# PDS-SBN Review of New Horizons LEISA Data (2014 $MU_{69}$ Approach)

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A spatial-spectral data cube is created by scanning the FOV across the target in a “push-broom” fashion. The data cube is a 3-dimensional array having 256x256xN elements, where N is the number of 256x256 files accumulated over the scan.

e.g., read in calibrated FITS file = ‘nh-p-leisa-3-pluto-v2.0/data/20150714_029917/lsb_0299172889_0x53c_sci.fit’

file = file(x,y,z),

x=spatial (256 elements),

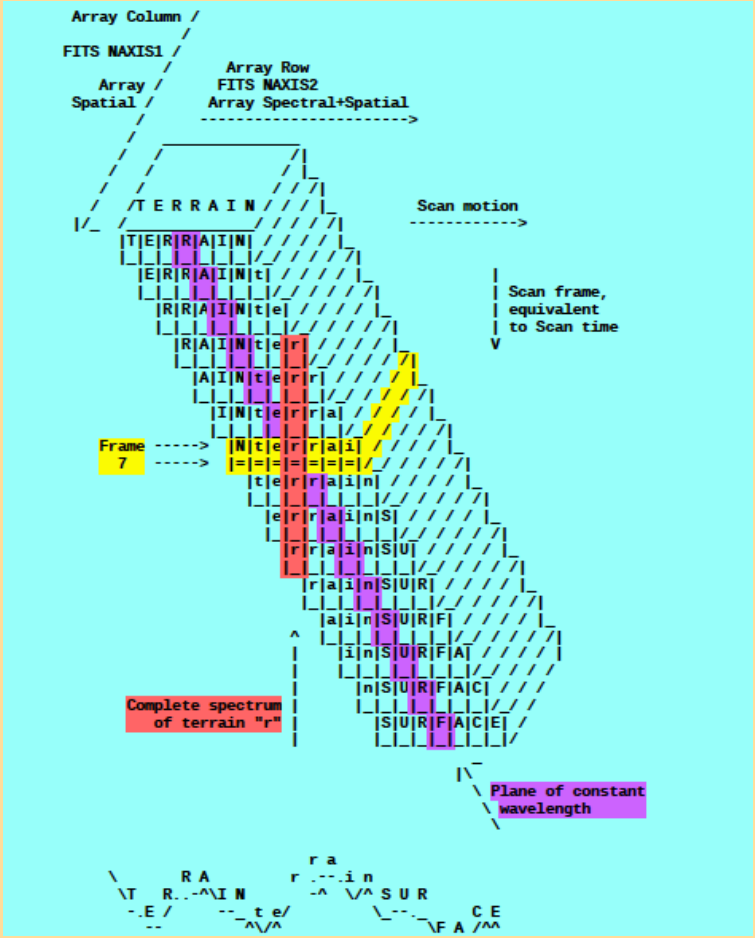
y=lambda(256 elements),

z=spectral/spatial

(N=elements; e.g., N=371)

(i.e., lambda varies spatially)

[figure from ‘leisa_data.pdf’ in folder ‘document’]

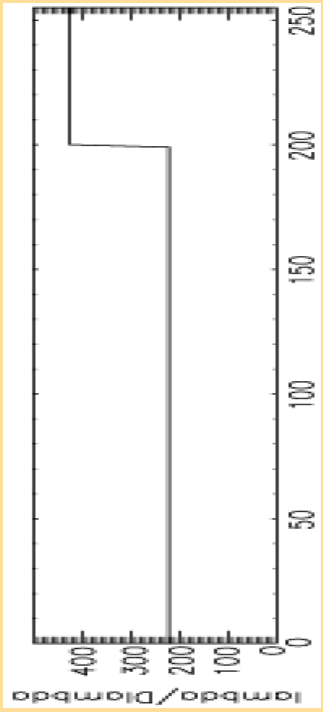


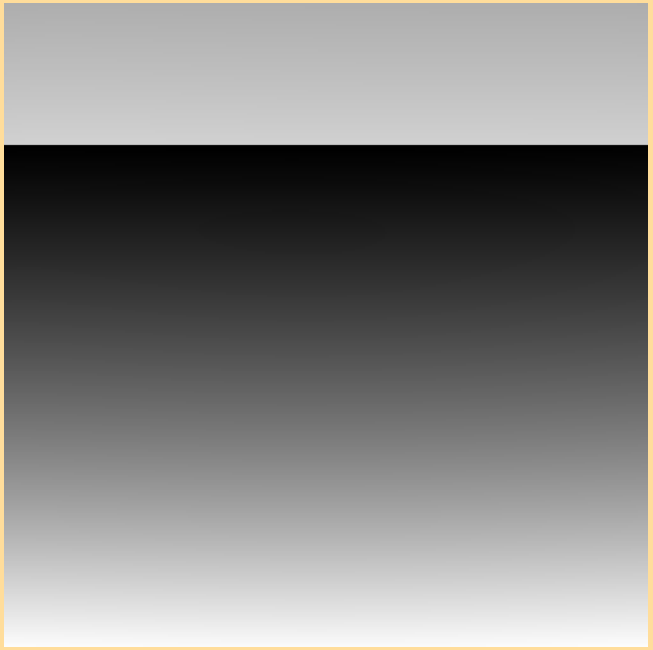
# LEISA

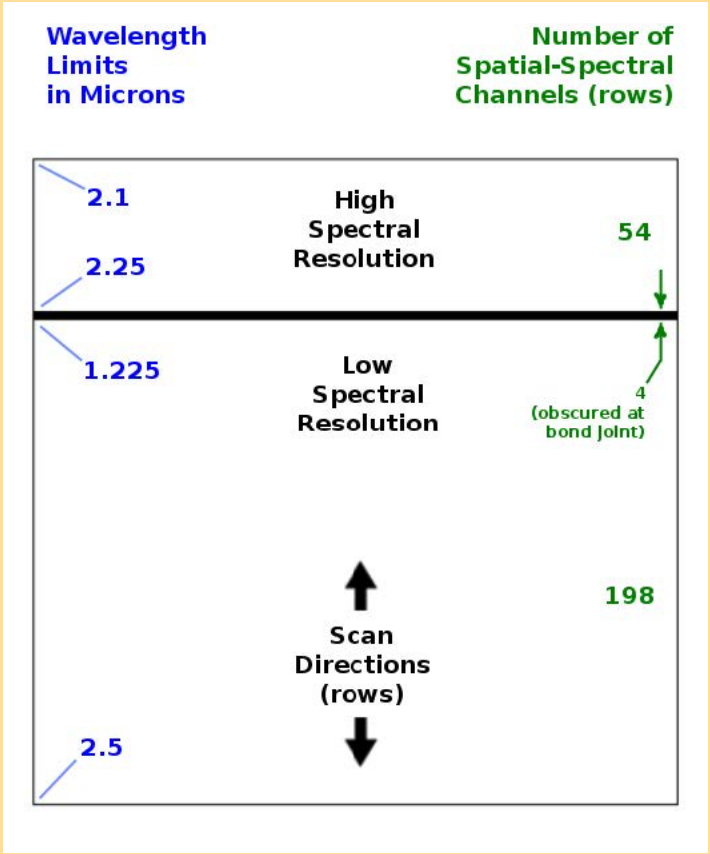
A near-IR (1.2 – 2.5 micron) spectrometer that uses a 256x256 Rockwell PICNIC array, with 40-micron square pixels.

It produces low-resolution ($\lambda/\Delta\lambda$ ~ 240) and higher-resolution ($\lambda/\Delta\lambda$ ~ 540) spectra over separate sections (ranges of 54 and 199 rows) that are separated by 4 rows obscured by a bond joint.

