
Radial Velocity Challenge at the AIUC

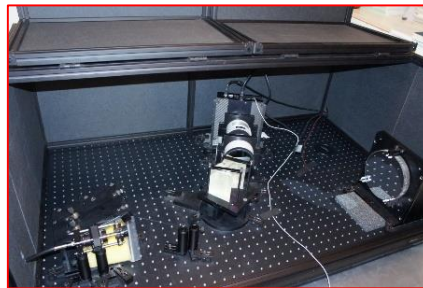
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AIUC Instrumentation

PUCHEROS

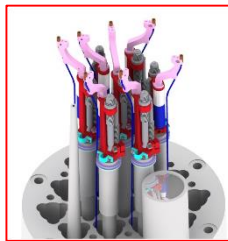


FIDEOS



ESO 1m, La Silla Observatory

MOONS



PUCHEROS & FIDEOS

Table 1. Main characteristic of PUCHEROS

Spectral resolution $\lambda/\Delta\lambda$ (average)	18000
Spectral coverage (single shot)	390 – 730 nm
Orders	42
Aperture on sky (diameter)	4.2 arcsec
Detector	FLI-PL1001E 1K, 1K x 1K, 24 μ m
Limiting mag. (1 h, S/N= 20)	V= 8
Total efficiency	< 5%
Calibration Method	Individual Thorium-Argon Lamp

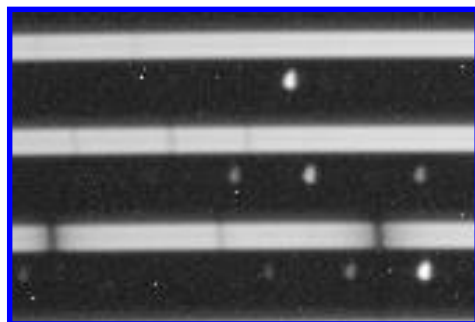
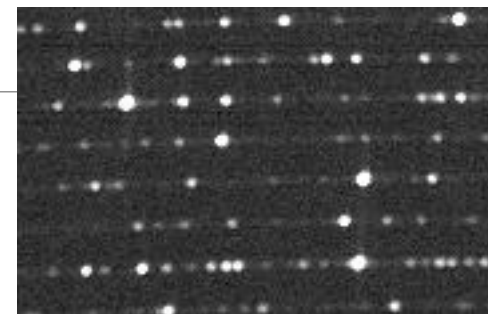
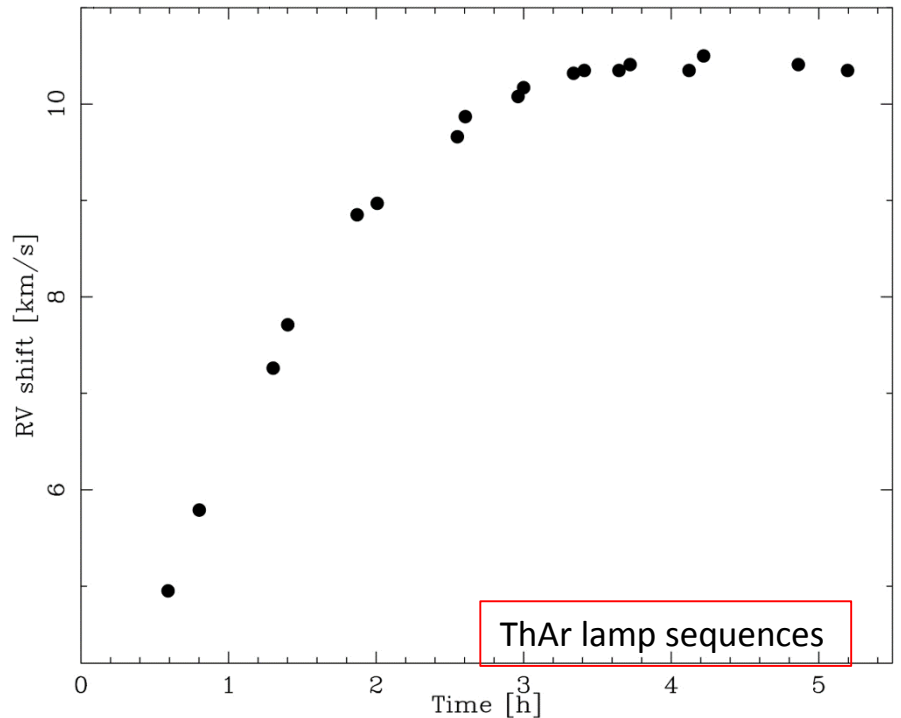
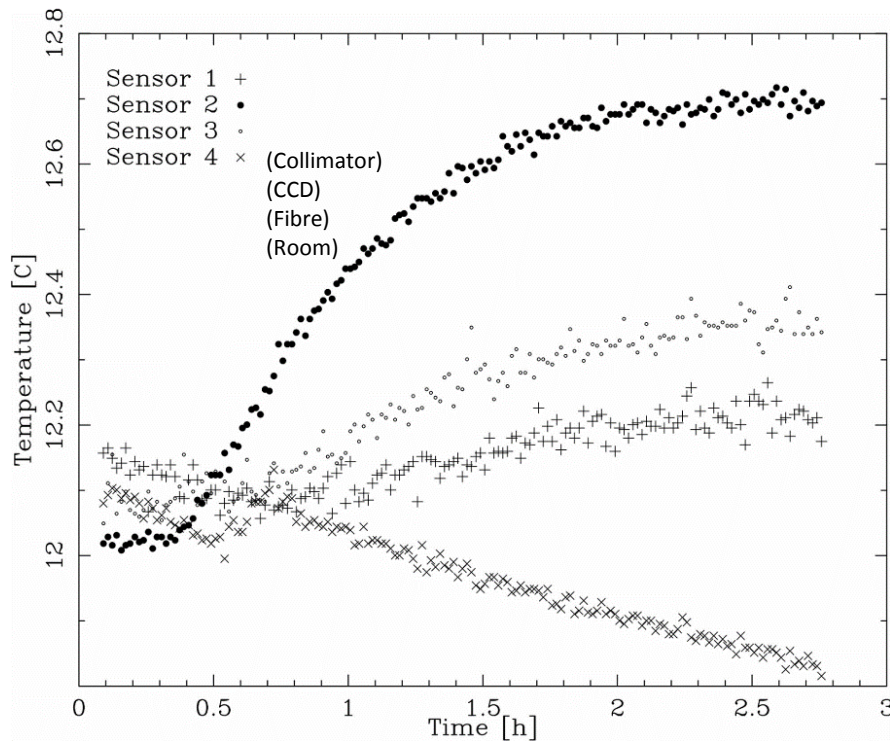


