Compression ID; n, *k* | | 1.1 (Header) |
| **CROPID** | | Crop table ID | | 1.1 (Crop table) |
| **LUTID** | | Lookup table id | | 1.1 (Header) |
| **NPACKETS** | | Number of packets in image | | 1.1 |
| **NERRORS** | | Number of decompression errors | | 1.1 |
| **EOIERROR** | | Last pixel error; End Of Image Error | | 1.1 |
| **HEADRERR** | | Header error in image | | 1.1 |
| **OVERFLOW** | | Data overflow error in image | | 1.1 |
| **QUALITY** = | **QUALLEV0** | Level-0 Quality word | | 1.1, 2.1 |
| | **QUALITY** | Level-1 Quality word | | 1.1, 2.1 |
| **TOTVALS** = | **TOTVALS** | Expected number of data values (pixels) | | 1.2 |
| **DATAVALS** = | **DATAVALS** | Actual number of data values in image | | 1.2 |
| **MISSVALS** = | **MISSVALS** | Missing values: TOTVALS – DATAVALS | | 1.2 |
| **PERCENTD** = | **PERCENTD** | Percentage of good data | 100.0 | 1.2 |
| **DATAMIN** = | **DATAMIN** | | 81.0 | 1.2 |
| **DATAMAX** = | **DATAMAX** | | 4100.0 | 1.2 |
| **DATAMEDN** = | **DATAMEDN** | | 218.345670 | 1.2 |
| **DATAMEAN** = | **DATAMEAN** | | 218.345670 | 1.2 |
| **DATARMS** = | **DATARMS** | | 22.687300 | 1.2 |
| **DATASKEW** = | **DATASKEW** | | 218.345670 | 1.2 |
| **DATAKURT** = | **DATAKURT** | | 218.345670 | 1.2 |
| | **PIXLUNIT** | | **‘**DN’ | 2.1 |
| | **KEYWDDOC** | | **‘**www.lmsal.com/sdodocs/…Keywords-AIA02840’ | 2.1 |
| | **FLAT_REC** | | | 2.1 |
| | **CTYPE1** | | ‘HPLN-TAN’ | 2.2 |
| | **CUNIT1** | | ‘arcsec’ | 2.2 |
| | **CRVAL1** | | 0.0 | 2.2 |
| | **CDELT1** | | 0.5 | 2.2 |
| | **CRPIX1** | | 2048.0 | 2.2 |

| | | | |
|---|---|---|---|
| **CTYPE2** | | 'HPLT-TAN' | 2.2 |
| **CUNIT2** | | 'arcsec' | 2.2 |
| **CRVAL2** | | 0.0 | 2.2 |
| **CDELT2** | | 0.5 | 2.2 |
| **CRPIX2** | | 2048.0 | 2.2 |
| **CROTA2** | | 0.0 | 2.2 |
| **R_SUN** | Radius of the Sun's image in pixels, for the visible light | | 2.2 |
| **MPO_REC** | Master Pointing series record pointer | | 2.2 |
| **INST_ROT** | Rotation of the camera from the SDO Z axis | | 2.2 |
| **IMSCL_MP** | Master pointing image scale | | 2.2 |
| **X0_MP** | | | 2.2 |
| **Y0_MP** | | | 2.2 |
| **RSUN_LF** | | | 2.2 |
| **X0_LF** | | | 2.2 |
| **Y0_LF** | | | 2.2 |
| **ASD_REC** | | | 2.2 |
| **SAT_Y0** | | | 2.2 |
| **SAT_Z0** | | | 2.2 |
| **SAT_ROT** | Position angle of solar pole wrt the SDO Z axis | | 2.2 |
| **ACS_MODE** | | | 2.2 |
| **ACS_ECLP** | | | 2.2 |
| **ACS_SUNP** | | | 2.2 |
| **ACS_SAFE** | | | 2.2 |
| **ACS_CGT** | | | 2.2 |
| **ORB_REC** | | | 2.2 |
| **DSUN_REF** | Reference distance to Sun | 149597870691.0 | 2.2 |
| **DSUN_OBS** | Distance from Sun's center to SDO | | 2.2 |
| **RSUN_REF** | Radius of the Sun in | 696000000.0 | 2.2 |
| **RSUN_OBS** | Apparent radius of the Sun seen by SDO | | 2.2 |
| **GCIEC_X** | | | 2.2 |
| **GCIEC_Y** | | | 2.2 |
| **GCIEC_Z** | | | 2.2 |
| **HCIEC_X** | | | 2.2 |
| **HCIEC_Y** | | | 2.2 |

| | | | | | |
|---|---|---|---|---|---|
| | | **HCIEC_Z** | | | 2.2 |
| | | **OBS_VR** | | | 2.2 |
| | | **OBS_VW** | | | 2.2 |
| | | **OBS_VN** | | | 2.2 |
| | | **CRLN_OBS** | | | 2.2 |
| | | **CRLT_OBS** | | | 2.2 |
| | | **CAR_ROT** | | | 2.2 |
| **ROI_NWIN** | = | **ROI_NWIN** | Number of windows or ROIs | 0 | 2.1 |
| | | **ROI_SUM** | | 0 | 2.1 |
| | | **ROI_NAX1** | | 4096 | 2.1 |
| | | **ROI_NAY1** | | 4096 | 2.1 |
| | | **ROI_NAX2** | | 0 | 2.1 |
| | | **ROI_NAY2** | | 0 | 2.1 |
| | | **ROI_LLX1** | | 0 | 2.1 |
| | | **ROI_LLY1** | | 0 | 2.1 |
| | | **ROI_LLX2** | | 0 | 2.1 |
| | | **ROI_LLY2** | | 0 | 2.1 |