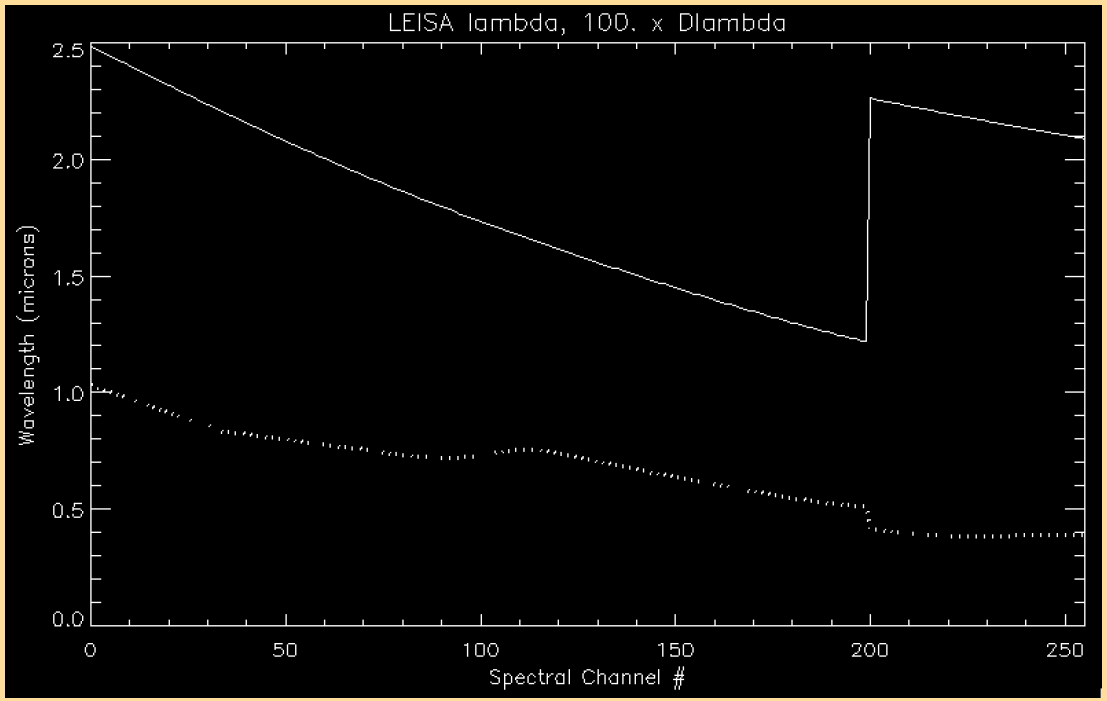
Note: "Hi-res" $\lambda/\Delta\lambda$ was ~ 425 for Pluto flyby data (as below) but is ~ 540 for cruise & 2014 $MU_{69}$ approach phases (recalibration)





