

## 7. ALICE INSTRUMENT DESCRIPTION

### 7.1 Overview

PERSI-Alice is a UV spectrograph that is sensitive to Ultraviolet (UV) light in the range of 520-1870 Å. The instrument consists of a telescope section with an off-axis parabolic mirror, and a spectrograph section that includes a diffraction grating and a microchannel plate (MCP) detector. The MCP detector is an electro-optical device sensitive to extreme and far ultraviolet light and energetic particles. It consists of a photo cathode-coated MCP surface that converts UV photons to electrons, an MCP Z-stack configuration of three MCPs to amplify the signal, and a two-dimensional double delay-line (DDL) anode readout array. The first (x) dimension provides the spectral location of the detected photon and the second (y) dimension provides one-dimensional spatial information. The DDL detector system outputs to the command-and-data-handling (C&DH) electronics the pixel location for each detected photon event. The pixel location ( $X, Y$ ) is given as a pair of coordinates, spectral ( $X$  axis) and spatial ( $Y$  axis). The events are processed by the C&DH electronics. The C&DH is also the controller of Alice; it receives commands from the spacecraft, acquires data from the MCP detector system, and returns telemetry to the spacecraft. Science data telemetry generation is performed by the detector hardware but the C&DH also controls this function. Alice has two acquisition modes (see below) in which the spectral/spatial data from the detector are processed by the C&DH subsystem.

All following descriptions assume a nominal operating instrument. The instrument hardware also provides a basic, hardware-controlled, default pixel list acquisition mode, which is activated when the instrument control hardware detects multiple successive software failures. This mode is called the ‘State Machine Mode’ (SMM); for a description of this mode, the reader is referred to the instrument C&DH hardware description. Once this mode is activated any software control of the acquisition operation is disabled, until the instrument C&DH is reset either by a power cycle reset or by a hardware S/C reset.

Data recorded on New Horizons are sent to the ground via the Deep Space Network. From there the data are sent to the Mission Operations Center (MOC) at the Applied Physics Laboratory (APL). The Science Operations Center (SOC) at the Southwest Research Institute (SwRI) in Boulder retrieves new data from the MOC daily. The data from the MOC are in a packetized form. Software pipelines at the SOC convert the data from these raw packets into FITS (Flexible Image Transport System) format files with scientifically useful and calibrated data. The initial processing sorts the packets into FITS files (as images and data tables) with useful header keywords. These keywords include the mode of the observation, exposure and timing information, and basic pointing information of the instrument boresight. The initial processing also adds relevant housekeeping telemetry (temperatures, voltages, etc.) in a binary table as an extension to the FITS file. The calibration pipeline then performs basic scientific calibration on these data.

### 7.2 “Raw” Data Specifics

The term “raw” as used here refers to CODMAC Level 2 data

#### 7.2.1 Data Format

P-Alice High Speed data frame formats:

Science data frames consist of “raw” science data of 32768 16-bit words in size, consisting of 1 word (16 bits) of frame ID header information and a 32767-word data block. Science data frames are generated by the acquisition hardware and sent to the spacecraft via the dedicated LVDS interface. Data are transferred

at a rate of 1 Mbit/sec, resulting in a frame transfer time of 557 milliseconds. The spacecraft tags the received data with a receive time (referred to as ‘collect time’) and stores the data in the Solid State Recorder (SSR). Note that these science frames are not identical to the CCSDS (Consultative Committee for Space Data Systems) telemetry packets that are used to transfer the science data to the ground. The generation of telemetry (TM) packets from the frames stored in the SSR is handled by the spacecraft and multiple CCSDS TM packets are used to transfer a single science frame.

To identify the Science frames, a single 16-bit word header is inserted into each frame. This header is generated by the acquisition hardware and includes the information listed in Table 10-7. The complete header word of the most recently generated science frame is included in the housekeeping TM packet to allow for correlation between the two data streams (low and high speed) after the data are received by the ground system.

