PDS-SBN Review of New Horizons LEISA v6.0 Data

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22 January 2024

Review: 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),

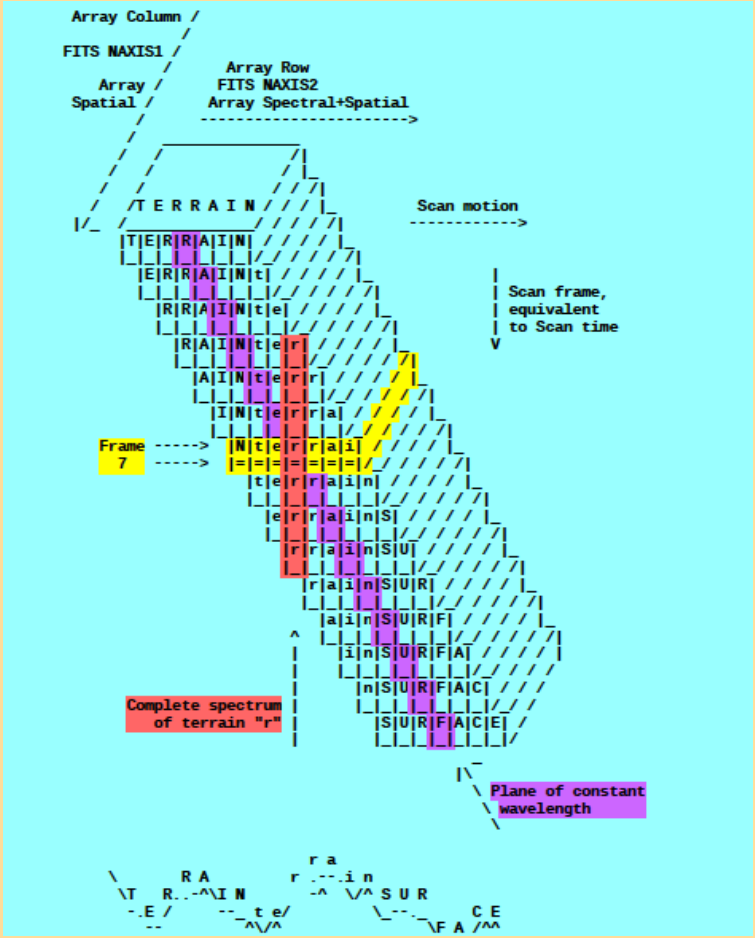
y=lambda(256 elements),

z=spectral/spatial

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

(i.e., lambda varies spatially)

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

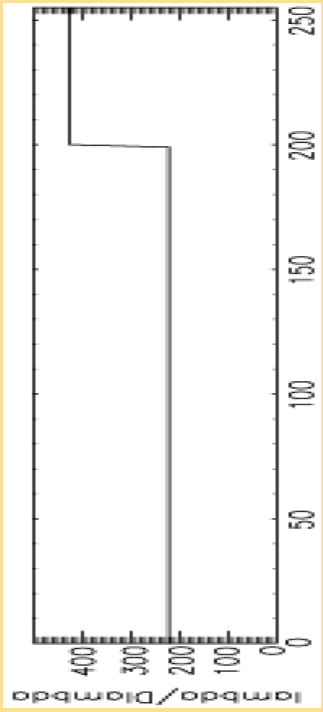


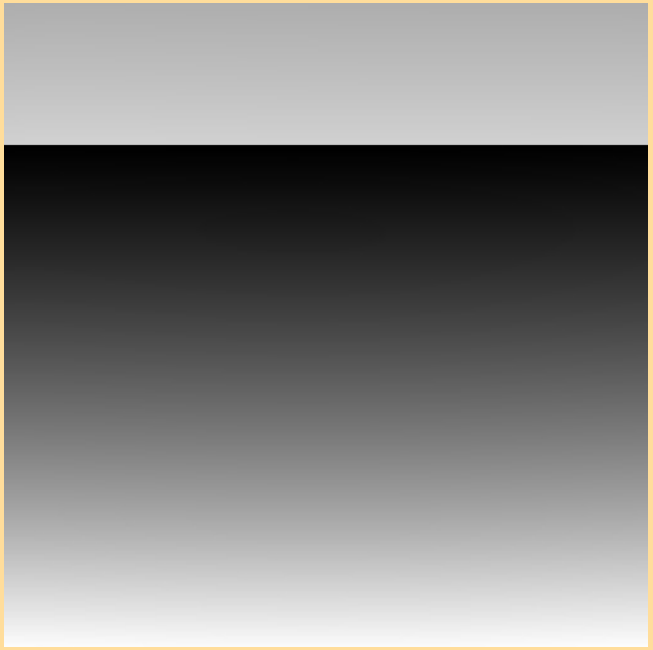
LEISA

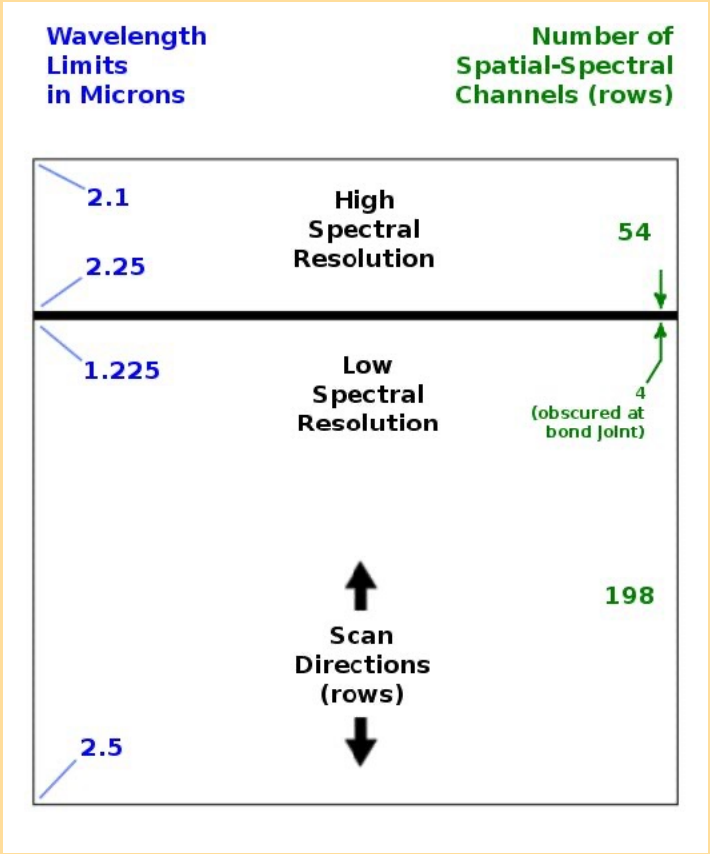
A near-IR (1.2 – 2.5 micron) spectrometer that uses a 256x256 Rockwell PICNIC array, with 40-micron square pixels.

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.