Table 2. Main characteristic of FIDEOS

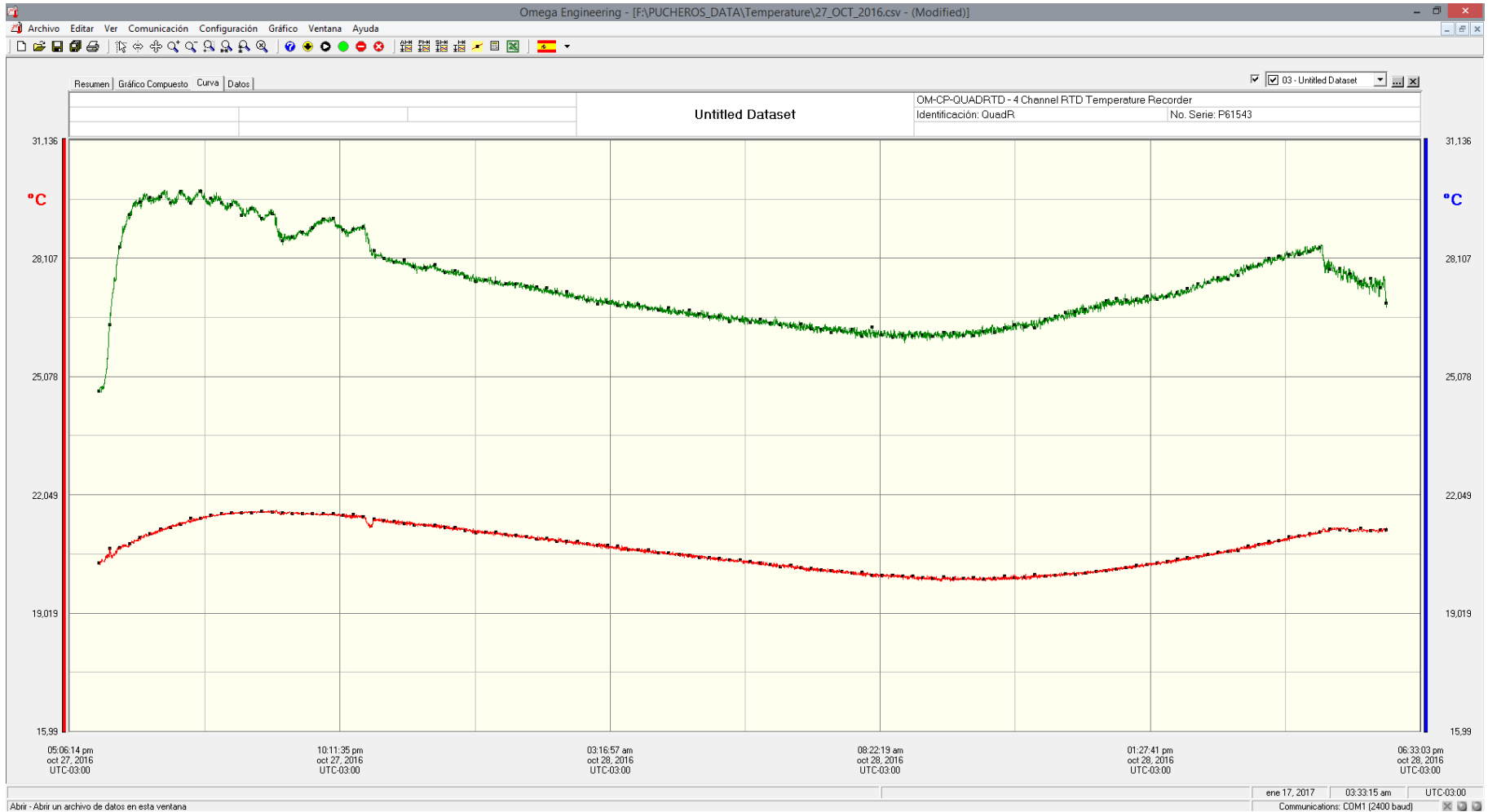
Spectral resolution $\lambda/\Delta\lambda$ (average)	43000
Spectral coverage (single shot)	400 – 700 nm
Orders	52
Aperture on sky (diameter)	1.87 arcsec
Detector	FLI-PL230, 2K x 2K, 15 μ m
Limiting mag. (1 h, S/N= 20)	V= 12
Total efficiency	~10%
Calibration Method	Simultaneous Thorium-Argon Lamp

PUCHEROS Stability



Temperature measured in four points of PUCHEROS versus time. Sensors 1, 2 and 3 are located on the optical bench, respectively, at the position of the collimator mirror, CCD camera and fibre optics. Sensor 4 is on the external surface of the enclosure. The effect of turning on the CCD is clearly observable in the temperature measured by sensor 2. (Vanzi et al. 2012)

Temperatures on PUCHEROS



The temperature of the instrument is dominated by environmental conditions and shutter effects. Environmental temperature (green) and instrument (red).

