

DART Data Review: LICIACube

Reviewer: Xiao-Duan Zou (Planetary Science Institute)

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1. Overview:

Bundle: PDS4 standard

Time range: 2022-09-16 to 2022-10-01

This bundle contains data files associated with DART LICIACube mission, hosting two different instruments and documentations related:

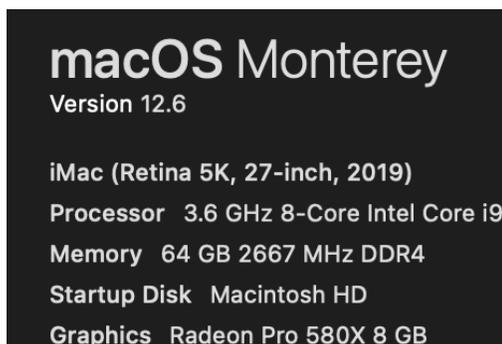
- LEIA is a narrow field panchromatic camera (raw + calibrated): 2048x2048
- LUKE is a wide field RGB camera (raw + calibrated): 3 (bands) x 1088 (lines) x 2048 (samples)

Total images:

| | Approach | Final | Total |
|----------|----------|-------|-------|
| LEIA raw | 114 | 221 | 335 |
| LEIA cal | 89 | 216 | 305 |
| LUKE raw | 46 | 228 | 274 |
| LUKE cal | 39 | 228 | 267 |

2. Review process:

Review environment:



Tools:

- Python Jupyter notebook 6.0.3
- PDS4_Tools v1.3
- Oxygen XML Editor 23.1

- Adobe Acrobat Reader DC 2019
- Beyond Compare 2

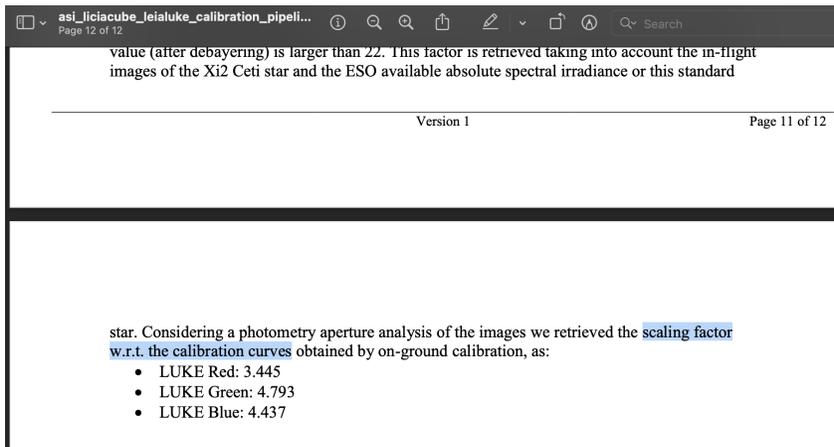
Review steps:

- Double checked a few items from the last review.
- Compare differences between sets.
- Read data files and label files.
- Check the headers and XML labels.
- Compare datasets, and analyze the difference.
- Check documents
- Collect aspect data from all image headers, check consistency.

3. Documents :

- Pipeline KEYWORD not listed in the sis file, only a few in calibration file.
(Side note: For DART mission, different instrument spells the KEYWORDS of a few measurements differently is not most convenient for image data users.)

- SIS file version doesn't match version mark in the xml label.
-



Need explanation. "W.r.t."?

- f_rad() details

The parameters to be used with the PchipInterpolator Scipy Python function are those present in the calibration FITS file and they can be extracted using the following approach:

1. After opening the FITS file in Python assuring of using it as LSB, instead of MSB (i.e., perform a byte swap)
2. For every LUKE color, or for the whole LEIA image, starting a loop scrolling once pixel at a time
3. The data extracted from the calibration file, for every pixel has to be divided in 3 different arrays, differentiating on the last Python index
4. For every array so created it is needed to reshape it as a list (i.e., flattening it) and then selecting only data with valid number (i.e., not 1e32 flag)
5. The 3 flattened arrays generated in this way have to be merged in a single list-of-lists and then converted in a Numpy array of dtype = object
6. To this array the Pchipinterpolator has to be applied and to its output function (the spline) computed at the background removed DN value

Would it be easier and clearer if the part of the code is printed in this file?

