

EMIR@GTC: Lights and Shades

S. Fernández-Acosta

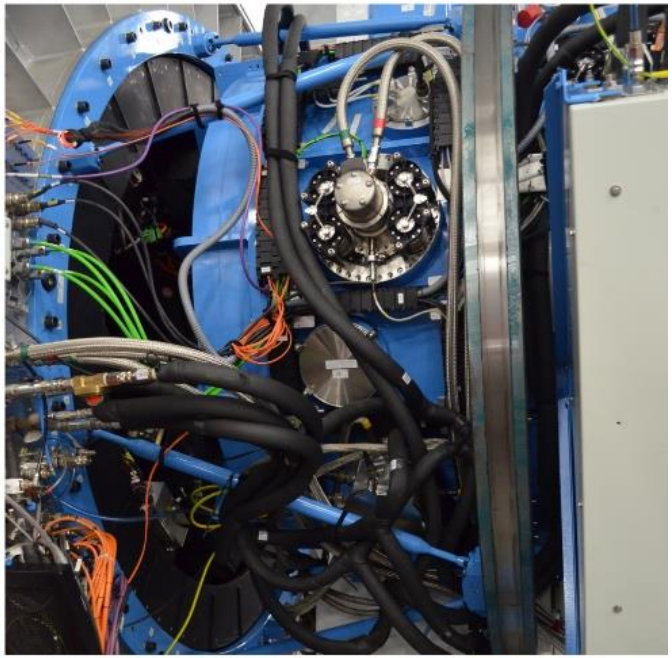
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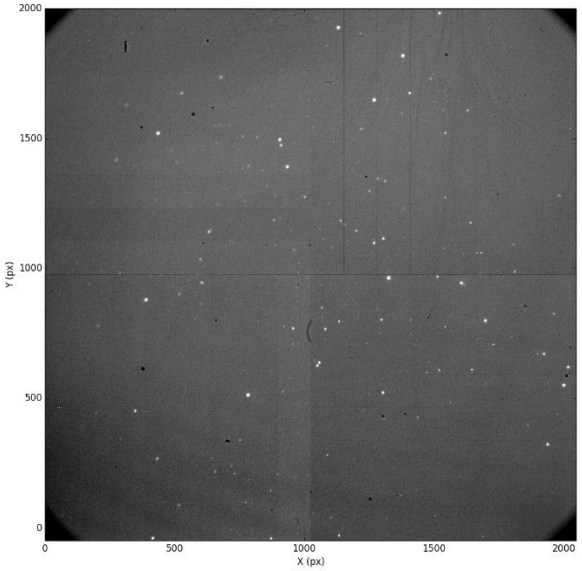
EMIR@GTC: Lights and Shades

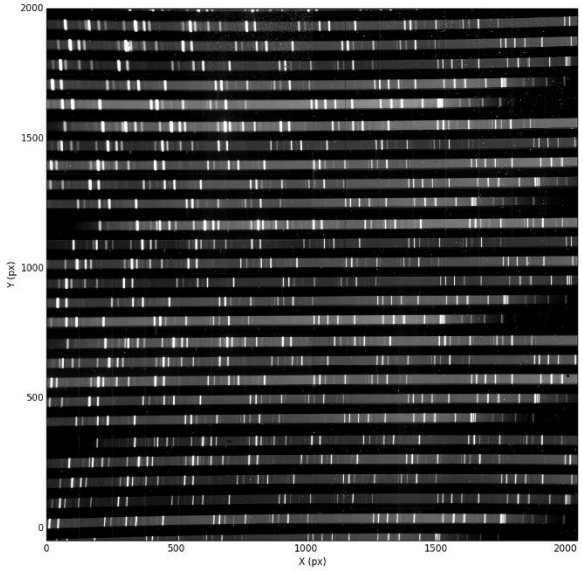
Outline:

- *EMIR@GTC: 17 months since first light. Current status*
- *Lights:*
  - **High expectations and interest from the community**
  - **Hardware is performing reliably now**
  - **Good overall performance and data quality**
- *Shades:*
  - **Non-Conformities:**
    - Detector Tilt => defocus across FOV
    - Entrance Window air supply (operational constraints and cleanliness)
    - "Software"
  - **CSU**
    - Lack of calibration => MOS pending & non-uniform LS
    - Operational constraints and current status
  - **DTU: Err48 and wrong flexure compensation**
  - **Observational Efficiency (Acquisition Overheads!) and low flexibility**
    - Note on Efficiency Calculator
  - **Progress Rate:** low efficiency (telescope constraints, lack of resources, tight schedule with other instruments, etc.)
  - **GTC issues:** Sky Offsets / Software / Image Stability?? / Other??

- *EMIR@GTC: 17 months since first light.*
- *First light: June 13th, 2016*
  - The so expected completion of a phase (it's been a long project), but just the **BEGINING** of a new and still very challenging stage in the project's lifecycle.