Improvement of FIDEOS respect to PUCHEROS

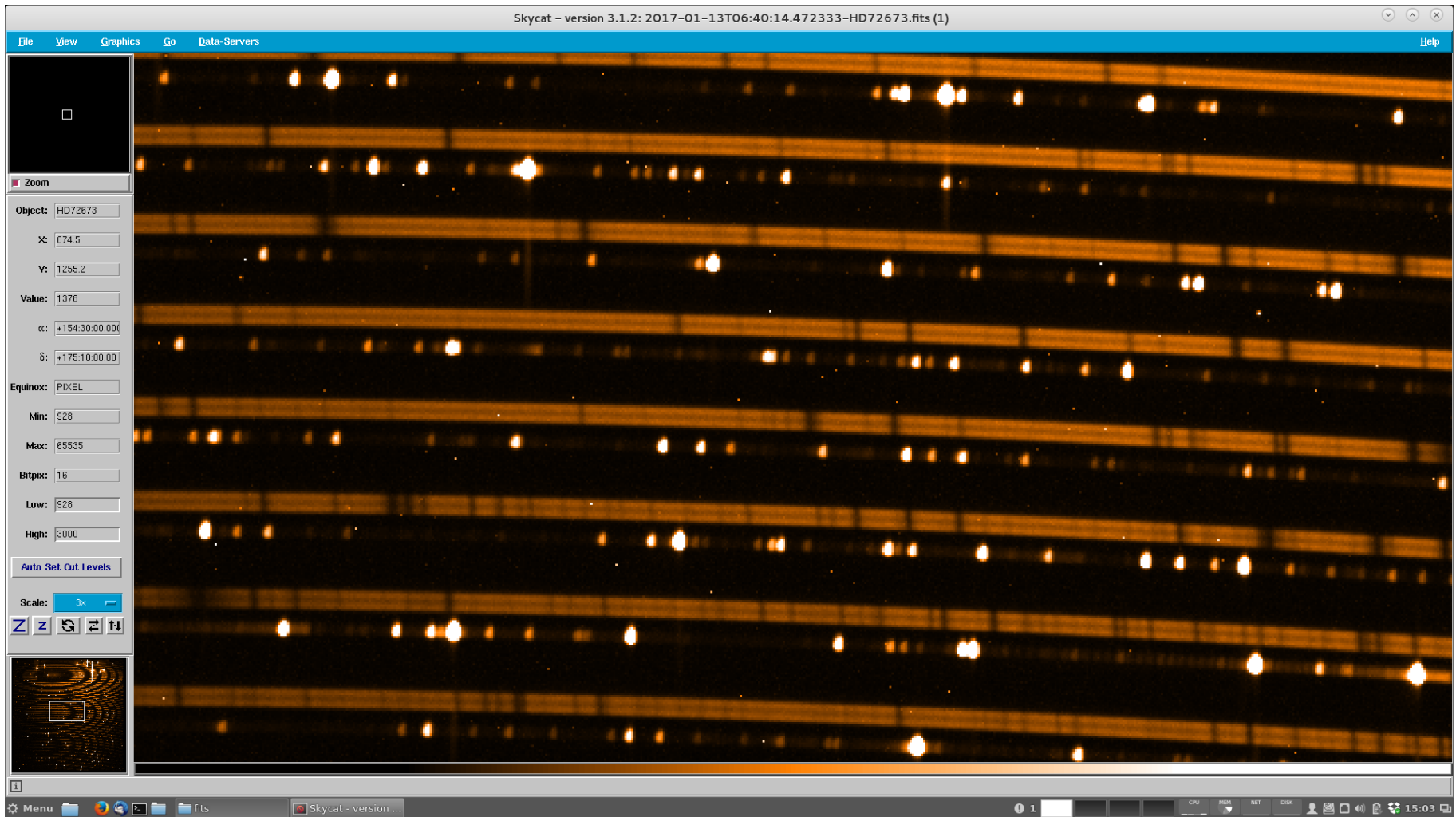
Simultaneous Calibration Th-Ar.

Temperature control.

Heat extraction liquid cooling (chiller) vs air flow.

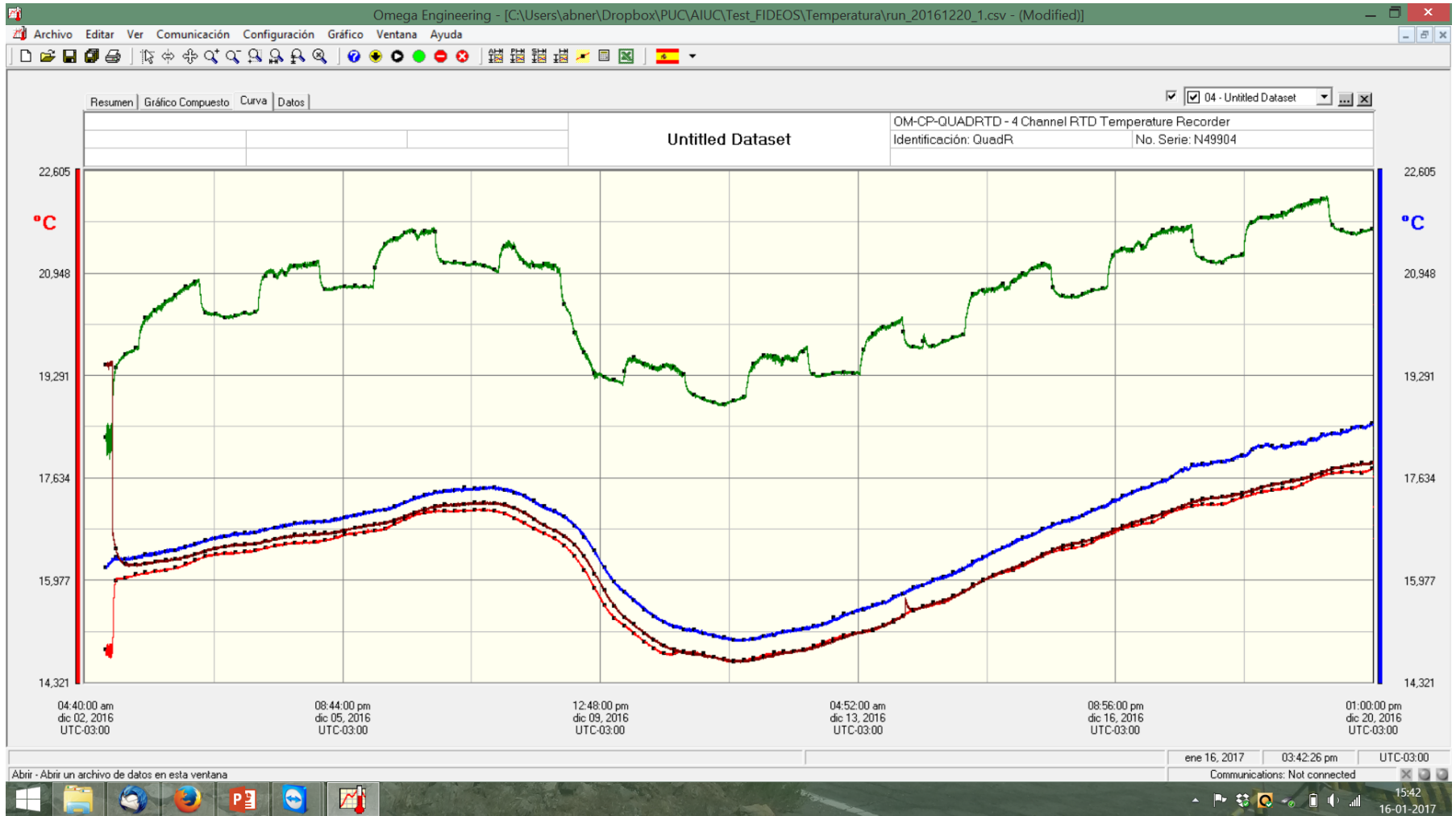
Octagonal fiber.