- In 4.3.6 “For LUKE these pixels are those with DN > 210 in the raw images, after background removal; for LEIA no saturated pixels have been identified. ”

But in 4.3.4:

LUKE pixels will be processed as non-saturated if their background-removed DN value is less than 210. For LUKE no saturation DN value is applied.

There are saturated DN's in LUKE images. Should be clear in 4.3.4.

- Error message in SIS file:

suite of FITS keywords, which includes information on LUKE mode, spacecraft attitude, and records of any windowing, binning, and calibration done via the on-board image processing pipeline, together with the TARGET and MPHASE (mission phase) keywords. The LSOC also stores the image in the FITS file in 8-bit integer format. The resultant FITS header is defined in Section **Errore. L'origine riferimento non è stata trovata**.5.2.5 and compliant to what described in [AD2]. Keyword values are directly derived from LCC telemetry (including the LCC header row), the GNC correlation packet, and some other spacecraft telemetry packets to which the MCC has direct access.

4. XML Labels:

- All are validated.
- The SPICE kernels list in the XML labels doesn't match the header mk (matched kernels are in black)

`\begindata`

```
PATH_VALUES = ( '/Users/user/Documents/spice_kernels/LICIACube' )
```

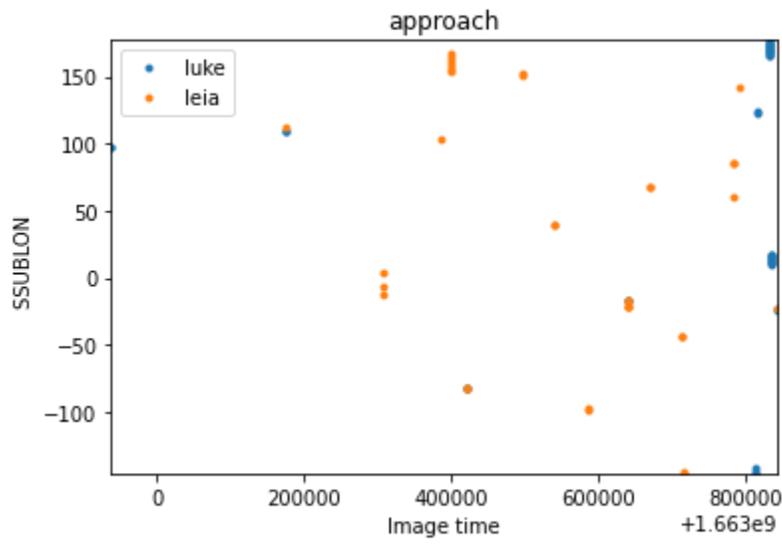
```
PATH_SYMBOLS = ( 'MOC' )
```

```
KERNELS_TO_LOAD = (  
'$MOC/lsk/naif0012.tls',  
'$MOC/spk/de430.bsp',  
'$MOC/spk/didymos_barycenter_2022_291_SOC_01.bsp',  
'$MOC/spk/dimorphos_s501.bsp',  
'$MOC/spk/didymos_d311_s104_01.bsp',  
'$MOC/spk/DART_R_2022_231_2022_269_v01.bsp',  
'$MOC/spk/LCC221028-NOB-UBO005-DEN181-220911-230401-221024-V1.bsp',  
'$MOC/pck/pck00010.tpc',  
'$MOC/ik/licia_pl_005.ti',  
'$MOC/lsk/NAIF-LSK-V1.tls',  
'$MOC/sclk/LCC220918-SCLK-V1.tsc',  
'$MOC/pck/dimorphos_d320_s104_01.tpc',  
'$MOC/pck/didymos_d320_s104_01.tpc',  
'$MOC/pck/didymos_system_07.tpc',  
'$MOC/pck/dimorphos_s501-postimp.tpc',  
'$MOC/pck/dimorphos_s501-preimp.tpc',  
'$MOC/fk/didymos_d320_s104_01.tf',  
'$MOC/fk/dimorphos_d320_s104_01.tf',  
'$MOC/fk/didymos_system_001.tf',  
'$MOC/fk/LCC221114-FK-V1.tf',  
'$MOC/ck/LCC220926-ATH-220926-220926-V1.bc',  
'$MOC/ck/LCC220926-ATH-220926-220926-V2.bc',  
'$MOC/ck/LCC220927-ATH-220926-220927-V1.bc',  
'$MOC/ck/LCC230207-ATH-TWIST-220926-220926-V1.bc',  
'$MOC/dsk/didymos_g_01220mm_spc_obj_0000n00000_v002.bds',  
'$MOC/dsk/dimorphos_g_00980mm_spc_obj_0000n00000_v01b.bds'  
)
```