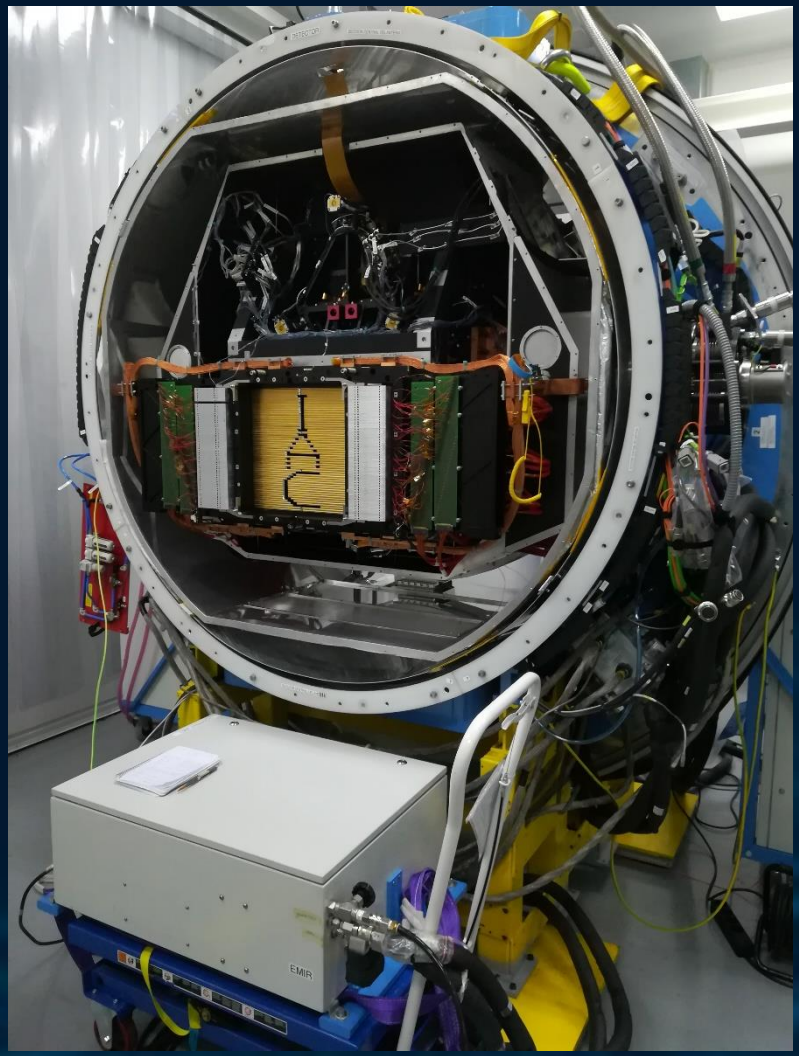






• *EMIR@GTC: 17 months since first light. Current status*

- *EMIR undergoing a major maintenance stand-down*
  - Correct detector tilt
  - CSU preventive maintenance (cleaning, pads and new piezos)
  - General inspection and cleaning of dewar interior
  - Cryocoolers corrective and preventive maintenance
  - Window cleaning
- *Expected to be back on the telescope first half of Jan 2018*
- *Multidisciplinary team (IAC/GTC)*
  - Science => Paco, Lee, Nieves, Peter, Antonio & Sergio
  - Eng => Mary, Ángel, Jesús, Nauzet, Enrique, Felipe, Roberto, Fran, Andreas, Luis A., Manoli, etc…



- *EMIR@GTC: Lights (I)*
- *High expectations and interest from the community*
  - Successful CfP for **Science Verification**:
    - > 40 programs from > 30 different Pis requesting near 300 hours!
    - Main goal is validating the instrument performance on-sky for not too tough real science cases => **13 programs approved**
    - **Total of 39.09 hours delivered** for 8 different programs.
      - 3 reports received (+2 informal comments)
      - **1 paper accepted** with EMIR data! Lodieu et al. =>
  - **TAC open time** requests:
    - **S17B**
      - **517,5 h approved (34.8%)**
      - **80.9 h delivered** (31.6%) since July 01st (extended sem.)
    - **S18A**
      - ~500 h requested
      - Almost 60 h from China

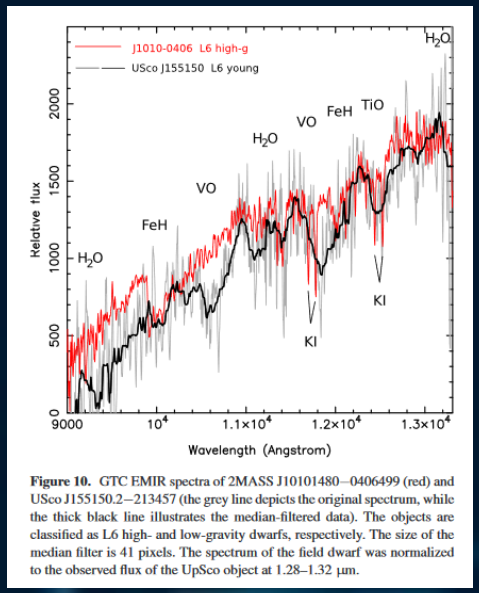


Figure 10. GTC EMIR spectra of 2MASS J10101480−0406499 (red) and USco J155150.2−213457 (the grey line depicts the original spectrum, while the thick black line illustrates the median-filtered data). The objects are classified as L6 high- and low-gravity dwarfs, respectively. The size of the median filter is 41 pixels. The spectrum of the field dwarf was normalized to the observed flux of the UpSco object at 1.28–1.32 μm.

BUT the interest need to be developed and keeping our community engaged is a must. Potential data quality issues, lack of end-user support (DRP) and further delays (MOS) can move our users away from EMIR@GTC!!

EMIR@GTC: Lights (II)

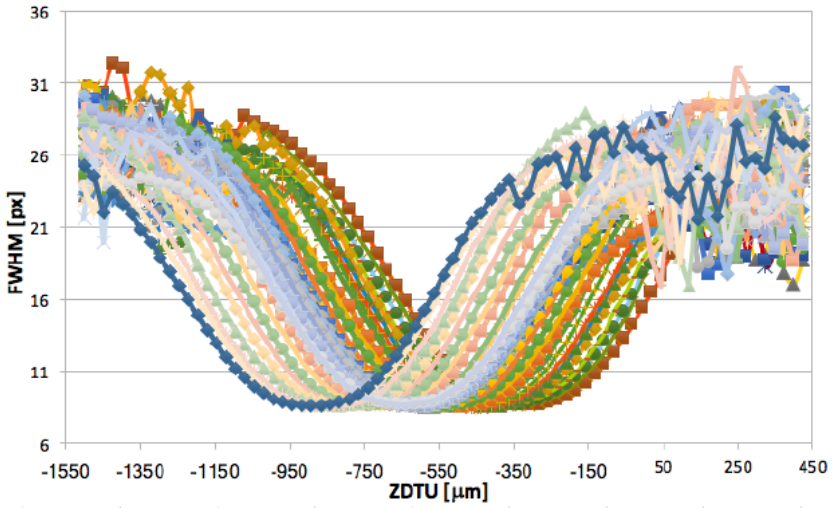
- *Hardware is performing reliably now*
  - **Mechanisms**:
    - **Wheels** (Filters and Grisms) have not failed
    - **DTU**: several instances of ERR48 which might be a mixed of hardware and software related issues. Software modifications have reduced its recurrence to negligible values
    - **CSU**: initially suffered sporadic faults. It was diagnosed to be a problem with insufficient power supplied to the unit because of a faulty connector. After repair, it has not failed again. More than 110 m of travel per bar (+50m of tests by Paco)
  - **DAS**:
    - SDSU Power Supply failures (x2), but repaired and improved
    - Sporadic readout issues (very infrequent!)
  - **Cryogenics & Vacuum:**
    - Coldheads in our (new) 100+m lines are performing well
    - Good vacuum levels

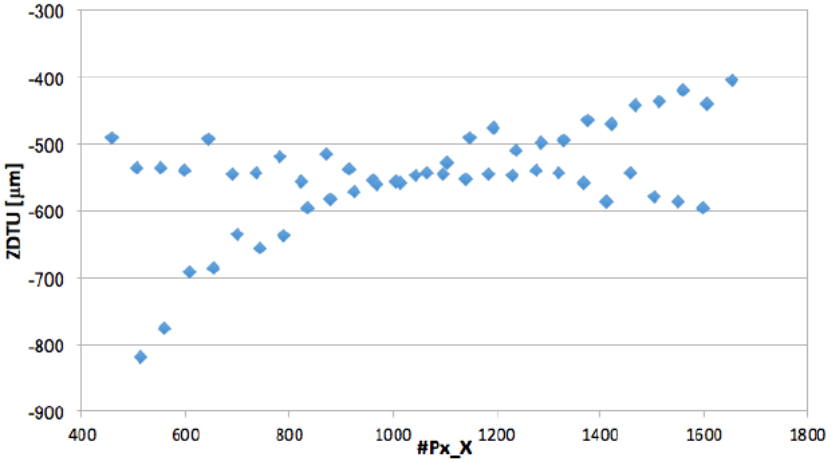
- *Good overall performance - to be detailed by Paco and other instrument team members*
  - Good throughput:
    - ZP_J=25,14±0,17
    - ZP_H=25,26±0,21
    - ZP_{Ks}=24,81±0,33
  - Data Quality fulfills specs