Example of spectrum with FIDEOS



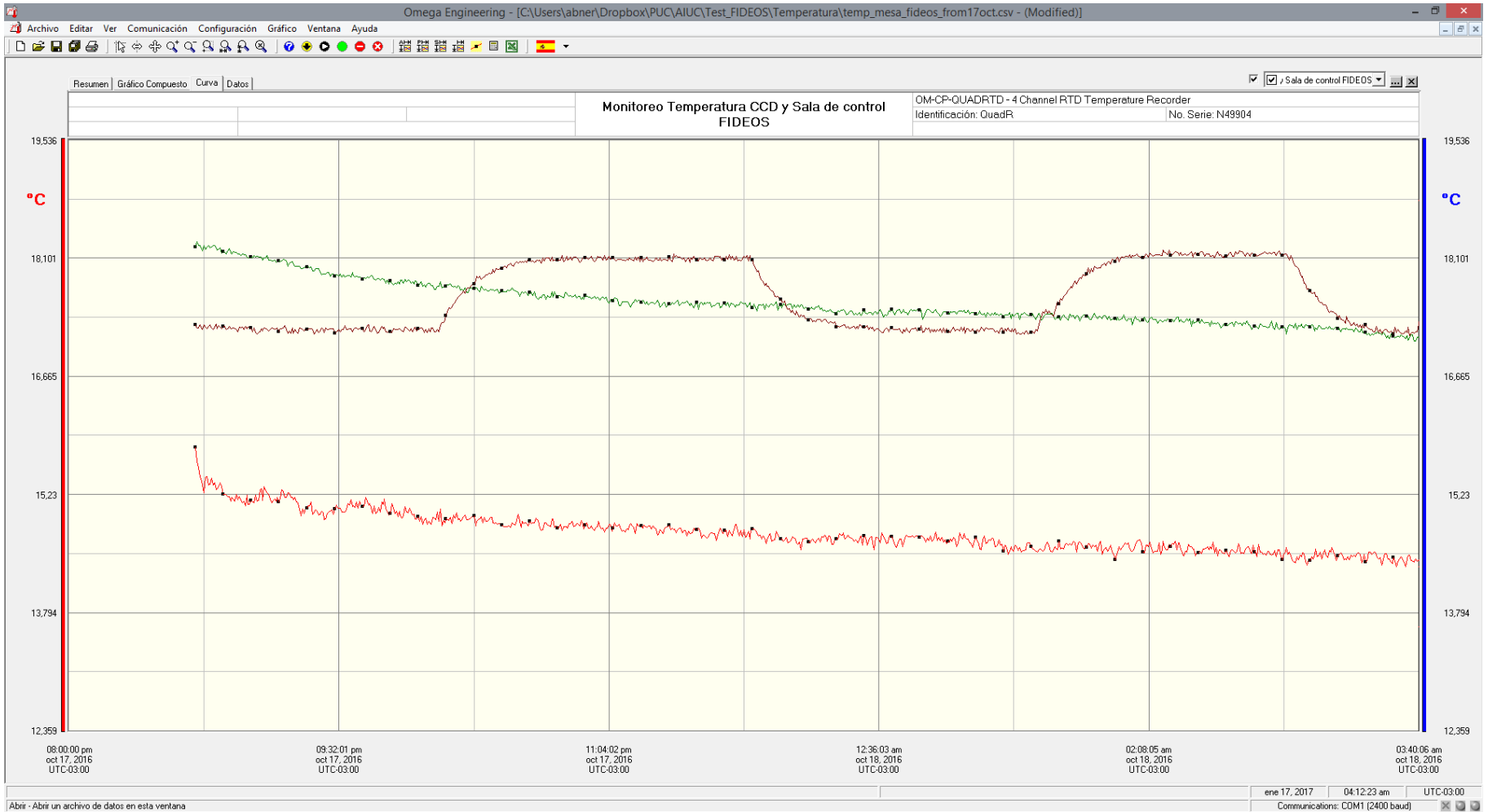
Simultaneous calibration with ThAr lamp and image slicer.