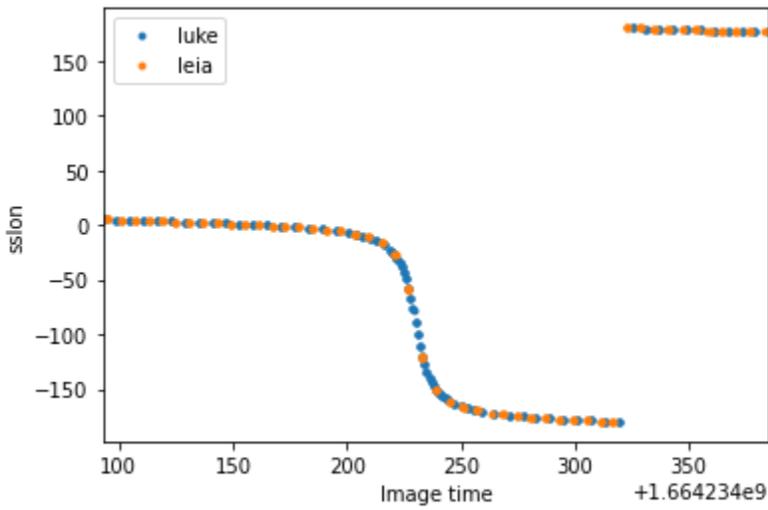
5. Data files:

- **Read normally: all files good.**
But not clear how some images are thrown away in the calibration process.
- **Geometry**