Currently all of the ISP keywords are in both Level-0 and Level-1:

| | | | | | |
|---|---|---|---|---|---|
| **ISPSNAME** | = | **ISPSNAME** | ISP Series Name | aia.lev0_isp_0011 | 1.3 (ISP) |
| **ISPPKTIM** | = | **ISPPKTIM** | Packet time | '2008-01-08T18:56:01.000' | 1.3 (ISP) |
| **ISPPKTVN** | = | **ISPPKTVN** | Packet version number | '001.1' | 1.3 (ISP) |
| ***AIVNMST*** | = | ***AIVNMST*** | ISP version number | | 1.3 (ISP) |
| ***AIMGOTS*** | = | ***AIMGOTS*** | seconds time tag | | 1.3 (ISP) |
| ***ASQHDR*** | = | ***ASQHDR*** | **[=** ***ASQTNUM*** (2b) {=Camera} + ***ASQFSN*** (30b) {=FSN}] | | 1.3 (ISP) |
| ***ASQTNUM*** | = | ***ASQTNUM*** | [= Camera – 1] | | 1.3 (ISP) |
| ***ASQFSN*** | = | ***ASQFSN*** | [another FSN] | | 1.3 (ISP) |
| ***AIAHFSN*** | = | ***AIAHFSN*** | the FSN of the image from which the histogram data was obtained | | 1.3 (ISP) |
| ***AECDELAY*** | = | ***AECDELAY*** | time since image used for AEC | | 1.3 (ISP) |
| ***AIAECTI*** | = | ***AIAECTI*** | Automatic Exposure Control (AEC) tables used with this image | | 1.3 (ISP) |
| ***AIASEN*** | = | ***AIASEN*** | **(= APERT_SEL, [TBD])** | aperture selection encoder reading | 1.3 (ISP) |
| ***AIFDBID*** | = | ***AIFDBID*** | [another FDB ID] | | 1.3 (ISP) |
| ***AIMGOTSS*** | = | ***AIMGOTSS*** | subseconds time tag | | 1.3 (ISP) |
| ***AIFCPS*** | = | ***AIFCPS*** | (= **FOCUSPOS, [TBD])** | currently loaded target value | 1.3 (ISP) |

| | | | |
|---|---|---|---|
| ***AIFTSWTH*** = | ***AIFTSWTH*** | filter switch threshold for 131A wavelength (exposure) | 1.3 (ISP) |
| ***AIFRMLID*** = | ***AIFRMLID*** | framelist id for this image | 1.3 (ISP) |
| ***AIFTSID*** = | ***AIFTSID*** | framelist timeline schedule (FTS) id | 1.3 (ISP) |
| ***AIHISMXB*** = | ***AIHISMXB*** | bin number of maximum of standard histogram for previous image in this wavelength used for the current AEC | 1.3 (ISP) |
| ***AIHIS192*** = | ***AIHIS192*** | cumulative histogram value at bin #192 | 1.3 (ISP) |
| ***AIHIS348*** = | ***AIHIS348*** | cumulative histogram value at bin #348 | 1.3 (ISP) |
| ***AIHIS604*** = | ***AIHIS604*** | cumulative histogram value at bin #604 | 1.3 (ISP) |
| ***AIHIS860*** = | ***AIHIS860*** | cumulative histogram value at bin #860 | 1.3 (ISP) |
| ***AIFWEN*** = | ***AIFWEN*** | **(= FILWLSEL)** filter wheel selector encoder reading | 1.3 (ISP) |
| ***AIMGSHCE*** = | ***AIMGSHCE*** | (= **COMDEXPT)** 5.0 | 1.3 (ISP) |
| ***AECTYPE*** = | ***AECTYPE*** | AEC table for current wavelength | 1.3 (ISP) |
| ***AECMODE*** = | ***AECMODE*** | mode of AEC | 1.3 (ISP) |
| ***AISTATE*** = | ***AISTATE*** | ISS on/off | 1.3 (ISP) |
| ***AIAECENF*** = | ***AIAECENF*** | AEC enable flag for this image | 1.3 (ISP) |
| ***AIFILTYP*** = | ***AIFILTYP*** | **(= FILT_TYP)** 01 | 1.3 (ISP) |
| ***AIMSHOBC*** = | ***AIMSHOBC*** | shutter timer register value | 1.3 (ISP) |
| ***AIMSHOBE*** = | ***AIMSHOBE*** | shutter timer register value | 1.3 (ISP) |
| ***AIMSHOTC*** = | ***AIMSHOTC*** | shutter timer register value | 1.3 (ISP) |
| ***AIMSHOTE*** = | ***AIMSHOTE*** | shutter timer register value | 1.3 (ISP) |
| ***AIMSHCBC*** = | ***AIMSHCBC*** | shutter timer register value | 1.3 (ISP) |
| ***AIMSHCBE*** = | ***AIMSHCBE*** | shutter timer register value | 1.3 (ISP) |
| ***AIMSHCTC*** = | ***AIMSHCTC*** | shutter timer register value | 1.3 (ISP) |
| ***AIMSHCTE*** = | ***AIMSHCTE*** | shutter timer register value | 1.3 (ISP) |
| ***AICFGDL1*** = | ***AICFGDL1*** | mechanism delay 1 | 1.3 (ISP) |
| ***AICFGDL2*** = | ***AICFGDL2*** | clear table delay | 1.3 (ISP) |
| ***AICFGDL3*** = | ***AICFGDL3*** | shutter operation delay | 1.3 (ISP) |
| ***AICDGDL4*** = | ***AICDGDL4*** | readout delay | 1.3 (ISP) |
| ***AIFOENFL*** = | ***AIFOENFL*** | flag to indicate if focus table used or not | 1.3 (ISP) |
| ***AIMGFSN*** = | ***AIMGFSN*** | position within framelist of this frame | 1.3 (ISP) |
| ***AIMGTYP*** = | ***AIMGTYP*** | 'dark' | 1.3 (ISP) |
| ***AIAWVLEN*** = | ***AIAWVLEN*** | (coded wavelength for this observation) | 1.3 (ISP) |
| ***AIAGP1*** = | ***AIAGP1*** | general purpose register word 1 | 1.3 (ISP) |
| ***AIAGP2*** = | ***AIAGP2*** | general purpose register word 2 | 1.3 (ISP) |