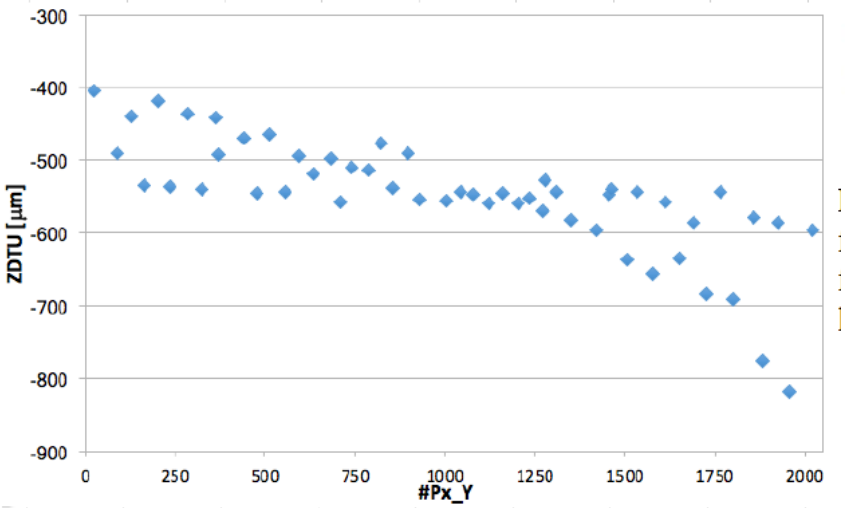
- *We are close (but…) to having a real (and very much expected) NIR workhorse multiobject spectrograph @GTC. But it is a facility instrument of a multi-inst-queue mode telescope…*

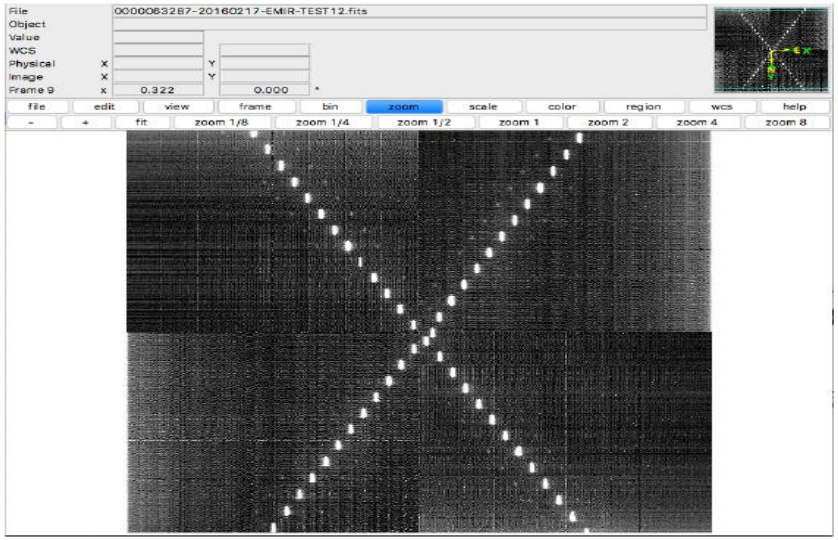
EMIR@GTC: Shades (I) - Non-Conformities

- *Detector tilt*
  - Around 7.5-8 mrad around horizontal axis and 6 mrad around vertical axis (±1 mrad)
  - Results in a defocus gradient across the FOV:









• EMIR@GTC: Shades (II) - Non-Conformities

• Detector tilt correction

- Adjustment made on Nov 15th, with rough metrology at room temperature.
- Potential error (without considering warm to cryogenics uncertainties) = 1.5 mrad => (80 um peak to peak defocus, not to far from focus depth ±25 um)

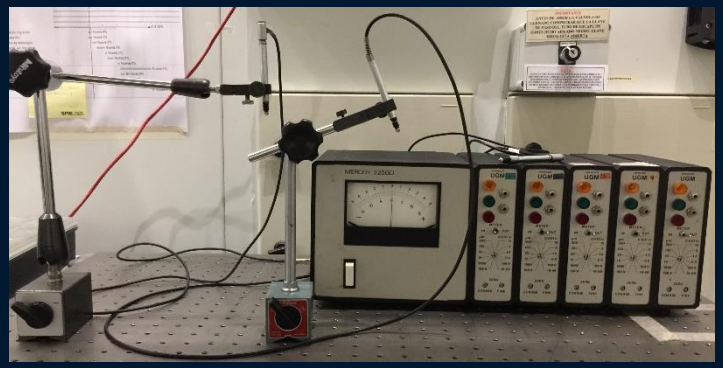


Ilustración 8. MERCER 225 GD (Panel Frontal con tres sondas micrométricas)

