Data Introduction: New Horizons Spacecraft, ALICE Instrument

This is an abbreviated guide to the main elements of this ALICE data set to provide an overview and a quick path to viewing the data. Many details and subtleties regarding these data have been excluded here for the sake of brevity and clarity; those who plan to perform scientific analysis on these data must first read the documentation referenced by or provided in this data set.

Science Goals

1) For Pluto's atmosphere, map temperature and vertical temperature gradients, search for haze, study minor species, and assess the escape rate; 2) For Pluto's upper atmosphere, profile temperature and pressure, assess N2, CO, CH4, and Ar abundance, and constrain the escape rate; 3) Search for an atmosphere on Charon.

Instrument

ALICE is an ultraviolet (UV) spectrograph sensitive to light in the range of 520-1870 angstroms. 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, an electro-optical device sensitive to extreme and far ultraviolet light and energetic particles, consists of a photo cathode-coated MCP surface that converts UV photons to electrons, a Z-stack configuration of three MCPs to amplify the signal, and a two-dimensional double delay-line (DDL) readout anode.

The ALICE MCP detector has a resolution of 1024x32 pixels. The X (1024) dimension provides the spectral location of a detected photon(s). The Y (32) dimension provides one-dimensional spatial information.

Operations

ALICE has two data acquisition modes: Pixel List and Histogram. In Pixel List acquisition mode, each 16-bit word in the data block describes a detector event, which can be either a photon event or periodic temporal information called “time hacks.” For each photon event on the detector, ALICE records the X (spectral) and Y (spatial) location in a 16-bit packet. In Histogram acquisition mode, each word in the data block is a 16-bit “counter” summing the number of photon events at each X (spectral) and Y (spatial) location on the detector. Each counting bin saturates at a value of 65535.

See the ICD for more details about each data acquisition mode, including details of a special pulse height distribution (PHD) block overlaying an unused region in the lower left corner when the detector operates in Histogram mode.

Directory- and file-names: YYYYMMDD_METMET/lsb_metmetmetm_0xaaa_ttt.sfx

The data are all stored as file pairs of one detached PDS label and one FITS file per exposure. The directory and file names are delimited by underscores and slashes as demonstrated above: ***YYYYMMDD*** is year, month and day-of-month; ***METMET*** is the first six digits of the ten-digit MET clock (Mission Event Time; ~spacecraft seconds since launch); ***ali*** is the prefix for ALICE data; ***metmetmetm*** is the full ten-digit MET of the image; ***0xaaa*** is the Application (Process) Identifier (ApID) for the telemetry data packet type; ***ttt*** is either ***eng*** or ***sci*** for EDR (raw) or RDR (calibrated) data, respectively; ***sfx*** is ***fit*** or ***lbl*** for the FITS or PDS label files, respectively.

Data file contents

Each EDR (raw) image acquired in Histogram mode comprises three data objects in the FITS file, described by its detached PDS label. The first data object (PDU; Primary Data Unit) is the raw image, with 1024x32 photon counts summed into unsigned 32-bit integers (with values from 0 to 65535). The second data object (EDU 1; Extension Data Unit 1) contains the PHD block (64 32-bit integers). The third data object, EDU 2, contains housekeeping information as a 117 column binary table, where the variable number of rows corresponds to the observation duration in seconds.

Each EDR (raw) image acquired in Pixel List mode comprises four data objects in the FITS file, described by its detached PDS label. The first data object, the PDU, is a ground-calculated "reconstructed histogram", with 1024x32 uncalibrated photon counts summed into unsigned 32-bit integers. EDU 1 contains raw lists of photon events and time hacks (see above, 32767 32-bit integers). EDU 2 contains count rate bins between successive time hacks (32-bit integers, with variable number of elements). EDU 3 contains housekeeping information as a 117 column binary table, where the variable number of rows corresponds to the observation duration in seconds.

Each RDR (calibrated) product for images acquired in Histogram mode comprises six data objects in the FITS file, described by its PDS label. The first data object, the PDU, consists of a 1024x32 array of photon counts (32-bit floating point), in units of photons/sec/cm**2. EDU 1 contains a 1024x32 array of uncertainty values (32-bit floating point), also in units of photons/sec/cm**2. EDU 2 contains a 1024x32 array of central pixel wavelength (32-bit floating point), in Angstroms. EDU 3 stores the 64-element PHD from EDU 1 in the raw data file. EDU 4 contains a variable-length list of photon events per housekeeping sample interval (32-bit floating point). EDU 5 contains the housekeeping data from EDU 2 of the raw data file.

The format and generated contents of the PDU, EDU 1, and EDU 2 for each RDR (calibrated) product for images acquired in Pixel List mode matches the format and contents for Histogram mode (above). EDU 3, a 5-column binary list of photon events, contains the X (spectral) and Y (spatial) position of each event, the wavelength, a cumulative number of elapsed time hacks, and "deadtime" correction factor events during the current time hack. The length of EDU 3 depends upon the source flux and the hack rate. EDU 4 contains the count rate vectors from EDU 2 of the raw data file, and EDU 5 contains the housekeeping information from EDU 3 of the raw data file.

N.B. Refer to the ICD for more detail e.g. unit conversion, time hacks, FITS and PDS header keywords, etc.

Calibration

Image calibration comprises three processing steps: deadtime correction; dark correction; effective area correction. Refer to the ICD for more detail.

Reading the data

Various tools are available to read these data. In the IDL environment, the READPDS.PRO package from PDS-SBN can read the data using the PDS label to access the accompanying FITS file. To use the FITS file directly, the NASA FITS Office has utilities and libraries in multiple languages and environments (from C to R and beyond). Refer to the documentation provided and referenced at those web sites for support.

N.B. Some utilities and libraries refer to the PDU as if it were EDU 0.