Leia time: extend to 10/01/22

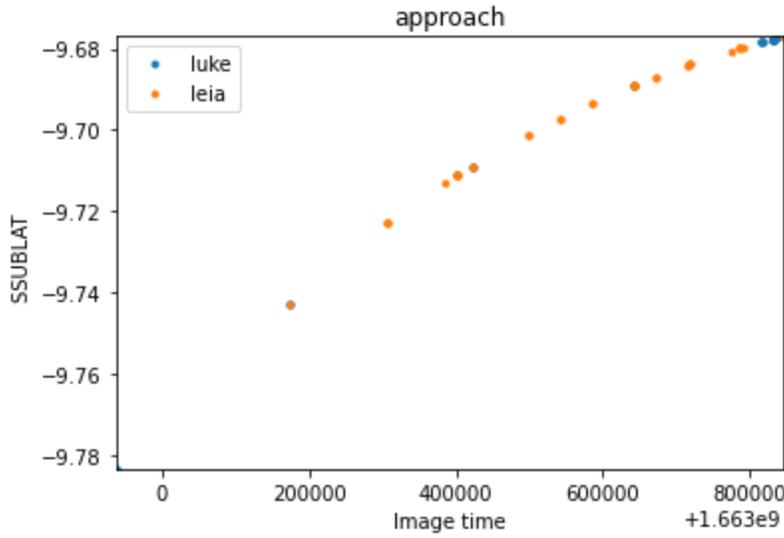


no clear maneuver features

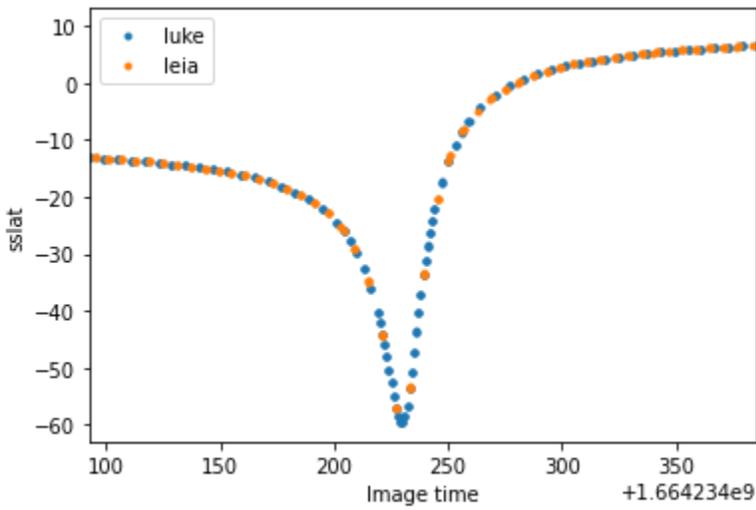


generally match but small

differences in trend.