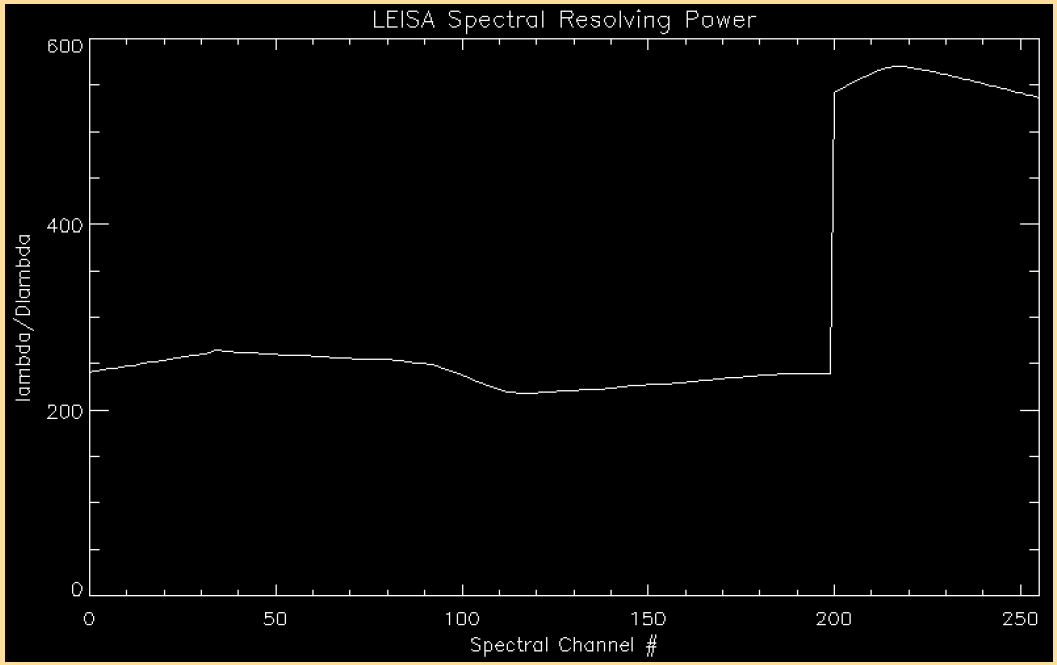
# LEISA Wavelength Calibration




lambda

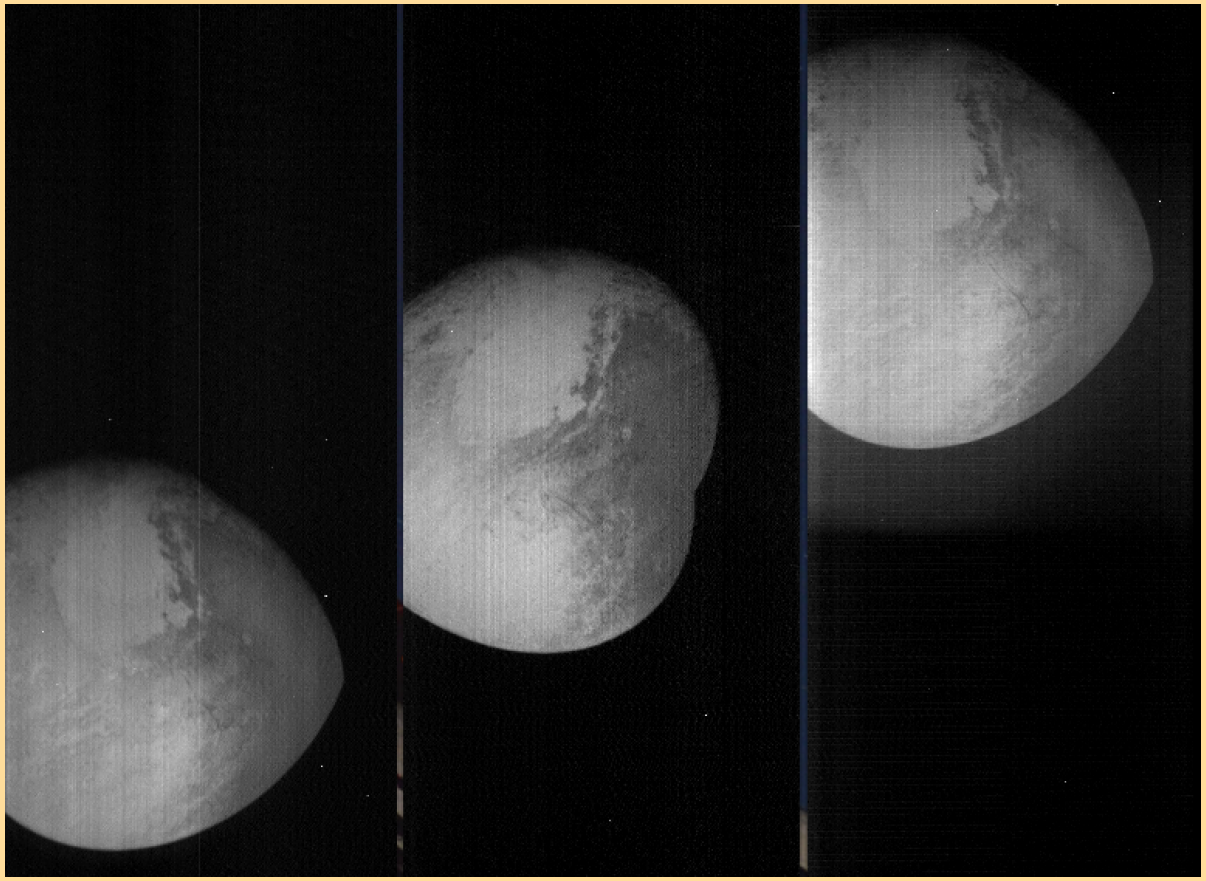
Delta-lambda x 100

Lambda / Delta-lambda



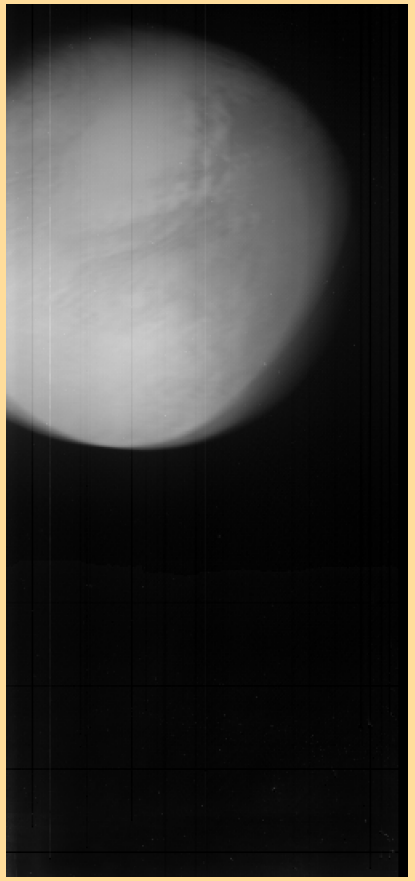
# LEISA Pluto flyby Data

Transpose file(x,y,z) [256,256,N] → file_tr(x,z,y) [256,N,256]



file(0:255,0:N-1,0) file(0:255,0:N-1,127) file(0:255,0:N-1,255)

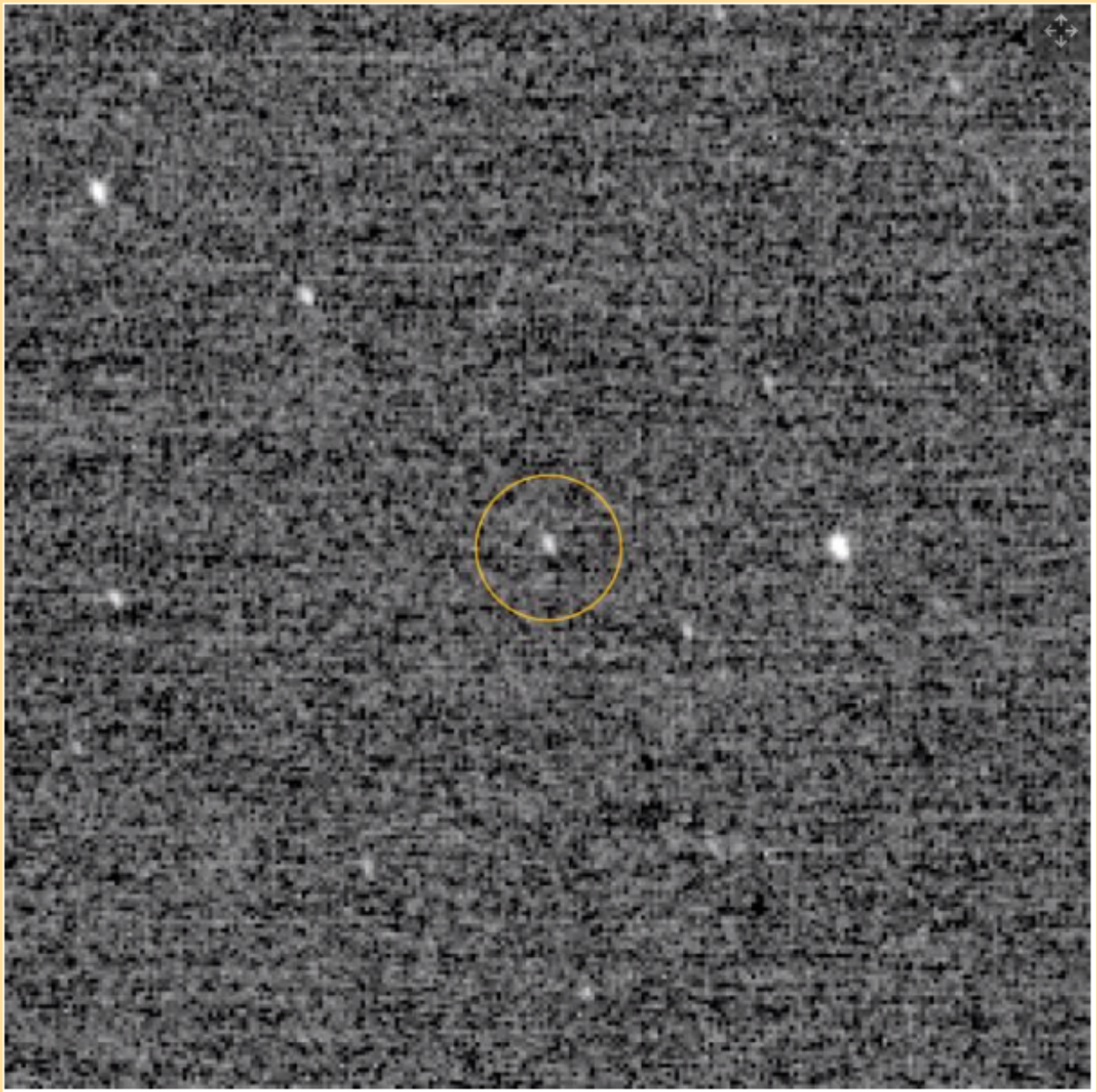
→ shift - register



file_tr_sh(0:255,0:N-1,Σ[0:255])
(i.e., summed over all lambdas)

(Some residual wobble in x-dim)

# Arrokoth (2014 $MU_{69}$) Approach



NASA/Johns Hopkins University Applied Physics Laboratory/Southwest Research Institute

"First Look" at MU69, at d~$10^6$ km (with LORRI)