| | | | | |
|---|---|---|---|---|
| ***AIAGP3*** | = | ***AIAGP3*** | general purpose register word 3 | 1.3 (ISP) |
| ***AIAGP4*** | = | ***AIAGP4*** | general purpose register word 4 | 1.3 (ISP) |
| ***AIAGP5*** | = | ***AIAGP5*** | general purpose register word 5 | 1.3 (ISP) |
| ***AIAGP6*** | = | ***AIAGP6*** | general purpose register word 6 | 1.3 (ISP) |
| ***AIAGP7*** | = | ***AIAGP7*** | general purpose register word 7 | 1.3 (ISP) |
| ***AIAGP8*** | = | ***AIAGP8*** | general purpose register word 8 | 1.3 (ISP) |
| ***AIAGP9*** | = | ***AIAGP9*** | general purpose register word 9 | 1.3 (ISP) |
| ***AIAGP10*** | = | ***AIAGP10*** | general purpose register word 10 | 1.3 (ISP) |
| ***AGT1SVY*** | = | ***AGT1SVY*** | GT 1 Sun vector in y direction | 1.3 (ISP) |
| ***AGT1SVZ*** | = | ***AGT1SVZ*** | GT 1 Sun vector in z direction | 1.3 (ISP) |
| ***AGT2SVY*** | = | ***AGT2SVY*** | GT 2 Sun vector in y direction | 1.3 (ISP) |
| ***AGT2SVZ*** | = | ***AGT2SVZ*** | GT 2 Sun vector in z direction | 1.3 (ISP) |
| ***AGT3SVY*** | = | ***AGT3SVY*** | GT 3 Sun vector in y direction | 1.3 (ISP) |
| ***AGT3SVZ*** | = | ***AGT3SVZ*** | GT 3 Sun vector in z direction | 1.3 (ISP) |
| ***AGT4SVY*** | = | ***AGT4SVY*** | GT 4 Sun vector in y direction | 1.3 (ISP) |
| ***AGT4SVZ*** | = | ***AGT4SVZ*** | GT 4 Sun vector in z direction | 1.3 (ISP) |
| ***AIMGSHEN*** | = | ***AIMGSHEN*** | shutter selector encoder reading | 1.3 (ISP) |
| **COMMENT** | = | **COMMENT** | Comment | 1.2 |
| **HISTORY** | = | **HISTORY** | ASCII history record, one or more | 1.2 |
| **END** | = | **END** | End of file | 1.2 |

**Appendix 1:** AIA Camera Exposure Time Calculation

Telemetry parameters required from AIA Image Status Packet:

***AIMGOTS*** = AIA_IMG_OBT_TIME_SH_SEC
***AIMGOTSS*** = AIA_IMG_OBT_TIME_SH_SS
cmdexp = double(***AIMGSHCE***) = AIA_IMG_SH_CMDED_EXPOSURE
shopbc = double(***AIMSHOBC***) = AIA_IMG_SH_OPEN_BOT_CENTR
shopbe = double(***AIMSHOBE***) = AIA_IMG_SH_OPEN_BOT_EDGE
shoptc = double(***AIMSHOTC***) = AIA_IMG_SH_OPEN_TOP_CENTR
shopte = double(***AIMSHOTE***) = AIA_IMG_SH_OPEN_TOP_EDGE
shclbc = double(***AIMSHCBC***) = AIA_IMG_SH_CLOSE_BOT_CENTR
shclbe = double(***AIMSHCBE***) = AIA_IMG_SH_CLOSE_BOT_EDGE
shcltc = double(***AIMSHCTC***) = AIA_IMG_SH_CLOSE_TOP_CENTR
shclte = double(***AIMSHCTE***) = AIA_IMG_SH_CLOSE_TOP_EDGE

***AIMGSHCE*** is the commanded exposure (19 bits) starting from ~0.005 s (due to size of narrow shutter slit) in 0.001 s steps to 524.28 s [$(2^{19}-1)*10^{-3} = 524287*10^{-3}$] (timings are from document AIA01259 rev H). The maximum exposure of the AIA shutter mechanism is ~268.4 s. The 24 bit shutter open and close time measurements have a resolution of 0.000004 s, starting at 0.000004 s up to ~67 s [$(2^{24} - 1) * 4*10^{-6} = 67108860*10^{-6}$]. The commanded exposure value can be used to determine the rollover value. The expected value of the commanded exposure to the nearest 0.1 sec just before each of the three possible rollover steps is 67.1 s, 134.2 s, and 201.3 s, respectively. When ***AIMGSHCE*** is above any of these values it has rolled over 1, 2, or 3 times, respectively, and the number of rollovers multiplied by 67.108864 s needs to be added to the respective shutter close minus open time before averaging. Please note that the programmer needs to take care near the rollover steps because the hardware and/or software may not work quite the same as in the ideal case presented here.

The actual exposure is the average of the difference of the closing time minus the opening time for each of the four measurements positions, except when ***AIMGSHCE*** is less than 0.072 s, in which case the shutter mechanism is in its narrow slit mode. In the latter mode the narrow slit opening (smaller by 0.35) is utilized for one or more passes. The current operational planning calls for the shutter exposure to be about 5 s per image for each camera.

Using the above, together with Rock Bush's email of 28-Feb-08 on HMI T_OBS and EXPTIME and John Serafin's email of 20-May-08 on a rollover algorithm in C, the following algorithm has been written in IDL for calculating the AIA camera shutter exposure time

for each camera, **EXPTIME;** standard deviation, **EXPSDEV;** the shutter open start time plus the middle of the exposure time, **T_OBS;** and the date when the observation started, **DATE_OBS.**

; Computer quantities (note: all variables should be double precision and time is in seconds):

AIA_Shutter_Open_Start_Time = ***AIMGOTS*** + ***AIMGOTSS*** ;combine these in TAI

;Intermediate calculation variables:

```
   cshclbc = shclbc + 67.108864d0 * nrollct(cmdexp, shclbc)      ;correct for rollovers
   cshclbe = shclbe + 67.108864d0 * nrollct(cmdexp, shclbe)
   cshcltc = shcltc + 67.108864d0 * nrollct(cmdexp, shcltc)
   cshclte = shclte + 67.108864d0 * nrollct(cmdexp, shclte)

   shebc = cshclbc – shopbc                                      ;close time – open time
   shebe = cshclbe - shopbe
   shetc = cshcltc - shoptc
   shete = cshclte - shopte

   mean = (shebc + shebe + shetc + shete)/4.0d0                  ;mean and standard deviation
   exp_sd = sqrt(1/3 * ( (shebc-mean) * (shebc-mean) + (shebe-mean) * (shebe-mean) + $
(shetc-mean) * (shetc-mean) + (shete-mean) * (shete-mean) ))     ;continued from previous line

   if (cmdexp lt 0.072d0) then begin                             ;in narrow slit mode
         mean = mean * 0.35
         exp_sd = expsd * 0.35
   endif

EXPTIME      = mean                                             ;AIA_Shutter_Exposure_Time
EXPSDEV      = exp_sd                                           ;AIA_Shutter_Exposure_SD

EXPTIME_Offset = (cshclbc + shopbc + cshclbe + shopbe + cshcltc + shoptc + cshclte + $ shopte)/8.0d0
                                ;continued from previous line
```

**T_OBS** = AIA_Shutter_Open_Start_Time + EXPTIME_Offset ;(add in seconds, calculate DATA_OBS, then convert T_OBS to UTC)