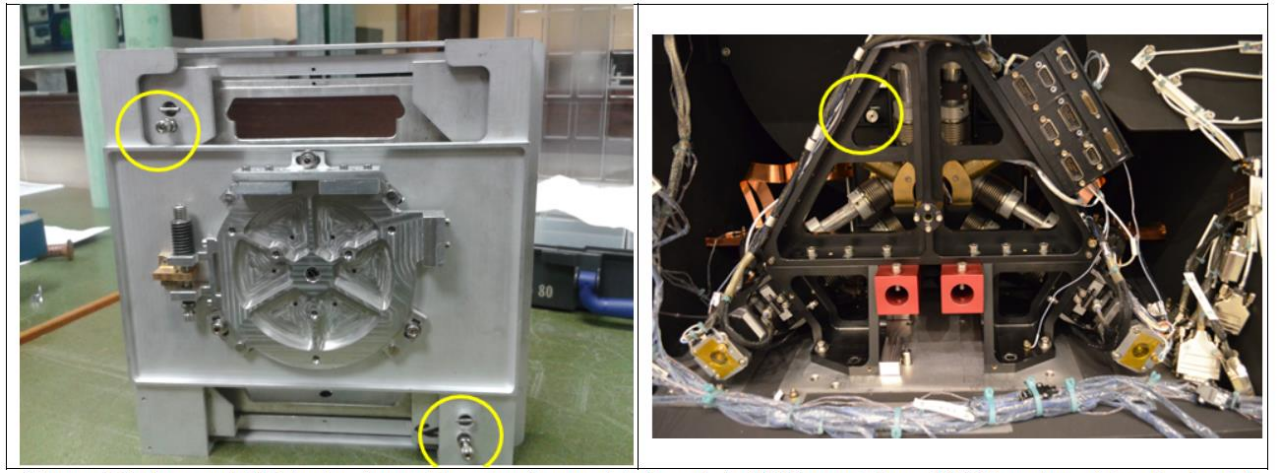


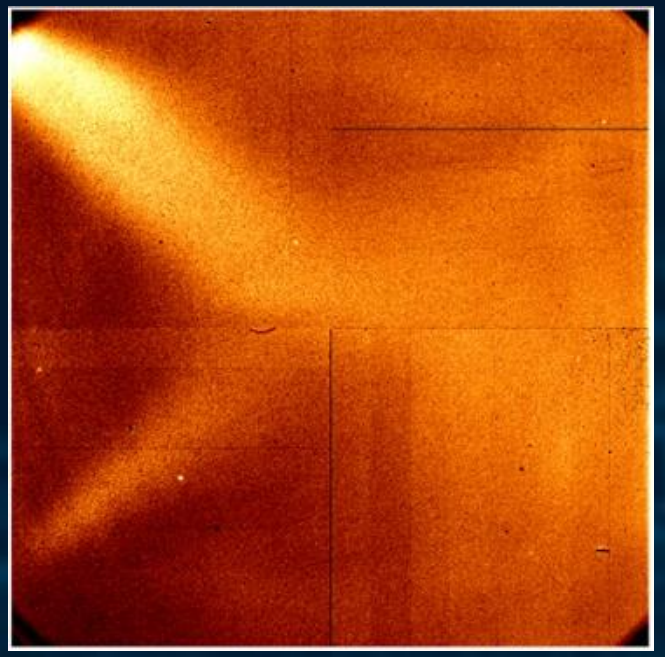
Figura 5 Imágenes del Detector Assembly antes de ser pintado y de la DTU montada en EMIR, ambos vistos desde atrás. Se marcan la posición de los tornillos de alineamiento de la DA

• EMIR@GTC: Shades (III) - Non-Conformities

• Entrance Window dry air supply

- It is not a laminar flow curtain and it is not preventing condensation with RH around 70%
- More importantly, it is causing an X pattern of dust being accumulated on the window surface:
  - Highly emissive for longer wavelengths (Ks)
  - For shorter wavelengths (Y,J,H) it appears primarily as an attenuation
  - Both effects can be corrected with proper NIR flat fielding (combination of bright and dark flats or Theil-Sen slope)
  - It is still unclear where is this dust coming from! (preventive and corrective actions)





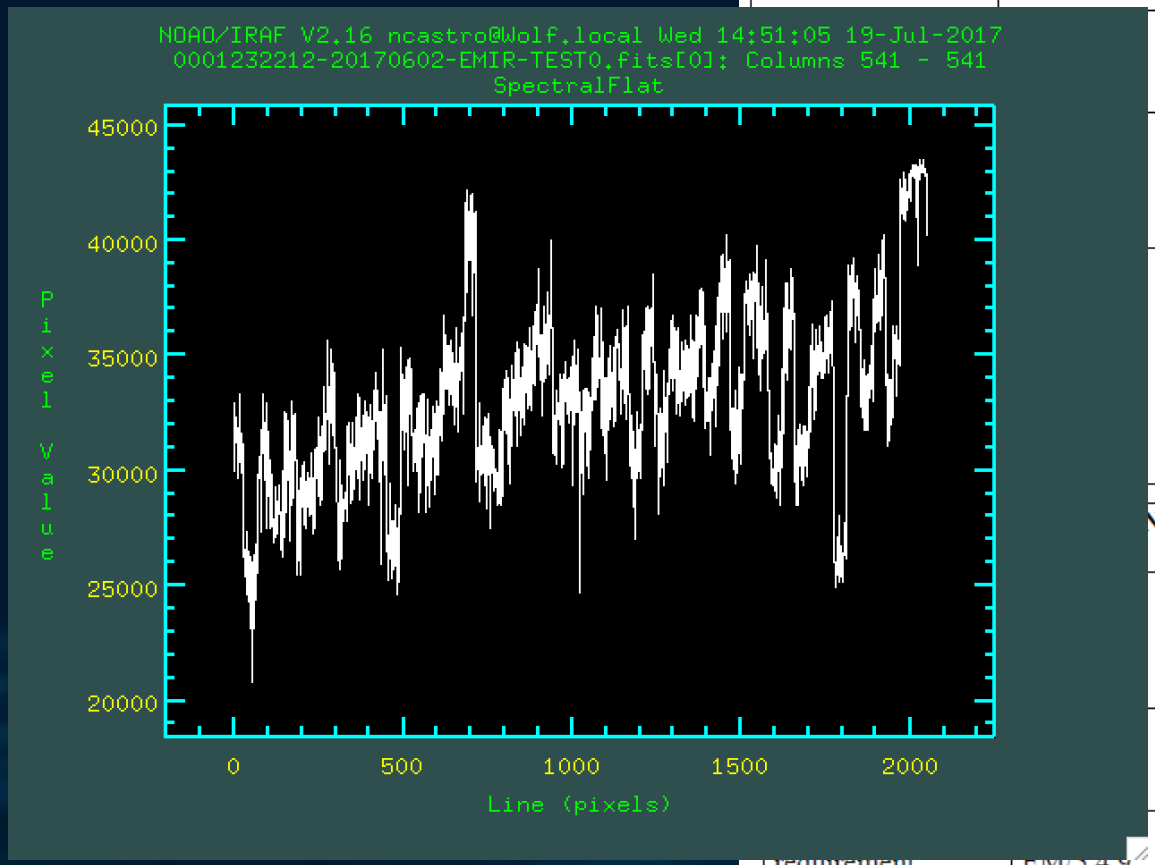
• *EMIR@GTC: Shades (IV) - Non-Conformities*



Software: not a formal non-conformity, but completeness and quality was not as expected. To be fair, GCS is a complex environment, and EMIR is the first and most complex NIR facility instrument (fully integrated)

- It affects observing efficiency (faults and recovery)
- Handling exceptions & logging information (logs, traces and UI messages) to be improved
- Need Sequence Control! (Abort and Pause/Resume)
- General quality (maintainability) issues
- Version Control for a shared environment (ops&dev)

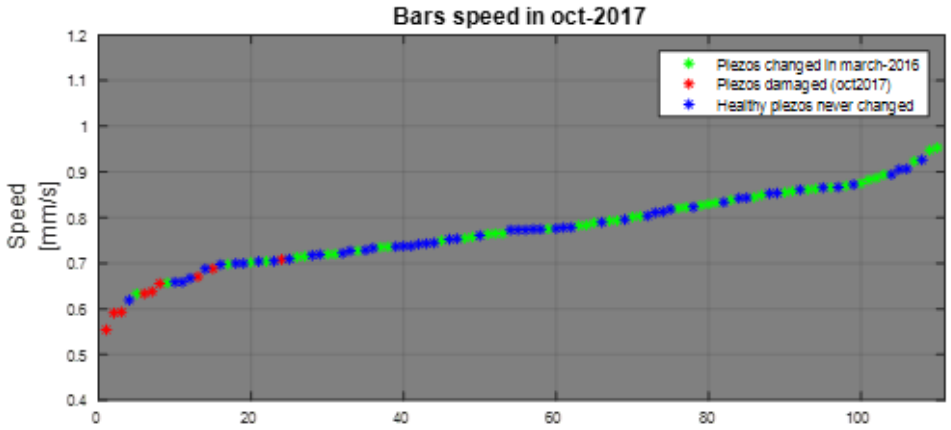
- *EMIR@GTC: Shades (V) - CSU*
- *Lack of full calibration: it reduces slitlet positioning accuracy*
  - CSU specs: Accuracy < 0.6 um (~1/30 pix) & Repeatability (3 sigmas) < 28 um (0.15 pix), though measured values are better in the unit.
  - MOS requires this calibration
  - LS iteratively being adjusted.