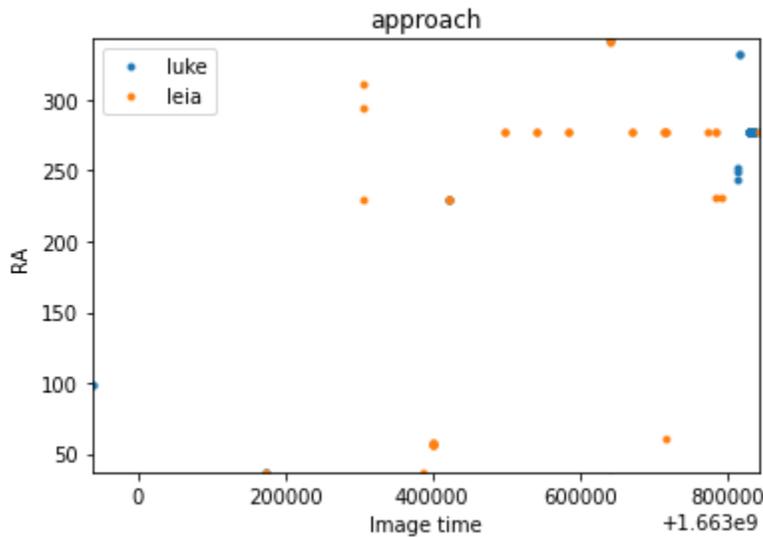


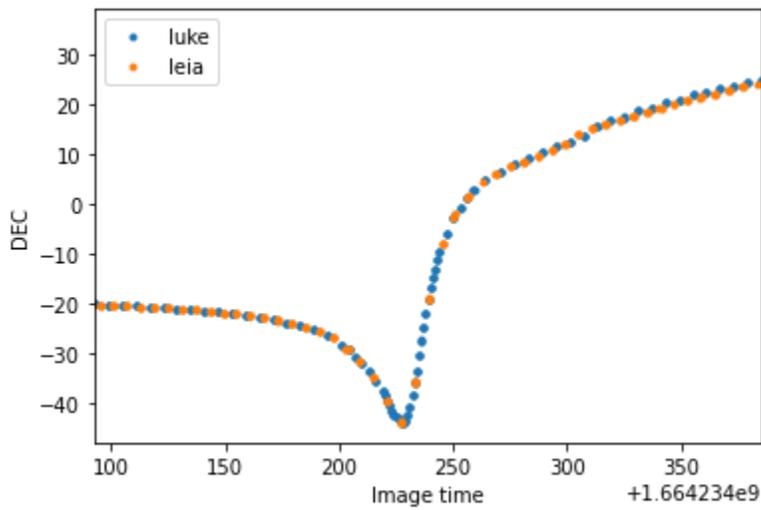
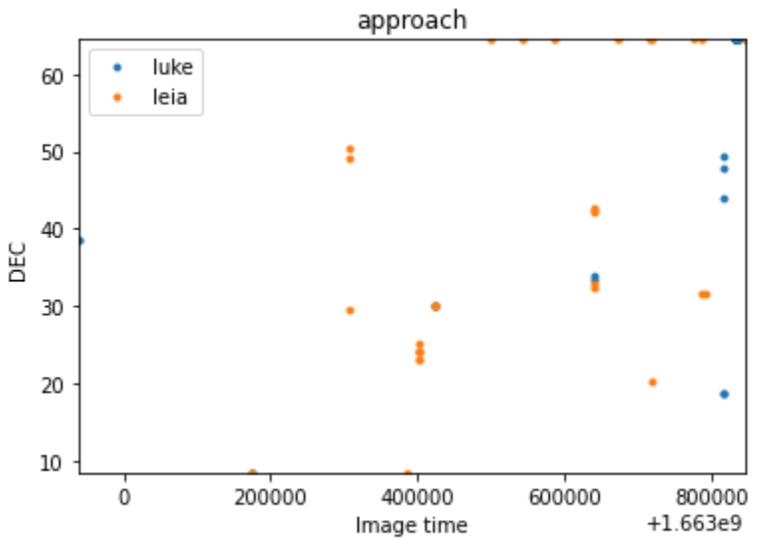
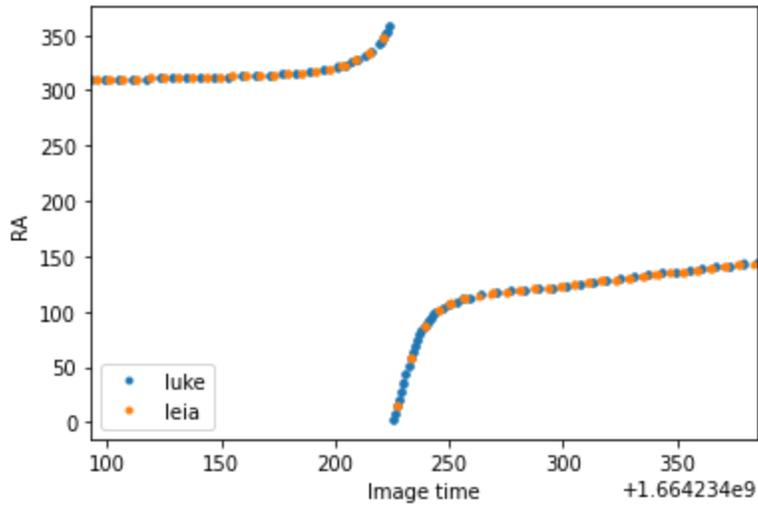
no clear maneuver features

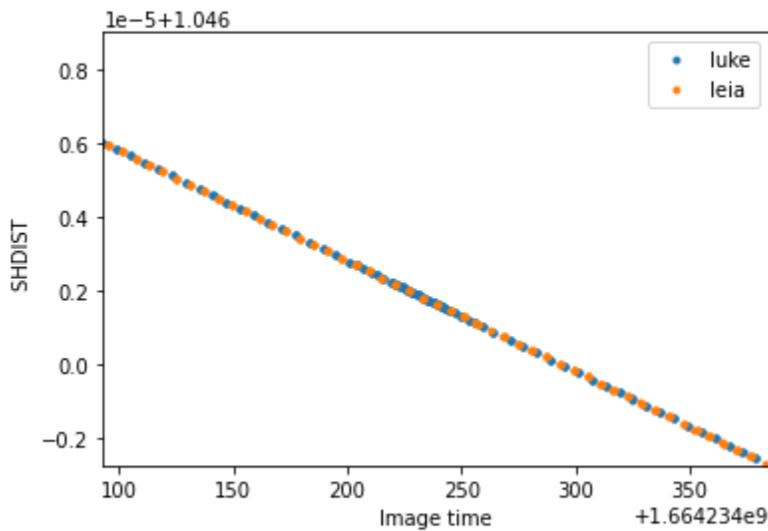
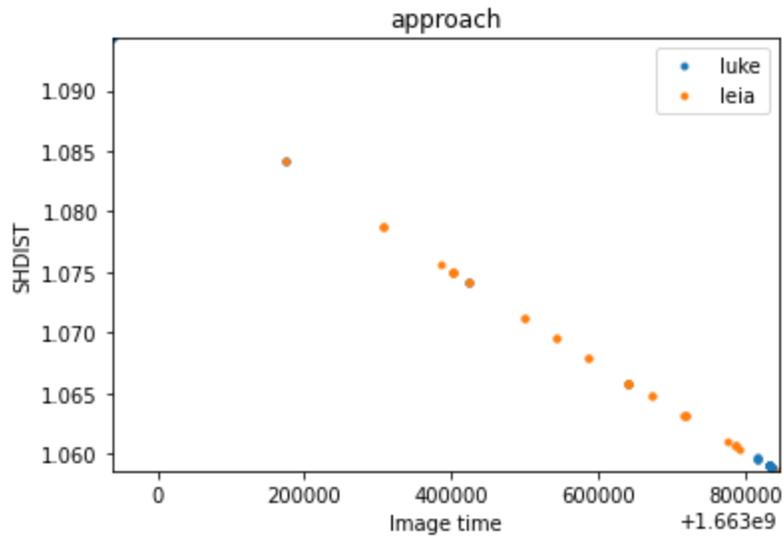