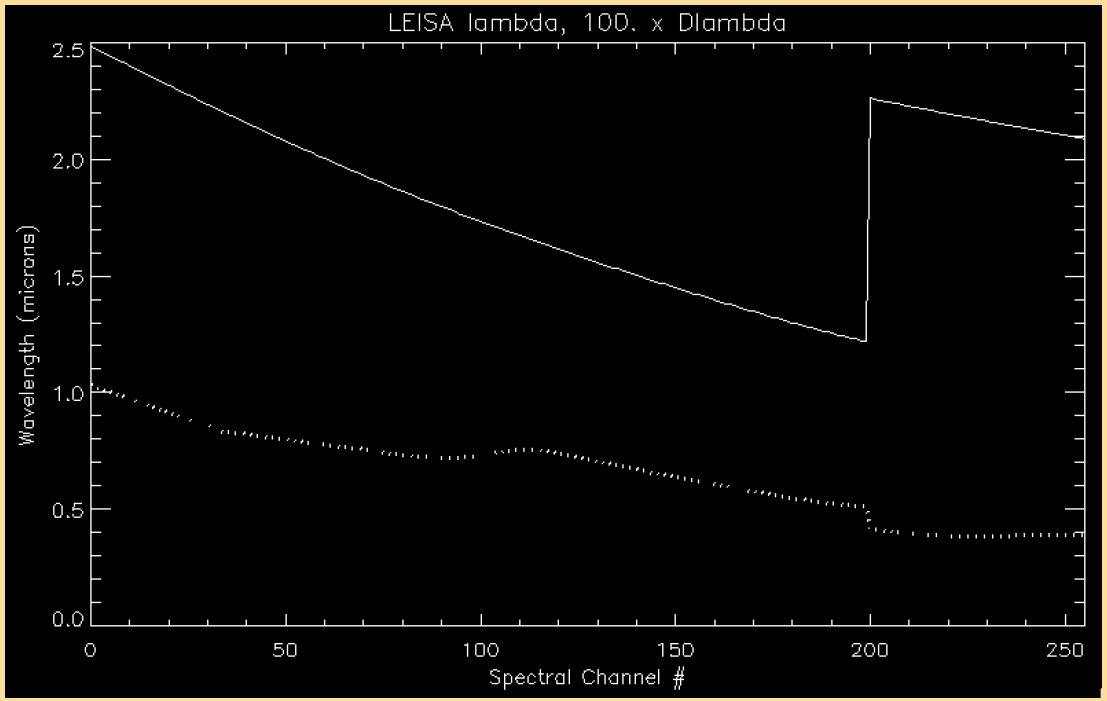
Note: "Hi-res" $\lambda/\Delta\lambda$ was ~ 425 for Pluto flyby data (as below) but is ~ 540 for cruise & 2014 MU_{69} approach phases (recalibration)







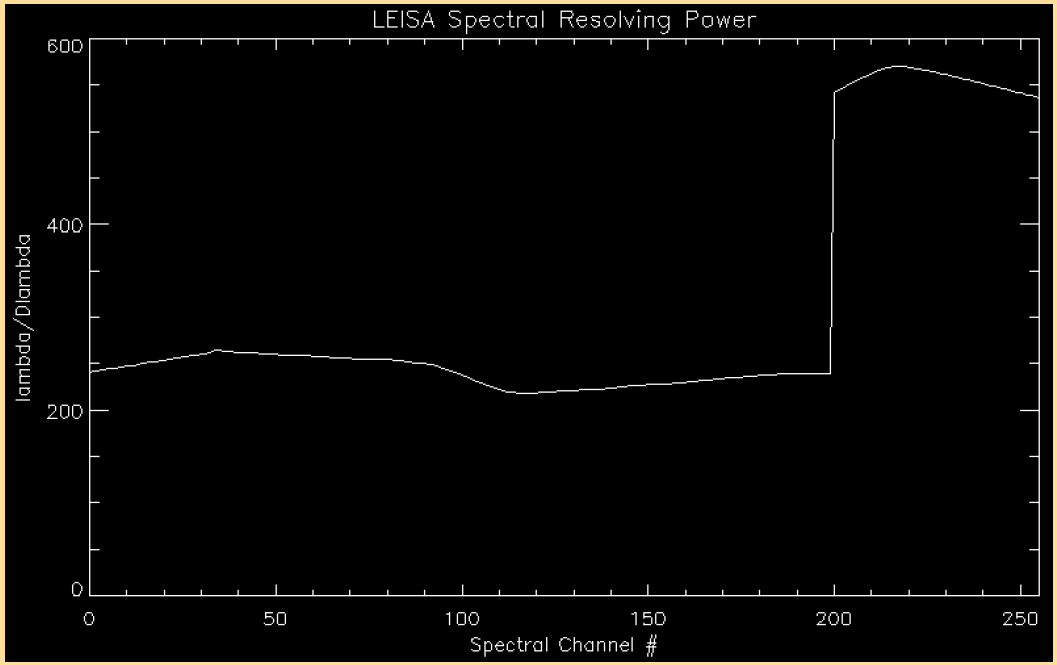
LEISA Wavelength Calibration



lambda

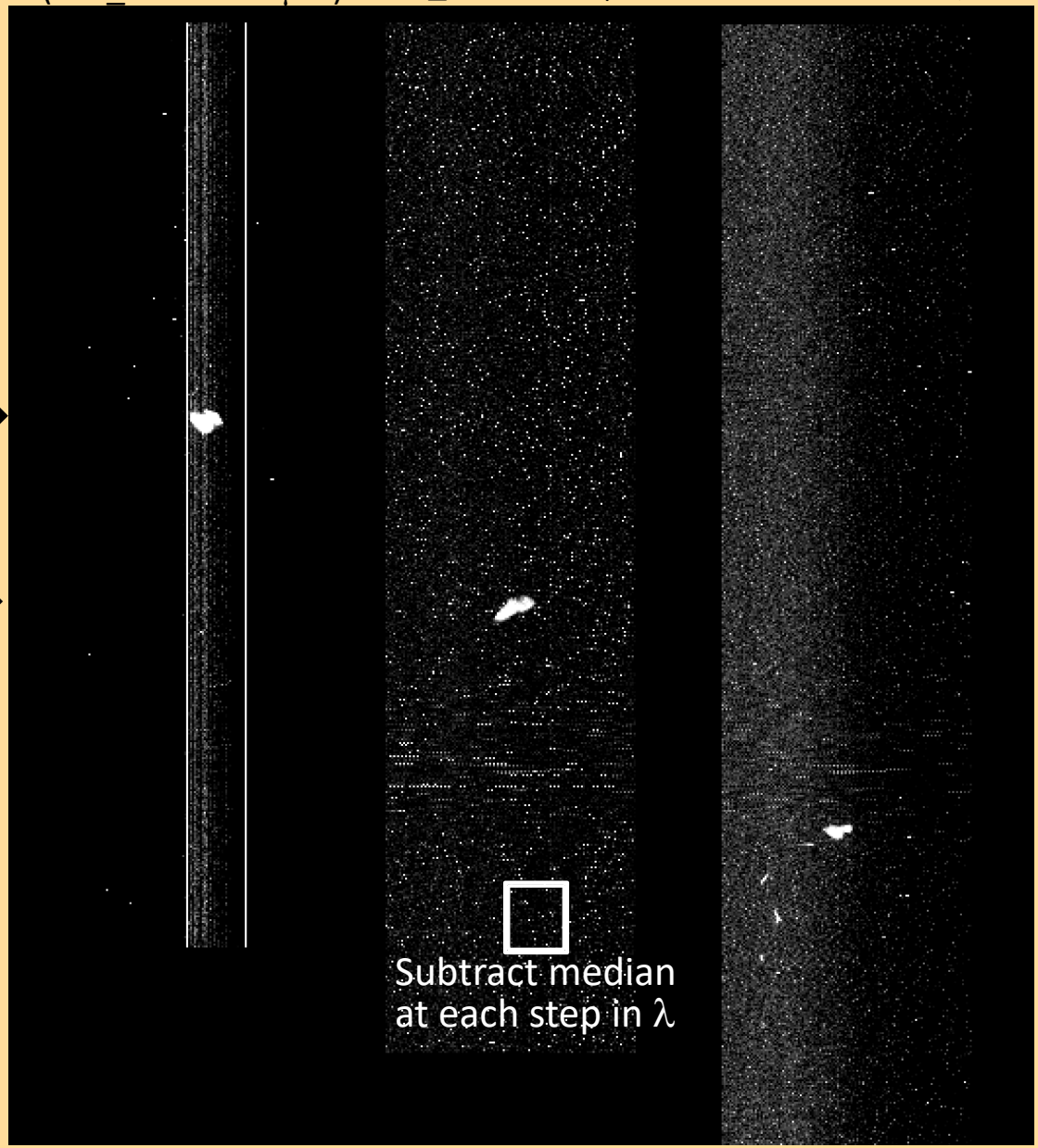
Delta-lambda x 100

Lambda / Delta-lambda



LEISA approaching MU69 (01jan2019)