Monitoring temperatures



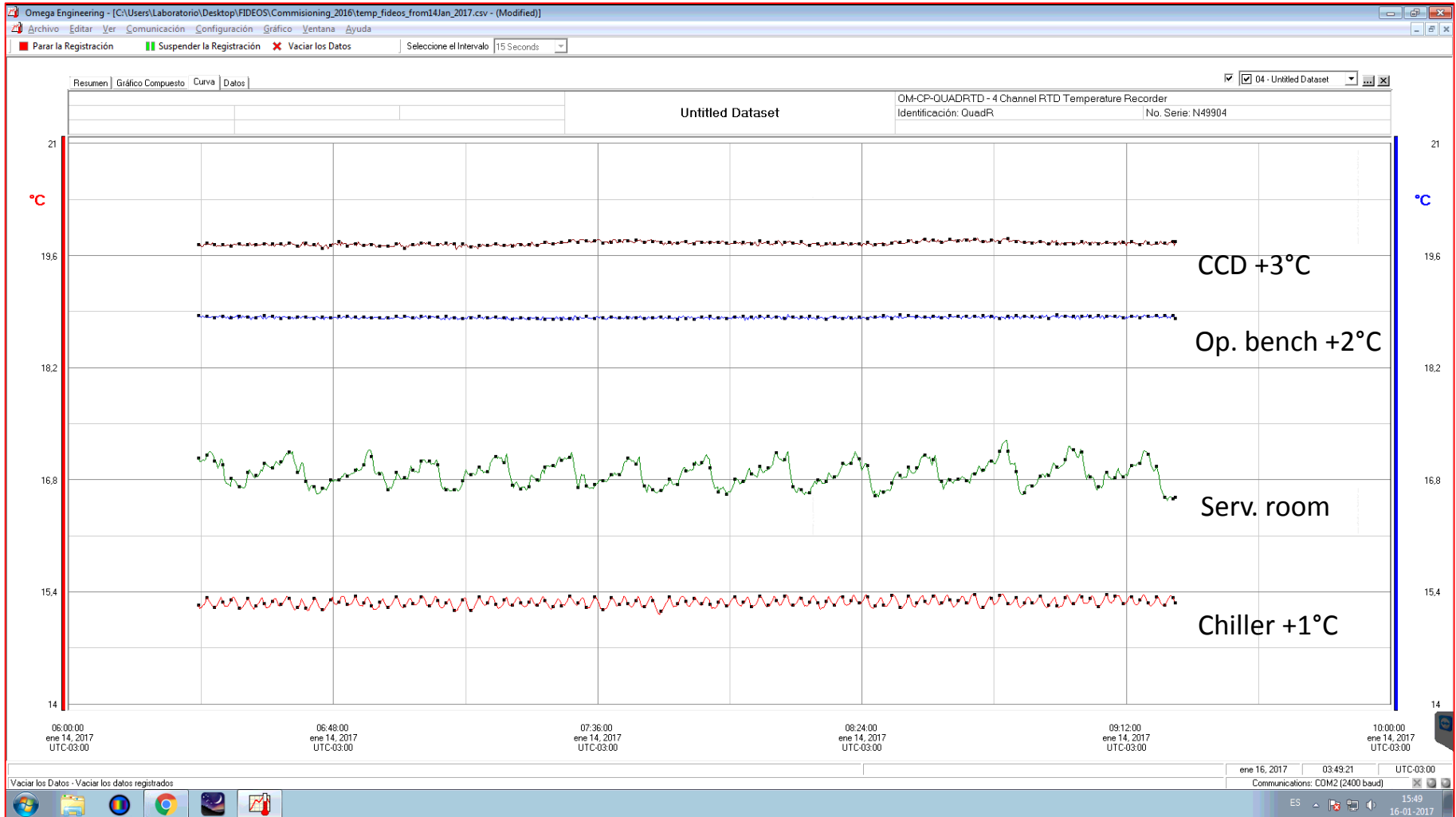
Temperatures on FIDEOS without control. Day and night cycle is observed. Service room (instrument next door) (green); Instrument (blue); CCD (brown) and Chiller (red).