Field	Size in bits	Description
Packet contents (msb)	1	0 - pixel list 1 - histogram
Memory	1	0 - ping (side A), 1 - pong (side B)
Last block	1	0 - intermediate block 1 - last block (acquisition cycle terminated)
HW acquisition	1	HW controlled acquisition (hardware “limp along”, a.k.a. “State machine Mode”), overrides software control after 8 consecutive watchdog timeouts (see C&DH hardware documentation).
Block number	12	Least significant 12 bits of the block number

*Table 7-1: PERSI-Alice Science packet telemetry header*

The contents of the remainder of the data frames (the 32767-word data block) depend on the acquisition mode:

- Pixel List** Each word in the data block from a pixel list exposure describes a photon event or a time hack. Photon events are indicated by bit 15 having a value of zero and time hacks are indicated by bit 15 having a value of one. For a photon event, the remaining 15 data bits encode the location of the detected event consisting of a 10-bit encoded spectral location ( $X$ ) and a 5-bit encoded spatial location ( $Y$ ). The time hack is used to provide temporal information about the photon events. The acquisition hardware will generate and insert time hacks in the frame on a periodic basis; the frequency of the time hacks is configurable (by command) for each acquisition in a range of 4 – 512 ms. For a time hack, the remaining 15 bits contain an incrementing counter that counts the number of 4 ms periods. This value allows for verification and correction of timing in case of lost frames or packets.
- Histogram** Each word in the data block from a histogram exposure is a 16-bit “counter” giving the number of photon events detected at each specific  $X,Y$  location on the detector. The format of the detector is 1024x32 pixels, which are the spectral and spatial dimensions respectively, i.e., there are 1024 spectral elements along the  $X$ -axis and 32 spatial elements along the  $Y$ -axis, giving a total of 32768 values (however, the first word always contains the header word). The counters are stored row-wise, corresponding to the spectral dimension indexing most quickly. These counters saturate at a maximum value of 65535 to indicate a completely filled counting bin, meaning that the counters do not wrap around. In addition some special data words (header cross-identification and pulse height distribution) are overlying the lower left-hand corner of the actual array in a block of 4 (spatial) x 32

(spectral) words. This usage doesn't affect the science data contents because detector events do not occur in this region. In this over-written block, the first row contains the header cross-identification word, the second and third rows contain the 64 words of pulse height information, and the fourth row is filled with zeros. A "pulse height" is the amplitude of a photon event, and this pulse height distribution (PHD) shows the number of events in a 64-bin distribution with 6-bit resolution; the value in each PHD bin gives the number of events that occurred with the particular amplitude associated with that bin. These PHD counters also saturate at a value of 65535. So a single photon event is counted both in the spectral/spatial array and in the pulse height list. The PHD is used as a diagnostic for the health and behavior of the detector.

For test purposes the instrument can fill the memory with known deterministic patterns so the interfaces to the spacecraft and ground can be verified. The instrument software allows for the generation of 5 different test patterns.

#### 7.2.1.1 Histogram FITS file:

The Primary Data Unit (PDU) in the FITS file is a 2-D raw histogram frame (also referred to as an "image") consisting of 1024x32 16-bit integer numbers. Note that the Alice instrument data are unsigned 16-bit integers (giving values of 0 to 65535). Following the PDU is the first Extension Data Unit (EDU), which contains the 64-element pulse height distribution (PHD) that was acquired together with the histogram. When the Level 1 pipeline saves the PHD to this extension, it then zeros out that part of the histogram array. The second data extension contains a 141 column by  $t$  row binary table, where  $t$  is the time of the exposure in seconds, of housekeeping values recorded during the observation (the housekeeping report rate is 1 Hz).