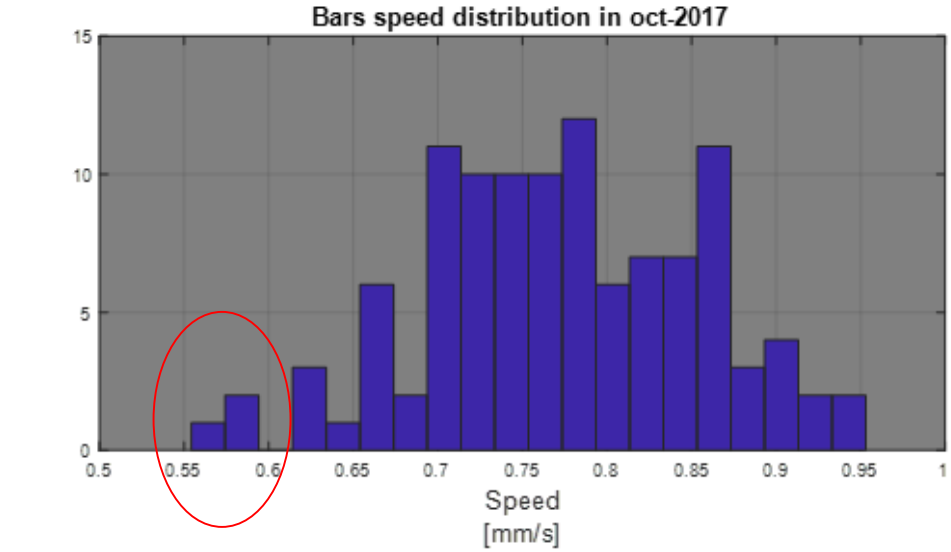


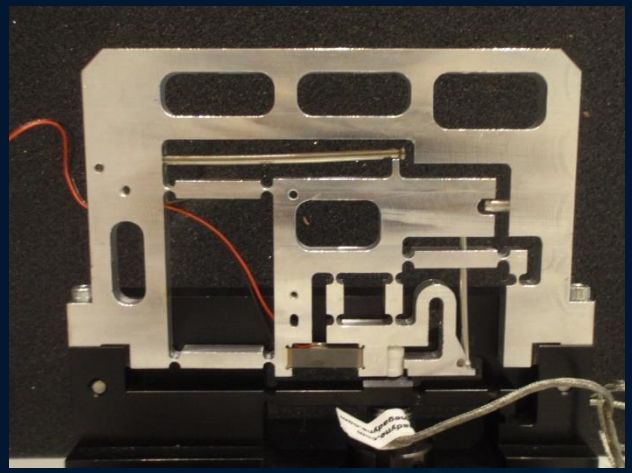
Positional accuracy of the slit image on detector	RQ/IN-EM/5.1.4.2	The maximum absolute positional error of each slit image on the detector shall be less than 0.4 times the size of the spectral resolution element, established as 3 pixels, in the spectral direction and 4 pixels in the spatial direction
		The image of each single spectrum on the detector shall be aligned with the detector columns/rows to a precision of 1 of pixel end to end.
		The different slitlets shall be positioned in the focal plane with respect each other with an accuracy in the image plane (detector) of 2 pixels in the spatial direction and 0.2 pixels in the spectral direction
		When changing from MOS acquisition to imaging and back to MOS acquisition, the relative positional change of the target image and the slit mask shall be less than 10% of a slit width of 0.6 arcsec (this amounts to 0.05 mm at f/17) in the spectral direction, and it shall be less than 10% of a nominal slit length of 6 arcsec (this amounts to 0.5 mm at f/17) in the spatial direction.

	REQUIREMENT
	The time interval to change between two different configurations of the focal plane field selection, i.e. two different object sets for spectroscopy, shall be less than 5 min.
	The line which joints the central points of the slit along the spatial direction has to be straight to a maximum deviation of 3.3% of a 0.6 arcsec slit width.
	The actual width of each slit shall be accurate to within 3.3% of a nominal slit of 0.6 arcsec width.
requirement	EM/5.4.9

- *EMIR@GTC: Shades (VI) - CSU*
- *CSU Constraints*
  - Specs => reconfiguration time **< 5min** in **any orientation**