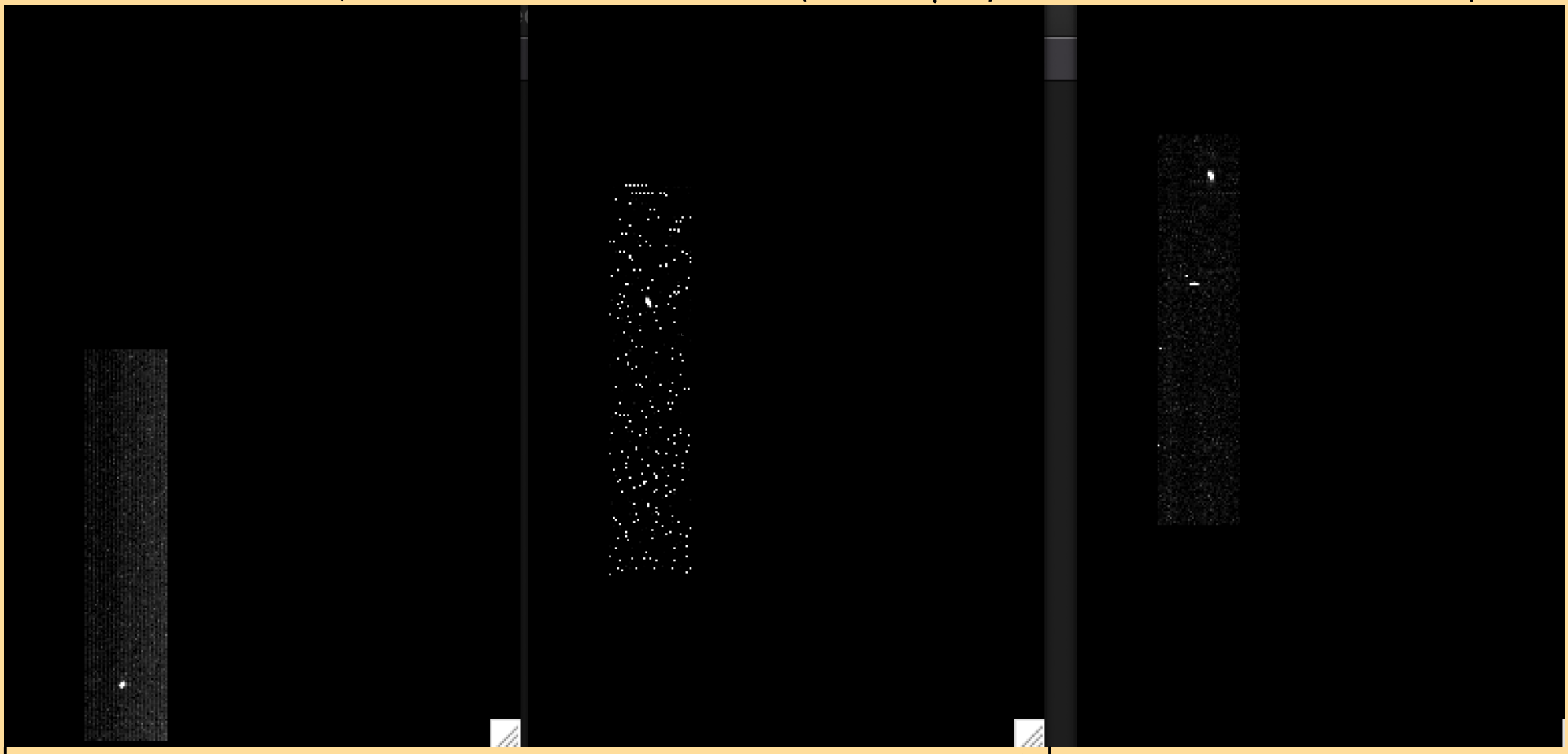
# LEISA $MU_{69}$ Approach DATA

| Summary of NHkele_1001 LEISA files, ~~February~~ May 2020 PDS-SBN review* | | | | | | |
|---|---|---|---|---|---|---|
| | | | | | | |
| "Folder" ID | *_0x53c_eng.lbl | UT Date | Start UT | End UT | Target | S/C dist (km) |
| | | | | | | |
| 20180820_039709 | lsb_0397097519 | 2018-08-20 | 19:00:01 | 19:07:44 | Vega | N/A |
| | | | | | | |
| 20181231_040854 | lsb_0408542761 | 2018-12-31 | 06:14:03 | 06:21:04 | MU_69 | 1.21e6 |
| | | | | | | |
| 20181231_040860 | lsb_0408605304 | 2018-12-31 | 23:36:26 | 23:43:12 | MU_69 | 3.06e5 |
| | | | | | | |
| 20190101_040860 | lsb_0408606595 | 2018-12-31 | 23:57:57 | 00:04:43 | MU_69 | 2.88e5 |
| | lsb_0408609177 | 2019-01-01 | 00:40:59 | 00:47:45 | MU_69 | 2.50e5 |
| | | | | | | |
| 20190101_040861 | lsb_0408610468 | 2019-01-01 | 01:02:30 | 01:09:16 | MU_69 | 2.32e5 |
| | lsb_0408613050 | 2019-01-01 | 01:45:32 | 01:52:18 | MU_69 | 1.94e5 |
| | lsb_0408614341 | 2019-01-01 | 02:07:03 | 02:13:49 | MU_69 | 1.75e5 |
| | lsb_0408619338 | 2019-01-01 | 03:30:20 | 03:37:09 | MU_69 | 1.04e5 |
| | | | | | | |
| 20190101_040862 | lsb_0408621929 | 2019-01-01 | 04:13:31 | 04:22:18 | MU_69 | 6.55e4 |
| | lsb_0408624118 | 2019-01-01 | 04:50:00 | 05:05:16 | MU_69 | 3.12e4 |
| | | | | | | |
| ***Closest approach to 2014 MU_69:** 3540 km, at 05:33 UT on 20190101 (scheduled) | | | | | | |

# LEISA CRUISE DATA (20aug2018)

/data/20180820_039709/lsb_0397097519_0x53c_eng.fit (Alpha Lyrae)

Channel 9 (2.4088 μm) Channel 194 (1.2384 μm) Channel 250 (2.1038 μm)



<----------> Low-res (λ/Δλ ~ 243) High-res (λ/Δλ ~ 542)

(Spatially unregistered)