generally match but small

differences in trend.





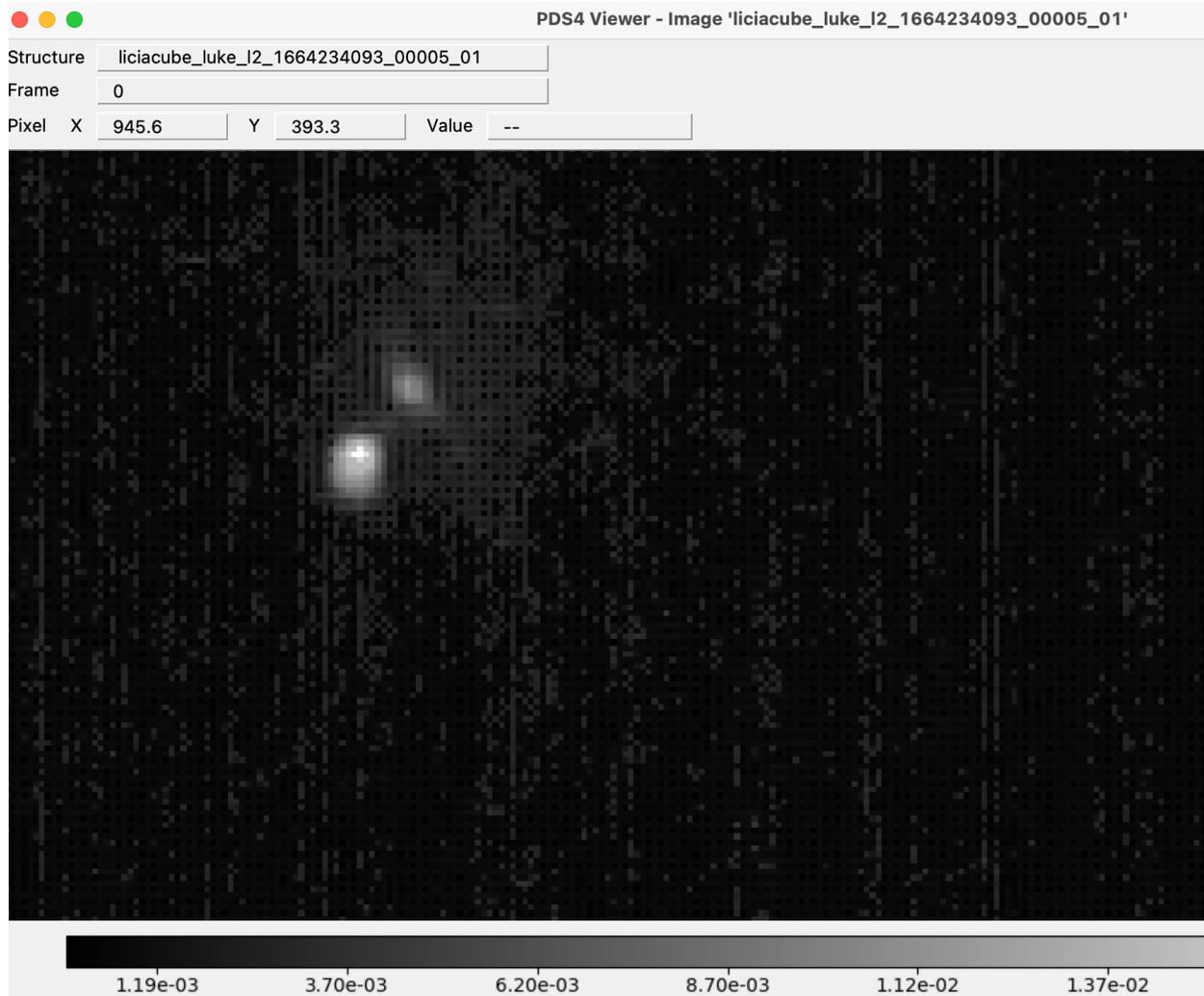


From what I see, the geometry does not match perfectly for LEIA and LUKE and the pointing changes don't match to the maneuvers recorded in the documents "Impulsive maneuver reconstructed from telemetry".