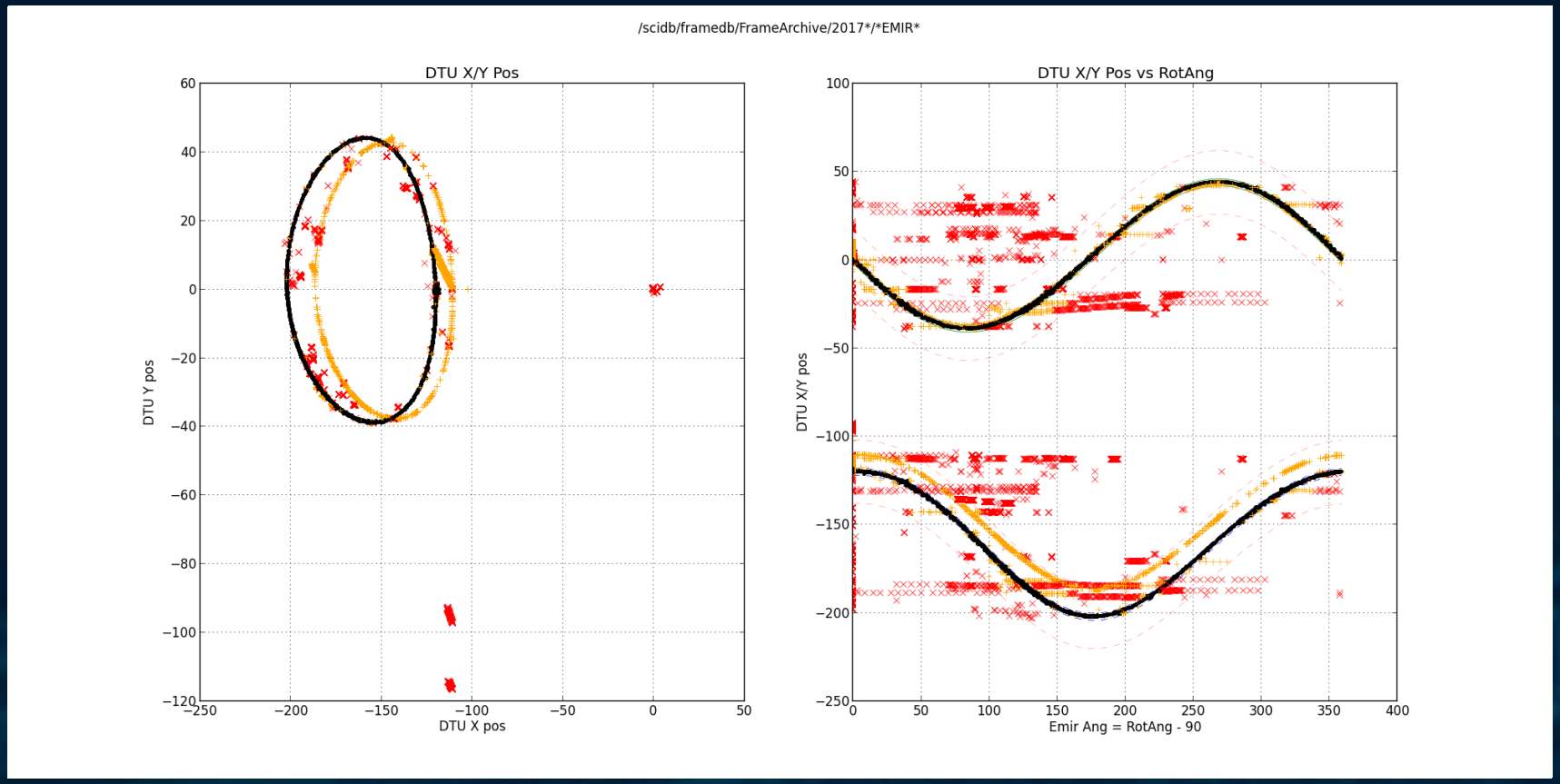






- *170 (mm) / 0.56 (mm/s) = 303 s*
- *But it is more like 330-340 s in average from Imaging to LS, always in horizontal position*
- *Expected Lifespan 800 m (now ~200) due to wear of the friction pads*

- *EMIR@GTC: Shades (VII) - DTU*
- *Flexure Compensation - 3 different bugs (now corrected)*
  - Correction not applied in park position => it affected spectral calibrations (flats & arcs)
  - Correction scale (wrong command after optical configuration) => double circle
  - Corrections stopped (and not resumed after) during sky-flats



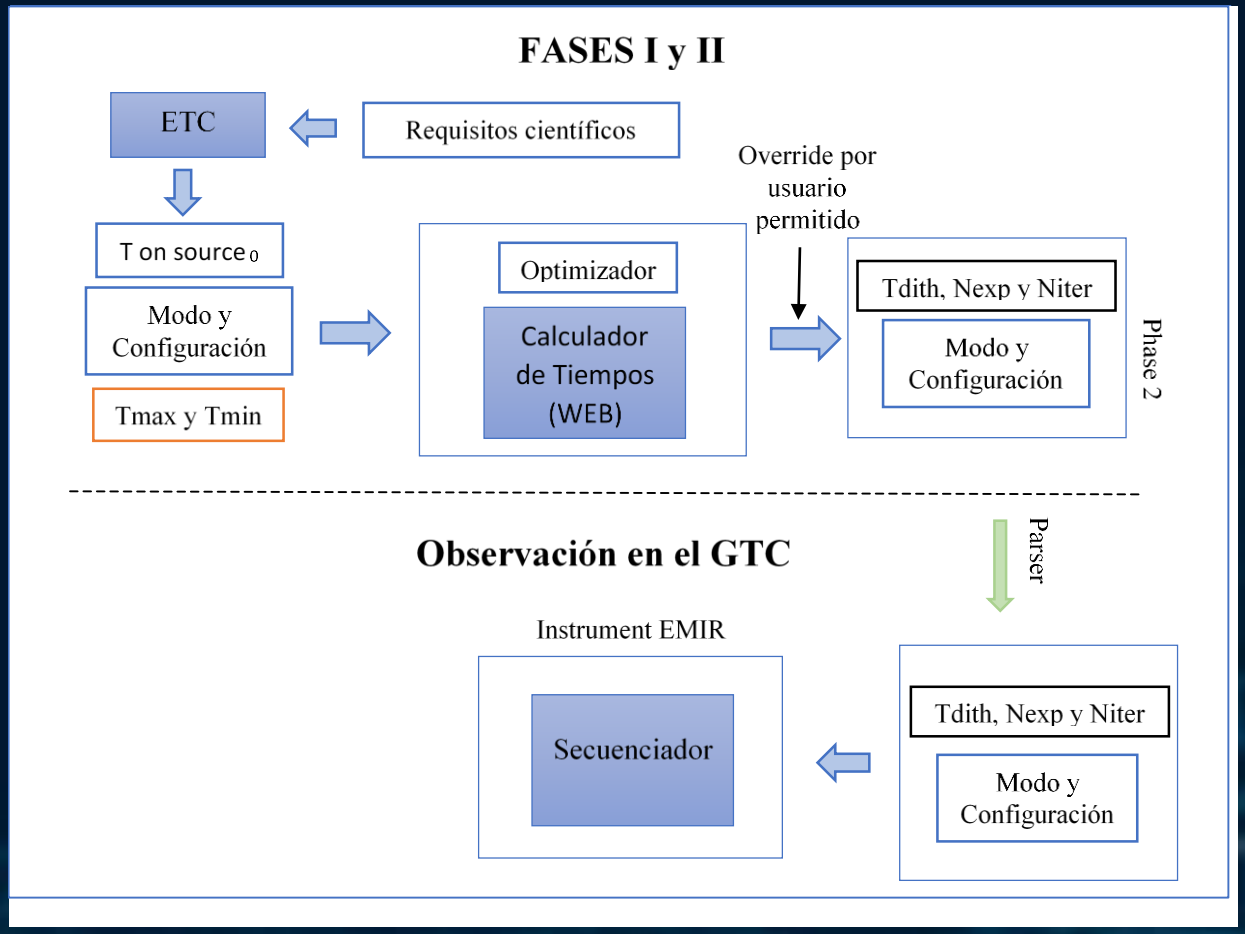
- *Err48 => used to cause an average of 1-2 faults/night (now filtered)*

- *EMIR@GTC: Shades (VIII) – Low Observational Efficiency*
- *Large Acquisition Overheads! For S18A these are the numbers we will consider:*
  - 600 s pointing
  - 600 s CSU configuration (x2) for LongSlit & MOS
  - 0 s CSU configuration for the "new mode" Telluric LongSlit
  - 60 s Filter Wheel configuration time
  - 120 s Grism Wheel configuration time
  - Duty cycle or proportional overheads: **1.1 LongSlit**/MOS & **1.4 Imaging**.
- *Acquisition methods:*
  - **Open Field** => offset to predicted LS position => Pause guiding & rotate to horizontal => configure CSU => rotate to previous sky PA & resume guiding => Through-slit fine acq.
  - **Direct to the LS** => we use the ASG camera in a certain position as a reference. Overheads associated to A&G mechanisms are smaller, but only feasible for bright point-source targets
  - **Direct to the LS-Acq-Box** (70x60 pix)=> requires good pointing accuracy (procedure "guideAtLocation" on a nearby astrometric star + good coords) and an additional large (known) pointing offset to the Slit.