FITS File Storage Location	Description
Primary Data Unit (PDU)	Raw Histogram image (uncorrected counts)
Extension #1	Pulse Height Distribution (PHD)
Extension #2	Binary Housekeeping Table

#### 7.2.1.2 Pixel list FITS file:

Upon receiving a pixel list frame, the Level 1 processing creates a ground-calculated "reconstructed histogram" from the received pixel list data and places it in the primary data unit of the FITS file; this enables an easy quick-look inspection of the pixel list data (e.g., using most FITS viewers that by default typically display the data in the primary data unit). The pixel list data itself can be hard to interpret, so this reconstructed histogram image is desirable to enable the scientist to determine, e.g., data quality, whether the target was in the field of view, etc... The first data extension contains the raw pixel list data set, which includes the full stream of photon events and time hacks. The second extension contains the derived count rate derived from the pixel list data. Each count rate bin shows the number of events that occurred between successive time hacks. The resolution of this count rate data set is determined by the hack rate used for the pixel list acquisition. The length of this vector is variable depending on the source flux and the hack rate. The third data extension contains a 141 column by  $t$  row binary table, where  $t$  is the number of housekeeping values recorded during the observation.

FITS File Storage Location	Description
Primary Data Unit (PDU)	Reconstructed Histogram image (uncalibrated counts)
Extension #1	raw pixel list
Extension #2	Count rate vector from pixel list data (sampled at time hack rate)
Extension #3	Binary Housekeeping Table

**7.2.2 Data Sources (High/Low Speed, CCSDS, ITF)**

PERSI-Alice data are transferred via CCSDS packets that are packetized by the spacecraft from the Solid State Recorder.

The spacecraft will packetize the PERSI-Alice High Speed Telemetry data into CCSDS packets before sending the data to the ground. Different ApIDs (packet Application Process Identifiers; also Application IDs) are used to distinguish the histogram and pixel list data packets (see Table 7-2). For the PERSI-Alice science frames the spacecraft will either use the “RAW” packetized format or the lossless compressed format to transfer the data. In either case the result will be data encoded in CCSDS telemetry packets. The packet ApIDs listed in Table 7-2 are used to distinguish between the different Alice CCSDS packets.

The packet time as listed in the CCSDS packet represents the time at which the packetization operation was performed. The second time field contains the frame collection time as sent from a spacecraft perspective, meaning this represents the time at which the spacecraft received the frame from the instrument. As the instrument immediately sends the frame at the completion of the acquisition this corresponds to the time at which the acquisition was completed. For each data type there are two ApIDs, one for each C&DH (Command and Data Handling) system on the spacecraft.

ApID CDH-1	ApID CDH-2	Data type
0x4B0	0x4B4	Compressed (Lossless) Alice Pixel list Data (DT-1)
0x4B1	0x4B5	Packetized (RAW) Alice Pixel list Data (DT-1)
0x4B2	0x4B6	Compressed (Lossless) Alice Histogram Data (DT-2)
0x4B3	0x4B7	Packetized (RAW) Alice Histogram Data (DT-2)

*Table 7-2: PERSI-Alice science ApIDs*

Packetized “RAW” telemetry:

The nominal data transfer method for the Alice pixel list science data is packetized “raw” data. Each CCSDS science packet can transfer a segment of up to 480 data bytes. In order to transfer a full PERSI-Alice frame of 32768 words (16-bits), 137 science packets are needed; the first 136 packets will all be full size segments of 480 bytes, the last packet will transfer the remaining 256 bytes. The grouping flags of the packets indicate the start and end segment within a complete frame transfer.

Note the ‘#’ marks in the following tables refer to the third hexadecimal digit of the ApID; valid values for that digit are as indicated in the table captions and in Table 7-2.