Temperatures FIDEOS



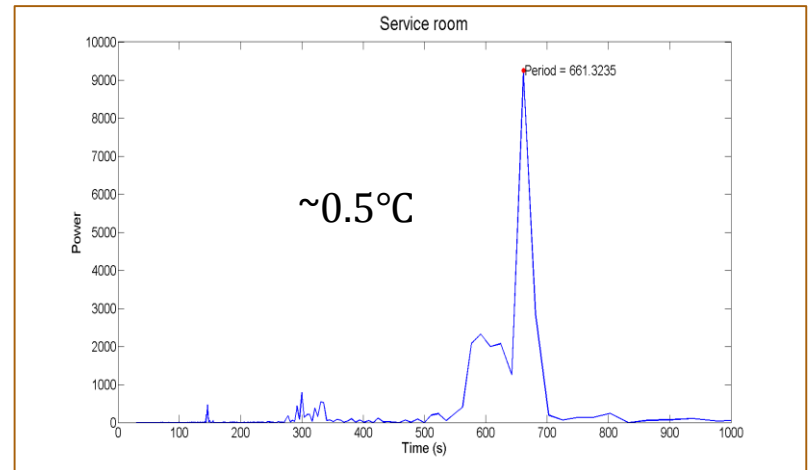
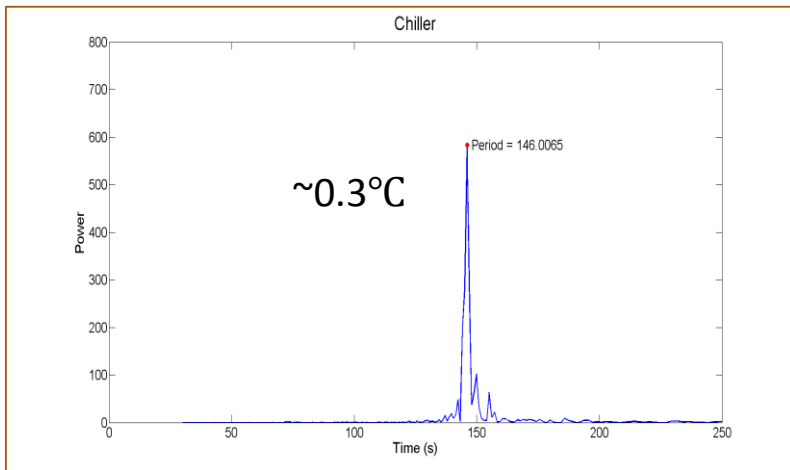
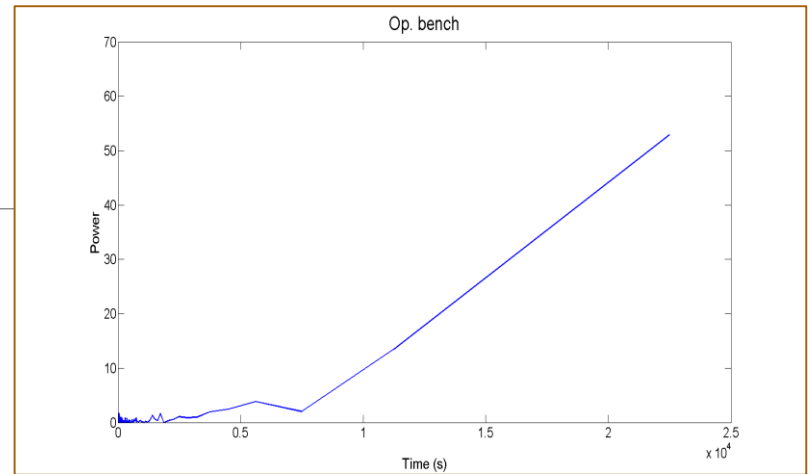
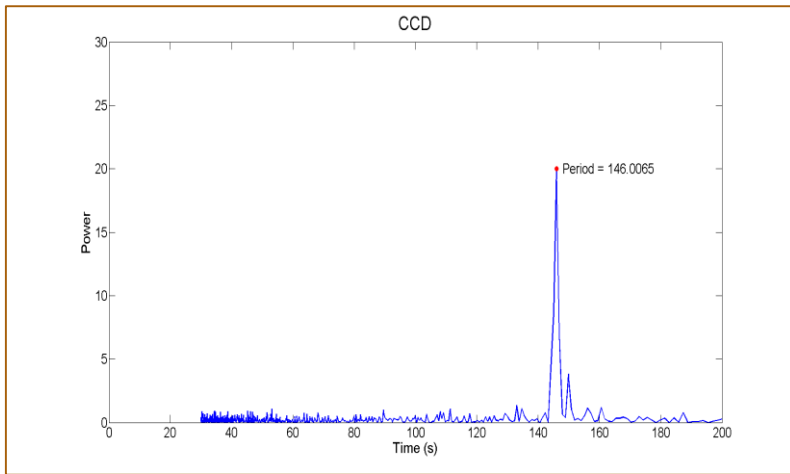
Temperatures on FIDEOS. Upper (brown line) it is observed electronic heating (CCD) when exposures are taken.

Thermalized condition



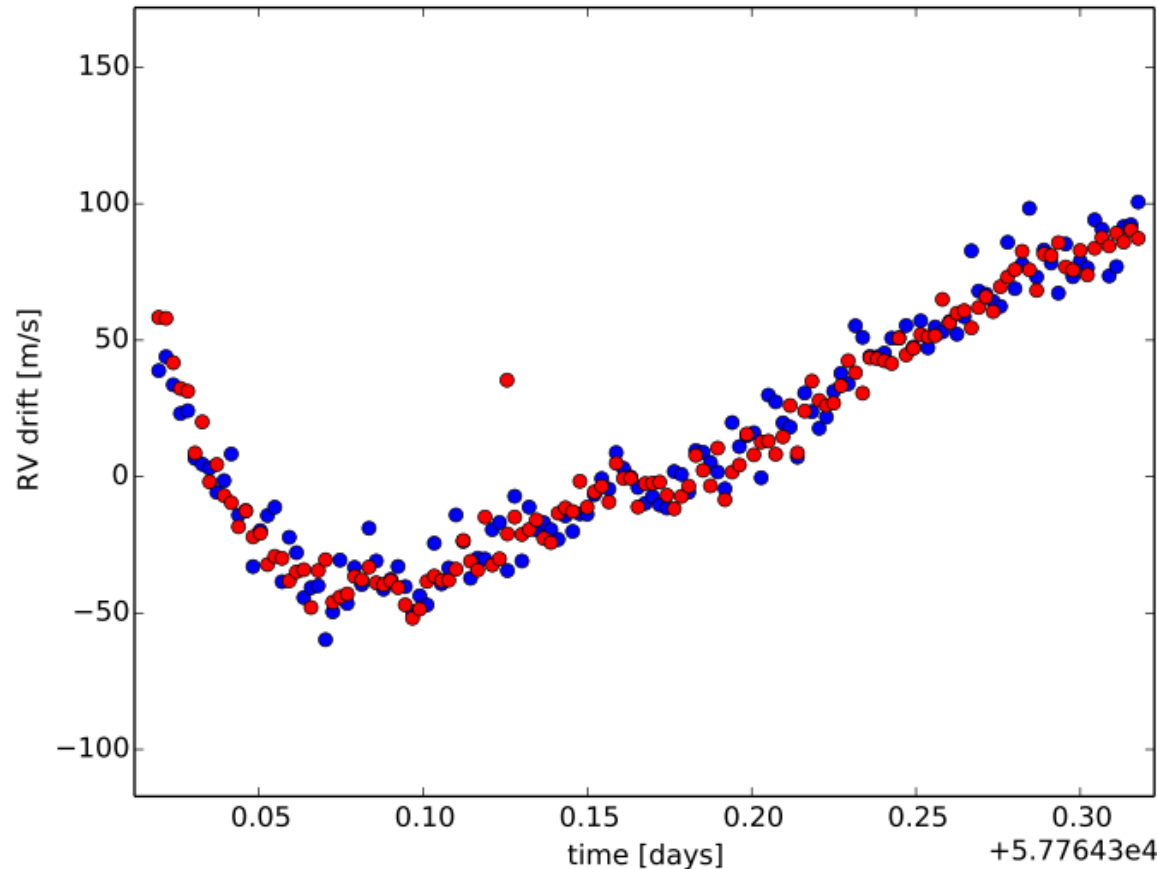
After thermal control it is observed minimal changes in the temperature of CCD and instrument (op. bench).