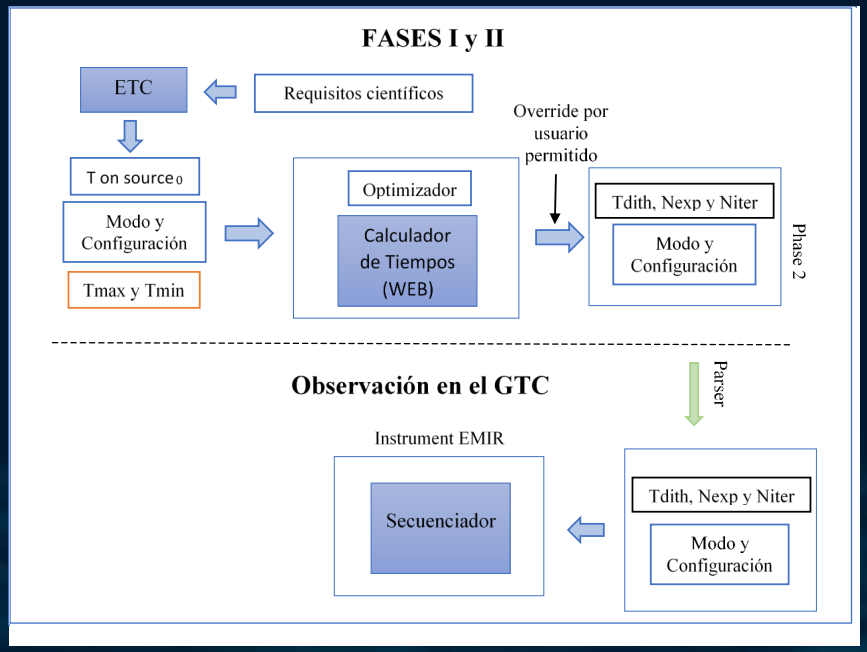


Many steps have been automated via sequences (Phase II Parser), but still requires some manual actions by the night crew.

- *EMIR@GTC: Shades (IX) – Low Observational Efficiency*
- *Efficiency Calculator considerations*



- *EMIR@GTC: Shades (X) – Observational Efficiency & Flexibility*
- *The concept of operations for EMIR is limiting the flexibility to configure your observations:*
  - Dither Pattern for Imaging (1,4 & 7) and Spect (4)
  - Frame-times and their distribution along the obs. sequence.
  - Coherence time for sky substraction
  - Optimization criteria
  - Added complexity to telescope operation



Total Exp time: 420 :

Tmax: 0 **Tmin** 0

Filter or Grism: Imaging: F1230

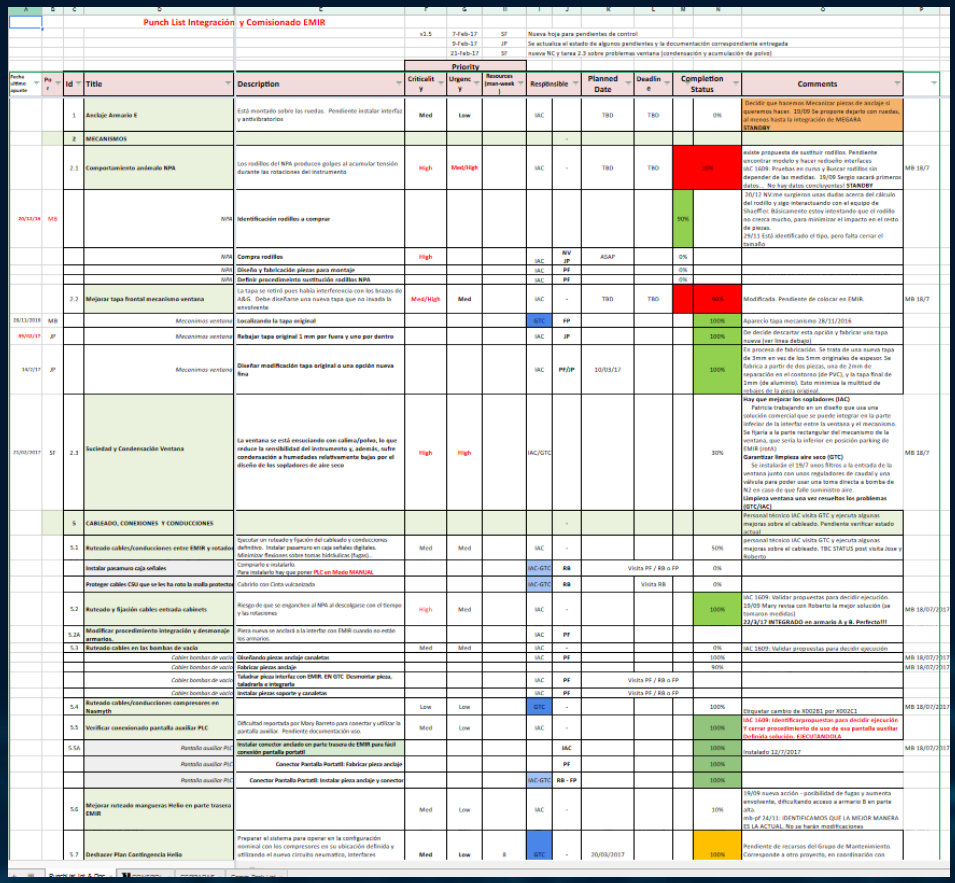
Dither points: 7 **Separated sky observation**

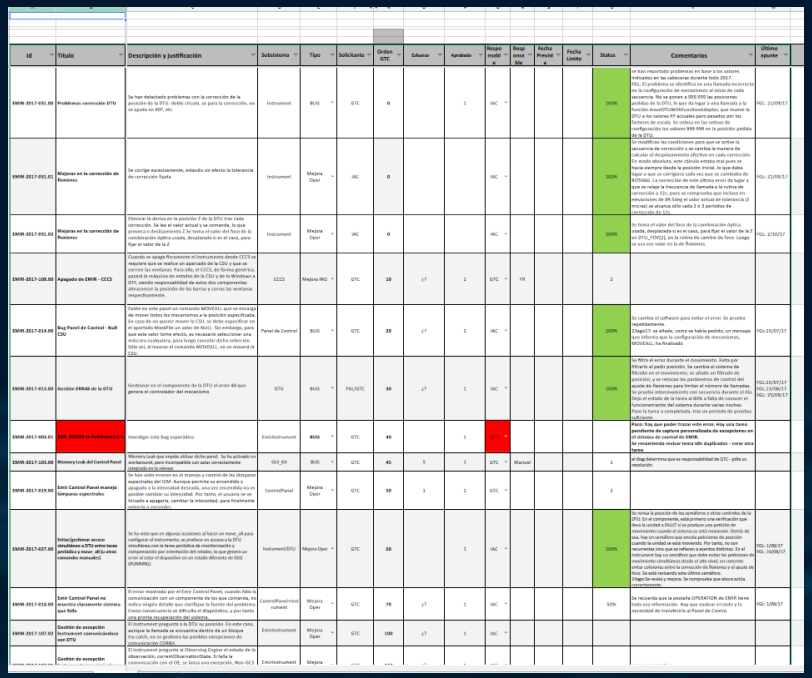
Calculate

Result

```
 SKY:  0 Tcoh:   300. Tmax:   30. Tmin:   1.5 Npoint:  7
 Niter:  2 Nexp:  1 Tdith:   30.
Tsource_e:   420 Ttot:   506  Efi: 82.96
 Tsource_e  Ttot   Efi  Niter Nexp Tdith
     420     506  82.96    2    1   30.0
     420     521  80.60    2    2   15.0
     420     536  78.37    2    3   10.0
     448     579  77.41    2    4    8.0
     420     549  76.45    3    1   20.0
     378     494  76.53    2    3    9.0
     392     523  74.99    2    4    7.0
     420     566  74.26    2    5    6.0
     420     572  73.48    3    2   10.0
     420     580  72.36    2    6    5.0
     441     615  71.72    3    3    7.0
```