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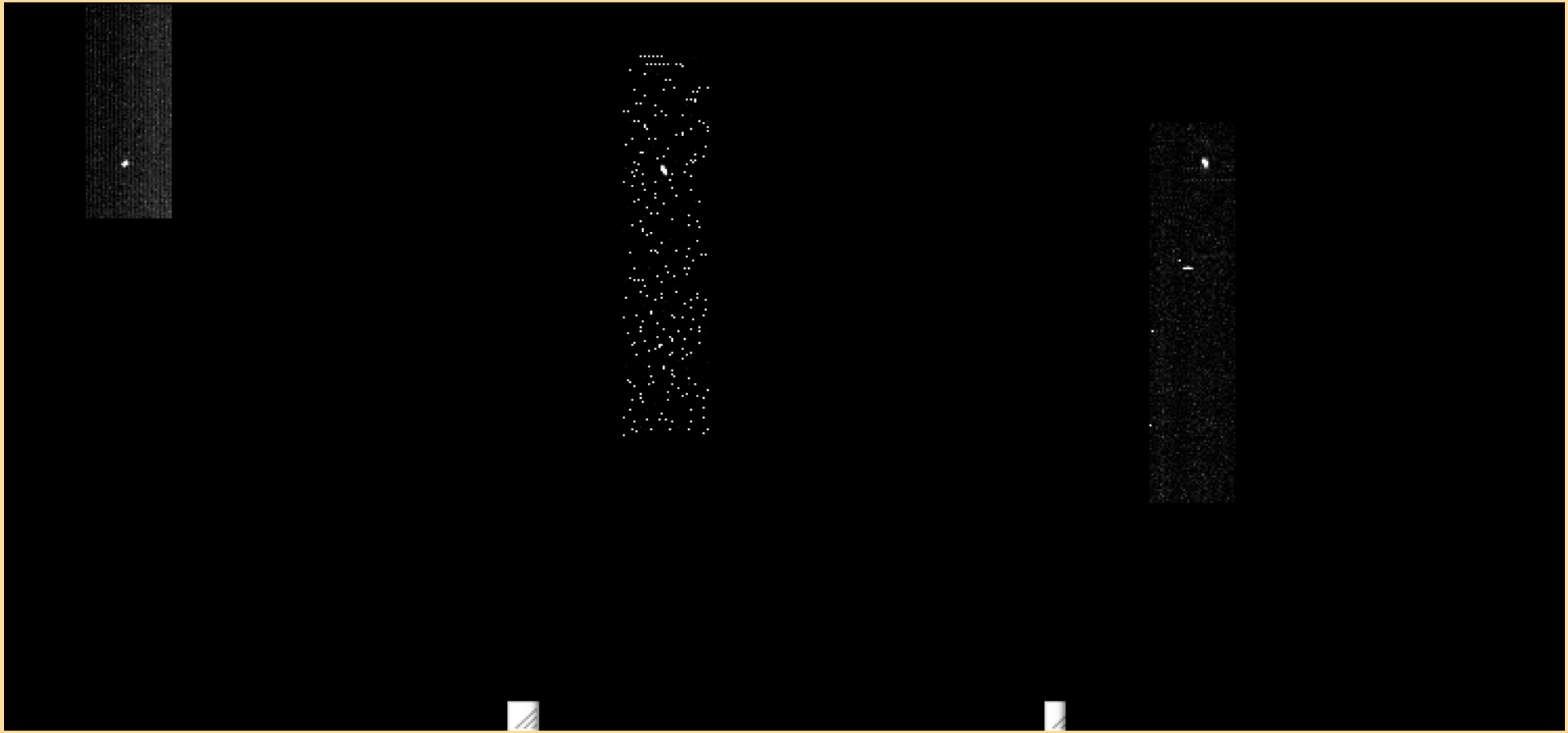

|<----------------------------------------------------------------------->|

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(Spatially registered)

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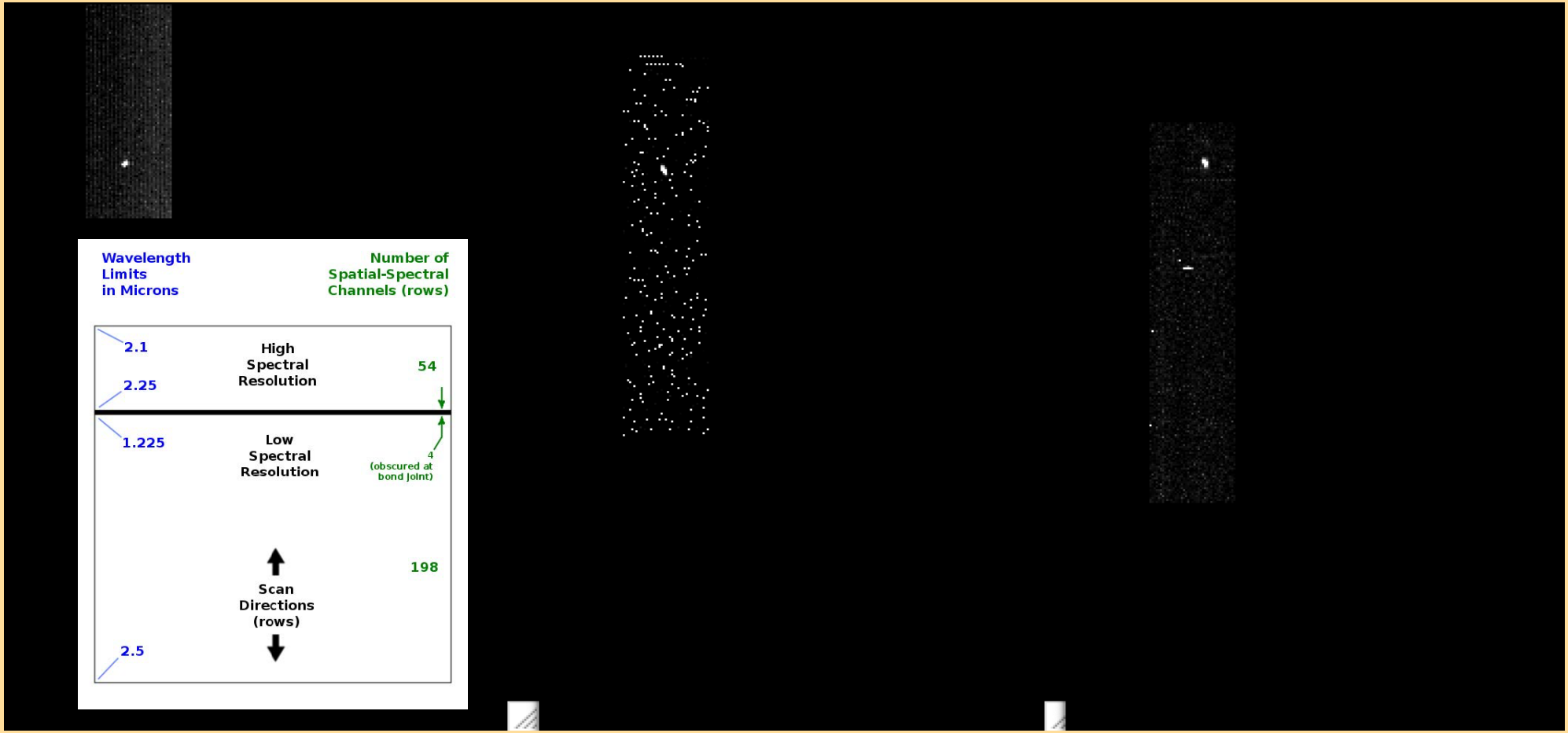


|<----------->|

Low-res (λ/Δλ ~ 243) High-res (λ/Δλ ~ 542)

(Spatially registered)