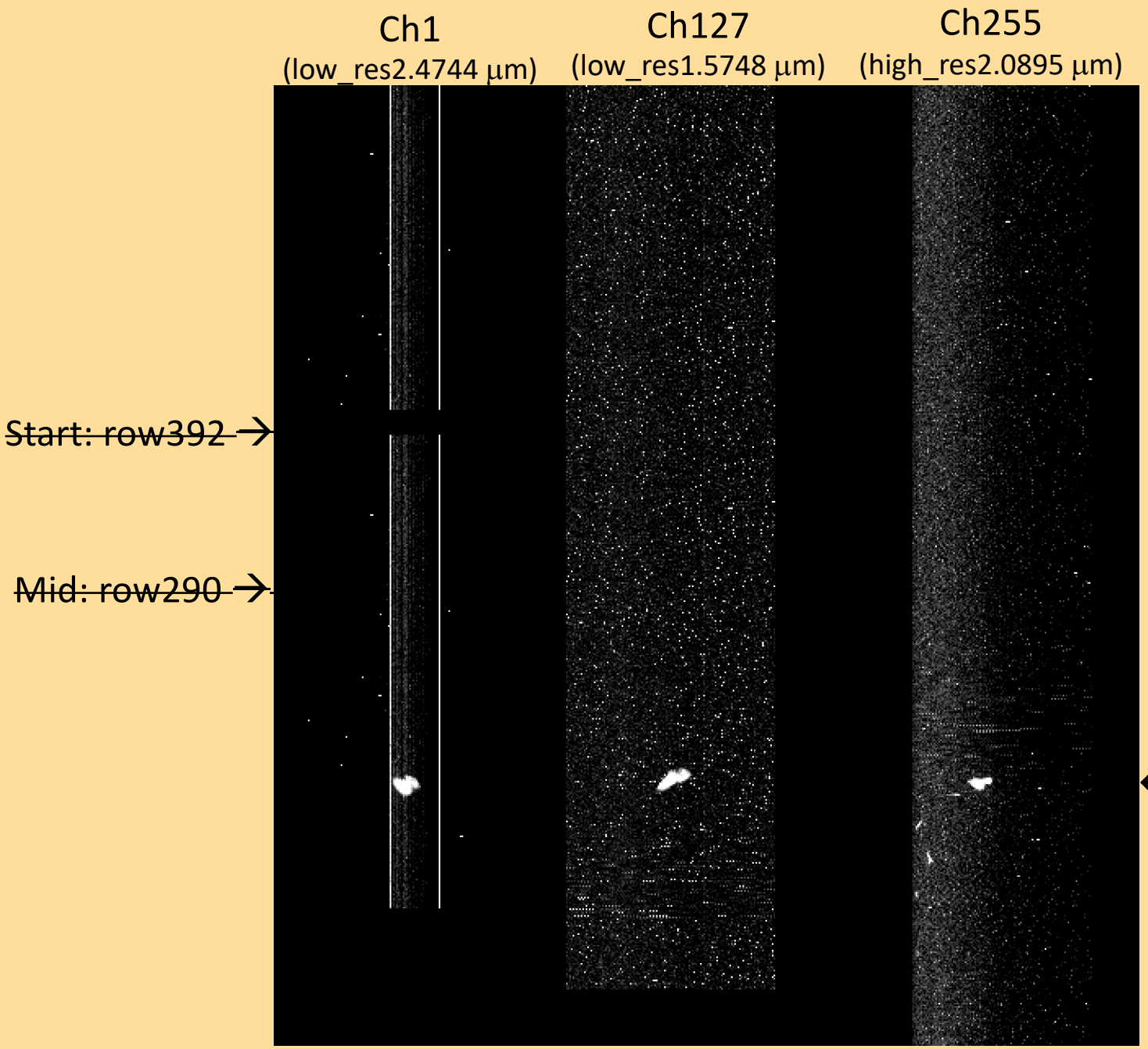
lsb_0408624418_0x53c_eng.fit (04:50 – 05:05 UT), <d> = 31.2e3 km



Spatially Unregistered (Raw)

LEISA approaching MU69 (01jan2019)

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



Spatially Registered (Raw)

Summary of NHkele_1001 LEISA files (MU_69 Approach) *						
"Folder" ID	lsb_0x53c_eng.lbl	UT Date	Start UT	End UT	Target	S/C dist (km) vis?
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 N
20181231_040858	lsb_0408587281	2018-12-31	18:36:03	18:42:52	MU_69	5.66e5**
20181231_040858	lsb_0408593941	2018-12-31	20:27:03	20:33:52	MU_69	4.70e5**
20181231_040860	lsb_0408605304	2018-12-31	23:36:26	23:43:12	MU_69	3.06e5 Y(???)
20190101_040860	lsb_0408606595	2018-12-31	23:57:57	00:04:43	MU_69	2.88e5 Y(??)
	lsb_0408609177	2019-01-01	00:4059	00:47:45	MU_69	2.50e5 Y(?)
20190101_040861	lsb_0408610468	2019-01-01	01:02:30	01:09:16	MU_69	2.32e5 Y
	lsb_0408613050	2019-01-01	01:45:32	01:52:18	MU_69	1.94e5 Y
	lsb_0408614341	2019-01-01	02:07:03	02:13:49	MU_69	1.75e5 Y
	lsb_0408619338	2019-01-01	03:30:20	03:37:09	MU_69	1.04e5 Y
20190101_040862	lsb_0408621929	2019-01-01	04:13:31	04:22:18	MU_69	6.55e4 Y
	lsb_0408624118	2019-01-01	04:50:00	05:05:16	MU_69	3.12e4 Y

*** Closest approach to 2014 MU_69:** 3540 km, at 05:33 UT on 20190101

**** Added for this review (January 2024)**

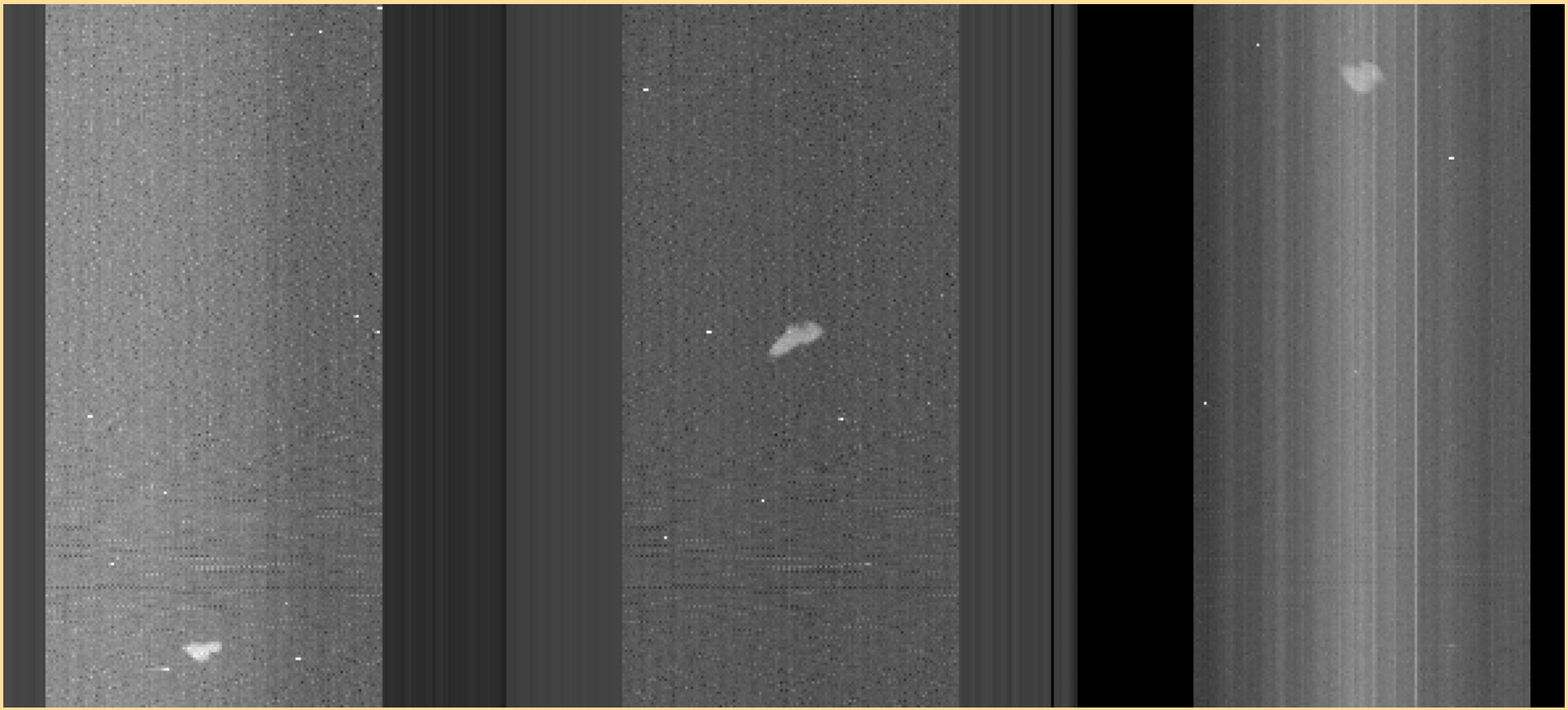
LEISA approaching MU69 (01jan2019)