- **Calibration**

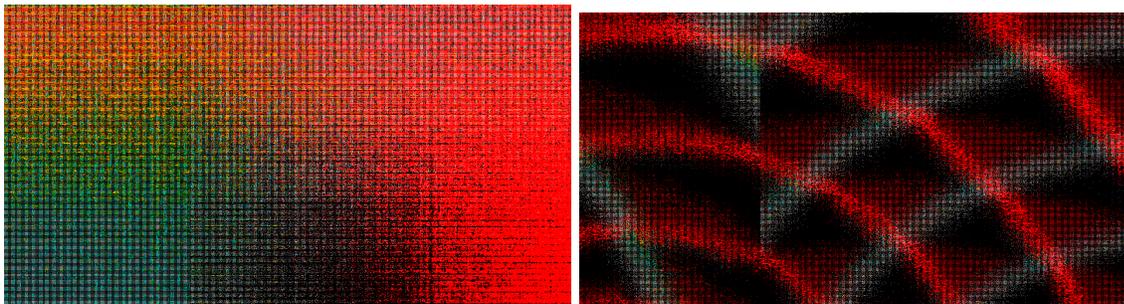
- The calibration files are in good shape. Did not repeat the calibration because I didn't fully understand the calibration pdf.
- User question, how to count in the uncertainties of the calibrated datasets?

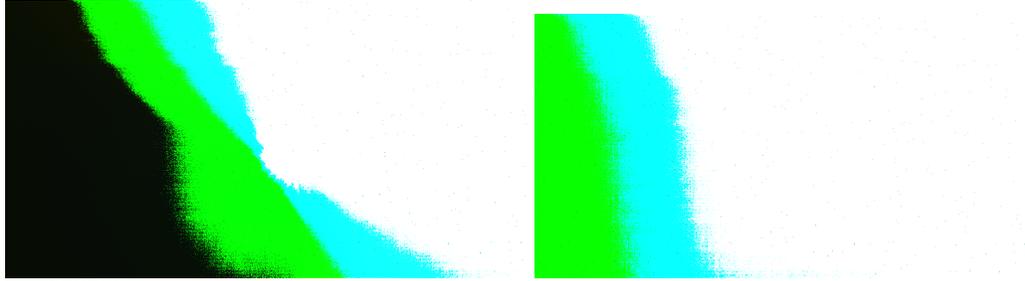
- Saturated value $1e+30$ shown as "- -" in PDS4 viewer image panel



What's causing the grids and 0.0 values in between? Bayer filter?

- Bad LUKE calibrated images, I suggest to remove or flag or explain them somewhere, e.g.,





6. Other small edits:

- In “asi_liciacube_leialuke_calibration_pipeline_description.pdf” Figure 1 looks unusual without arrows.
- “Luke_raw_overview.txt”:
 - “The pixels contains red, green and blue values...” → “contain”
 - “Additional information includes: integration time...” remove “:.”
- “Luke_calibrated_overview.txt”:
 - “pixel values using a standard algorithm for the RGB of the LUKE detector .” remove the space after “detector”.
 - “In addition the FITS header contains UTC data and start time, exposure” → “In addition, ”
- “Lcc_leia_luke_sis.pdf”:
 - “The users for whom this document is intended are the scientists who will analyse the data ...” → “analyze”
 - “It integrates a reconfigurable Flash-based FPGA, its frame rate is equal to 7 fps saving in RAM and 0.5 fps saving in the payload mass memory (flash memory) at 12 bit resolution.” → “12-bit”
- A comma should follow both e.g. and i.e.
- Functions, module names and table headers use an *italic style* to distinguish them.