Fourier analysis of temperatures



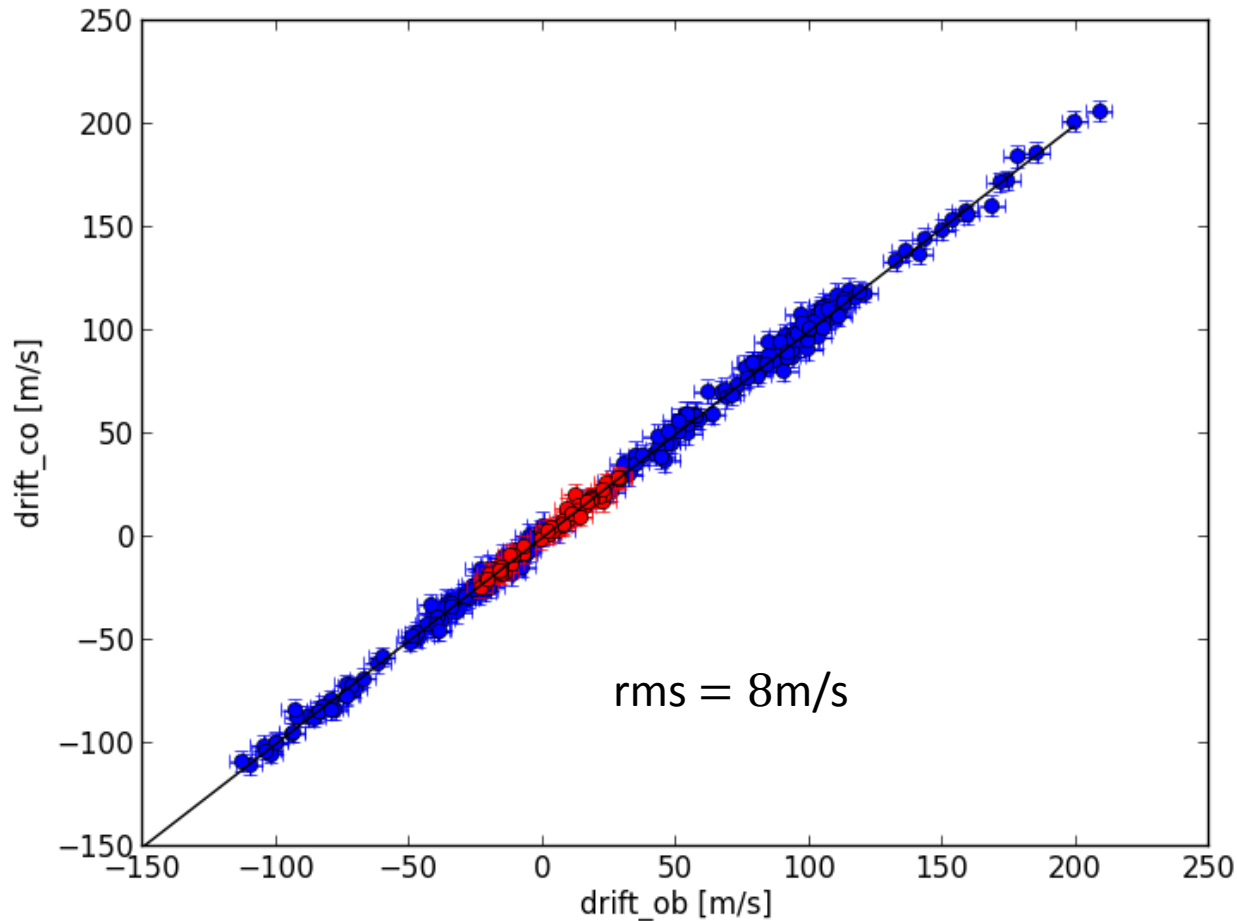
Upper right: The CCD present a thermal cycle of 0.1°C which correspond to the cooling cycle (bottom right). Upper left: The instrument (op. bench) do not present any dependency with the thermal cycle of the service room neither the Chiller cycle.

Drifts of Science vs Comparison



Drifts of the spectral lines from the ThAr lamp sequences. Red and blue dots are the observed (science) fiber and the comparison fiber (simultaneous calibration).