# LEISA $MU_{69}$ Approach

| Summary of NHkele_1001 LEISA files, ~~February~~ May 2020 PDS-SBN review* | | | | | | |
|---|---|---|---|---|---|---|
| | | | | | | |
| "Folder" ID | *_0x53c_eng.lbl | UT Date | Start UT | End UT | Target | S/C dist (km) |
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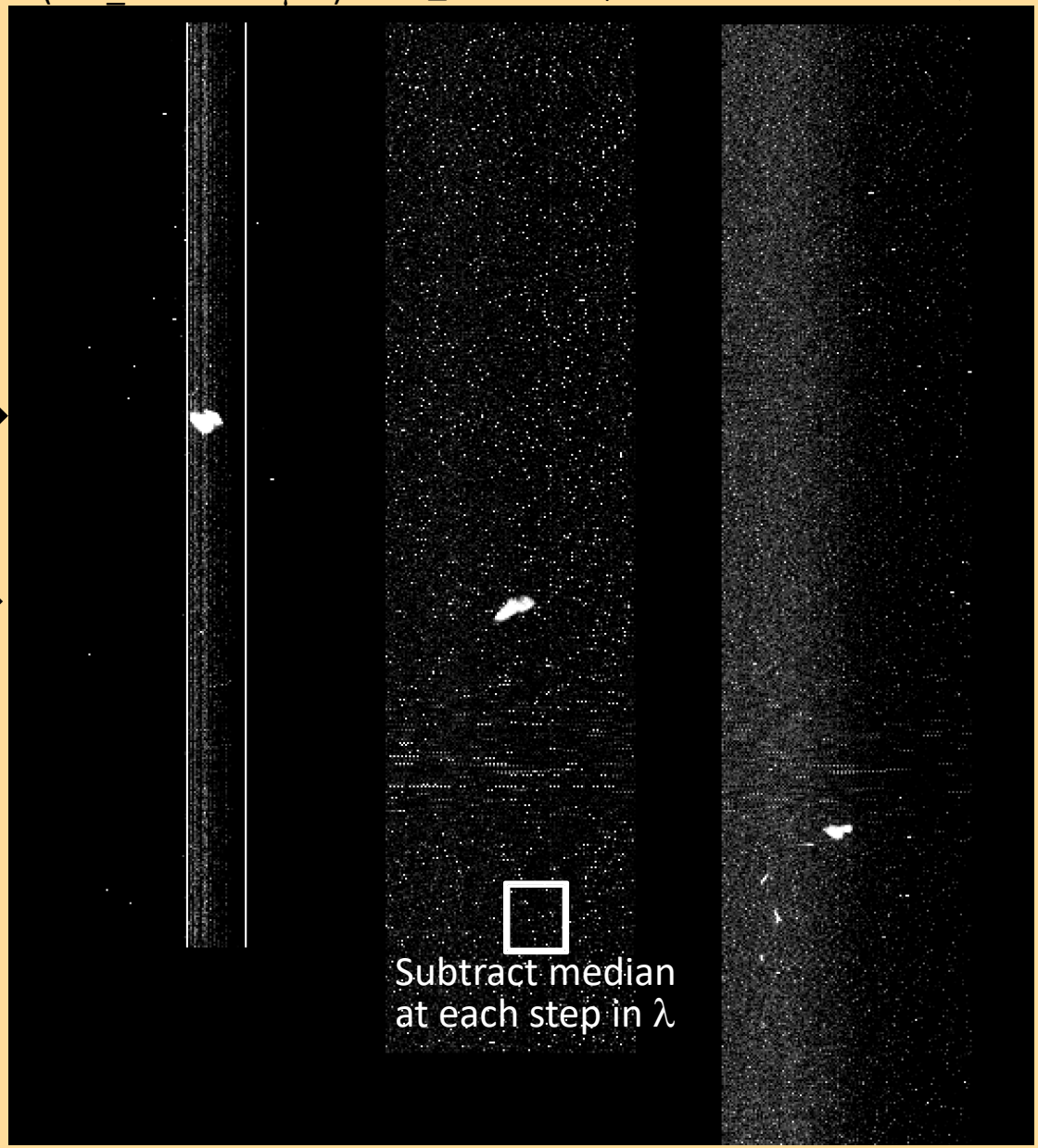
| 20181231_040860 | lsb_0408605304 | 2018-12-31 | 23:36:26 | 23:43:12 | MU_69 | 3.06e5 |
| | | | | | | |
| 20190101_040860 | lsb_0408606595 | 2018-12-31 | 23:57:57 | 00:04:43 | MU_69 | 2.88e5 |
| | lsb_0408609177 | 2019-01-01 | 00:40:59 | 00:47:45 | MU_69 | 2.50e5 |
| | | | | | | |
| 20190101_040861 | lsb_0408610468 | 2019-01-01 | 01:02:30 | 01:09:16 | MU_69 | 2.32e5 |
| | lsb_0408613050 | 2019-01-01 | 01:45:32 | 01:52:18 | MU_69 | 1.94e5 |
| | lsb_0408614341 | 2019-01-01 | 02:07:03 | 02:13:49 | MU_69 | 1.75e5 |
| | lsb_0408619338 | 2019-01-01 | 03:30:20 | 03:37:09 | MU_69 | 1.04e5 |
| | | | | | | |
| 20190101_040862 | lsb_0408621929 | 2019-01-01 | 04:13:31 | 04:22:18 | MU_69 | 6.55e4 |
| | lsb_0408624118 | 2019-01-01 | 04:50:00 | 05:05:16 | MU_69 | 3.12e4 |
| | | | | | | |
| ***Closest approach to 2014 MU_69:** 3540 km, at 05:33 UT on 20190101 (scheduled) | | | | | | |

# LEISA approaching MU69 (01jan2019)

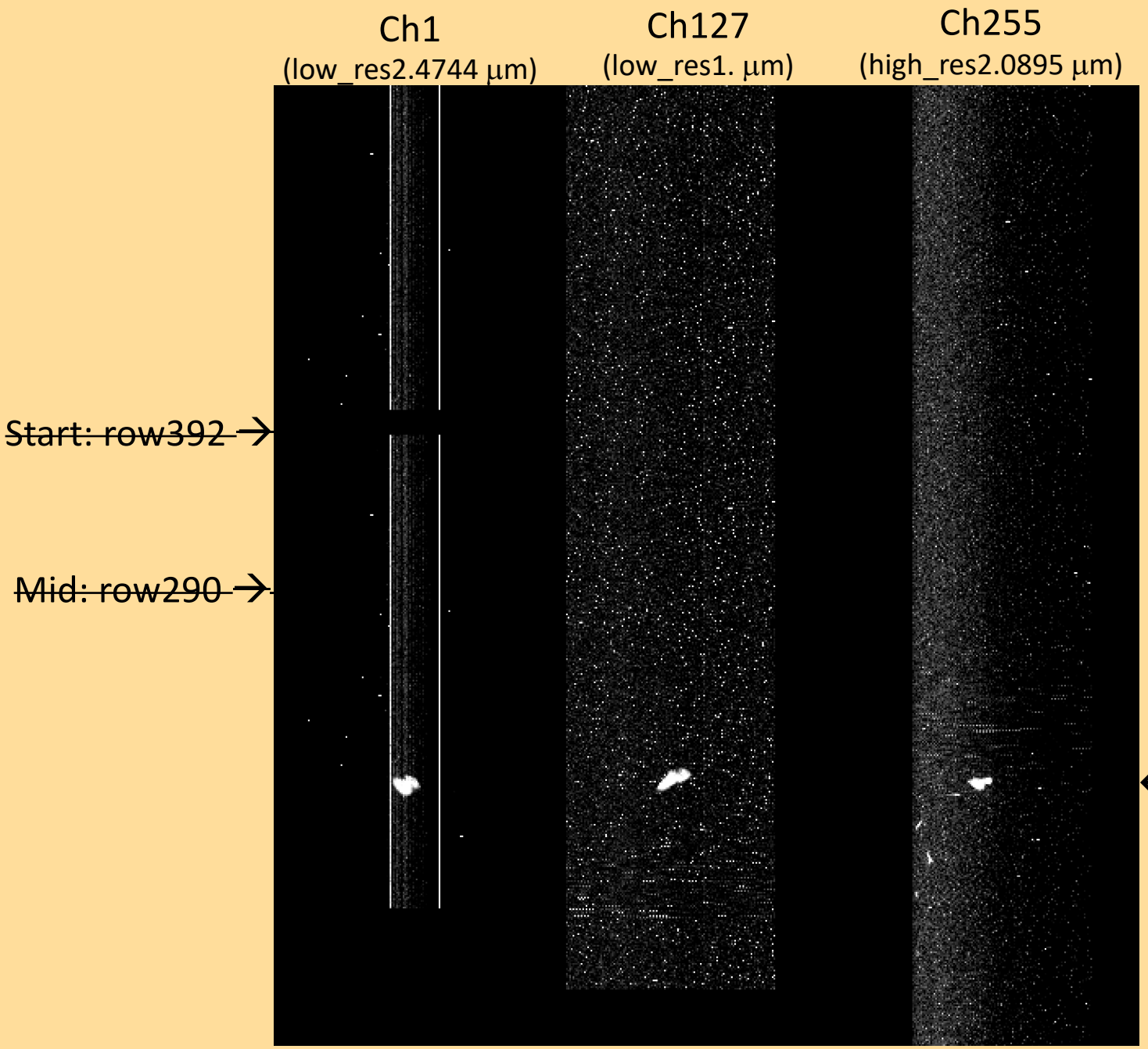
lsb_0408624418_0x53c_eng.fit (04:50 – 05:05 UT), <d> = 31.2e3 km