lsb_0408624418_0x53c_sci.fit (calibrated), <d> = 31.2e3 km

Ch255
(high_res2.0895 μm)

Ch127
(low_res1.5748 μm)

Ch10
(low_res2.4004 μm)



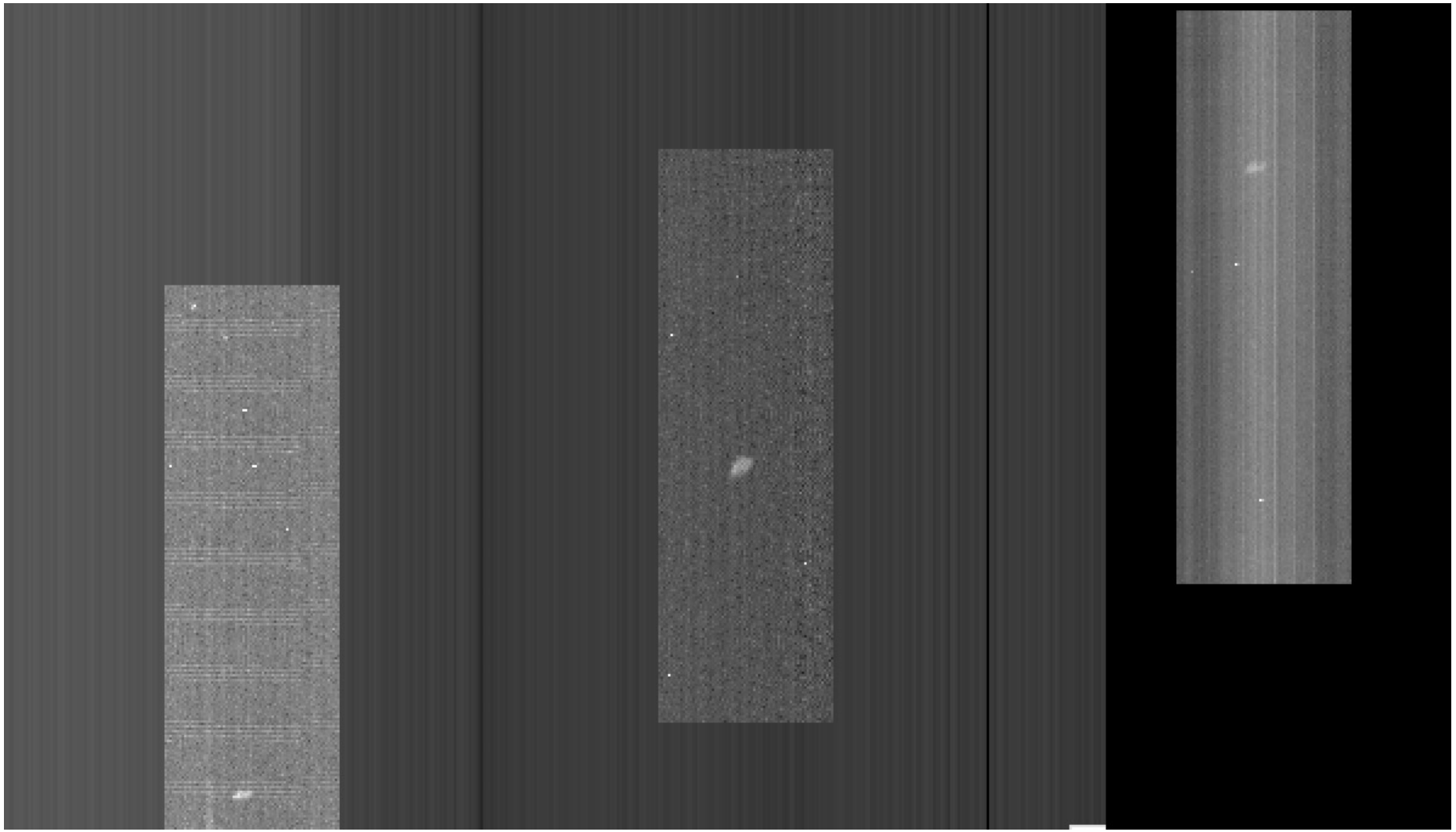
LEISA approaching MU69 (01jan2019)

lsb_0408621929_0x53c_sci.fit (calibrated), <d> = 65.5e3 km

Ch255
(high_res2.0895 μm)

Ch127
(low_res1.5748 μm)

Ch10
(low_res2.4004 μm)

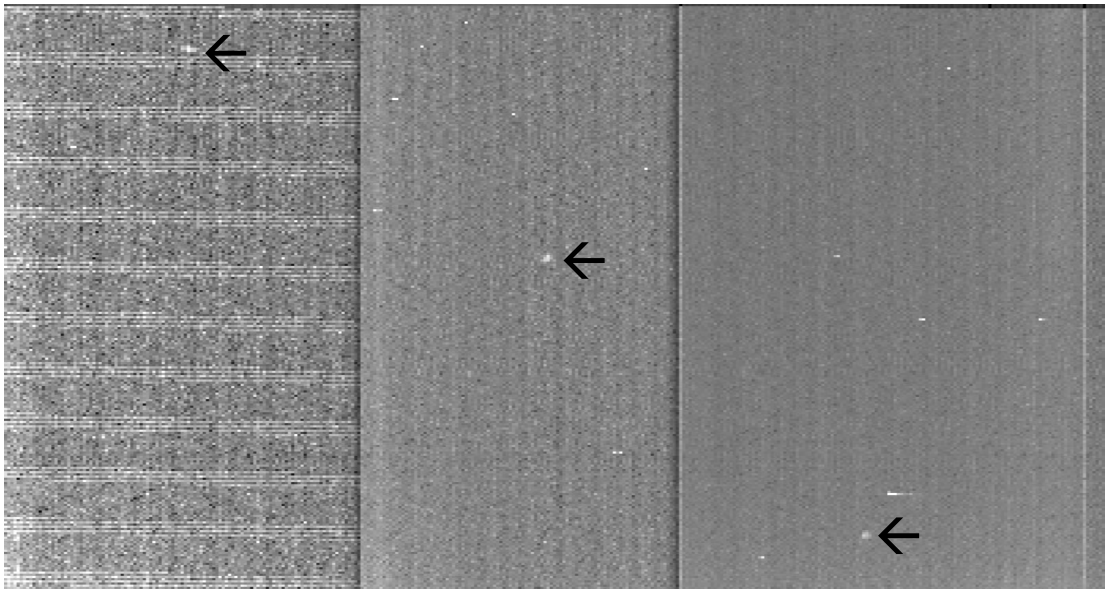


lsb_0408619338_0x53c_sci.fit (calibrated), <d> = 104e3 km

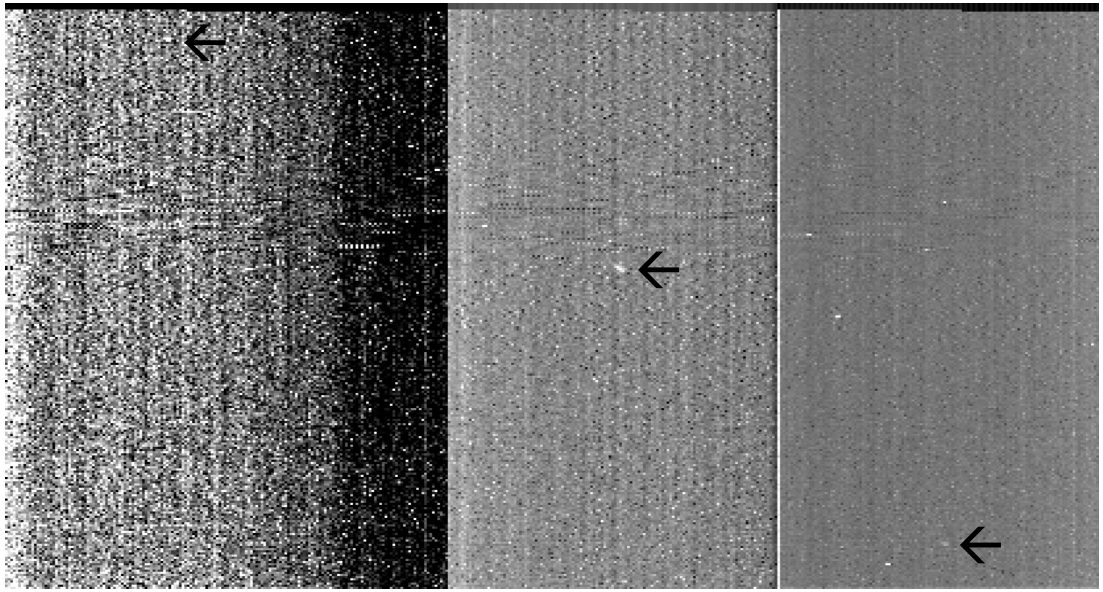
Ch225
(high_res2.1795 μm)

Ch127
(low_res1.5748 μm)

Ch10
(low_res2.4004 μm)



lsb_0408614341_0x53c_sci.fit (calibrated), <d> = 175e3 km



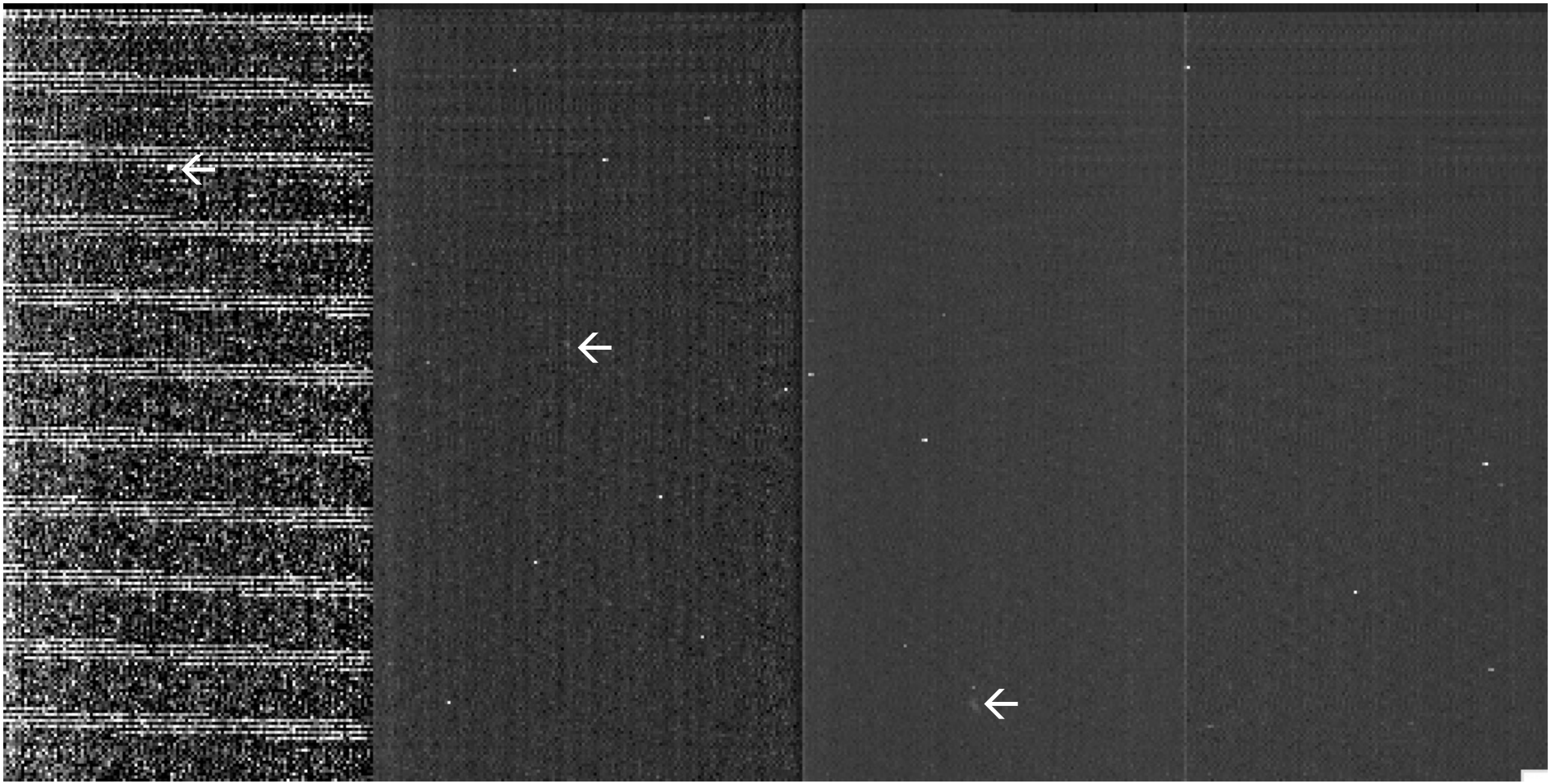
LEISA approaching MU69 (01jan2019)

lsb_0408613050_0x53c_sci.fit (calibrated), <d> = 194e3 km

Ch190
(high_res1.2552 μm)

Ch127
(low_res1.5748 μm)

Ch10
(low_res2.4004 μm)



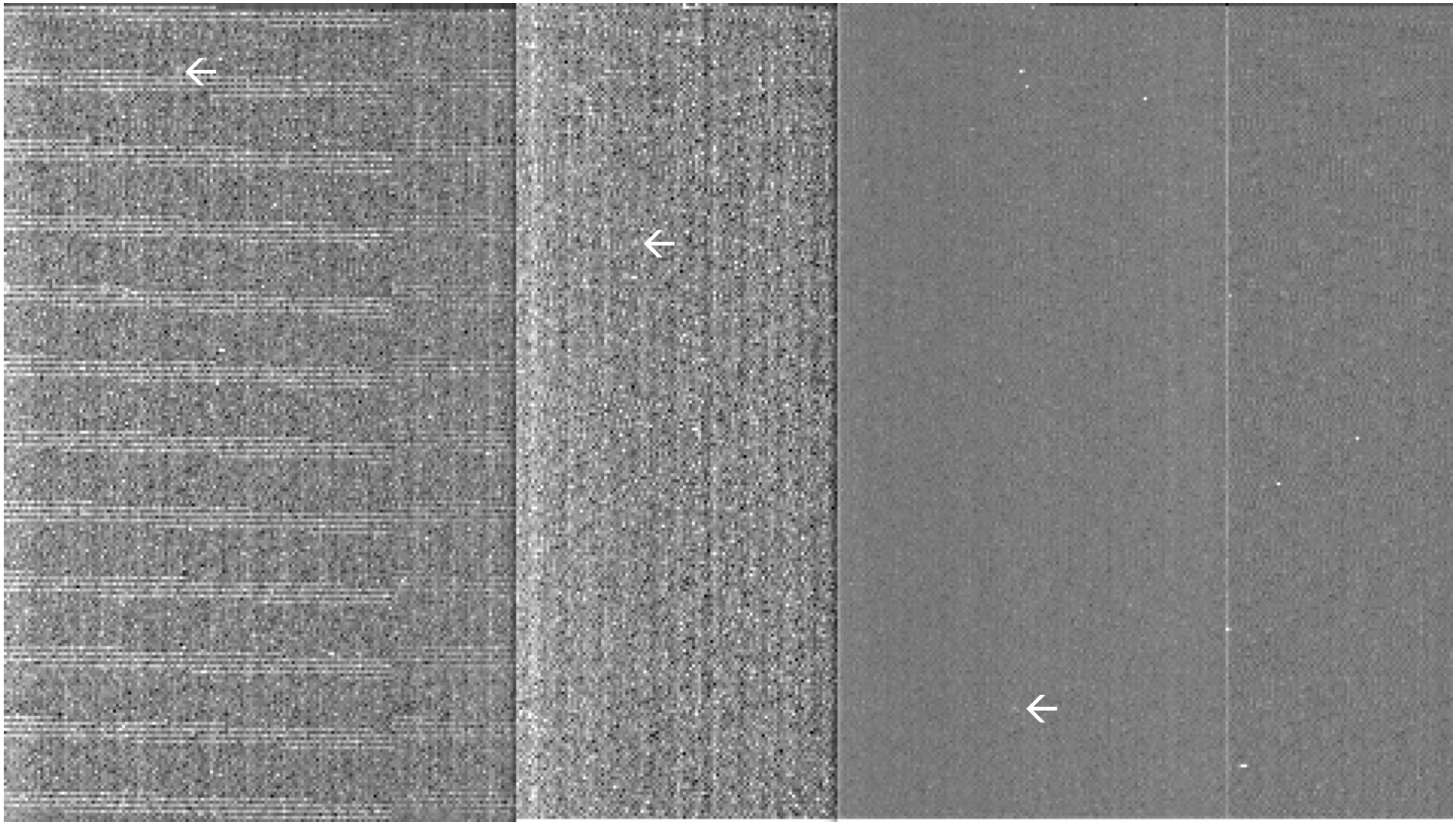
LEISA approaching MU69 (01jan2019)

lsb_0408610468_0x53c_sci.fit (calibrated), <d> = 232e3 km

Ch190
(high_res1.2552 μm)

Ch127
(low_res1.5748 μm)

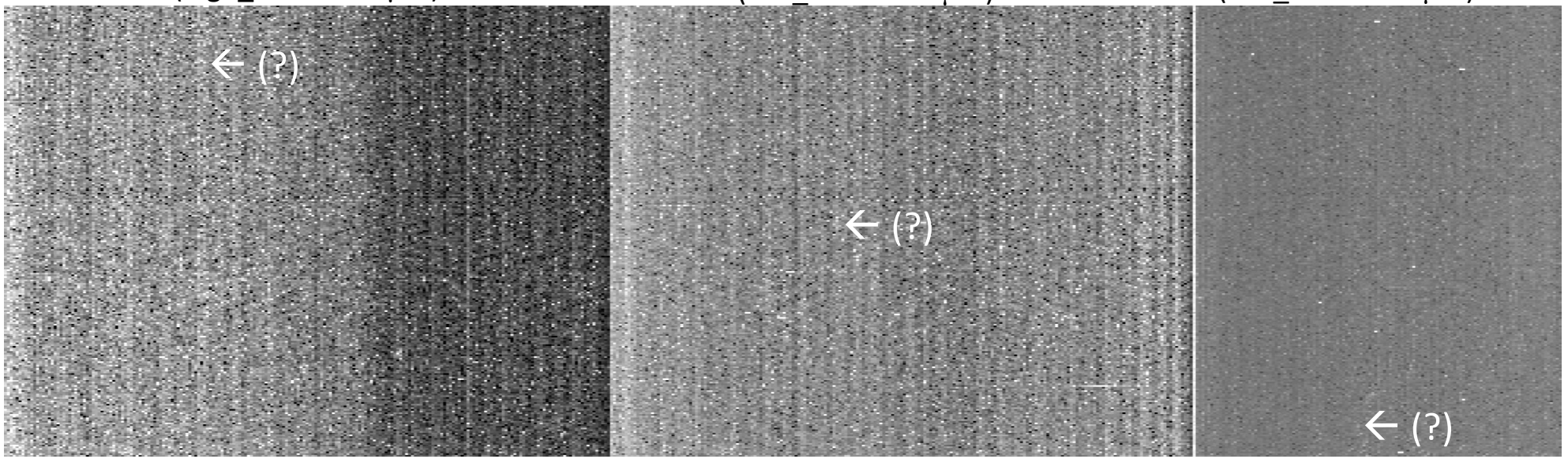
Ch10
(low_res2.4004 μm)



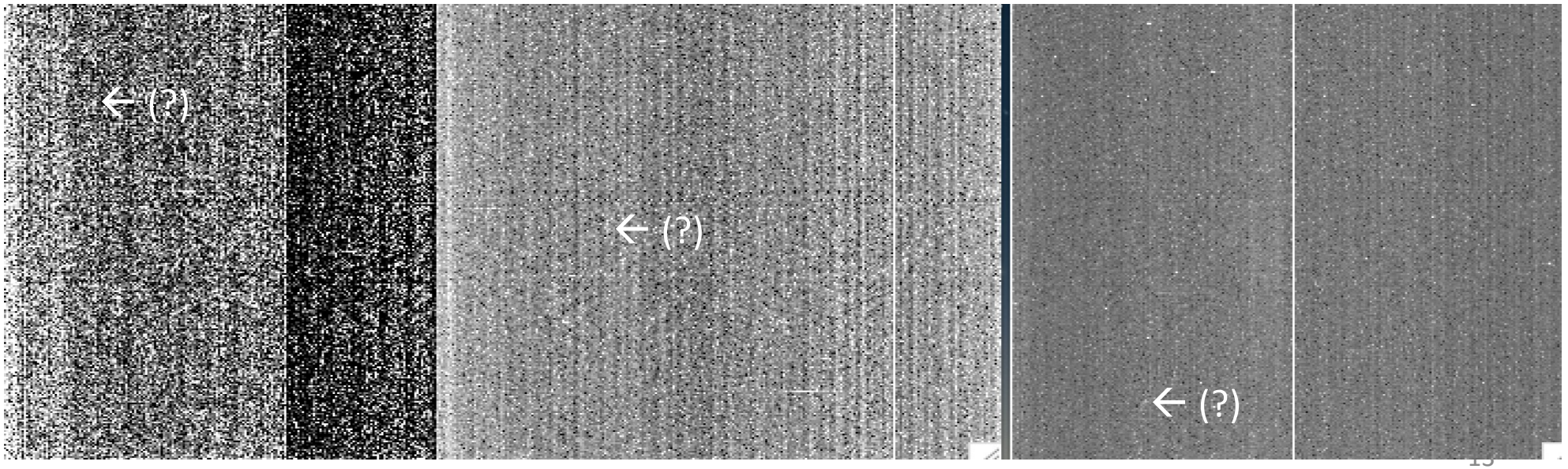
LEISA approaching MU69

lsb_0408609177_0x53c_sci.fit (calibrated), <d> = 250e3 km (01jan2019)

Ch190 (high_res1.2552 μm) | Ch127 (low_res1.5748 μm) | Ch10 (low_res2.4004 μm)



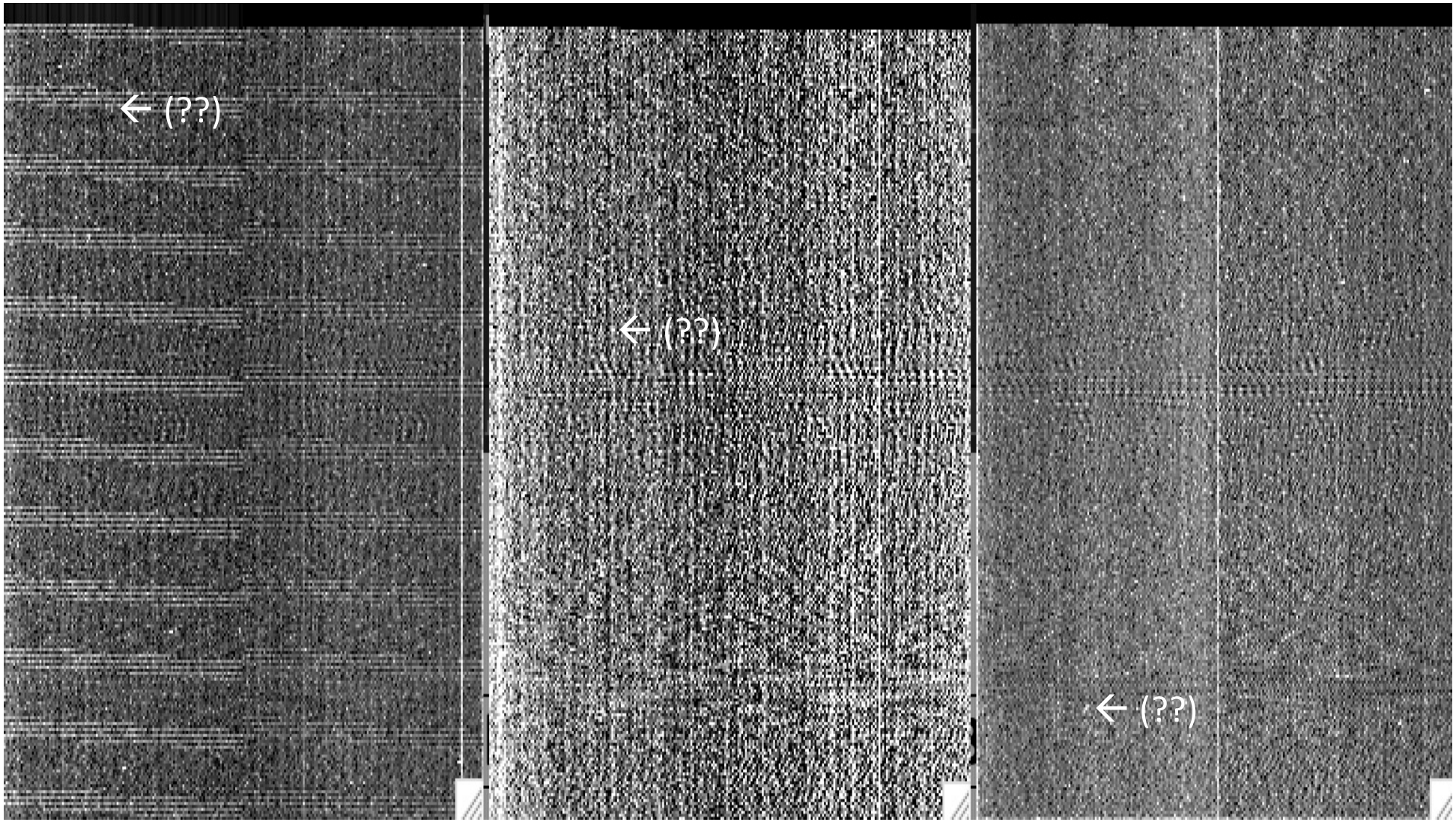
lsb_0408606595_0x53c_sci.fit (calibrated), <d> = 288e3 km (31dec/01jan)



LEISA approaching MU69 (31dec2019)

lsb_0408605304_0x53c_sci.fit (calibrated), <d> = 306e3 km

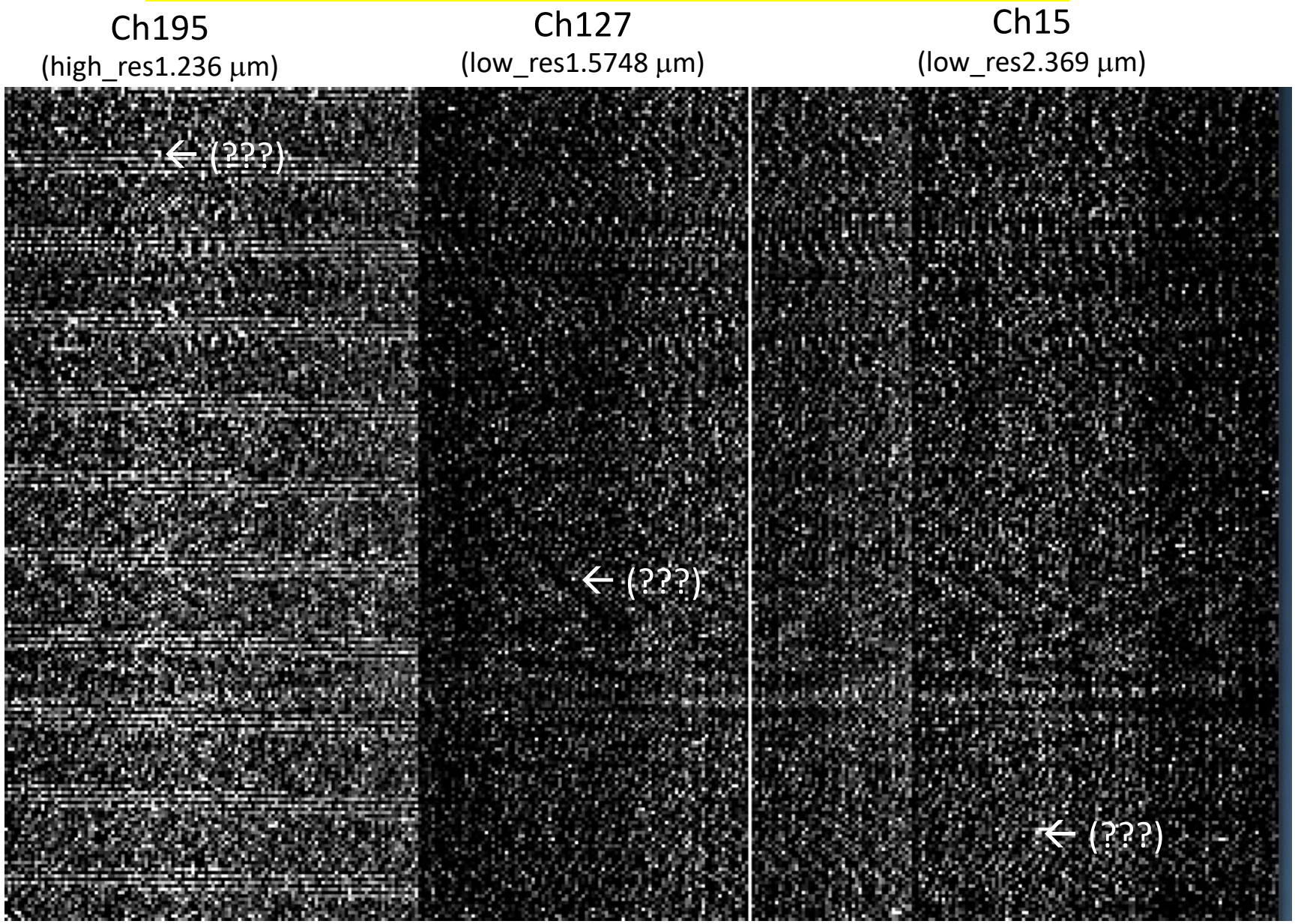
Ch190 (high_res1.2552 μm) | Ch127 (low_res1.5748 μm) | Ch10 (low_res2.4004 μm)



NEW (Jan 2024)

LEISA approaching MU69 (31dec2019)

lsb_0408593941_0x53c_sci.fit (calibrated), <d> = 470e3 km



NEW (Jan 2024)

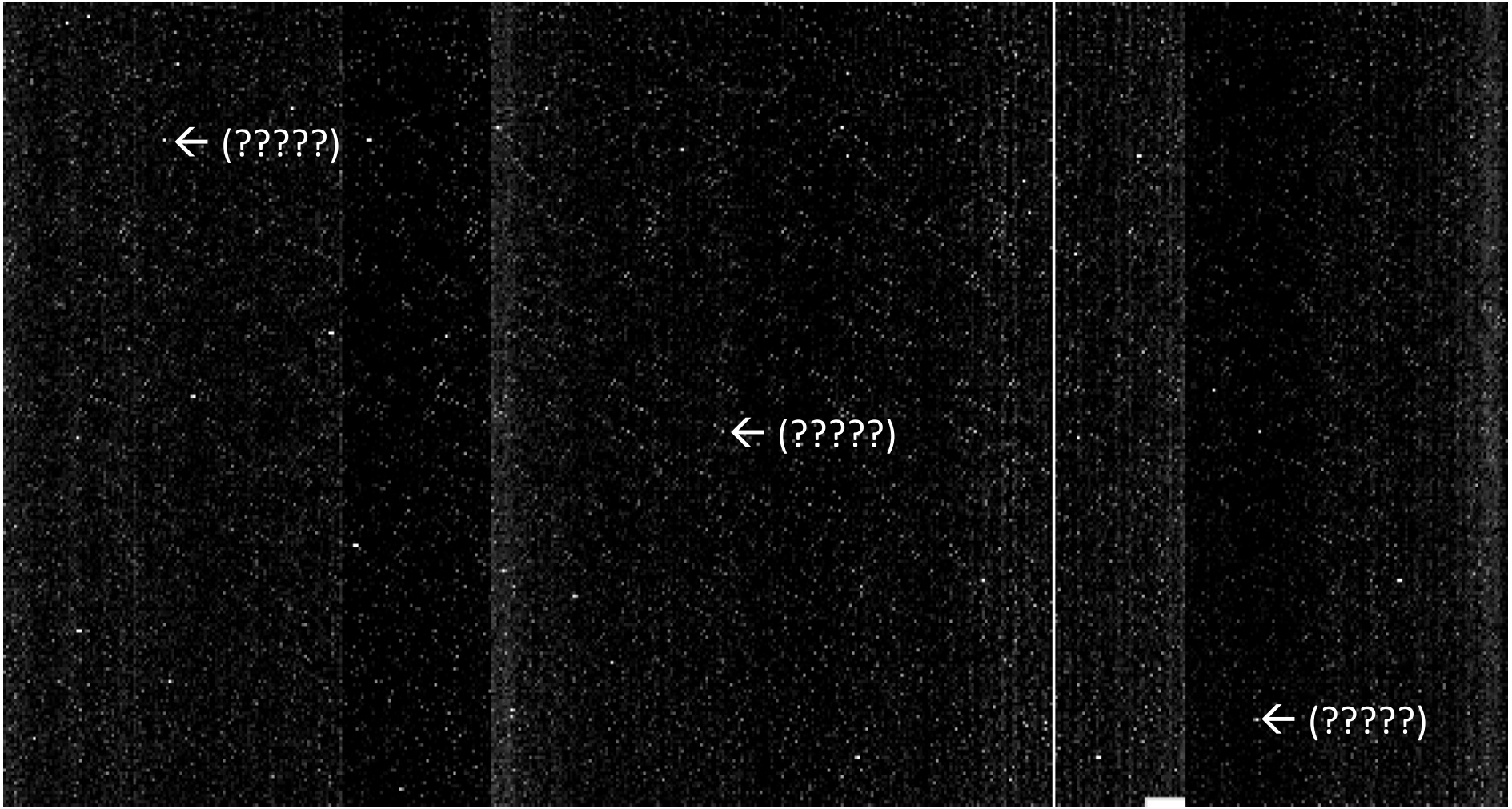
LEISA approaching MU69 (31dec2019)

lsb_0408587281_0x53c_sci.fit (calibrated), <d> = 566e3 km

Ch195
(high_res1.236 μm)

Ch127
(low_res1.5748 μm)

Ch15
(low_res2.369 μm)



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20181231_040858	lsb_0408587281	2018-12-31	18:36:03	18:42:52	MU_69	5.66e5 ?????
20181231_040858	lsb_0408593941	2018-12-31	20:27:03	20:33:52	MU_69	4.70e5 Y(???)
20181231_040860	lsb_0408605304	2018-12-31	23:36:26	23:43:12	MU_69	3.06e5 Y(???)
20190101_040860	lsb_0408606595	2018-12-31	23:57:57	00:04:43	MU_69	2.88e5 Y(??)
	lsb_0408609177	2019-01-01	00:4059	00:47:45	MU_69	2.50e5 Y(?)
20190101_040861	lsb_0408610468	2019-01-01	01:02:30	01:09:16	MU_69	2.32e5 Y
	lsb_0408613050	2019-01-01	01:45:32	01:52:18	MU_69	1.94e5 Y
	lsb_0408614341	2019-01-01	02:07:03	02:13:49	MU_69	1.75e5 Y
	lsb_0408619338	2019-01-01	03:30:20	03:37:09	MU_69	1.04e5 Y
20190101_040862	lsb_0408621929	2019-01-01	04:13:31	04:22:18	MU_69	6.55e4 Y
	lsb_0408624118	2019-01-01	04:50:00	05:05:16	MU_69	3.12e4 Y

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**** Added for this review (January 2024)**

Summary/Suggestions

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

- This includes the current data cubes, at d = 470 & 566e3 km from MU69.
- lambda 2.5-1.225um (rows0 thru 199, low res), 2.25-2.10um (rows204 thru 255, hi res). (These are separated by a ~4-row bond joint.)

- **Object MU69** is very difficult to see, in lsb_0408593941 at 470e3 km, and (especially) in lsb_0408587281 at 566e3 km. Tough if not impossible to distinguish from the "salt&pepper" noise level/pattern.

- **Extracting spectra** requires highly accurate spatial registration, both row-by-row (primary motion across lambda), but also accounting for (small) perpendicular "wobble" in stepping through lambda. Corrections were most reliable for Pluto, owing to its large apparent size during the flyby on 01-January-2019.

Questions/comments

Is there a keyword in the lbl files that informs the user as to the "sense" of data cubes? In particular, as to the direction of motion of the target when stepping through lambda?

Minor point, for clarification: *.lbl files list "TARGET_SUN_POSITION_VECTOR" and "TARGET_SUN_VELOCITY_VECTOR", yet then lists "SOLAR_DISTANCE." I suggest modifying the latter to "TARGET_SOLAR_DISTANCE" to avoid confusion with S/C solar distance (explicitly listed as such in the .lbl file).