Parameter	Bit Count	Size in bytes	Description
<b>Primary Header</b>			
PH_VER_NUM_4B#	3	2	Version Number, fixed value = 0; designates a source packet
PH_PKT_TYP_4B#	1		Type Indicator, fixed value = 0; designates a telemetry packet
PH_SH_FLG_4B#	1		Secondary Header Flag, fixed value = 1; designates presence of secondary header
PH_APP_ID_4B#	11		Application Process identifier, see Table 7-2
PH_SEQ_FLG_4B#	2	2	Grouping Flags: 1 – first segment 0 – intermediate segment 2 – last segment
PH_SEQ_CNT_4B#	14		Source Count, continuous sequence count of all generated packets (per ApID) (modulo 16384)
PH_PKT_LEN_4B#	16	2	Number of bytes (secondary header + data bytes – 1): 511 or 287
<b>Secondary Header</b>			
SH_PACKET_TIME_4B#	32	4	Spacecraft MET at time the Telemetry packet is constructed
SH_COLLECT_TIME_4B#	32	4	Spacecraft MET at time the high-speed science data was collected
<b>Data</b>			
ERROR_STATUS	64	8	Information from the SSR forward error correcting code, not important for simple decoding
SSR_HEADER	128	16	Information from the SSR storage administration, not important for simple decoding
DATA_BLOCK	3840	480	Data bytes, all packets except the last packet 480 bytes, the last one is 256 bytes

Table 7-3: PERSI-Alice CCSDS Packetized (RAW) science packet; # = 1, 3, 5, 7.

#### Lossless Compressed telemetry:

The nominal data transfer method for the Alice histogram science data is lossless compressed data. When applied to pixel list data, the ‘FAST’ algorithm results in negligible compression rates, and occasionally in a 1% expansion, therefore lossless compression will generally not be used with pixel list data. The spacecraft uses the so called ‘FAST’ algorithm to compress the image data. The ‘FAST’ algorithm uses one-dimensional correlation between successive data elements to remove redundancy. Data is encoded in blocks of 16 successive science values, the first value of such a block is send in full 16 bits, the remainder of the block is encoded using successive differences, using an adaptive coding mechanism.

Parameter	Bit Count	Size in bytes	Description	
<b>Primary Header</b>				
PH_VER_NUM_4B#	3	2	Version Number, fixed value = 0; designates a source packet	
PH_PKT_TYP_4B#	1		Type Indicator, fixed value = 0; designates a telemetry packet	
PH_SH_FLG_4B#	1		Secondary Header Flag, fixed value = 1; designates presence of secondary header	
PH_APP_ID_4B#	11		Application Process identifier, see Table 2	
PH_SEQ_FLG_4B#	2	2	Grouping Flags: 1 – first segment 0 – intermediate segment 2 – last segment	
PH_SEQ_CNT_4B#	14		Source Count, continuous sequence count of all generated packets (per ApID) (modulo 16384)	
PH_PKT_LEN_4B#	16	2	Number of bytes (secondary header + data bytes – 1): maximum 265	
<b>Secondary Header</b>				
SH_PACKET_TIME_4B#	32	4	Spacecraft MET at time the Telemetry packet is constructed	
SH_COLLECT_TIME_4B#	32	4	Spacecraft MET at time the high-speed science data was collected	
<b>Data</b>				
COMP_UNIT_INDICATOR	16	2	Compression Unit (CU) Indicator The compression unit indicator (CUI) is sequential with the MSB set if it is the first packet within a CUI.	
FIRST CU only	IMAGE_LINE_SIZE	16	2	Width of an image line
	IMAGE_LENGTH	16	2	Total image length
	X_POSITION	16	2	Bottom left start position (windowed data)
	Y_POSITION	16	2	Bottom left start position (windowed data)
	COLOR_INDICATOR	16	2	Color channel of data, 0 = not applicable for Alice
FAST_DATA	8 ... 2048	1..256	Lossless (FAST) compressed alice science data; total packet data size is limited to 256+2 bytes, so for the first CU only 246 data bytes are used.	
<p>Description of the FAST encoded data:</p> <ul style="list-style-type: none"> <li>• Each compressed observation consists of an integer number of Compression Units (CUs).</li> <li>• Each CU represents a fixed number of samples (2048).</li> <li>• Each CU starts with a 16 bit initial value, this value is byte aligned.</li> <li>• In the first CU of an observation the third byte contains the block length (16).</li> <li>• Each Compression Unit contains an integer number of Blocks ( = 2048/block length = 128).</li> <li>• Each Block starts with a 5 bit number that indicates the number of bits used to encode the successive differences.</li> <li>• Each Block continues with the differences, the least significant bit of these small numbers is used as a sign indicator, so the differences can be positive and negative.</li> </ul> <p>Note that even after an initial value (start of a CU) a difference is encoded to calculate the first data sample, so the initial delta after the initial value will be zero.</p>				

Table 7-4: PERSI-Alice CCSDS Compressed (Lossless) science packet; # = 0, 2, 4, 6.