**DATE_OBS** = **T_OBS -** (**EXPTIME**/2.0) ;(add in seconds then convert to UTC time)

Note: the T_OBS time is the shutter open start time plus the middle of the exposure time. As such a shutter exposure offset is the mean of all the open and close times. The EXPTIME is the shutter open time duration. DATE_OBS is the date when observation started.

```
;Rollover procedure nrollct
;for rollovers at 67.1, 134.2 and 201.3 with integers used below that are about one quarter of the
;interval away from the rollover values and thus not critical

   Pro nrollct, cmdexp, clostim

   If (cmdexp < 51.0) then  return 0
   If (cmdexp < 84.0) then  if (clostim > 33.0)  then return 0  else return 1
   If (cmdexp < 117.0)  then return 1
   If (cmdexp < 151.0) then  if (clostim > 33.0)  then return 1  else return 2
   If (cmdexp < 184.0) then  return 2
   If (cmdexp < 217.0) then  if (clostim > 33.0)  then return 2  else return 3
   If (cmdexp < 251.0) then  return 3
   return  if (clostim > 33.0)  then return 3  else return 4
   end
```

**Appendix 2:** AIA Level-0 Quality Definition

(updated by Rock Bush, 6/09/10)

QUALITY = 0 means OK.

Bit 0 is the low bit (0x01).
The first 4 bits are determined from the Img struct passed back by imgdecode
The parameter MISSVALS is from Img struct TOTVALS - DATAVALS

| Bit | Meaning |
|---|---|
| 0 | Overflow Flag Set |
| 1 | Header Error Flag Set |
| 2 | Compression Error in Image |
| 3 | Last Pixel Error |
| 4 | Missing Image Status Packet: (FSN != HSQFGSN) or HSQFGSN missing |
| 5 | Missing Image: (MISSVALS = TOTVALS) or NPACKETS = 0 |
| 6 | Corrupt Image: (FSN = 469769216) |
| 7 | Invalid Time: (AIMGSHCE != 0) and (AIMGOTS = 0) |
| | |
| 8 | MISSVALS > 0 |
| 9 | MISSVALS > 0.01*TOTVALS |
| 10 | MISSVALS > 0.05*TOTVALS |
| 11 | MISSVALS > 0.25*TOTVALS |
| 12 | |
| 13 | |
| 14 | |
| 15 | |

AIA specific

| | | |
|---|---|---|
| 16 | Dark Image; | IMG_TYPE == 'DARK' |
| 17 | ISS Loop Open; | AISTATE == "OPEN"; (AISTATE != 0) |

```
18      9.4nm Mech Error;  AIAWVLEN == 9 &&
                              {(AIFILTYP == 0 && AIFWEN != 269 && AIFWEN != 270
                                && AIFWEN !=  74 && AIFWEN !=  75)}
                             || (AIFILTYP == 1 && AIFWEN !=  11 && AIFWEN !=  12)
19      13.1nm Mech Error; AIAWVLEN == 1 &&
                              {(AIFILTYP == 0 && AIFWEN != 269 && AIFWEN != 270
                                && AIFWEN !=  74 && AIFWEN !=  75)}
                             || (AIFILTYP == 1 && AIFWEN !=  11 && AIFWEN !=  12)
20      17.1nm Mech Error; AIAWVLEN == 7 &&
                              {(AIFILTYP == 0 && AIFWEN != 203 && AIFWEN != 204)
                             || (AIFILTYP == 1 && AIFWEN !=  11 && AIFWEN !=  12)}
21      19.3nm Mech Error; AIAWVLEN == 3 && {AIASEN != 6
                             || (AIFILTYP == 0 && AIFWEN != 269 && AIFWEN != 270
                                && AIFWEN !=  74 && AIFWEN !=  75)}
                             || (AIFILTYP == 1 && AIFWEN !=  11 && AIFWEN !=  12)
22      21.1nm Mech Error; AIAWVLEN == 2 && {AIASEN != 24
                             || (AIFILTYP == 0 && AIFWEN != 203 && AIFWEN != 204
                                && AIFWEN !=  74 && AIFWEN !=  75)}
                             || (AIFILTYP == 1 && AIFWEN != 137 && AIFWEN != 138)
23      30.4nm Mech Error; AIAWVLEN == 8 &&
                              {(AIFILTYP == 0 && AIFWEN != 203 && AIFWEN != 204
                                && AIFWEN !=  74 && AIFWEN !=  75)}
                             || (AIFILTYP == 1 && AIFWEN != 137 && AIFWEN != 138)
24      33.5nm Mech Error; AIAWVLEN == 0 &&
                              {(AIFILTYP == 0 && AIFWEN != 203 && AIFWEN != 204
                                && AIFWEN !=  74 && AIFWEN !=  75)}
                             || (AIFILTYP == 1 && AIFWEN != 137 && AIFWEN != 138)
25      160nm Mech Error;  AIAWVLEN == 4 && AIFWEN != 269 && AIFWEN != 270
26      170nm Mech Error;  AIAWVLEN == 5 && AIFWEN != 137 && AIFWEN != 138
27      450nm Mech Error;  AIAWVLEN == 6 && AIFWEN !=  74  && AIFWEN !=   75
28      Invalid Wavelength; WAVE_STR == "UNKNOWN"
29
30
31
```

**********

AIA Mechanism position definitions from Paul Boerner

| WAVELEN | FILTER_TYPE | FW_ENCODER | AS_ENCODER" |
|---|---|---|---|
| 1600 | "Don't check" | "269 or 270" | "Don't check" |
| | "Don't check" | "269 or 270" | "Don't check" |
| | "Don't check" | "269 or 270" | "Don't check" |
| 1700 | "Don't check" | "137 or 138" | "Don't check" |
| | "Don't check" | "137 or 138" | "Don't check" |
| | "Don't check" | "137 or 138" | "Don't check" |
| 4500 | "Don't check" | "74 or 75" | "Don't check" |
| | "Don't check" | "74 or 75" | "Don't check" |
| | "Don't check" | "74 or 75" | "Don't check" |

| WAVELEN | FILTER_TYPE | FW_ENCODER | AS_ENCODER" |
|---|---|---|---|
| 94 | 0 | "269 or 270" | "Don't check" |
| | 1 | "11 or 12" | "Don't check" |
| | 2 (0) | "74 or 75" | "Don't check" |
| 131 | 0 | "269 or 270" | "Don't check" |
| | 1 | "11 or 12" | "Don't check" |
| | 2 (0) | "74 or 75" | "Don't check" |
| 171 | 0 | "203 or 204" | "Don't check" |
| | 1 | "11 or 12" | "Don't check" |
| 304 | 0 | "203 or 204" | "Don't check" |
| | 1 | "137 or 138" | "Don't check" |

| | | | |
|---|---|---|---|
| | 2 (0) | "74 or 75" | "Don't check" |
| 335 | 0 | "203 or 204" | "Don't check" |
| | 1 | "137 or 138" | "Don't check" |
| | 2 (0) | "74 or 75" | "Don't check" |

| WAVELEN | FILTER_TYPE | FW_ENCODER | AS_ENCODER" |
|---|---|---|---|
| 193 | 0 | "269 or 270" | 6 |
| | 1 | "11 or 12" | 6 |
| | 2 (0) | "74 or 75" | 6 |
| 211 | 0 | "203 or 204" | 24 |
| | 1 | "137 or 138" | 24 |
| | 2 (0) | "74 or 75" | 24 |

Note: FILTER_TYPE "2" is not set correctly in the AIA flight software and is always reported as "0". The quality checks for FILTER_TYPE = 0 include both the FILTER_TYPE "0" and "2" mechanism positions.

**********

Fits keyword and Image Status Packet (ISP) keyword translation:

| | | |
|---|---|---|
| ASQFSN | AIA_SEQ_FRAME_SN | int |
| AISTATE | AIA_IMG_ISS_LOOP | string |
| AIAWVLEN | AIA_IMG_WAVELENGTH | int |
| AIASEN | AIA_IMG_AS_ENCODER | int |
| AIFILTYP | AIA_IMG_FILTER_TYPE | short |
| AIFWEN | AIA_IMG_FW_ENCODE | int |

**********

AIAWVLEN lookup values:

Index: { 0, 1, 2, 3, 4, 5, 6, 7, 8 9 }
Wavelength: { 335, 131, 211, 193, 1600, 1700, 4500, 171, 304, 94 }

**Appendix 3:** HMI and AIA Level 1 Quality Definition

(from Rock Bush, June 23, 2010)

Bit0 is the low bit (0x01)
The parameter MISSVALS is from Img struct TOTVALS - DATAVALS

| Bit | Meaning |
|---|---|
| 0 | FLAT_REC == MISSING; Flatfield data not available |
| 1 | ORB_REC == MISSING; Orbit data not available |
| 2 | ASD_REC == MISSING; Ancillary Science Data not available |
| 3 | MPO_REC == MISSING; Master pointing data not available |
| 4 | Limb fit not acceptable (if required) |
| 5 | |
| 6 | |
| 7 | |
| 8 | MISSVALS > 0 |
| 9 | MISSVALS > 0.01*TOTVALS |
| 10 | MISSVALS > 0.05*TOTVALS |
| 11 | MISSVALS > 0.25*TOTVALS |
| 12 | ACS_MODE != 'SCIENCE'; Spacecraft not in science pointing mode |
| 13 | ACS_ECLP == 'YES'; Spacecraft eclipse flag set |
| 14 | ACS_SUNP == 'NO'; Spacecraft sun presence flag not set |
| 15 | ACS_SAFE == 'YES'; Spacecraft safemode flag set |
| 16 | IMG_TYPE == 'DARK'; Dark image |
| 17 | HWLTNSET == "OPEN" or AISTATE == "OPEN"; ISS Loop Open |
| 18 | Calibration Image |
| 19 | |
| 20 | |
| 21 | |

22
23
24
25
26
27
28
29
30
31 Image not available

HMI ISS Loop Open; HWLTNSET == "OPEN"; (HWLTNSET != 0)
HWLTNSET = HMI_IMG_ISS_LOOP

AIA ISS Loop Open; AISTATE == "OPEN"; (AISTATE != 0)
AISTATE = AIA_IMG_ISS_LOOP

IMG_TYPE; "Image type: LIGHT or DARK"

**Appendix 4:** SDO Master Pointing Parameter Definition File

(this jsd from Rock Bush on May 4, 2010)

```
#=====General Series Information=====
Seriesname:          sdo.master_pointing
Author:              "production"
Owner:               production
Unitsize:            0
Archive:             0
Retention:           0
Tapegroup:           0
PrimeKeys:           T_START
DBIndex:             T_START
Description:         "Master Pointing Parameters"

#=====Keywords=====
#===== (0) Keywords from document: JSOC keywords used for metadata

Keyword:ORIGIN,       string, constant, record,     "SDO/JSOC-SDP", "%s",   "none", "ORIGIN Location where file made"
Keyword:TELESCOP,  string, constant, record,            "SDO", "%s",   "none", "SDO spacecraft"
Keyword:DATE,            time, variable, record, DRMS_MISSING_VALUE,  "0",    "ISO", "Date_time of processing; ISO 8601"
Keyword:T_START,      time, variable, record, DRMS_MISSING_VALUE,  "0",    "ISO", "Interval start Date_time; ISO 8601"
Keyword:T_STOP,        time, variable, record, DRMS_MISSING_VALUE,  "0",    "ISO", "Interval stop Date_time; ISO 8601"
Keyword:T_HKVALS,   time, variable, record, DRMS_MISSING_VALUE,  "0",    "ISO", "Housekeeping data select Date_time; ISO
8601"
Keyword:VERSION,       int, variable, record, DRMS_MISSING_VALUE, "%d",   "none", "Version"

#===== (0.1) SDO Spacecraft Inertial Reference Pointing Offset

Keyword:SC_Y_INRT_BIAS, float, variable, record, DRMS_MISSING_VALUE, "%f", "arcsec", "SDO Y Axis offset between
inertial and science sun center"
Keyword:SC_Z_INRT_BIAS, float, variable, record, DRMS_MISSING_VALUE, "%f", "arcsec", "SDO Z Axis offset between
inertial and science sun center"
```

#===== (1) HMI Image Locations

Keyword:H_CAM1_IMSCALE, float, variable, record, DRMS_MISSING_VALUE, "%f", "arcsec", "Image scale in arcsec/pixel"
Keyword:H_CAM1_X0, float, variable, record, DRMS_MISSING_VALUE, "%f", "pixel", "Image center in CCD x direction"
Keyword:H_CAM1_Y0, float, variable, record, DRMS_MISSING_VALUE, "%f", "pixel", "Image center in CCD y direction"
Keyword:H_CAM1_INSTROT, float, variable, record, DRMS_MISSING_VALUE, "%f", "deg", "Rotation of CCD from SDO Z axis"