Spatially Unregistered (Raw)

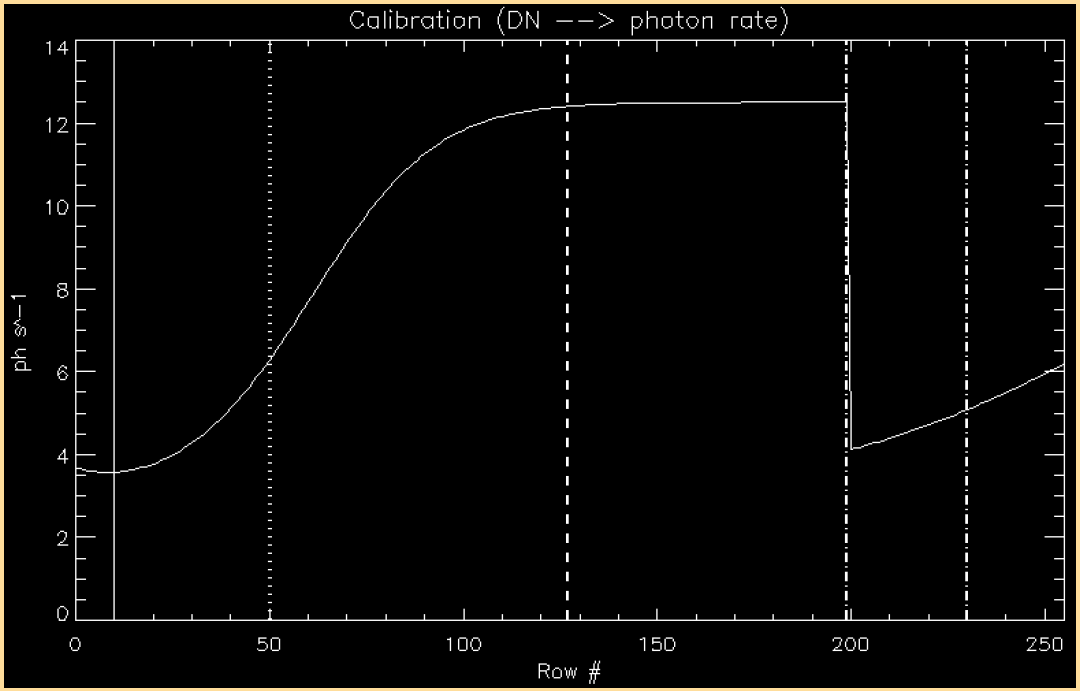
# LEISA approaching MU69 (01jan2019)

lsb_0408624418_0x53c_eng.fit (04:50 – 05:05 UT), <d> = 31.2e3 km

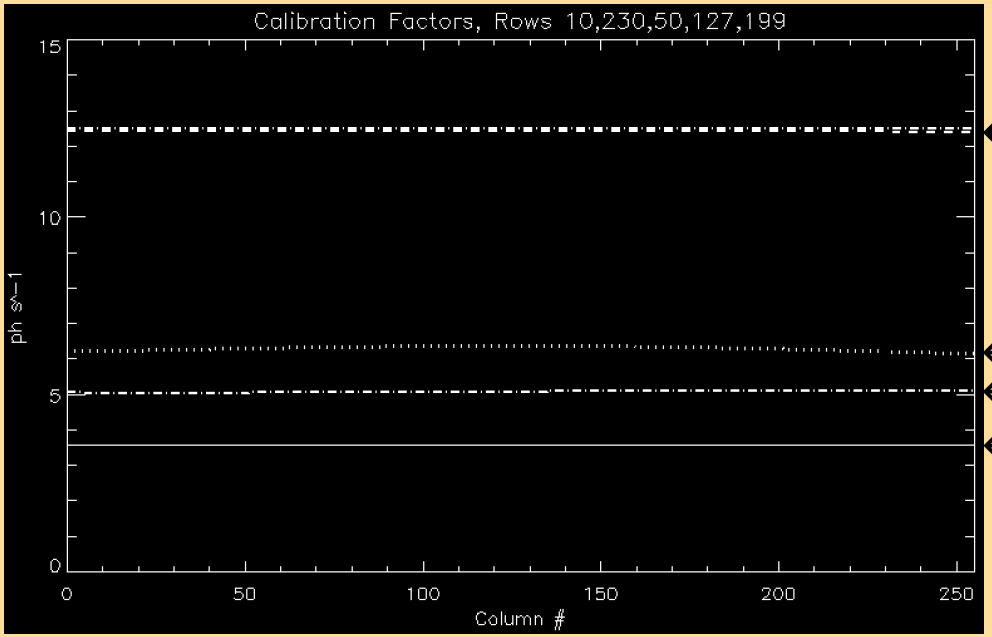



Spatially Registered (Raw)

# LEISA Intensity Calibration



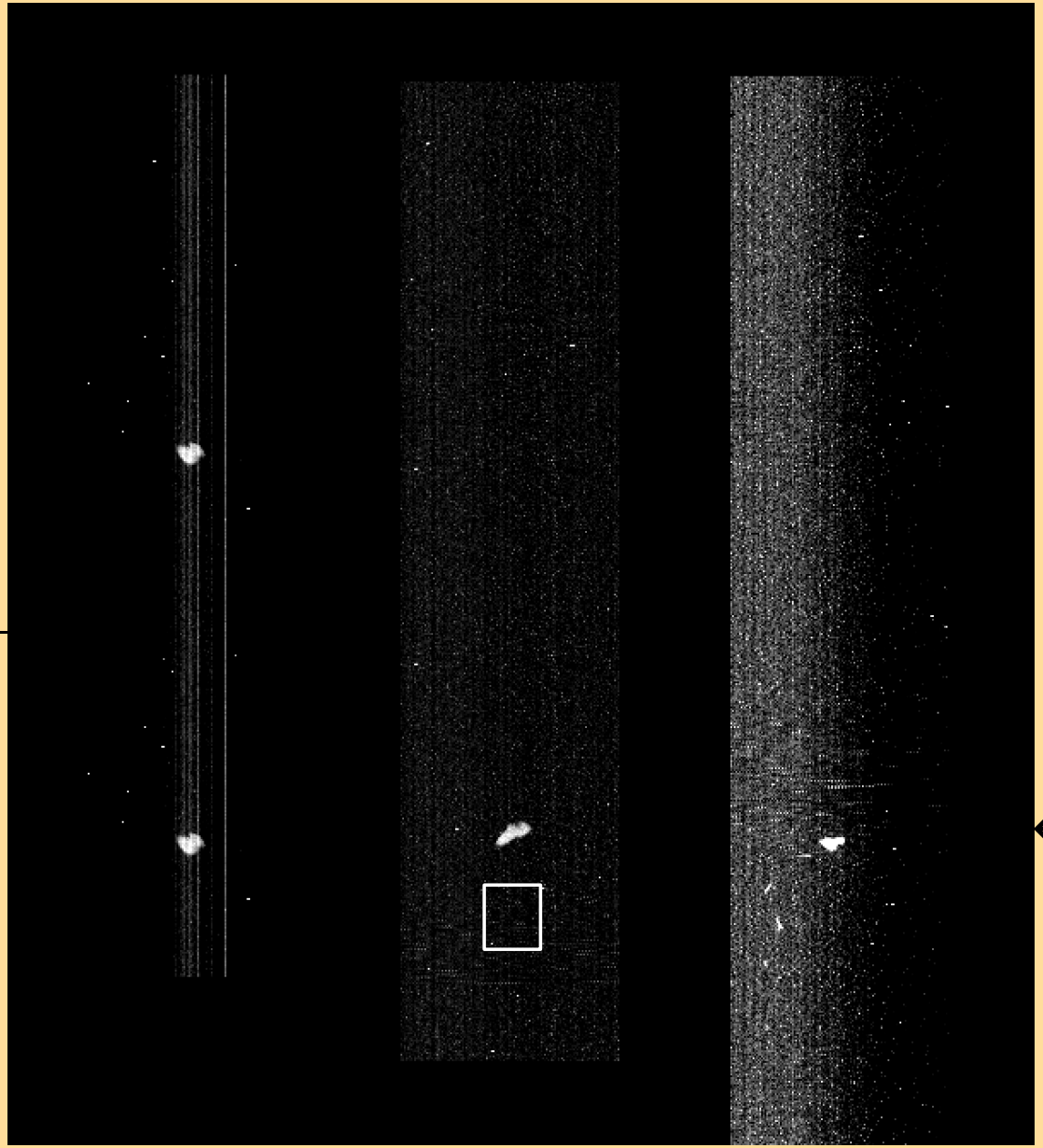

Could express as flux density, e.g., Rayleighs/Angstrom ($\equiv 10^6$ ph $s^{-1}$ $cm^{-2}$ $A^{-1}$) once aperture (e.g., pixel) angular subtense is specified. The pixel solid angle Omega(pix) ≅ 1.7e-7 sr (taken from 'calinfo.txt').



# LEISA approaching MU69 (01jan2019)

lsb_0408624418_0x53c_eng.fit (04:50 – 05:05 UT), <d> = 31.2e3 km

Ch1 (low_res2.4744 μm) | Ch127 (low_res1. μm) | Ch255 (high_res2.0895 μm)



Start: row392 →

~~Mid: row290 →~~

← Row173

Spatially Registered (Calibrated)

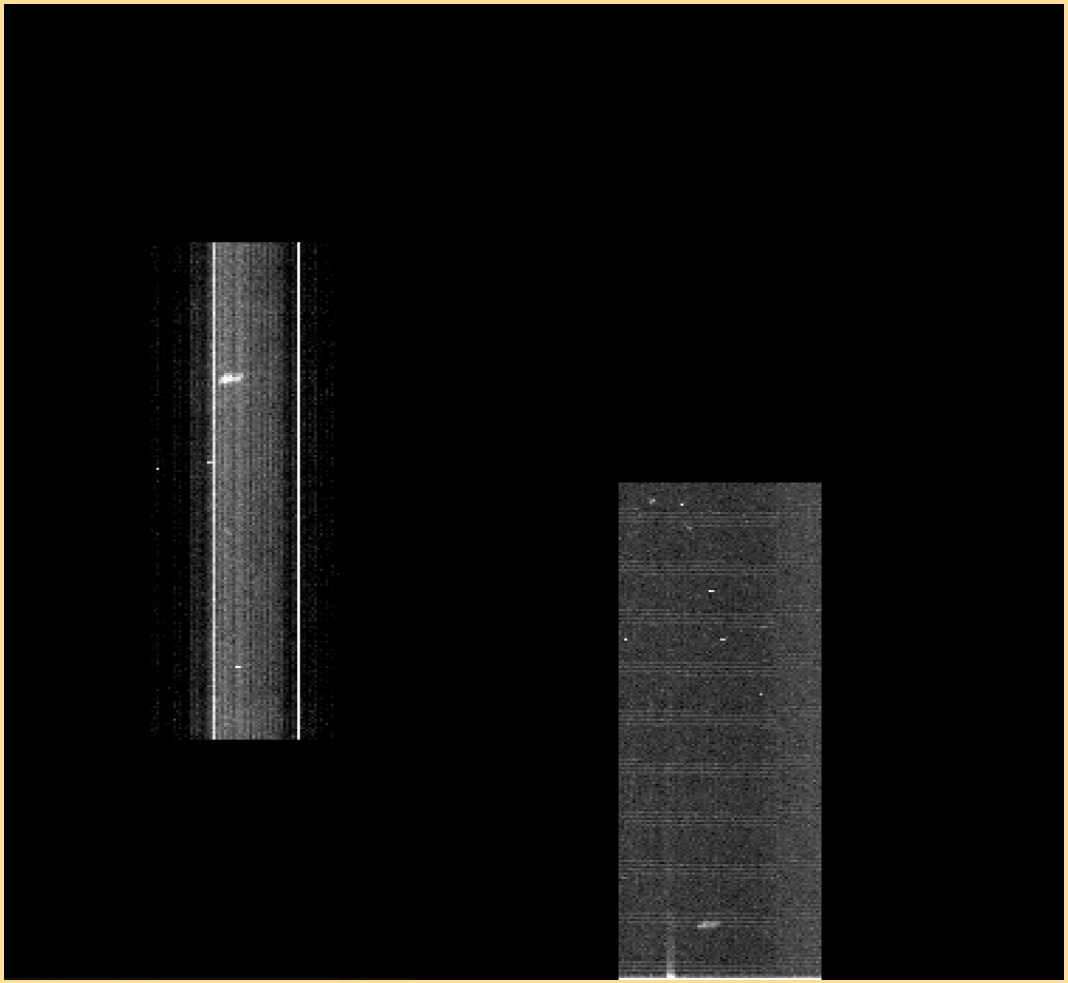
# LEISA approaching MU69 (01jan2019)

/data/20190101_040862/lsb_0408621929_0x53c_eng.fit (04:14 - 04:22 UT), 65.5e3 km

Ch1
(low_res2.4842 μm)

Ch255
(high_res2.0895 μm)

Start: peak row=285 →



←End: peak row = 26

(Spatially unregistered)

# Summary/Suggestions

LEISA frames read in fine, for both raw and calibrated) data.

- lambda 2.5-1.225um (rows0 thru 199, low res), 2.25-2.10um (rows204 thru 255, hi res).
- Asteroid Arrokoth (2014 $MU_{69}$) is clearly detected at 65e3 and 31e3 km, but tough to see at 102e3km.
- While Vega scan direction is "as expected" (target moved upward through lambda, as w/ Pluto scans), $MU_{69}$ scan direction is reversed (target moved downward through lambda). In each case it was ~1 row per step in $\lambda$.
  (Question: Is this due to S/C roll? If so, is there a keyword indicator in the .lbl files?)

Spatial Registration

- Both Vega and $MU_{69}$ data show some "wobble" in the x-direction, more so for Vega, less so for $MU_{69}$.

Difficult to extract spectra for Vega or $MU_{69}$, due to spatial smearing (not so critical for Pluto).

Should be less important for $MU_{69}$, near closest flyby approach of ~3500 km.

Owing to the reversal in scan direction for $MU_{69}$, the algorithm to register $MU_{69}$ data toward closest approach was revised; downward drift rate seems constant, as expected.

Typo in "calinfo.txt', "I is the **intergration** time, seconds."

Looking forward to seeing the actual $MU_{69}$ flyby data.