### 7.2.3 *Definition of an “Observation”*

An observation will be a single histogram image or one frame of a pixel list series. Each observation will be written to a separate FITS file. A pixel list resulting from a single exposure command may therefore produce many such frames, each of which will be saved as a separate FITS file.

### 7.2.4 *S/C Housekeeping Needed in Level 1 Files (for Calibration)*

Spacecraft housekeeping that may be needed in the Alice pipeline include any temperature sensors on the spacecraft around the Alice instrument and the spacecraft-measured instrument bus voltage and power consumption on the different busses.

Spacecraft measured temperatures related to Alice (ApId 0x00D and 0x08D):

T\_A.CDH\_TEMP\_ALICE\_BRACK\_BASE\_00D

T\_A.CDH\_TEMP\_ALICE\_1\_00D

T\_A.CDH\_TEMP\_ALICE\_2\_00D

PDU parameters related to Alice (ApId 0x009, 0x00a, 0x089 and 0x08a):

ALICE\_LVPS\_A\_VOLT\_009

ALICE\_LVPS\_A\_CURR\_009

ALICE\_LVPS\_B\_VOLT\_009

ALICE\_LVPS\_B\_CURR\_009

ALICE\_ACT\_A\_VOLT\_00A

ALICE\_ACT\_A\_CURR\_00A

ALICE\_ACT\_B\_VOLT\_009

ALICE\_ACT\_B\_CURR\_009

Note that these temperatures currently are not used in the pipeline processing, but may be used in the future as the code and calibrations are revised.

## 7.3 “Calibrated” Data Specifics

“Calibrated” data as used here refers to CODMAC level 3 data.

### 7.3.1 *Algorithm for Pipeline*

Overview: The Alice calibration pipeline that is run at the SOC applies various calibrations to raw Alice data to convert the data from units of counts to flux units (photons/s/cm<sup>2</sup>). Four types of operations can be performed. They are, in order of application to the data: deadtime correction, dark correction, effective area correction, and flat field correction. These are described in more detail below.

#### 7.3.1.1 **Deadtime Correction**

The Alice detector electronics require a finite time to process an event pulse. As a result, if event pulses arrive too close together in time, the latter pulse(s) will not be recorded, resulting in an effective decrease

in the sensitivity of the instrument that is a function of the count rate. The deadtime correction time constant for the high-speed electronics, i.e. the science data is 18 microseconds. The deadtime correction time constant for the low-speed electronics, i.e. the housekeeping data is 4 microseconds. At input rates below 50 kHz, the detector electronics is non-paralyzable (i.e. a fixed deadtime per event that is not re-triggerable). To calculate the detector output count rate, the following formula is used:

$$C_{\text{out}} = C_{\text{in}} / (1 + C_{\text{in}} \tau)$$

where  $C_{\text{out}}$  is the output (i.e., detected) count rate and  $C_{\text{in}}$  is the input count rate. At a count rate of 1 kHz, the deadtime correction factor ( $\tau$ ) is approximately 1.02, while at 20 kHz, the deadtime correction factor is approximately 1.56.

### 7.3.1.2 Dark Correction

The Alice detector electronics register events even when the aperture door is closed and the detector is not illuminated by FUV photons. The spatial distribution of these dark counts is approximately uniform across the detector. However, there is some low-level 2-D structure to the dark counts. Alice observations made with the aperture door closed are summed together to create a "superdark". This superdark image is then scaled to the exposure time of an Alice science observation and subtracted from the data.

During in-flight commissioning, these dark counts were measured at a rate of approximately 94 Hz across the entire detector. The primary source of dark counts is the spacecraft RTG. Dark exposures are made throughout the mission to monitor the background event rate and detector performance.