- *EMIR@GTC: Progress*
- *Several accomplishments, but still many things to do*
  - Actions monitored in a shared punch-list, both for hardware and software/control
  - Several constraints after delivery
    - Telescope
    - Manpower
    - Time
    - Remote Access (IAC/UF)
    - Other commitments (MEGARA…)
    - Shared environment for ops&dev

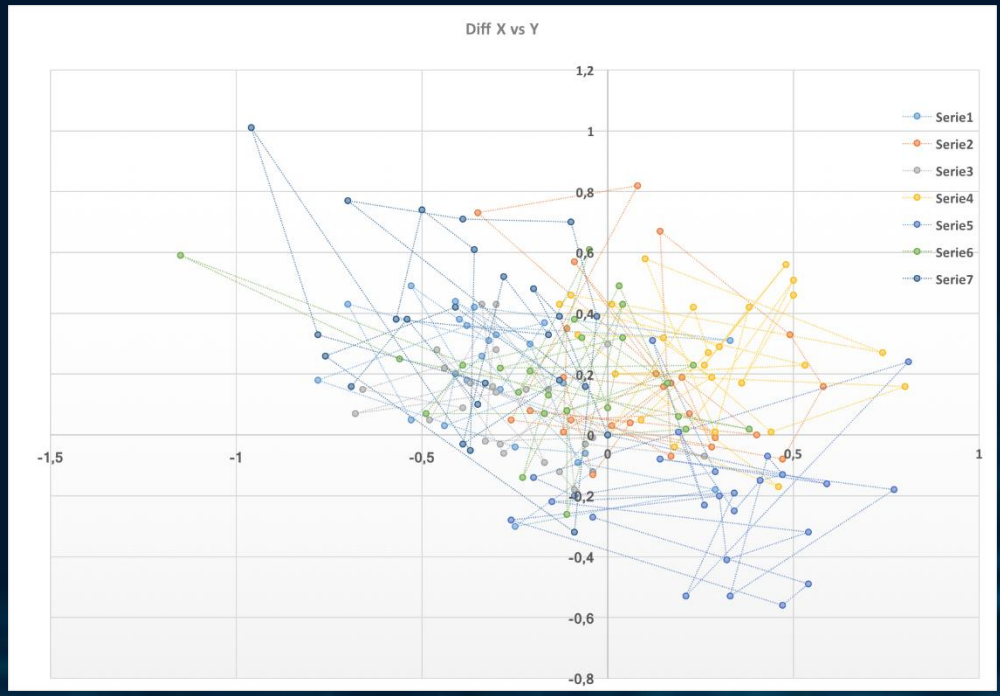




- *EMIR@GTC: GTC issues*
- *No self-satisfaction. Some GTC issues:*
  - GCS upgrades for new instruments
  - GCS bug fixing (BAD_PARAM)
  - Sky offset

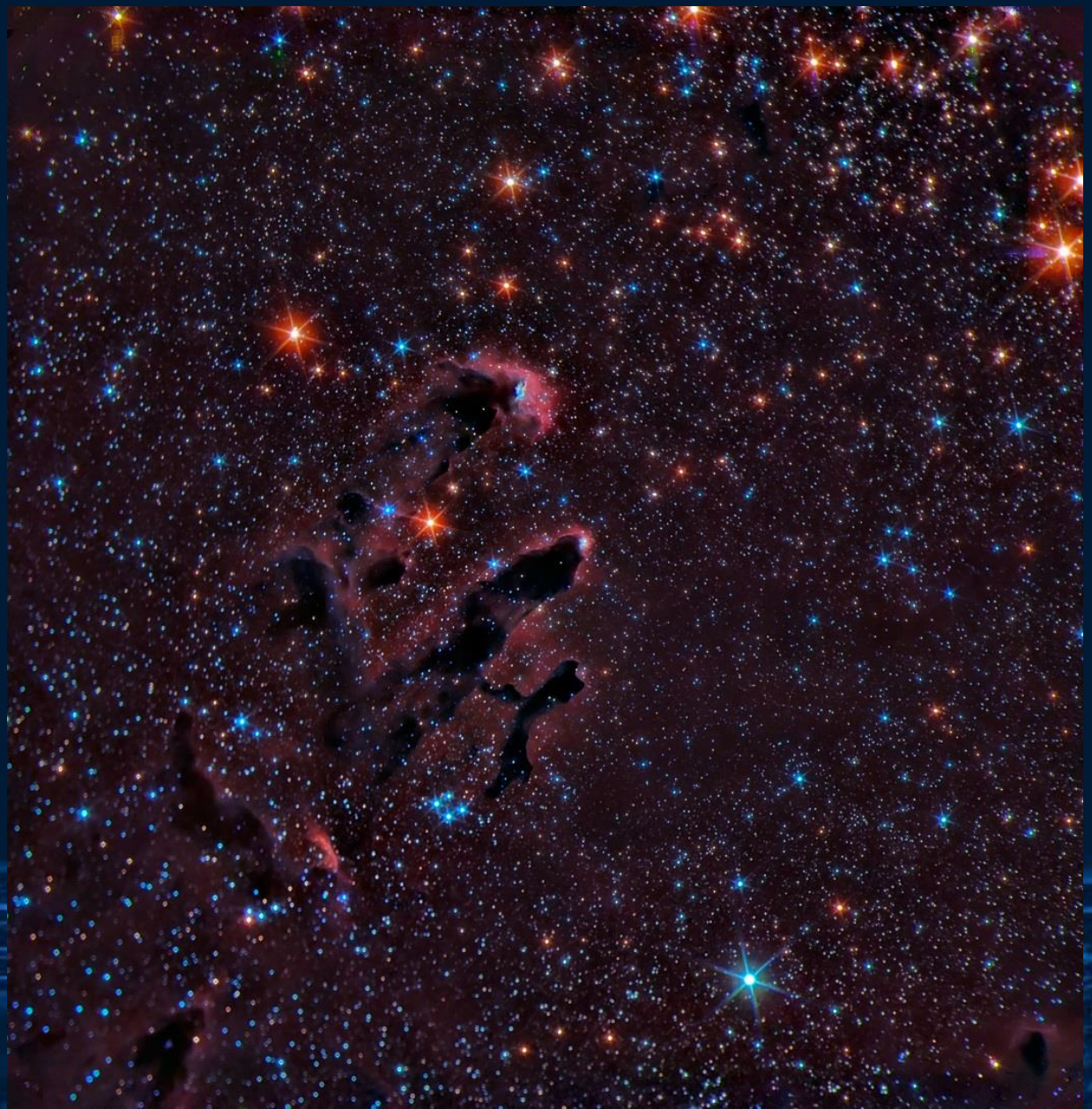
$$\alpha_1 = \alpha_0 + \frac{d\alpha}{\cos\delta}$$
$$\delta_1 = \delta_0 + d\delta$$

  - Image stability??



  - Other?? Please let us know!

EMIR@GTC: Lights and Shades



Thanks!