Drifts of Science vs Comparison

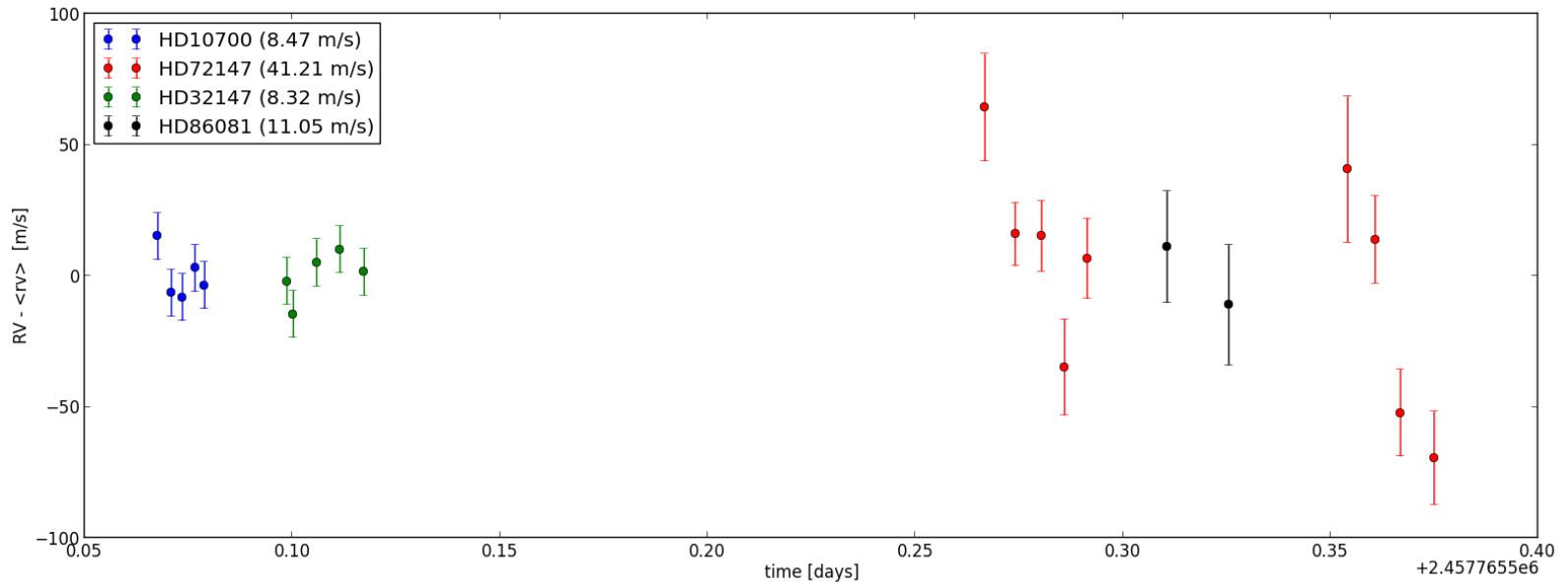


Drifts in terms of velocity precision. The scatter measured is rms=8 m/s.

FIDEOS Calibration plan

- ThAr + ThAr
- Flat + Flat
- Simultaneous

RV early results



Few spectra of RV standars. HD10700 and HD32147 show a RV dispersion of ~ 8 m/s in agreement with the expected.

Comparison with theoretical expectation

$$\sigma(m/s) = \frac{C}{R^{3/2} \sqrt{B(A)} S/N} \quad (1)$$

C calibrated with HARPS.

$R = 45000$

$B = 3000$

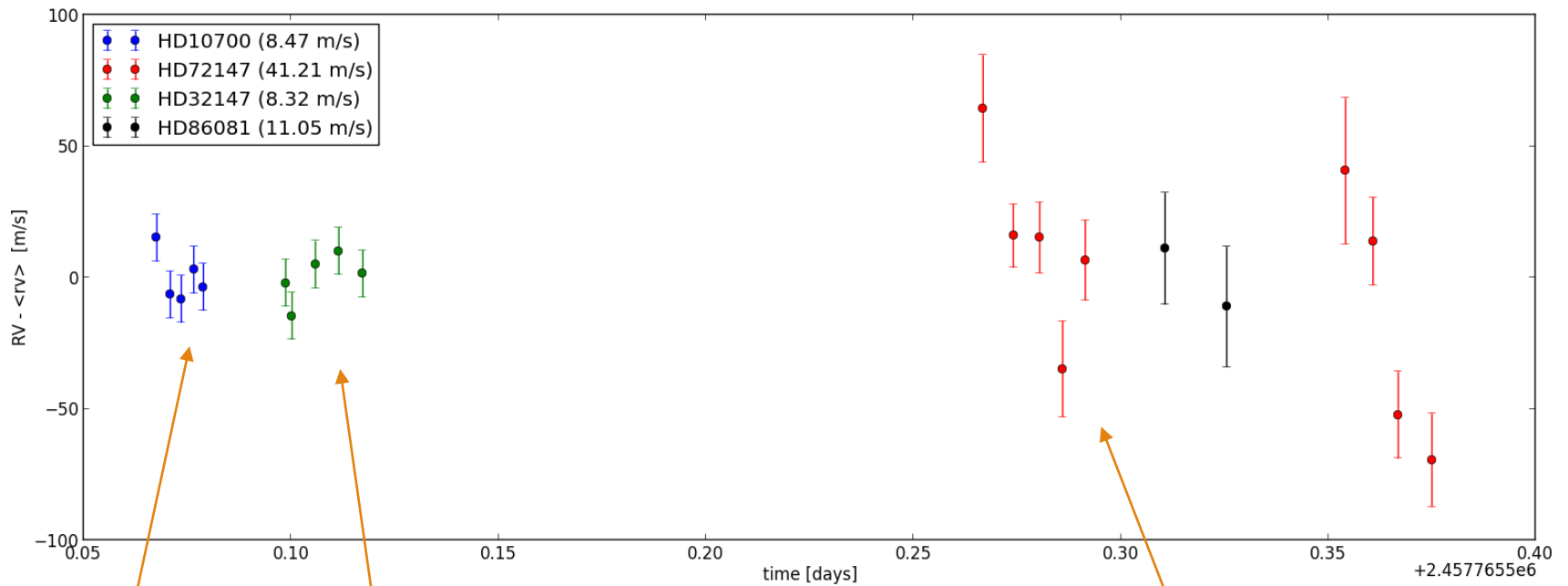
$S/N = 100$

$$\sigma = 4.6 \text{ m/s}$$

Reference value for RV precision expected on FIDEOS for a $S/N \sim 100$.

(1): Hatzes and Cochran (1992)

Radial Velocity results



S/N = 100
 $\sigma = 4.6$ m/s

S/N = 200
 $\sigma = 2.3$ m/s

← Theoretical values →

S/N = 12-15
 $\sigma = 38.3$ m/s

What next?

- To improve the temperature control.

Seasonal change in the temperature and electronic heating are observed yet.

- To improve and stabilize guiding.

This help us to improve the efficiency of the system.

- To explore alternative wavelength reference (Etalon, Iodine).

Summary

- PUCHEROS was the first step in the development of spectrographs at the AIUC.
- FIDEOS has been intended to be RV precision better than 10 m/s with a simultaneous ThAr calibration lamp.
- Important improvement in the stability and RV precision has been done during the commissioning of FIDEOS.
- Early results indicate that we are capable to achieve RV precision ~ 8 m/s or even better. Now we are working to get similar results in long term RV stability.