Review notes for New Horizons cruise-phase data submission to PDS Small Bodies Node

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Data sets: LEISA raw and calibrated; ALICE raw and calibrated

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**General Notes:**

*Aareadme.txt (top level in each archive):*

Utility of the raw vs. calibrated data products:

I was unable to find any description of when a user might benefit from using the raw data products (contained in the nh-x-alice-2… nh-x-leisa-2… directories) rather than using the reduced and calibrated products (contained in the nh-alice-3… and nh-x-leisa-3… directories). My guess is that such instances are likely to be very rare, and users would probably have to work with NH project personnel to do much with the raw products. If that’s correct, it would be useful to have a brief statement in the raw data archives saying that for most applications users would be better off using the reduced and calibrated data. It would also be useful to have a brief statement describing when starting with the raw data might be called for (if a summary of those conditions is difficult to compile, perhaps a couple of examples could be given).

Filenames and Product IDs section:

It would be worth noting that the filename used is an example relevant to Alice. The same filename is used in this file in the Liesa data archive, and perhaps all (?) the others. It would be helpful to enumerate the instrument IDs, perhaps in another note, or to tailor the example filename used to the instrument that produced the data in the archive being examined (i.e. in a Liesa archive, use a filename like “lsb\_0052459065\_0x53c\_sci\_1.fit” rather than an Alice file).

Processing Level:

Here the Raw and Calibrated data products are associated with something called “CODMAC Level 2” and “CODMAC Level 3”, respectively. I have no idea what CODMAC is or why it’s relevant here. Maybe explain or delete these associations.

Contact information:

Alan Stern’s address is given as NASA HQ. I think that’s incorrect, in which case an updated address and/or an alternative contact should be provided.

**Leisa Notes (based primarily on files in the Calibrated data archive):**

Calib Directory:

Catalog Directory:

*Leisa.cat file:*

* The instrument Overview could usefully be expanded to a few sentences. Including the spectral range and approximate resolving power, for instance, would be good.
* The filter in the instrument is variously referred to as an ‘etalon’, a ‘wedged filter’,
* The Science Objectives section has a typo, ‘hase-angle-...’ should be ‘Phase-angle-…’
* Nowhere is it mentioned that the instrument is a part of the RALPH package. I realize that Leisa and MVIC are independent instruments, but the RALPH terminology does crop up at times so it would be good to say a few words about RALPH as it pertains to Liesa here. I realize RALPH is mentioned in the nhsc.cat file, but think it would be worth it to also say something in the .cat file for Liesa and MVIC.
* The Description section states that “LEISA… (uses heat radiation)…” I think it is unnecessary and confusing to link IR wavelengths to heat radiation here. Scientists know what IR wavelengths means, and by making the link to “heat radiation” the text suggests that Leisa may be measureing the thermal emission from the surface (which it does not), whereas it is actually sensitive reflected sunlight at Pluto. I’d simply delete the parenthetical statement about heat radiation.
* Similarly, the text talks about “fingerprints” of different molecules. Here it is better to simply refer to spectral features – this isn’t information being presented to people who don’t understand what a spectrum is.
* The Description section states, incorrectly I think, that “… its etalon acts like a prism to bend different wavelengths of light by different amounts…” Etalons are interference filters that pass particular wavelengths through wile reflecting others. It might be more accurate to say something like, “…its etalon (a filter with a narrow spectral bandpass that varies linearly in one dimension) is bonded to the illuminated side of the IR detector. As a result, each row of detector pixels receives only light of a particular wavelength. Spectral maps are produced by sweeping the FOV of the instrument across a scene, sequentially sampling each point in the scene at each wavelength.”
* Should mention that Leisa has high- and low-resolution sections that overlap in wavelength, but cover different total bandpasses.

*Nhsc.cat file:*

* The RALPH/LEISA section presents the same erroneous information about the etalon bending the light that I note under comments on the leisa.cat file, and should be fixed.

Data Directory:

Document Directory:

Index Directory:

**Alice Notes:**

Calib Directory:

*Pa\_flat\_000.fit file:*

* The flat-field is a placeholder with all values set to 1.0. The RMS pixel variation is quoted as 15% in the SOC\_ICD, so this seem like a big issue for trying to use the data to accurately measure emission strengths for lines that aren’t spread over many pixels (e.g. for the solar occultation experiment and for calibration measurements on stars).

Catalog Directory:

*Alice.cat file:*

* In the Data Acquisition Modes section there are two references to P-Alice, but no information of how (or whether) P-Alice is distinct from Alice. The dataset.cat file says something about PERSI-Alice, but again no info is given about why it is being referred to as P-Alice or PERSI-Alice. I suspect this may have been a way to distinguish this instrument as being the one on New Horizons (i.e. not on Rosetta). Anyway, better to either give a very brief background about why it’s sometimes called P- or PERSI-Alice, or just drop those and refer to it consistently as Alice.
* In the Scientific Objectives section there is a sentence: “Temperature and vertical temperature gradient should be measured to ~10% at a vertical resolution of ~100 km for atmospheric densities greater than ~109 cm-3.” Just want to check that “109 cm^-3” is correct (that’s a very hard vacuum…), and whether a specific molecular species is relevant to this measurement capability.
* The Operational Considerations section discusses tests to be performed in 2006/7. The discussion should be updated to reflect the outcome of those tests, if relevant.
* The Detectors section notes that a ~250 x 32 pixels in the array are inactive. Might note here that the spectral grasp stated earlier in the document excludes wavelengths that would be covered by the inactive pixels.