### 7.3.1.3 Effective Area

The sensitivity of Alice to UV photons varies as a function of wavelength. It is convenient to think of the Alice sensitivity in terms of the effective area of the instrument. For a point source located at infinity, effective area is defined as the area of the surface that intercepts incident photons at the same rate as is detected by the Alice instrument. Dividing the observed count rate by the effective area yields the incident flux of photons. In general, effective area depends on the geometric size of the instrument aperture, reflectivities of the optical surfaces, sensitivity and quantum efficiency of the detector, etc.

The Alice effective area curve is based on observations of stars that have been previously observed by IUE and HST. In wavelength regions outside those covered by the IUE/HST observations, the pre-flight effective area estimate has been linearly scaled so that it matches the effective area derived at longer wavelengths.

### 7.3.1.4 Flat Field

When uniformly illuminated by a monochromatic source, the counts detected by the Alice instrument vary from pixel to pixel with a standard deviation of approximately 15%. This spatial variation in instrument sensitivity is the instrument flat field response.

As of September 2007, no suitable observations have been made from which to derive an in-flight flat field calibration. Thus the flat field correction is currently disabled in the Alice pipeline code.

Update as of February, 2014: no flat field was generated during the pre-flight ground calibration, extended targets are rare to non-existent in flight for New Horizons (the spacecraft flew by the moon 9h after leaving earth orbit), and generating a flat with point sources is problematic, so no suitable flat field is available for ALICE calibration. The flat field correction in the pipeline is still effectively disabled via

the use of an all-unity flat field calibration file named `pa_flat_000.fit`, the name of which is included in the FITS header of the PDU, and which is delivered with the PDS data sets. There is what appears to be repeatable, quasi-periodic analog-to-digital noise visible in images summed along rows of darks taken during ground and flight calibrations, but its behavior across columns is not clear (cf. the ALICE Space Science Review paper, Stern et al., 2008, a pre-print copy of which is provided with the PDS data sets).

### 7.3.2 *Format of Calibrated Data*

#### 7.3.2.1 Histogram

The primary data unit in the FITS file is a 2-D calibrated histogram frame consisting of 1024x32 array of 32-bit floating-point numbers. The units of the histogram image are photons/s/cm<sup>2</sup>. The first data extension in the FITS file is a 1024x32 array of 32-bit floating numbers containing the uncertainty in the histogram image. The second data extension is a 1024x32 element array containing the wavelength for each pixel in the histogram image. The third data extension is the 64-element PHD, identical to that in the raw data. The fourth data extension is an array containing the number of photon events per housekeeping sampling interval. The fifth data extension is the 141 column by  $t$  row housekeeping row as in the raw data.

FITS File Storage Location	Description
Primary Data Unit (PDU)	Calibrated Histogram image (photons/sec/cm <sup>2</sup> )
Extension #1	Uncertainties in histogram data values
Extension #2	Wavelength Image (Angstroms)
Extension #3	Pulse Height Distribution (PHD)
Extension #4	Count rate vector from HK (sampled at 1 Hz)
Extension #5	Binary Housekeeping Table

#### 7.3.2.2 Pixel List

The primary data unit in the FITS file is a 2-D calibrated reconstructed histogram image consisting of a 1024x32 array of 32-bit floating-point numbers. The units of the histogram image are photons/s/cm<sup>2</sup>. The first data extension in the FITS file is a 1024x32 array of 32-bit floating numbers containing the uncertainty in the reconstructed histogram image. The second data extension is a 1024x32 element array containing the wavelength for each pixel in the reconstructed histogram image. The third data extension contains a binary table of 5 columns and rows for each photon event. The five columns are the  $X$  (spectral) position of each photon event, the  $Y$  (spatial) position of the photon event, the wavelength of the photon event, the cumulative number of elapsed time hack intervals (starting from 0 at the beginning of the file), and the deadtime correction factor events occurring during the time hack in question. The temporal resolution of this pixel list data set is determined by the hack rate used for the pixel list acquisition. The length of this vector is variable depending on the source flux and the hack rate. The fifth data extension contains the binary housekeeping table.