Keyword:H_CAM2_IMSCALE, float, variable, record, DRMS_MISSING_VALUE, "%f", "arcsec", "Image scale in arcsec/pixel"
Keyword:H_CAM2_X0, float, variable, record, DRMS_MISSING_VALUE, "%f", "pixel", "Image center in CCD x direction"
Keyword:H_CAM2_Y0, float, variable, record, DRMS_MISSING_VALUE, "%f", "pixel", "Image center in CCD y direction"
Keyword:H_CAM2_INSTROT, float, variable, record, DRMS_MISSING_VALUE, "%f", "deg", "Rotation of CCD from SDO Z axis"

#===== (2) AIA Image Locations

Keyword:A_094_IMSCALE, float, variable, record, DRMS_MISSING_VALUE, "%f", "arcsec", "Image scale in arcsec/pixel"
Keyword:A_094_X0, float, variable, record, DRMS_MISSING_VALUE, "%f", "pixel", "Image center in CCD x direction"
Keyword:A_094_Y0, float, variable, record, DRMS_MISSING_VALUE, "%f", "pixel", "Image center in CCD y direction"
Keyword:A_094_INSTROT, float, variable, record, DRMS_MISSING_VALUE, "%f", "deg", "Rotation of CCD from SDO Z axis"

Keyword:A_131_IMSCALE, float, variable, record, DRMS_MISSING_VALUE, "%f", "arcsec", "Image scale in arcsec/pixel"
Keyword:A_131_X0, float, variable, record, DRMS_MISSING_VALUE, "%f", "pixel", "Image center in CCD x direction"
Keyword:A_131_Y0, float, variable, record, DRMS_MISSING_VALUE, "%f", "pixel", "Image center in CCD y direction"
Keyword:A_131_INSTROT, float, variable, record, DRMS_MISSING_VALUE, "%f", "deg", "Rotation of CCD from SDO Z axis"

Keyword:A_171_IMSCALE, float, variable, record, DRMS_MISSING_VALUE, "%f", "arcsec", "Image scale in arcsec/pixel"
Keyword:A_171_X0, float, variable, record, DRMS_MISSING_VALUE, "%f", "pixel", "Image center in CCD x direction"
Keyword:A_171_Y0, float, variable, record, DRMS_MISSING_VALUE, "%f", "pixel", "Image center in CCD y direction"
Keyword:A_171_INSTROT, float, variable, record, DRMS_MISSING_VALUE, "%f", "deg", "Rotation of CCD from SDO Z axis"

Keyword:A_193_IMSCALE, float, variable, record, DRMS_MISSING_VALUE, "%f", "arcsec", "Image scale in arcsec/pixel”
Keyword:A_193_X0, float, variable, record, DRMS_MISSING_VALUE, "%f", "pixel", "Image center in CCD x direction"
Keyword:A_193_Y0, float, variable, record, DRMS_MISSING_VALUE, "%f", "pixel", "Image center in CCD y direction"

Keyword:A_193_INSTROT, float, variable, record, DRMS_MISSING_VALUE, "%f", "deg", "Rotation of CCD from SDO Z axis"

Keyword:A_211_IMSCALE, float, variable, record, DRMS_MISSING_VALUE, "%f", "arcsec", "Image scale in arcsec/pixel"
Keyword:A_211_X0, float, variable, record, DRMS_MISSING_VALUE, "%f", "pixel", "Image center in CCD x direction"
Keyword:A_211_Y0, float, variable, record, DRMS_MISSING_VALUE, "%f", "pixel", "Image center in CCD y direction"
Keyword:A_211_INSTROT, float, variable, record, DRMS_MISSING_VALUE, "%f", "deg", "Rotation of CCD from SDO Z axis"

Keyword:A_304_IMSCALE, float, variable, record, DRMS_MISSING_VALUE, "%f", "arcsec", "Image scale in arcsec/pixel"
Keyword:A_304_X0, float, variable, record, DRMS_MISSING_VALUE, "%f", "pixel", "Image center in CCD x direction"
Keyword:A_304_Y0, float, variable, record, DRMS_MISSING_VALUE, "%f", "pixel", "Image center in CCD y direction"
Keyword:A_304_INSTROT, float, variable, record, DRMS_MISSING_VALUE, "%f", "deg", "Rotation of CCD from SDO Z axis"

Keyword:A_335_IMSCALE, float, variable, record, DRMS_MISSING_VALUE, "%f", "arcsec", "Image scale in arcsec/pixel"
Keyword:A_335_X0, float, variable, record, DRMS_MISSING_VALUE, "%f", "pixel", "Image center in CCD x direction"
Keyword:A_335_Y0, float, variable, record, DRMS_MISSING_VALUE, "%f", "pixel", "Image center in CCD y direction"
Keyword:A_335_INSTROT, float, variable, record, DRMS_MISSING_VALUE, "%f", "deg", "Rotation of CCD from SDO Z axis"

Keyword:A_1600_IMSCALE, float, variable, record, DRMS_MISSING_VALUE, "%f", "arcsec", "Image scale in arcsec/pixel"
Keyword:A_1600_X0, float, variable, record, DRMS_MISSING_VALUE, "%f", "pixel", "Image center in CCD x direction"
Keyword:A_1600_Y0, float, variable, record, DRMS_MISSING_VALUE, "%f", "pixel", "Image center in CCD y direction"
Keyword:A_1600_INSTROT, float, variable, record, DRMS_MISSING_VALUE, "%f", "deg", "Rotation of CCD from SDO Z axis"

Keyword:A_1700_IMSCALE, float, variable, record, DRMS_MISSING_VALUE, "%f", "arcsec", "Image scale in arcsec/pixel"
Keyword:A_1700_X0, float, variable, record, DRMS_MISSING_VALUE, "%f", "pixel", "Image center in CCD x direction"
Keyword:A_1700_Y0, float, variable, record, DRMS_MISSING_VALUE, "%f", "pixel", "Image center in CCD y direction"
Keyword:A_1700_INSTROT, float, variable, record, DRMS_MISSING_VALUE, "%f", "deg", "Rotation of CCD from SDO Z axis"

Keyword:A_4500_IMSCALE, float, variable, record, DRMS_MISSING_VALUE, "%f", "arcsec", "Image scale in arcsec/pixel"
Keyword:A_4500_X0, float, variable, record, DRMS_MISSING_VALUE, "%f", "pixel", "Image center in CCD x direction"
Keyword:A_4500_Y0, float, variable, record, DRMS_MISSING_VALUE, "%f", "pixel", "Image center in CCD y direction"
Keyword:A_4500_INSTROT, float, variable, record, DRMS_MISSING_VALUE, "%f", "deg", "Rotation of CCD from SDO Z axis"