*Dataset.cat file:*

* In the Filename/Product IDs section the various ApIDs are described and associated with either CDH 1 or CDH 2. Might quickly state what CDH means and whether it refers to the Alice CDH or a computer associated with the spacecraft. I’m guessing that essentially all data were taken using one or the other CDH, with perhaps only aliveness data taken on the other. If so, it might be worth noting that nearly all of the data of interest to scientists is associated with a subset of the listed ApIDs.
* The ApID description notes that data comes in “lossless” and “packetized” flavors. There is no further detail offered in this file about those modes, nor is there anything I can see in the alice.cat file. It would be good to provide a little information about the two modes, when they are employed, any differences in the quality of the data from them, and what mission phases they are used in.

*Nhsc.cat file:*

* Who needs the Lego version when there’s such great ACII art? Awesome!

Data Directory:

I inspected a few of the fits files, things generally look OK. Images that were supposed be pointed at stars clearly had sources in them, darks didn’t, flats…

The first extension (only) doesn’t have an extension name. Others do (WAVELENGTHCAL, ERROR, …).

The Units (BUNIT keyword) for the first extension is buried at the very end of the header. Would be better if it appeared at the top, as it normally would and as it does for the other extensions.

The .lbl files don’t describe the image data contained in the fits files (in contrast to the labels describing the fits table extensions, EDUs 3-4). Examples:

* The PDU description is just boilerplate about the FITS standard (see quoted example below). The PDU in the Alice level-3 files contains the count-rate spectral image, so it seems like the label should say so, and include a statement of the units, the calibration steps applied, …?

The text from one PDU label reads:

OBJECT = IMAGE

DESCRIPTION = "

FITS PDU

PDU

Primary Data Unit (PDU)

This is the first Data Unit (DU) in this FITS

file; any DUs which follow this PDU are

are designated Extension Data Units (EDUs),

and are numbered starting with 1 (EDU#1, EDU#2,

etc.). As a result, this PDU is sometimes

referred to as DU number 0 by software packages

that read FITS files. E.g. the IRAF package

refers to the PDU as FITS unit 0 cf.

http://iraf.noao.edu/docs/fitsuserguide.html#ifs

"

SAMPLE\_BITS = 32

SAMPLE\_TYPE = "MSB\_INTEGER"

AXIS\_ORDER\_TYPE = "FIRST\_INDEX\_FASTEST"

LINE\_DISPLAY\_DIRECTION = "UP"

SAMPLE\_DISPLAY\_DIRECTION = "RIGHT"

LINE\_SAMPLES = 1024

LINES = 32

OFFSET = 0.00000000000

SCALING\_FACTOR = 1.00000000000

END\_OBJECT = IMAGE

* The labels for EDUs 2-3 (error and wavelength images) are even worse:

OBJECT = EXTENSION\_PHD\_IMAGE

DESCRIPTION = "

FITS EDU number: 1

PHD

This FITS EDU IMAGE has a limited description

in this PDS label. Refer to the SOC Instrument

Interface Control Document (ICD)

(/DOCUMENT/SOC\_INST\_ICD.\*) for further details

about this extension.

"

SAMPLE\_BITS = 32

SAMPLE\_TYPE = "MSB\_INTEGER"

AXIS\_ORDER\_TYPE = "FIRST\_INDEX\_FASTEST"

LINE\_DISPLAY\_DIRECTION = "UP"

SAMPLE\_DISPLAY\_DIRECTION = "RIGHT"

LINE\_SAMPLES = 64

LINES = 1

END\_OBJECT = EXTENSION\_PHD\_IMAGE

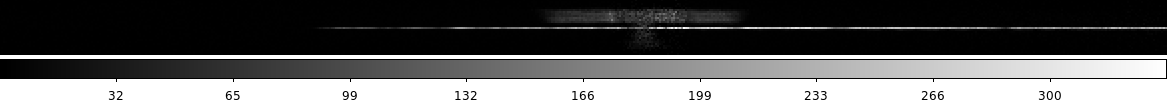
*Sequence/Data Discrepancies:*

Sometimes the number of images in the seq\_alice\_plutocruise.tab file didn’t correspond to the number of images in the data directories. Examples:

* There are 9 images in directory 20070928\_005329, but the sequence listing says there should be 7.

*Useability of the spectra:*

* The level-3 data appear to have significant background contamination in certain regions. I was expecting images where such artifacts had been corrected, such that an extracted spectrum would contain only signal from the target and be in (or easily converted to) physical units (see image below).
* The units of the spectral image (first extension) are given in the fits header, but not in the PDS label file. Since the PDS label is the gold standard for defining the data set, the label should be updated to include information about what data are in the PDU and what the units are. PDS labels for the 2nd and 3rd extensions should also be updated to state what data is present and give units.



Document Directory:

*seq\_alice\_plutocruise.tab file:*

* The entries in this file typically include a frequency in Hz. I wasn’t able to find anything in the alice.cat, dataset.cat, or seq\_alice\_plutocruise.lbl files stating what frequency is referred to or why it might matter to a scientist. Saying something brief, maybe in alice.cat, would be good.
* The entry for “07267:A1AL705\_02\_StdUV2FFScan” the exposure duration is given as “1.5 hr sec” (typo of some sort). That’s the only entry w/ that typo.

Index Directory: