Preliminary quality analysis

Or my First impressions dealing with EMIR data

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Motivation of my talk

- Mainly to help to the success of EMIR operation.
- Positive Criticism from the "common user" point of view, or sort of "experienced common user"
- I have not been (and I am not currently) part of EMIR team.
- Just glancing EMIR activities since mid September

I have been mostly looking at few spectra, but I also have got some feeling from imaging data.
In the next months I expect to become familiar with DRP + to help EMIR-IAC/GTC team with MOS commissioning tasks.

First contact with the data

Usually very excited after receiving e-mail from GTC-Astronomers: Observations are done!!!, but then:

Unpack the tarfile, what did we get?? :

Well organized directories with the data: flats, object, arc, std,…😀

But VERY LONG NAMES (some numbers+EMIR-STARE_SPECTRA,EMIR-TEST …) , which is VERY CONFUSING. 🙃 🙃 🙃

PROPOSAL: TO ADOPT A NON-IDENTIFICATIVE NAMING (just like EMIR-date+time, similar to ESO –VLT data)

Acquisition images & actual spectra are both named EMIR-STARE_SPECTRA!!!

Spectral-flats called as EMIR-TESTo, or IMAGE-BIAS!!!

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0001265524-20170710-EMIR-STARE_SPECTRA.fits  GTCS1-17B  0002 Teacup  14:30:31.170  13:39:47.350  MULTISLIT  169.760  170.365 -152.23100 -36.54930  Ks  OPEN  1
0001265527-20170710-EMIR-STARE_SPECTRA.fits  GTCS1-17B  0002 Teacup  14:30:31.170  13:39:47.350  MULTISLIT  169.760  170.365 -152.23100 -36.54930  Ks  OPEN  1
0001265530-20170710-EMIR-STARE_SPECTRA.fits  GTCS1-17B  0002 Teacup  14:30:31.170  13:39:47.350  MULTISLIT  169.760  170.365 -152.23100 -36.54930  Ks  OPEN  1
0001265533-20170710-EMIR-STARE_SPECTRA.fits  GTCS1-17B  0002 Teacup  14:30:31.170  13:39:47.350  MULTISLIT  169.760  170.365 -152.23100 -36.54930  Ks  OPEN  1
0001265536-20170710-EMIR-STARE_SPECTRA.fits  GTCS1-17B  0002 Teacup  14:30:31.170  13:39:47.350  MULTISLIT  169.760  170.365 -152.23100 -36.54930  Ks  OPEN  1
0001265539-20170710-EMIR-STARE_SPECTRA.fits  GTCS1-17B  0002 Teacup  14:30:31.170  13:39:47.350  MULTISLIT  169.760  170.365 -152.23100 -36.54930  Ks  OPEN  1
0001265565-20170710-EMIR-STARE_SPECTRA.fits  GTCS1-17B  0002 Teacup  14:30:31.170  13:39:47.350  MULTISLIT  169.760  170.365 -152.09300 -36.51770  Ksp  K  1
0001265591-20170710-EMIR-STARE_SPECTRA.fits                                                                 169.760  170.365 -165.74699 -37.31140  Ksp  K  1
0001265617-20170710-EMIR-STARE_SPECTRA.fits                                                                 169.760  170.365 -165.74699 -37.31140  Ksp  K  1
0001265643-20170710-EMIR-STARE_SPECTRA.fits                                                                 169.760  170.365 -166.34300 -37.17940  Ksp  K  1
0001265669-20170710-EMIR-STARE_SPECTRA.fits                                                                 169.760  170.365 -166.34300 -37.17940  Ksp  K  1
0001265695-20170710-EMIR-STARE_SPECTRA.fits                                                                 169.760  170.365 -167.26601 -36.96470  Ksp  K  1
0001265721-20170710-EMIR-STARE_SPECTRA.fits                                                                 169.760  170.365 -167.96400 -36.79550  Ksp  K  1
0001265747-20170710-EMIR-STARE_SPECTRA.fits                                                                 169.760  170.365 -167.96400 -36.79550  Ksp  K  1

Flat
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0001268008-20170710-EMIR-TEST0.fits  SPECTRAL_CALIBs  CALIB SpectralFlat  23:19:21.845  76:45:44.400  CSU_OPEN  169.766  170.362 -123.48500  17.71180  Ksp  K  1
0001268011-20170710-EMIR-TEST0.fits  SPECTRAL_CALIBs  CALIB SpectralFlat  23:19:21.845  76:45:44.400  CSU_OPEN  169.766  170.362 -123.48500  17.71180  Ksp  K  1
0001268014-20170710-EMIR-TEST0.fits                                                                         169.766  170.362 -123.48500  17.71180  Ksp  K  1
0001268017-20170710-EMIR-TEST0.fits                                                                         169.766  170.362 -123.48500  17.71180  Ksp  K  1
0001268020-20170710-EMIR-TEST0.fits                                                                         169.766  170.362 -123.48500  17.71180  Ksp  K  1
0001268023-20170710-EMIR-IMAGE_BIAS.fits                                                                    169.766  170.362 -120.20000  -0.01597  Ksp  K  1
0001268026-20170710-EMIR-IMAGE_BIAS.fits                                                                    169.766  170.362 -120.20000  -0.01597  Ksp  K  1
0001268029-20170710-EMIR-IMAGE_BIAS.fits                                                                    169.766  170.362 -120.20000  -0.01597  Ksp  K  1
0001268032-20170710-EMIR-IMAGE_BIAS.fits                                                                    169.766  170.362 -120.20000  -0.01597  Ksp  K  1
0001268035-20170710-EMIR-IMAGE_BIAS.fits                                                                    169.766  170.362 -120.20000  -0.01597  Ksp  K  1

Arcs
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0001267999-20170710-EMIR-TEST0.fits  SPECTRAL_CALIBs  CALIB ArcLamp_HgAr  23:19:21.845  76:45:44.400  CSU_OPEN  169.766  170.362 -123.48500  17.71180  Ksp  K  1
0001268002-20170710-EMIR-TEST0.fits  SPECTRAL_CALIBs  CALIB ArcLamp_Ne  23:19:21.845  76:45:44.400  CSU_OPEN  169.766  170.362 -123.48500  17.71180  Ksp  K  1
0001268005-20170710-EMIR-TEST0.fits  SPECTRAL_CALIBs  CALIB ArcLamp_Xe  23:19:21.845  76:45:44.400  CSU_OPEN  169.766  170.362 -123.48500  17.71180  Ksp  K  1

Spectrophotometric standard
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0001265850-20170710-EMIR-TEST0.fits  CALIB  CALIB STD_BD+133373  17:27:04.810  13:39:02.454  MULTISLIT  168.019  168.660 -170.25400 -35.86870  Ksp  OPEN  1
0001265856-20170710-EMIR-STARE_SPECTRA.fits  CALIB  CALIB STD_BD+133373  17:27:04.810  13:39:02.454  MULTISLIT  168.019  168.660 -168.43201 -36.51450  Ksp  K  1
0001265862-20170710-EMIR-STARE_SPECTRA.fits  CALIB  CALIB STD_BD+133373  17:27:04.368  13:38:48.872  MULTISLIT  168.019  168.660 -167.92000 -36.71410  Ksp  K  1
0001265868-20170710-EMIR-STARE_SPECTRA.fits  CALIB  CALIB STD_BD+133373  17:27:04.368  13:38:48.872  MULTISLIT  168.019  168.660 -167.92000 -36.71410  Ksp  K  1
0001265874-20170710-EMIR-STARE_SPECTRA.fits  CALIB  CALIB STD_BD+133373  17:27:04.810  13:39:02.453  MULTISLIT  168.019  168.660 -167.92000 -36.71410  Ksp  K  1
```

Reading the data-log or qc-report

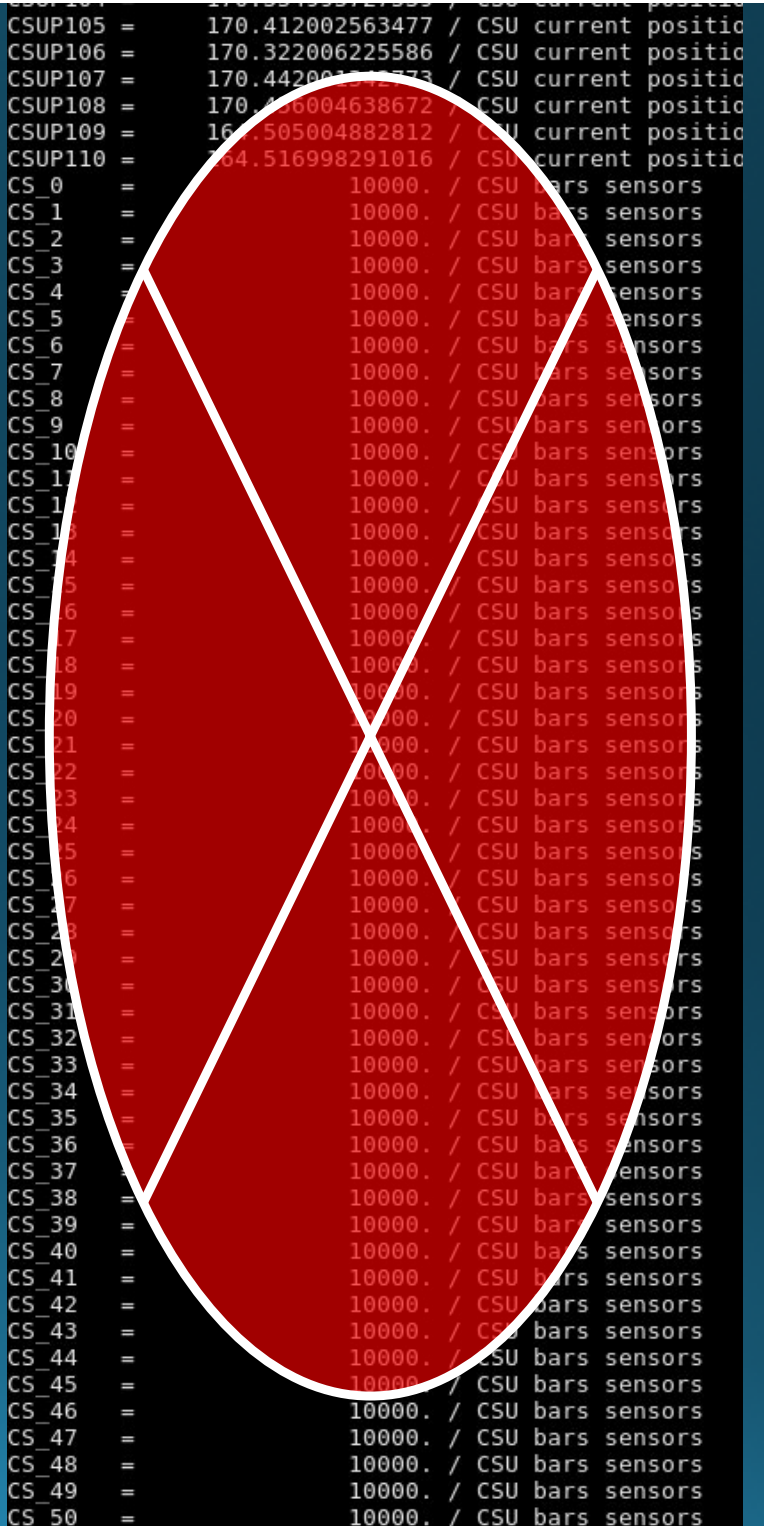
- QC reports seem very useful, but still contain several keywords which are difficult to interpret (~NOBSBLCK) or not relevant at this level (XDTU, YDTU, CSU, …). Format is not very user-friendly: quantities such as IPA, AIRMASS, M2UZ... with many decimal places.

CSUSTATE	CSUP28	CSUP83	XDTU	YDTU	FILTER	GRISM	IPA	AIRMASS	M2UZ	NOBSBLCK	OBSE
351	MULTISLIT	0.500	0.497	-151.96201	-36.52310	Ks	OPEN	123.95010000	1.129937	-4.62026	1	1
351	MULTISLIT	0.500	0.497	-151.96201	-36.52310	Ks	OPEN	123.95010000	1.130139	-4.62009	1	1
351	MULTISLIT	0.500	0.497	-151.96201	-36.52310	Ks	OPEN	123.95010000	1.130341	-4.61994	1	1
417	MULTISLIT	0.500	0.497	-151.96201	-36.52310	Ks	OPEN	123.95010000	1.131030	-4.61947	1	1
417	MULTISLIT	0.500	0.497	-151.96201	-36.52310	Ks	OPEN	123.95010000	1.131232	-4.61928	1	1
417	MULTISLIT	0.500	0.497	-151.96201	-36.52310	Ks	OPEN	123.95010000	1.131436	-4.61900	1	1
417	MULTISLIT	0.500	0.497	-151.96201	-36.52310	Ks	OPEN	123.95010000	1.131673	-4.61896	1	1
417	MULTISLIT	0.500	0.497	-151.96201	-36.52310	Ks	OPEN	123.95010000	1.131877	-4.61880	1	1
417	MULTISLIT	0.500	0.497	-151.96201	-36.52310	Ks	OPEN	123.95010000	1.132081	-4.61863	1	1
351	MULTISLIT	0.500	0.497	-151.96201	-36.52310	Ks	OPEN	123.95010000	1.132645	-4.61814	1	1
351	MULTISLIT	0.500	0.497	-151.96201	-36.52310	Ks	OPEN	123.95010000	1.132850	-4.61795	1	1
351	MULTISLIT	0.500	0.497	-151.96201	-36.52310	Ks	OPEN	123.95010000	1.133055	-4.61751	1	1
351	MULTISLIT	169.760	170.365	-152.23100	-36.54930	Ks	OPEN	123.95010000	1.158106	-4.59597	1	1
351	MULTISLIT	169.760	170.365	-152.23100	-36.54930	Ks	OPEN	123.95010000	1.158343	-4.59591	1	1
351	MULTISLIT	169.760	170.365	-152.23100	-36.54930	Ks	OPEN	123.95010000	1.158580	-4.59575	1	1
351	MULTISLIT	169.760	170.365	-152.23100	-36.54930	Ks	OPEN	123.95010000	1.158817	-4.59572	1	1
351	MULTISLIT	169.760	170.365	-152.23100	-36.54930	Ks	OPEN	123.95010000	1.159055	-4.59538	1	1
351	MULTISLIT	169.760	170.365	-152.23100	-36.54930	Ks	OPEN	123.95010000	1.159332	-4.59500	1	1
417	MULTISLIT	169.760	170.365	-152.23100	-36.54930	Ks	OPEN	123.95010000	1.160100	-4.59447	1	1
417	MULTISLIT	169.760	170.365	-152.23100	-36.54930	Ks	OPEN	123.95010000	1.160340	-4.59439	1	1
417	MULTISLIT	169.760	170.365	-152.23100	-36.54930	Ks	OPEN	123.95010000	1.160579	-4.59431	1	1

Exploring the FITS data

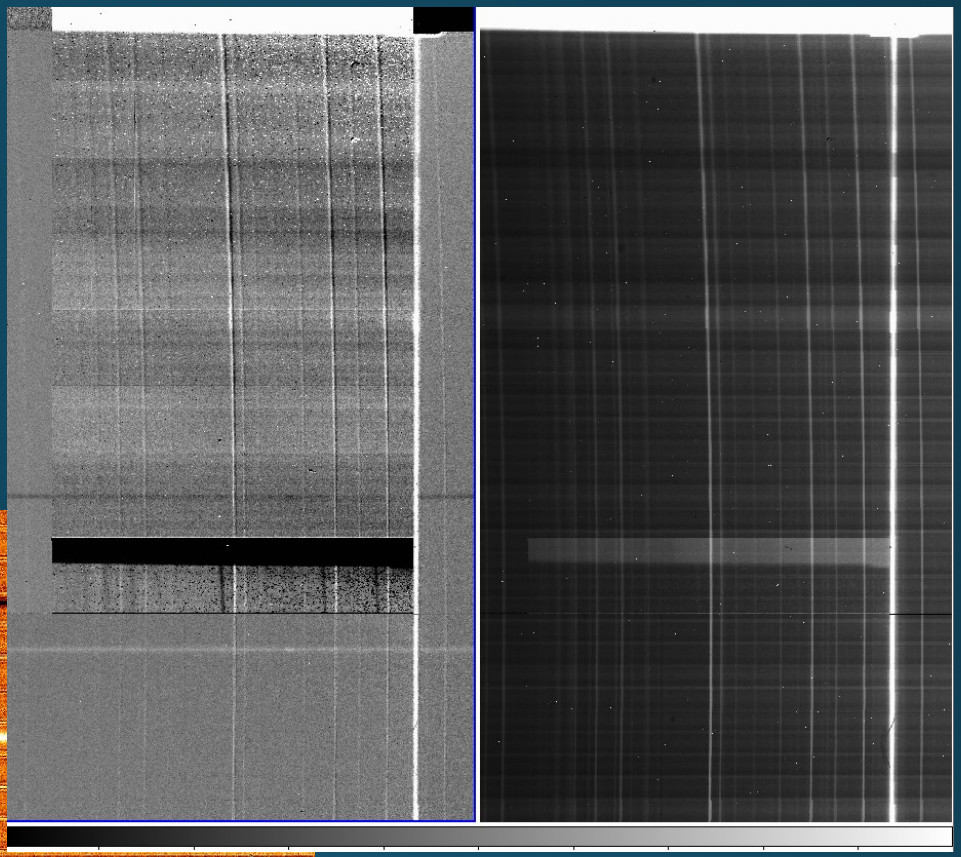
- Data files contain 2 extensions: what are they? Where is the information about this?
- Detector drift correction has been validated on sky data?

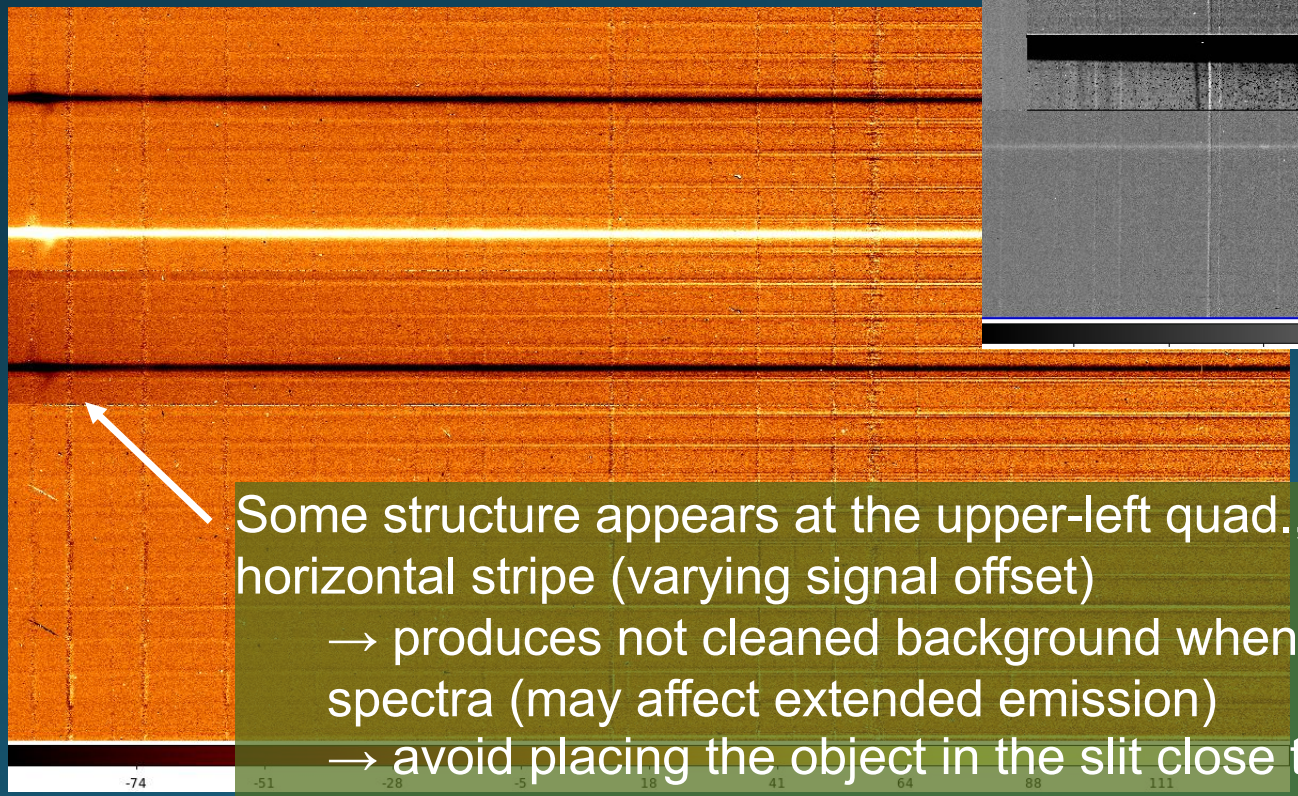
- Image header contain many keywords related to CSU (not very useful for the astronomer):
  - → better to write a new FITS-extension with such specific information



Detector anomalies

Bad behaviour in a section of the detector, seen twice in the inspected dataset. It may ruin a long sequence, it does appear in a single exposure, not affecting near ones. It may be difficult to avoid and predict.



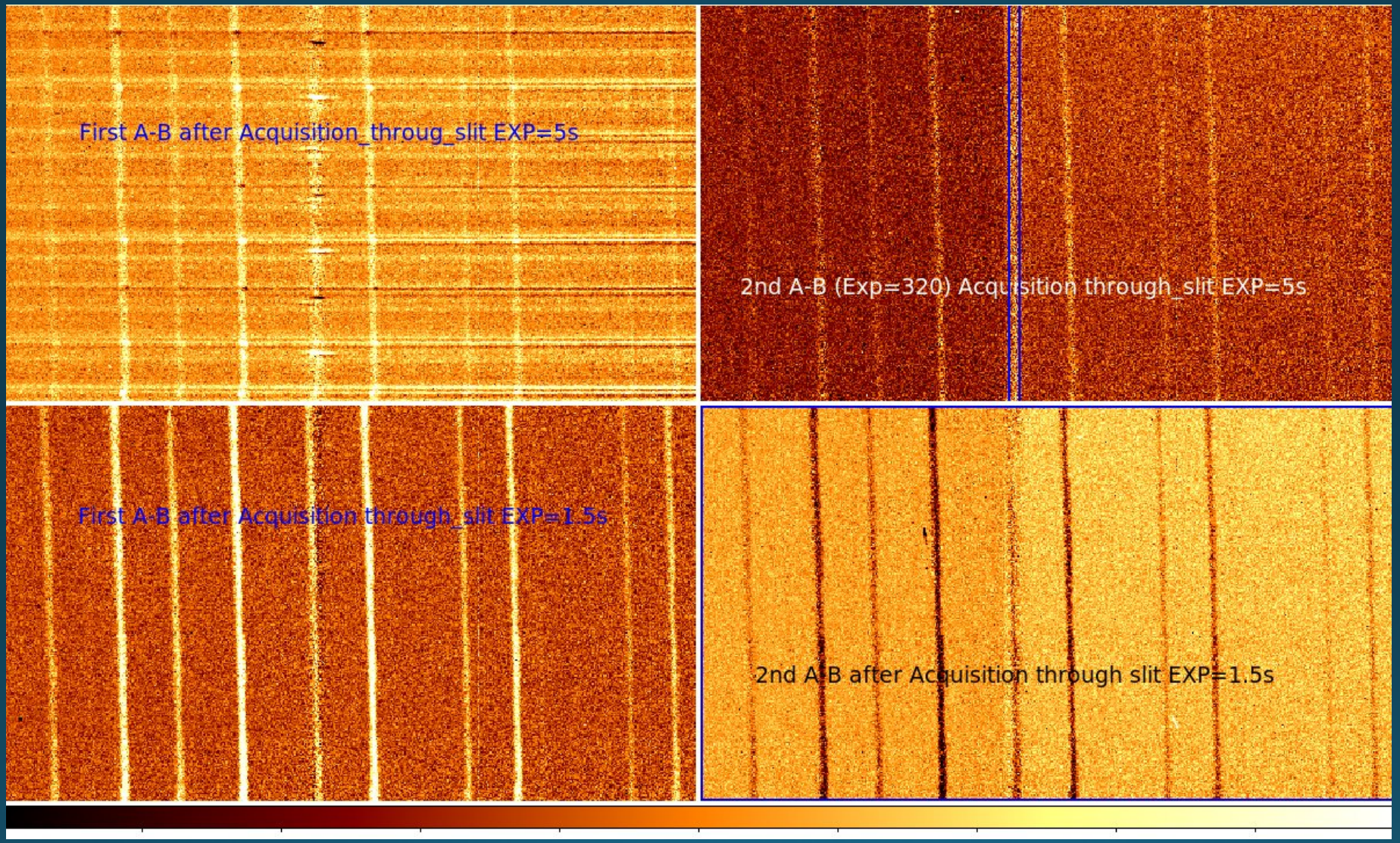


Some structure appears at the upper-left quad., in the 1st bottom horizontal stripe (varying signal offset)

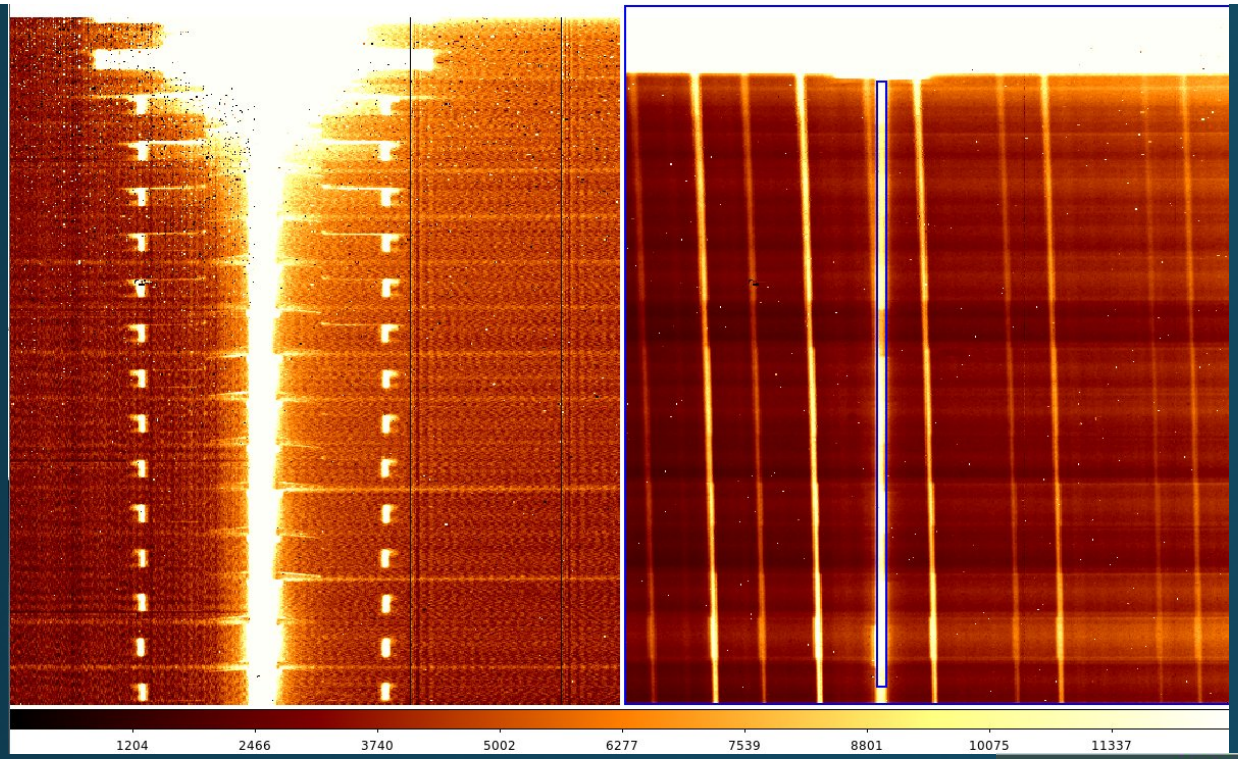
→ produces not cleaned background when subtracting sky to the spectra (may affect extended emission)

→ avoid placing the object in the slit close to these rows

Detector defects or effects - Persistence

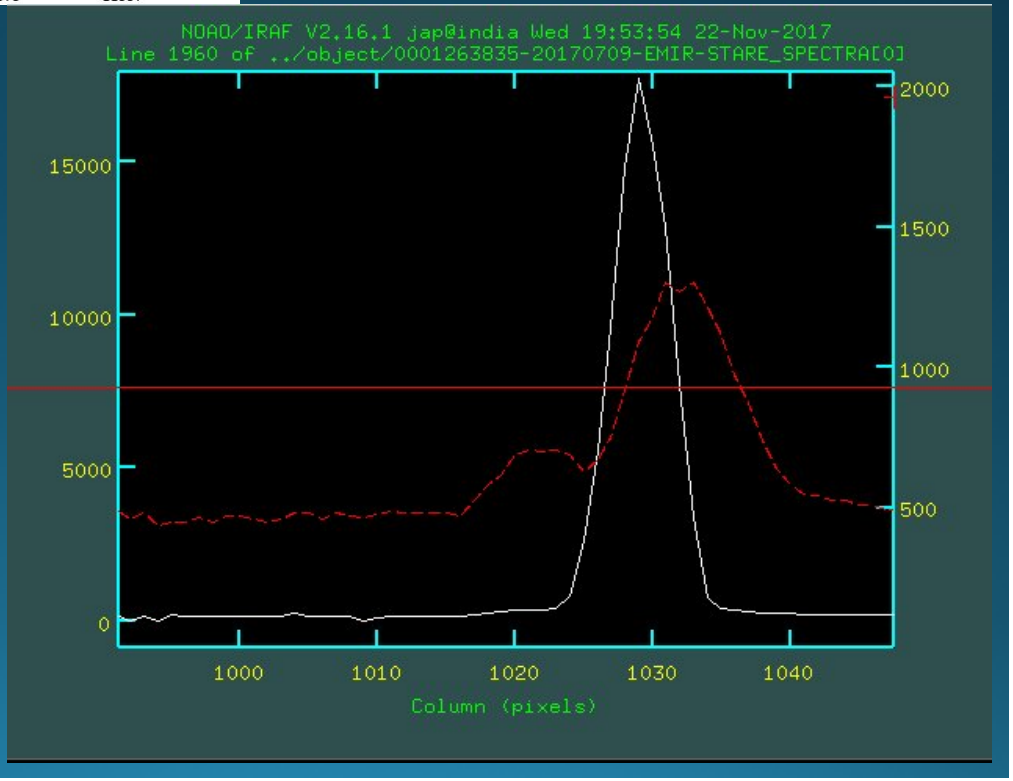


- Persistence: memory from previous observations, critical when observing bright targets or changing from imaging to spectroscopy, e.g. image_through_slit [ITS] (see example above). Possible Solutions:
- avoid exposing long in the ITS,
- if unavoidable, before starting science frames take few cleaning images



Strange effects in the data – A ghost sky line

It appears as bright sky line but it is NOT (just vertical line, not curved)
It looks like a memory effect from previous image through slit, but peak of emission is shift respect to slit position.
It persists along several exposures

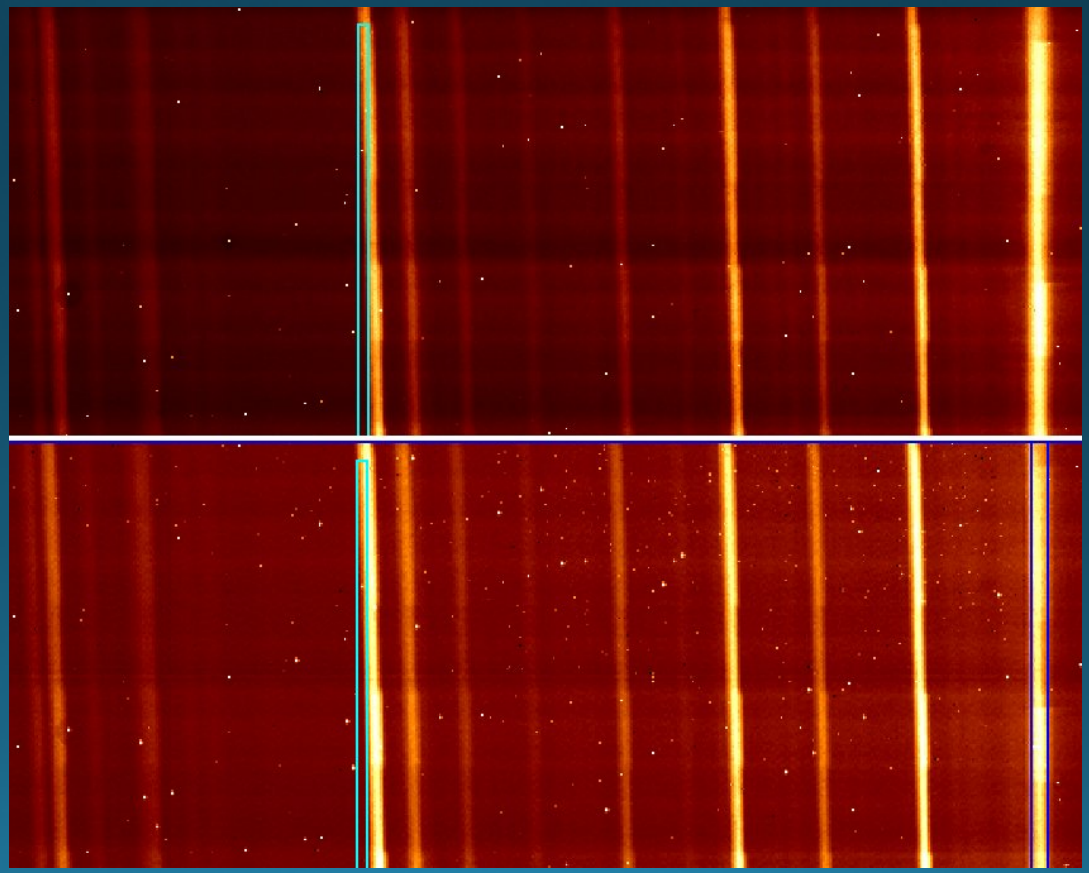


Spectroscopy

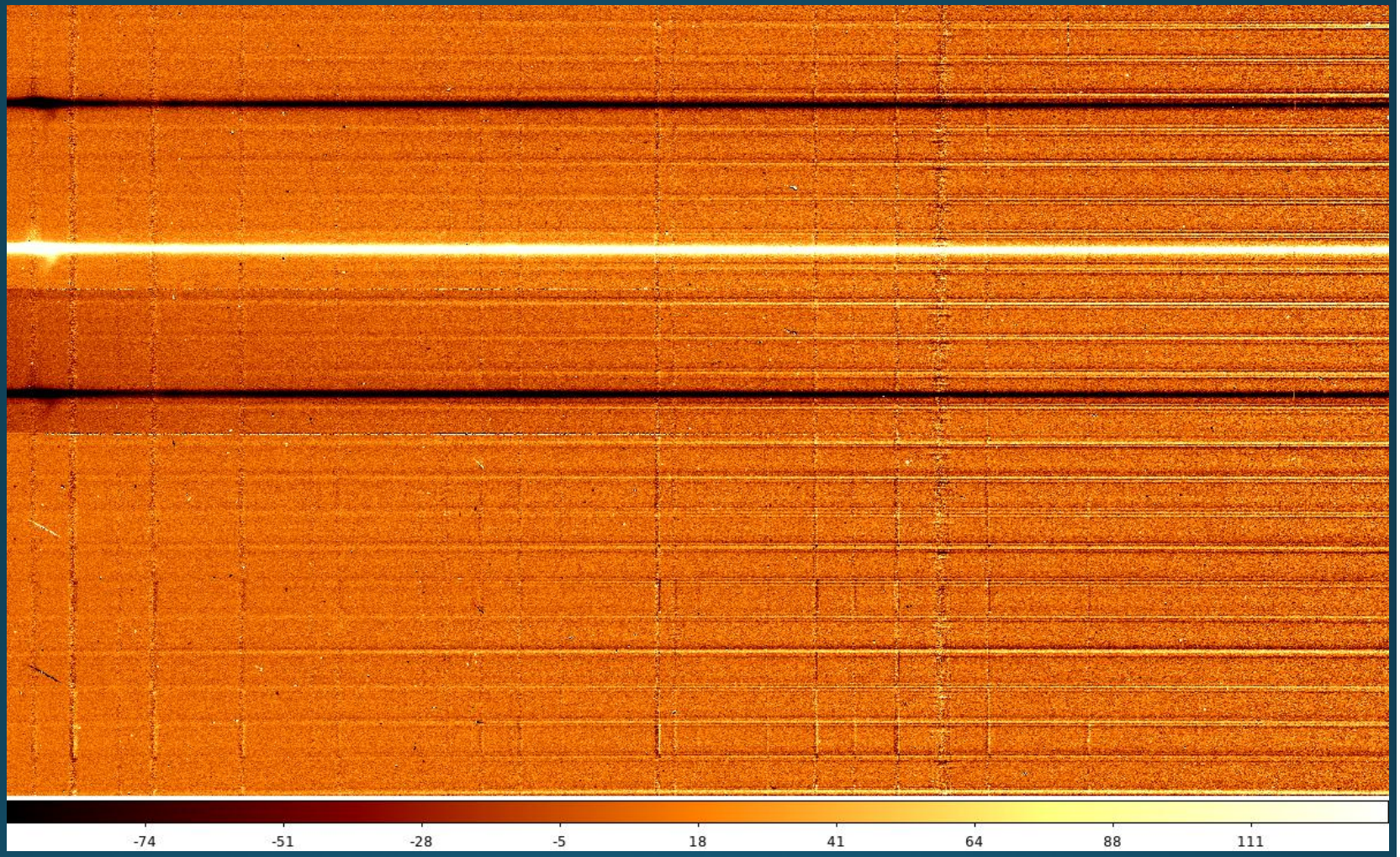
- Spectroscopic setup seems rather stable:
  - sky-line position is well fixed in the detector after relatively long-exposures
  - Sky line position is mantained after several nights by less than …
  - Most of sky line subtraction noise comes from non-uniformous slit witdth.
  - Recomendation: when observing very faint targets, search for a reference brightness target to be placed in the slit at the same time, VERY useful to coadd frames and to check quality along the exposures (eventually - clouds passing, seeing worsening, autoguider jumps, others…)

First experience with spectroscopy

- Spectroscopic setup seems rather stable:
  - sky-line position is very stable in the detector after relatively long-exposures (but based on not many examples)
  - Sky line positions are constant after several nights by about +/-0.5 pixel – no need to take arcs very frequently, just for quality check

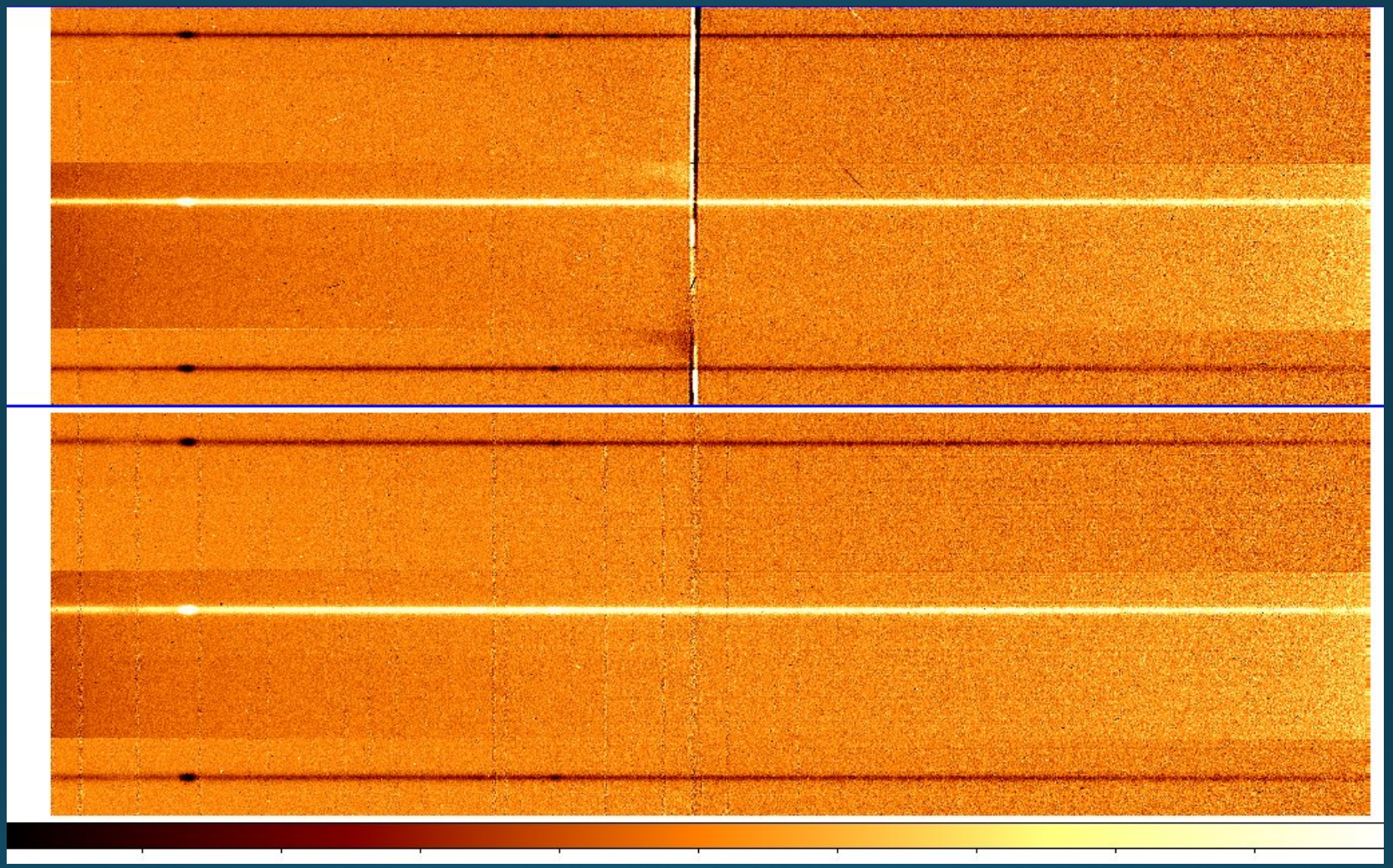


K-band spectroscopy



- Analized several OBs from objects with emission lines, using K grism.
  - Reduced using “old-fashion” IRAF+LIRISDR (A-B+shift-and-add)
  - Satisfactory sky line subtraction but residuals are mostly due to:
    - Differences of slit width of different bars (supposed to be improved soon)
    - horizontal lines (persistence, light leaking through bars?, ???)

K-band spectroscopy+



- Analized several OBs from objects with emission lines, using K grism.
  - Reduced using “old-fashion” IRAF+LIRISDR (A-B+shift-and-add)
  - Satisfactory sky line subtraction but residuals are mostly due to:
    - Differences of slit width of different bars (supposed to be improved soon)
    - in this case no horizontal lines, but offset difference in one of stripes
    - Anomalous detector behaviour

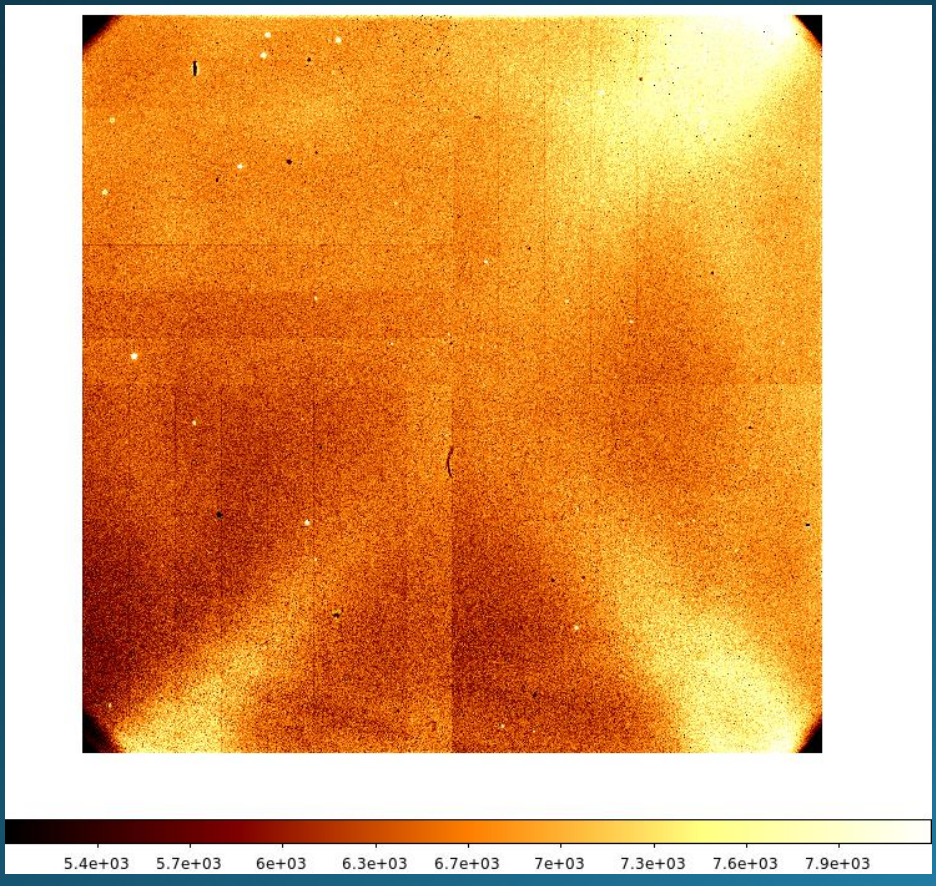
Espectroscopy of very faint targets

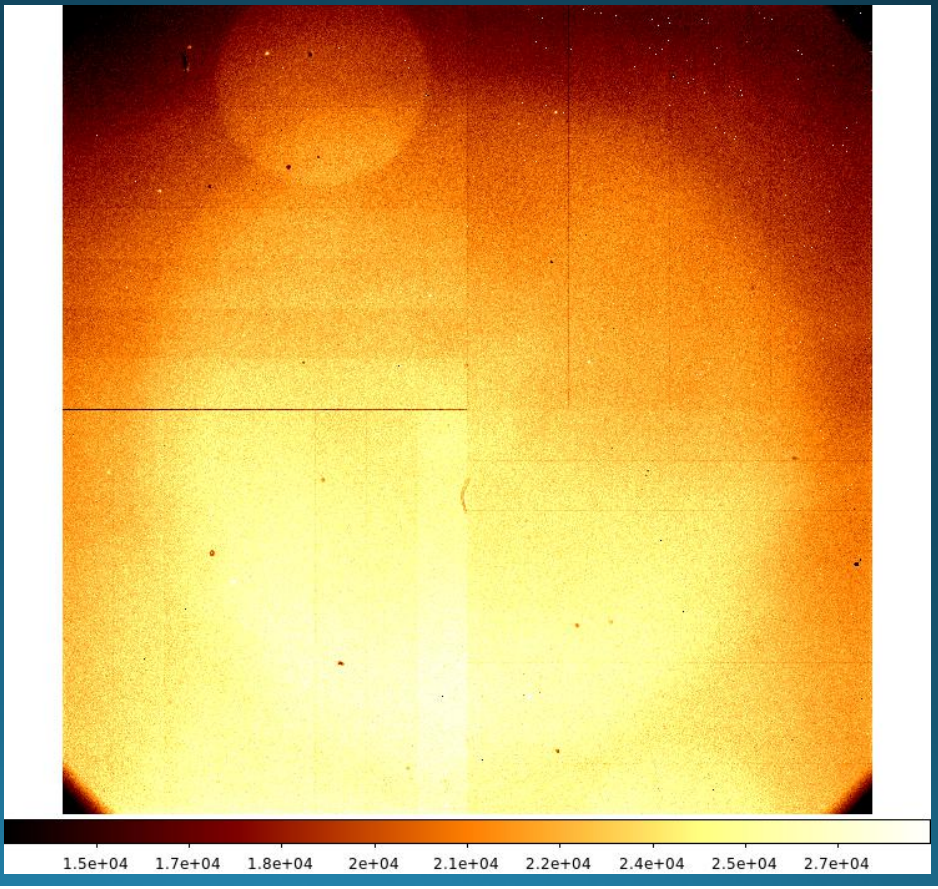
My advice is:

- If long-slit mode add a reference target (not fainter than K~16-17 to be well detected in 300s or less, TBC by EMIR ETC) in the slit, adapt slit orientation. It is very useful to:
  - help with spectra combination during data reduction
  - Check quality of individual exposures, seeing may change dramatically, cirrus passing, AG jumps or drifts, whatever…
- If MOS mode reserve 1-2 slit positions for reference star for same reasons

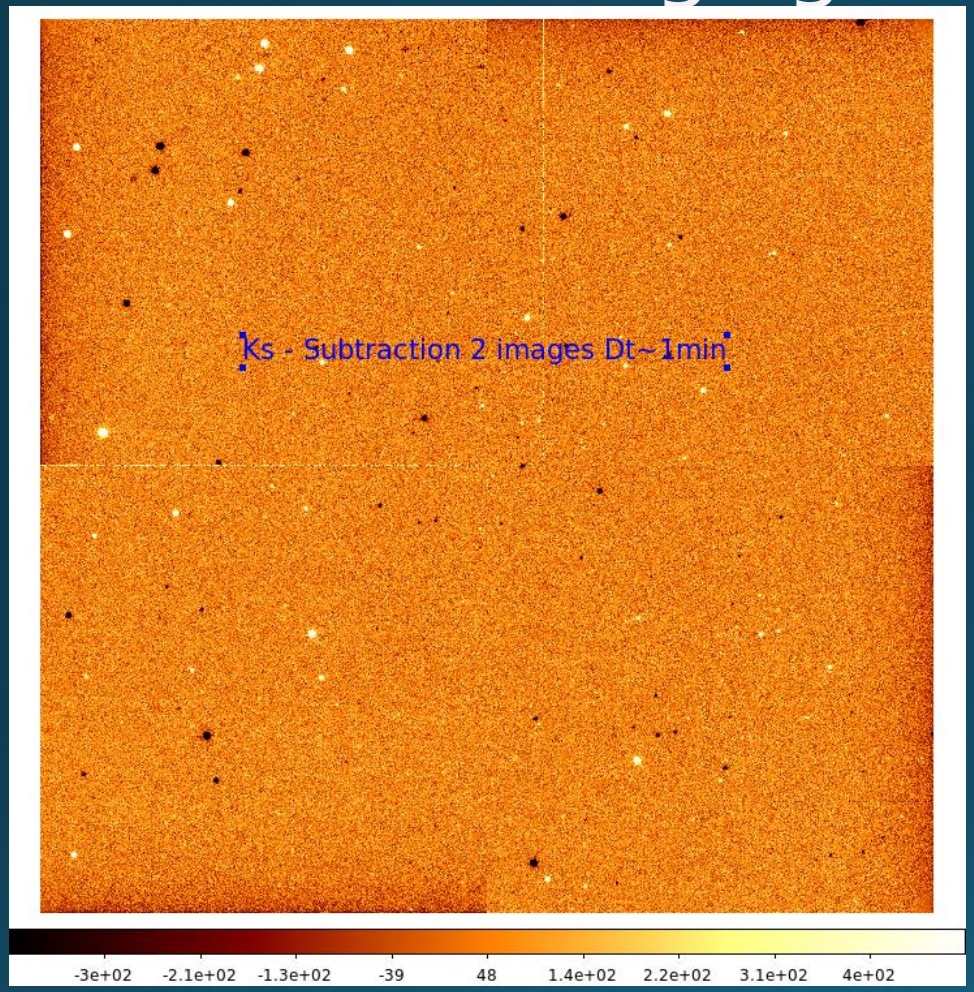
Imaging mode

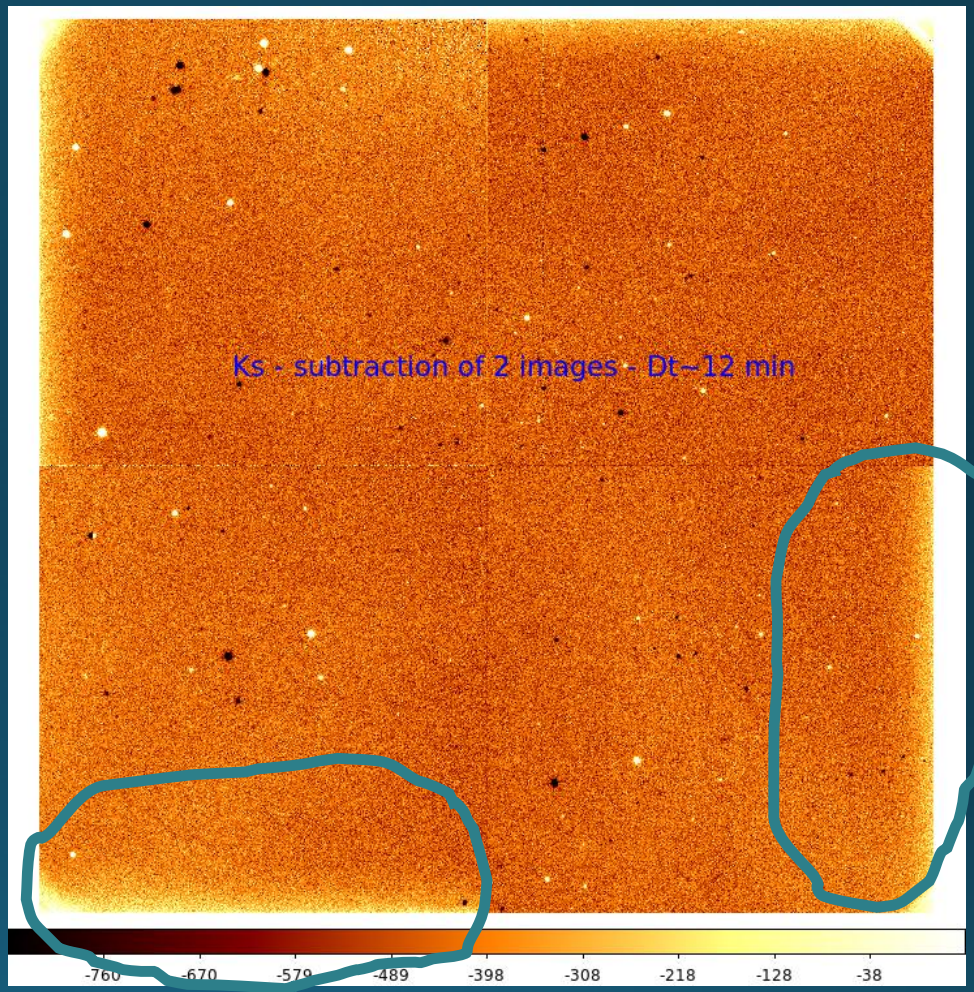
- Images taken at Ks and H2 (1-0) using STARE_MODE (which is actually DITHERING MODE!!!)
- Raw Images show peculiar structures:
  - Sort of diagonal shadows in the Ks band
  - Two non-concentric diffuse circles in the H2 band





More on Imaging mode – differential

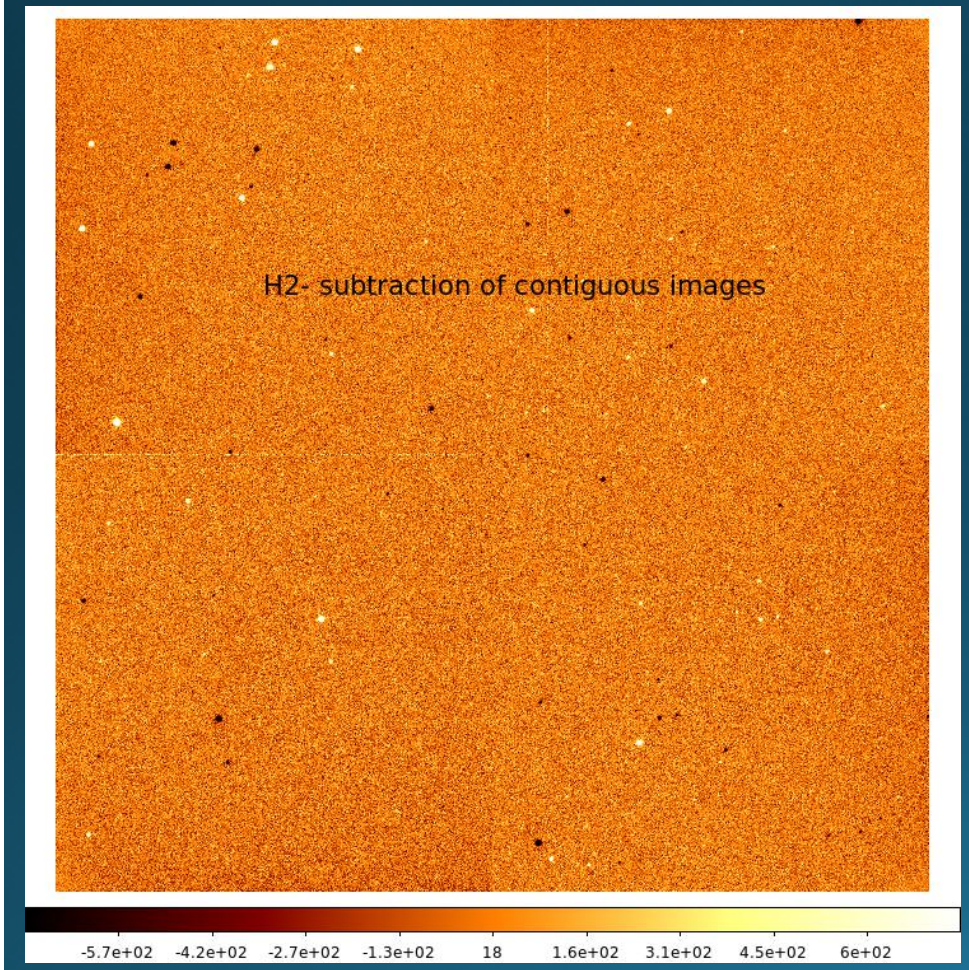


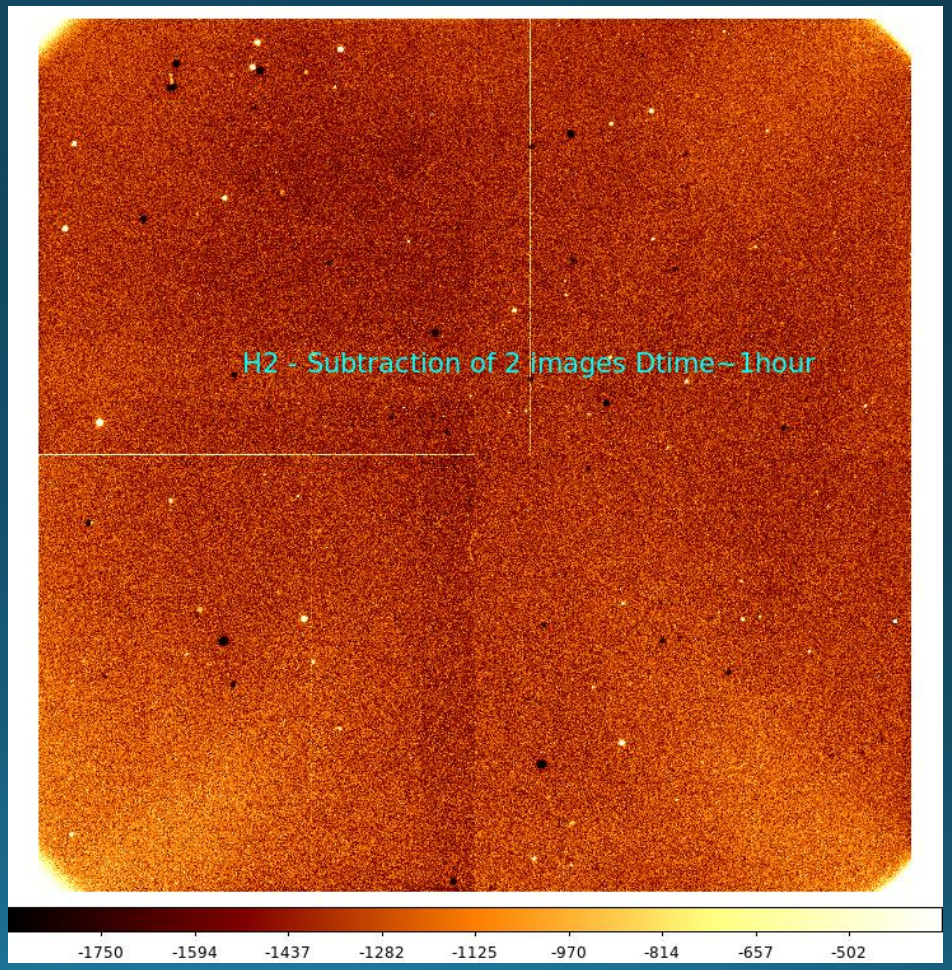


- After subtraction peculiar structures tend to dissappear but new things come:
  - In the broad band (Ks) the residual structures resemble read-out scheme (likely related to detector drift)

More on Imaging mode – differential

- After subtraction peculiar structures tend to dissappear but new things come





DRP

- Actually no time to test, but good feeling after browsing manuals, although bit scared about complexity.
- Guess that Numina and PyEMIR manuals will be carefully updated to recent developments and changes: To avoid things like Pyemir as instrument name is set to MEGARA (!!!), not critical but suspicious…