#===== (3) HMI Alignment Parameters

Keyword:HMI_FSW_AL1_POSITION, float, variable, record, DRMS_MISSING_VALUE, "%f", "none", "[HAL1POS]"
Keyword:HMI_FSW_AL2_POSITION, float, variable, record, DRMS_MISSING_VALUE, "%f", "none", "[HAL2POS]"
Keyword:HMI_AL1_STATUS, float, variable, record, DRMS_MISSING_VALUE, "%f", "none", "[HAL1STAT]"
Keyword:HMI_AL2_STATUS, float, variable, record, DRMS_MISSING_VALUE, "%f", "none", "[HAL2STAT]"

Keyword:HMI_ISS_ERRGAINY, float, variable, record, DRMS_MISSING_VALUE, "%f", "none", "[HIERRGNY]"
Keyword:HMI_ISS_ERRGAINZ, float, variable, record, DRMS_MISSING_VALUE, "%f", "none", "[HIERRGNZ]"
Keyword:HMI_ISS_ERROFFY, float, variable, record, DRMS_MISSING_VALUE, "%f", "none", "[HIERROFY]"
Keyword:HMI_ISS_ERROFFZ, float, variable, record, DRMS_MISSING_VALUE, "%f", "none", "[HIERROFZ]"

Keyword:HMI_ISS_PZTOFFA, float, variable, record, DRMS_MISSING_VALUE, "%f", "none", "[HIPZTOFA]"
Keyword:HMI_ISS_PZTOFFB, float, variable, record, DRMS_MISSING_VALUE, "%f", "none", "[HIPZTOFB]"
Keyword:HMI_ISS_PZTOFFC, float, variable, record, DRMS_MISSING_VALUE, "%f", "none", "[HIPZTOFC]"

Keyword:HMI_ISS_PKT_YCOEF_A, float, variable, record, DRMS_MISSING_VALUE, "%f", "none", "[HIYCOEFA]"
Keyword:HMI_ISS_PKT_YCOEF_B, float, variable, record, DRMS_MISSING_VALUE, "%f", "none", "[HIYCOEFB]"
Keyword:HMI_ISS_PKT_YCOEF_C, float, variable, record, DRMS_MISSING_VALUE, "%f", "none", "[HIYCOEFC]"
Keyword:HMI_ISS_PKT_ZCOEF_A, float, variable, record, DRMS_MISSING_VALUE, "%f", "none", "[HIZCOEFA]"
Keyword:HMI_ISS_PKT_ZCOEF_B, float, variable, record, DRMS_MISSING_VALUE, "%f", "none", "[HIZCOEFB]"
Keyword:HMI_ISS_PKT_ZCOEF_C, float, variable, record, DRMS_MISSING_VALUE, "%f", "none", "[HIZCOEFC]"

#===== (4) AIA Alignment Parameters

Keyword:AIA_IS1_ERRGAINY, float, variable, record, DRMS_MISSING_VALUE, "%f", "none", "[A1ERRGNY]"
Keyword:AIA_IS1_ERRGAINZ, float, variable, record, DRMS_MISSING_VALUE, "%f", "none", "[A1ERRGNZ]"
Keyword:AIA_IS1_ERROFFY, float, variable, record, DRMS_MISSING_VALUE, "%f", "none", "[A1ERROFY]"
Keyword:AIA_IS1_ERROFFZ, float, variable, record, DRMS_MISSING_VALUE, "%f", "none", "[A1ERROFZ]"

Keyword:AIA_IS1_PZTGAINA, float, variable, record, DRMS_MISSING_VALUE, "%f", "none", "[A1PZTGNA]"
Keyword:AIA_IS1_PZTGAINB, float, variable, record, DRMS_MISSING_VALUE, "%f", "none", "[A1PZTGNB]"
Keyword:AIA_IS1_PZTGAINC, float, variable, record, DRMS_MISSING_VALUE, "%f", "none", "[A1PZTGNC]"

Keyword:AIA_IS1_PZTOFFA, float, variable, record, DRMS_MISSING_VALUE, "%f", "none", "[A1PZTOFA]"
Keyword:AIA_IS1_PZTOFFB, float, variable, record, DRMS_MISSING_VALUE, "%f", "none", "[A1PZTOFB]"
Keyword:AIA_IS1_PZTOFFC, float, variable, record, DRMS_MISSING_VALUE, "%f", "none", "[A1PZTOFC]"

Keyword:AIA_GT1_PKT_YCOEF_A, float, variable, record, DRMS_MISSING_VALUE, "%f", "none", "[AGT1_YCA]"
Keyword:AIA_GT1_PKT_YCOEF_B, float, variable, record, DRMS_MISSING_VALUE, "%f", "none", "[AGT1_YCB]"
Keyword:AIA_GT1_PKT_YCOEF_C, float, variable, record, DRMS_MISSING_VALUE, "%f", "none", "[AGT1_YCC]"
Keyword:AIA_GT1_PKT_ZCOEF_A, float, variable, record, DRMS_MISSING_VALUE, "%f", "none", "[AGT1_ZCA]"
Keyword:AIA_GT1_PKT_ZCOEF_B, float, variable, record, DRMS_MISSING_VALUE, "%f", "none", "[AGT1_ZCB]"
Keyword:AIA_GT1_PKT_ZCOEF_C, float, variable, record, DRMS_MISSING_VALUE, "%f", "none", "[AGT1_ZCC]"

Keyword:AIA_IS2_ERRGAINY, float, variable, record, DRMS_MISSING_VALUE, "%f", "none", "[A2ERRGNY]"
Keyword:AIA_IS2_ERRGAINZ, float, variable, record, DRMS_MISSING_VALUE, "%f", "none", "[A2ERRGNZ]"
Keyword:AIA_IS2_ERROFFY, float, variable, record, DRMS_MISSING_VALUE, "%f", "none", "[A2ERROFY]"
Keyword:AIA_IS2_ERROFFZ, float, variable, record, DRMS_MISSING_VALUE, "%f", "none", "[A2ERROFZ]"

Keyword:AIA_IS2_PZTGAINA, float, variable, record, DRMS_MISSING_VALUE, "%f", "none", "[A2PZTGNA]"
Keyword:AIA_IS2_PZTGAINB, float, variable, record, DRMS_MISSING_VALUE, "%f", "none", "[A2PZTGNB]"
Keyword:AIA_IS2_PZTGAINC, float, variable, record, DRMS_MISSING_VALUE, "%f", "none", "[A2PZTGNC]"
Keyword:AIA_IS2_PZTOFFA, float, variable, record, DRMS_MISSING_VALUE, "%f", "none", "[A2PZTOFA]"
Keyword:AIA_IS2_PZTOFFB, float, variable, record, DRMS_MISSING_VALUE, "%f", "none", "[A2PZTOFB]"
Keyword:AIA_IS2_PZTOFFC, float, variable, record, DRMS_MISSING_VALUE, "%f", "none", "[A2PZTOFC]"

Keyword:AIA_GT2_PKT_YCOEF_A, float, variable, record, DRMS_MISSING_VALUE, "%f", "none", "[AGT2_YCA]"
Keyword:AIA_GT2_PKT_YCOEF_B, float, variable, record, DRMS_MISSING_VALUE, "%f", "none", "[AGT2_YCB]"
Keyword:AIA_GT2_PKT_YCOEF_C, float, variable, record, DRMS_MISSING_VALUE, "%f", "none", "[AGT2_YCC]"
Keyword:AIA_GT2_PKT_ZCOEF_A, float, variable, record, DRMS_MISSING_VALUE, "%f", "none", "[AGT2_ZCA]"
Keyword:AIA_GT2_PKT_ZCOEF_B, float, variable, record, DRMS_MISSING_VALUE, "%f", "none", "[AGT2_ZCB]"
Keyword:AIA_GT2_PKT_ZCOEF_C, float, variable, record, DRMS_MISSING_VALUE, "%f", "none", "[AGT2_ZCC]"

Keyword:AIA_IS3_ERRGAINY, float, variable, record, DRMS_MISSING_VALUE, "%f", "none", "[A3ERRGNY]"
Keyword:AIA_IS3_ERRGAINZ, float, variable, record, DRMS_MISSING_VALUE, "%f", "none", "[A3ERRGNZ]"
Keyword:AIA_IS3_ERROFFY, float, variable, record, DRMS_MISSING_VALUE, "%f", "none", "[A3ERROFY]"
Keyword:AIA_IS3_ERROFFZ, float, variable, record, DRMS_MISSING_VALUE, "%f", "none", "[A3ERROFZ]"

Keyword:AIA_IS3_PZTGAINA, float, variable, record, DRMS_MISSING_VALUE, "%f", "none", "[A3PZTGNA]"
Keyword:AIA_IS3_PZTGAINB, float, variable, record, DRMS_MISSING_VALUE, "%f", "none", "[A3PZTGNB]"
Keyword:AIA_IS3_PZTGAINC, float, variable, record, DRMS_MISSING_VALUE, "%f", "none", "[A3PZTGNC]"
Keyword:AIA_IS3_PZTOFFA, float, variable, record, DRMS_MISSING_VALUE, "%f", "none", "[A3PZTOFA]"
Keyword:AIA_IS3_PZTOFFB, float, variable, record, DRMS_MISSING_VALUE, "%f", "none", "[A3PZTOFB]"
Keyword:AIA_IS3_PZTOFFC, float, variable, record, DRMS_MISSING_VALUE, "%f", "none", "[A3PZTOFC]"

Keyword:AIA_GT3_PKT_YCOEF_A, float, variable, record, DRMS_MISSING_VALUE, "%f", "none", "[AGT3_YCA]"
Keyword:AIA_GT3_PKT_YCOEF_B, float, variable, record, DRMS_MISSING_VALUE, "%f", "none", "[AGT3_YCB]"
Keyword:AIA_GT3_PKT_YCOEF_C, float, variable, record, DRMS_MISSING_VALUE, "%f", "none", "[AGT3_YCC]"
Keyword:AIA_GT3_PKT_ZCOEF_A, float, variable, record, DRMS_MISSING_VALUE, "%f", "none", "[AGT3_ZCA]"
Keyword:AIA_GT3_PKT_ZCOEF_B, float, variable, record, DRMS_MISSING_VALUE, "%f", "none", "[AGT3_ZCB]"
Keyword:AIA_GT3_PKT_ZCOEF_C, float, variable, record, DRMS_MISSING_VALUE, "%f", "none", "[AGT3_ZCC]"

Keyword:AIA_IS4_ERRGAINY, float, variable, record, DRMS_MISSING_VALUE, "%f", "none", "[A4ERRGNY]"
Keyword:AIA_IS4_ERRGAINZ, float, variable, record, DRMS_MISSING_VALUE, "%f", "none", "[A4ERRGNZ]"
Keyword:AIA_IS4_ERROFFY, float, variable, record, DRMS_MISSING_VALUE, "%f", "none", "[A4ERROFY]"
Keyword:AIA_IS4_ERROFFZ, float, variable, record, DRMS_MISSING_VALUE, "%f", "none", "[A4ERROFZ]"

Keyword:AIA_IS4_PZTGAINA, float, variable, record, DRMS_MISSING_VALUE, "%f", "none", "[A4PZTGNA]"
Keyword:AIA_IS4_PZTGAINB, float, variable, record, DRMS_MISSING_VALUE, "%f", "none", "[A4PZTGNB]"
Keyword:AIA_IS4_PZTGAINC, float, variable, record, DRMS_MISSING_VALUE, "%f", "none", "[A4PZTGNC]"
Keyword:AIA_IS4_PZTOFFA, float, variable, record, DRMS_MISSING_VALUE, "%f", "none", "[A4PZTOFA]"
Keyword:AIA_IS4_PZTOFFB, float, variable, record, DRMS_MISSING_VALUE, "%f", "none", "[A4PZTOFB]"
Keyword:AIA_IS4_PZTOFFC, float, variable, record, DRMS_MISSING_VALUE, "%f", "none", "[A4PZTOFC]"

Keyword:AIA_GT4_PKT_YCOEF_A, float, variable, record, DRMS_MISSING_VALUE, "%f", "none", "[AGT4_YCA]"
Keyword:AIA_GT4_PKT_YCOEF_B, float, variable, record, DRMS_MISSING_VALUE, "%f", "none", "[AGT4_YCB]"
Keyword:AIA_GT4_PKT_YCOEF_C, float, variable, record, DRMS_MISSING_VALUE, "%f", "none", "[AGT4_YCC]"
Keyword:AIA_GT4_PKT_ZCOEF_A, float, variable, record, DRMS_MISSING_VALUE, "%f", "none", "[AGT4_ZCA]"
Keyword:AIA_GT4_PKT_ZCOEF_B, float, variable, record, DRMS_MISSING_VALUE, "%f", "none", "[AGT4_ZCB]"
Keyword:AIA_GT4_PKT_ZCOEF_C, float, variable, record, DRMS_MISSING_VALUE, "%f", "none", "[AGT4_ZCC]"