FITS File Storage Location	Description
Primary Data Unit (PDU)	Reconstructed Calibrated Histogram image

	(photons/sec/cm <sup>2</sup> )
Extension #1	Uncertainties in reconstructed histogram data values
Extension #2	Wavelength Image (Angstroms)
Extension #3	Binary Pixel List Table (X, Y, wavelength, time hack #, MET)
Extension #4	Count rate vector from pixel list data (sampled at time hack rate)
Extension #5	Binary Housekeeping Table

**7.3.3 Scientific Units**

For Histogram, units are photons/s/cm<sup>2</sup> (histogram), angstroms (wavelength array), and counts (PHD array).

For Pixel List, units are photons/s/cm<sup>2</sup> (generated histogram), angstroms (wavelength array), counts, pixel location, and angstroms, and seconds (pixel list array), counts per second (count rate array).

**7.3.4 Additional FITS and PDS Keywords Added**

Below is an example of the Mike pipeline keyword block added to the FITS header:

```

COMMENT =====
COMMENT
MIKE_BEG= 'Feb 15 16:12:57 2005' / START MIKE KEYWORD BLOCK
MIKE_VER= '2.0 [2005 Feb 15]' /Version of Mike pipeline code
K_MODE = 'ACQMODE ' / Keyword containing the mode name
K_ETIME = 'EXPTIME ' / Keyword for the effective exposure time
FILE_IN = 'test/ali_0000006498_0x4b3_eng_1.fit' / Input file for processing
FILE_OUT= 'test/test_his.fit' / Output file after processing
DIR_CAL = 'cal/ ' / Directory of calibration data
DIR_DONE= ' ' / Directory to put raw data after processing
BADFILE = ' ' / FITS file of bad pixel mask array
BADFLAG = -1 / Bad pixel mask flag
BADVALUE= -666 / Bad pixel value
DEADFILE= 'deadtime/ra_dead_002.txt' / Deadtime correction file
DEADFLAG= 1 /
DEADTYPE= 'FUN ' / Correct using FUNction or lookup table (LUT)?
DEADCORR= 'TOTAL ' / Correct by TOTAL or each PIXEL count rate?
BIASFILE= ' ' / Bias image filename
BIASFLAG= -1 / Bias correction flag
DARKFILE= 'dark/ra_dark_001.fit' / Dark image filename
DARKFLAG= -1 / Dark correction flag
FLATFILE= 'flat/ra_flat_001.fit' / Flag field image filename
FLATFLAG= -1 / Flat field correction flag
FLATNORM= 'AVERAGE ' / How to normalize flat field
WCALFLAG= 0 / Wavelength calibration flag
WCALPRO = 'alice_wavecal' / IDL program to perform wavelength calibration
WCALPARS= 'T_DELECC' / keywords for parameters to use for wave cal
    
```

**New Horizons SOC to Instrument Pipeline ICD**

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```
AEFFFLAG=                1 /
AEFFPRO = 'alice_aeff'    / IDL program to get effective area
AEFFPARS= 'T_DELECC'      / keywords for parameters to get effective area
LOG_FILE= 'test/log.out'  / Filename to save log file (default = append to
LOG_MAIL= '                ' / address (if any) to e-mail log file
MIKE_ERR=                1 /
MIKE_END= 'Tue Feb 15 16:12:57 2005' / END MIKE KEYWORD BLOCK
COMMENT
```

=====

COMMENT

**7.3.5 *Hardware/OS Development Platform***

Dell Linux, Redhat 7.2; Apple G5 Power PC and PowerBook G4, OS X v10.4

**7.3.6 *Language(s) Used***

IDL

**7.3.7 *Third Party Libraries Required***

IDL Astro (<http://idlastro.gsfc.nasa.gov/>)

**7.3.8 *Predicted Execution time***

A few seconds per file.

**7.3.9 *Contact/Support Person(s)***

, Joel Parker, and Maarten Versteeg