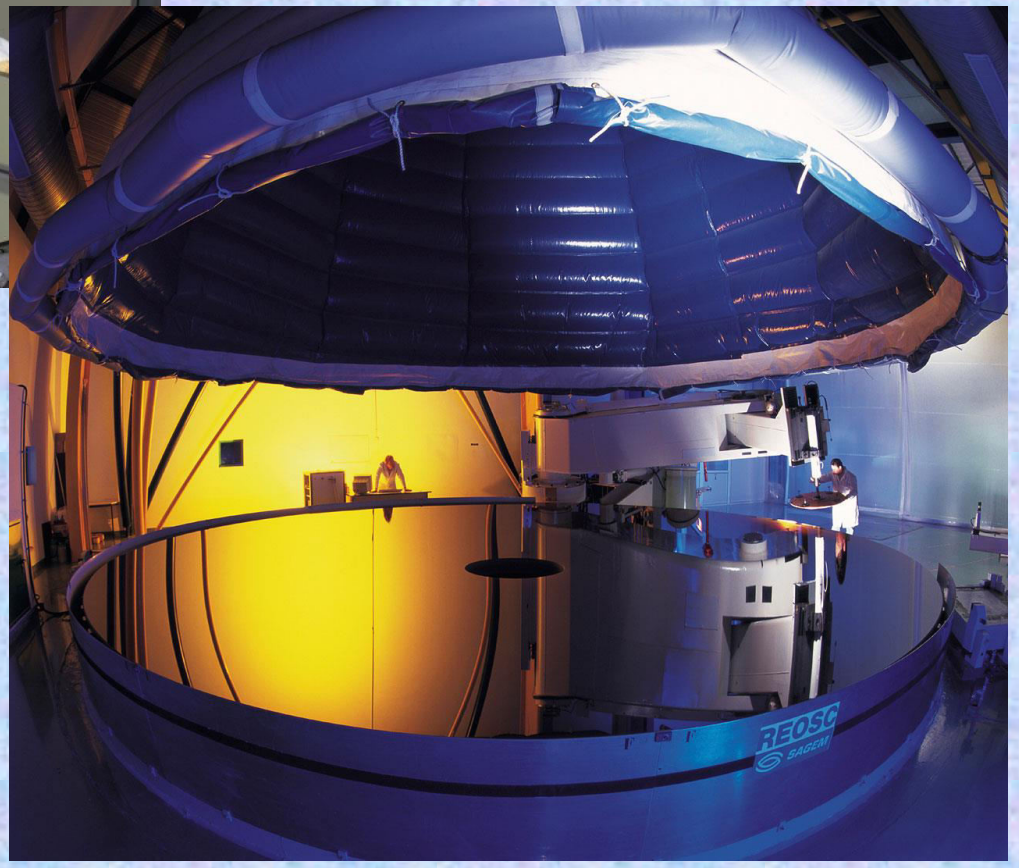
PITFALLS OF SPECTRAL REDUCTIONS AND THE CALIBRATION PROCESS

Jan Janík

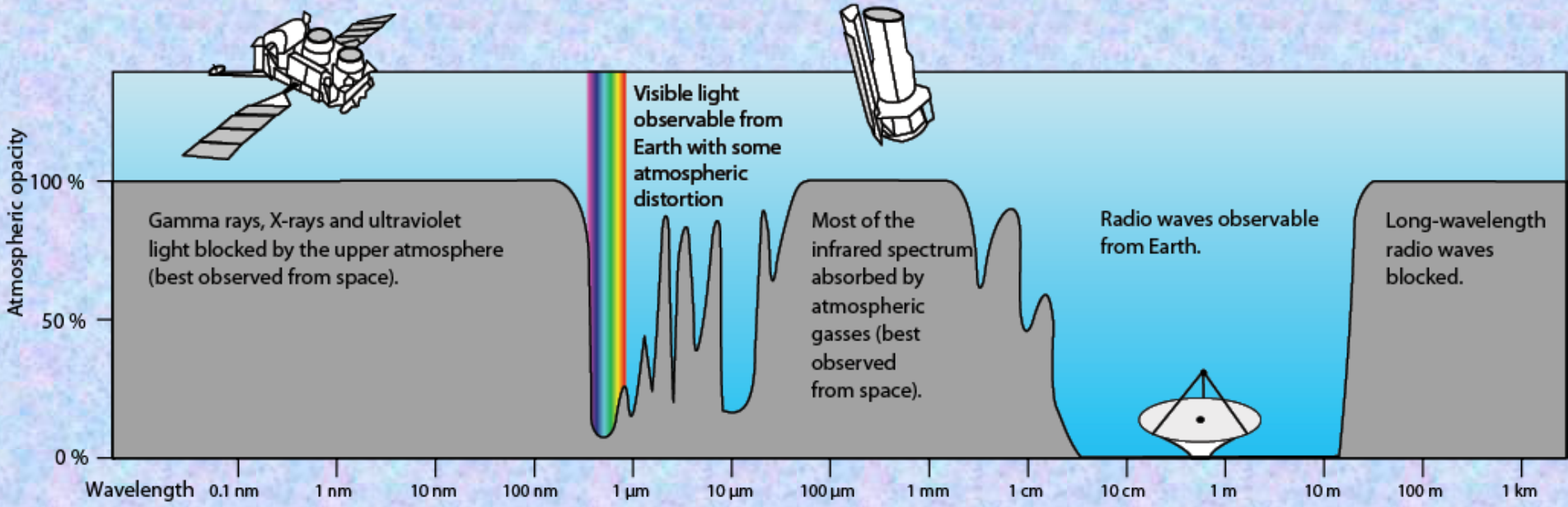
Spectroscopic workshop, 6.-10.2.2017, Brno


WE NEED MORE LIGHT !!!

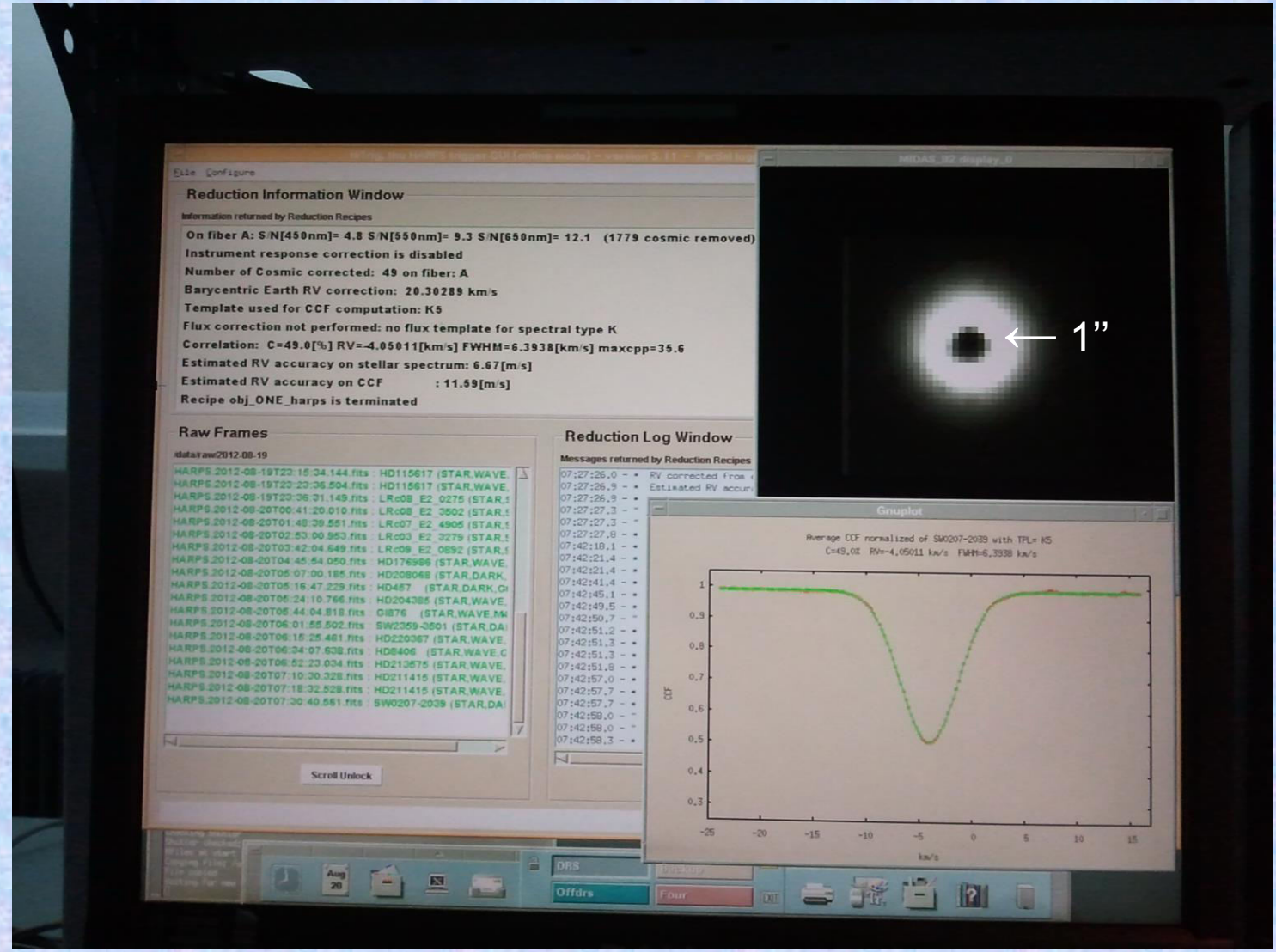
BIGGER TELESCOPES



ATMOSPHERE - FILTER

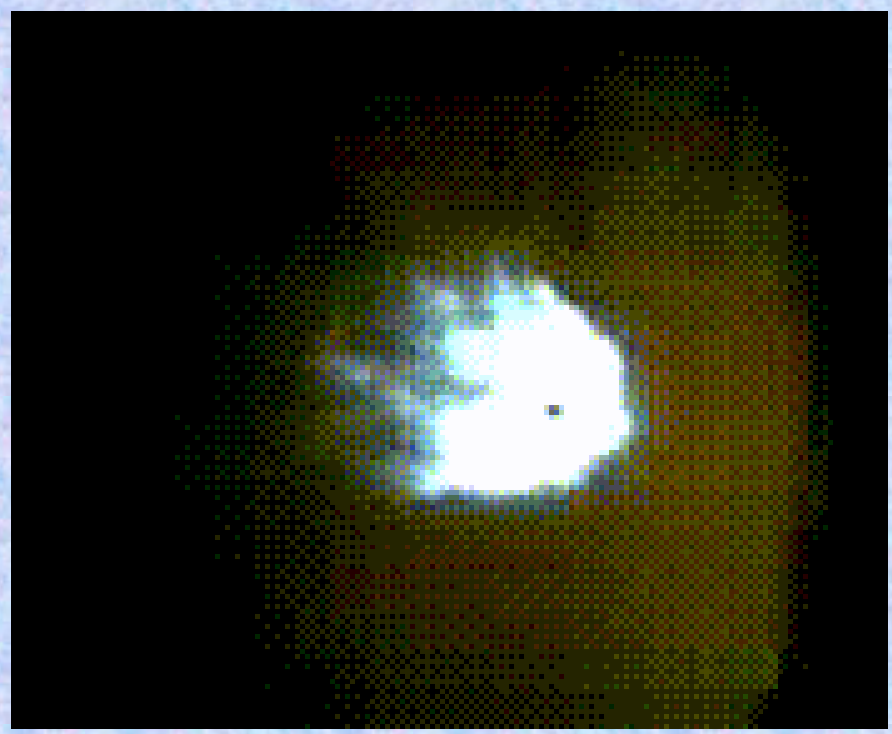


ATMOSPHERE - SEEING



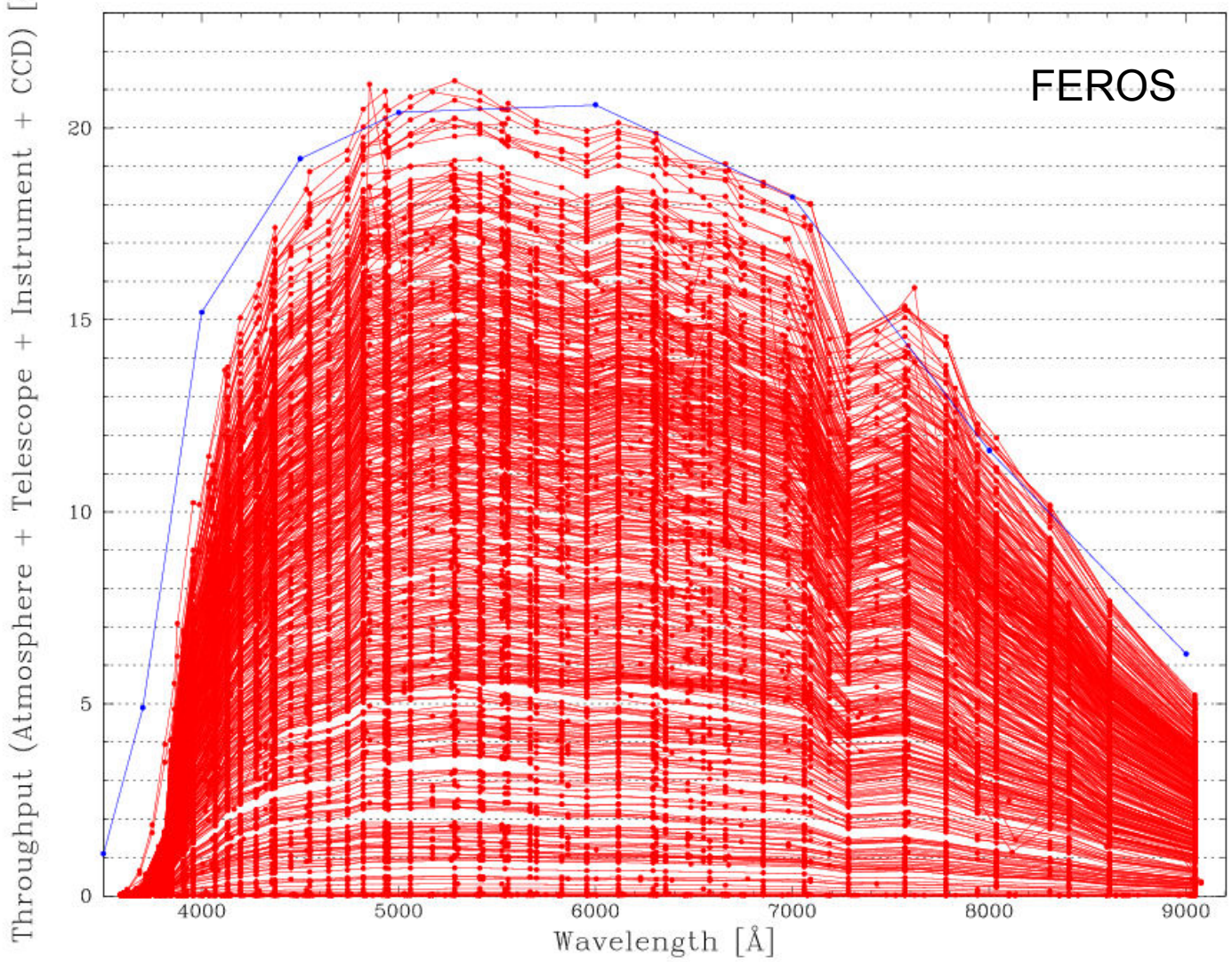
ATMOSPHERE - SEEING

- Big seeing – smaller then 10 % of light to spectroscop

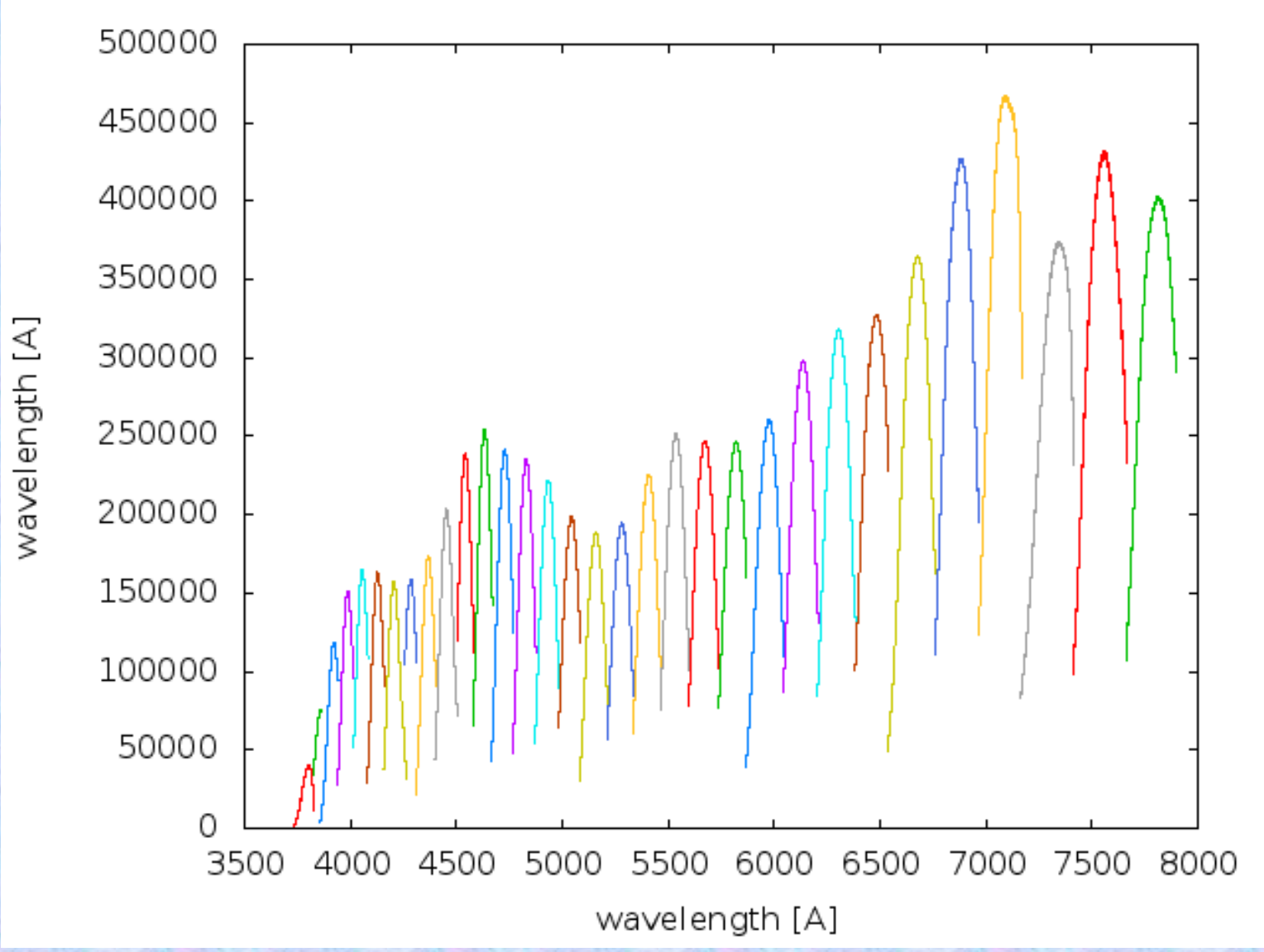


ATMOSPHERE – AdO+AcO

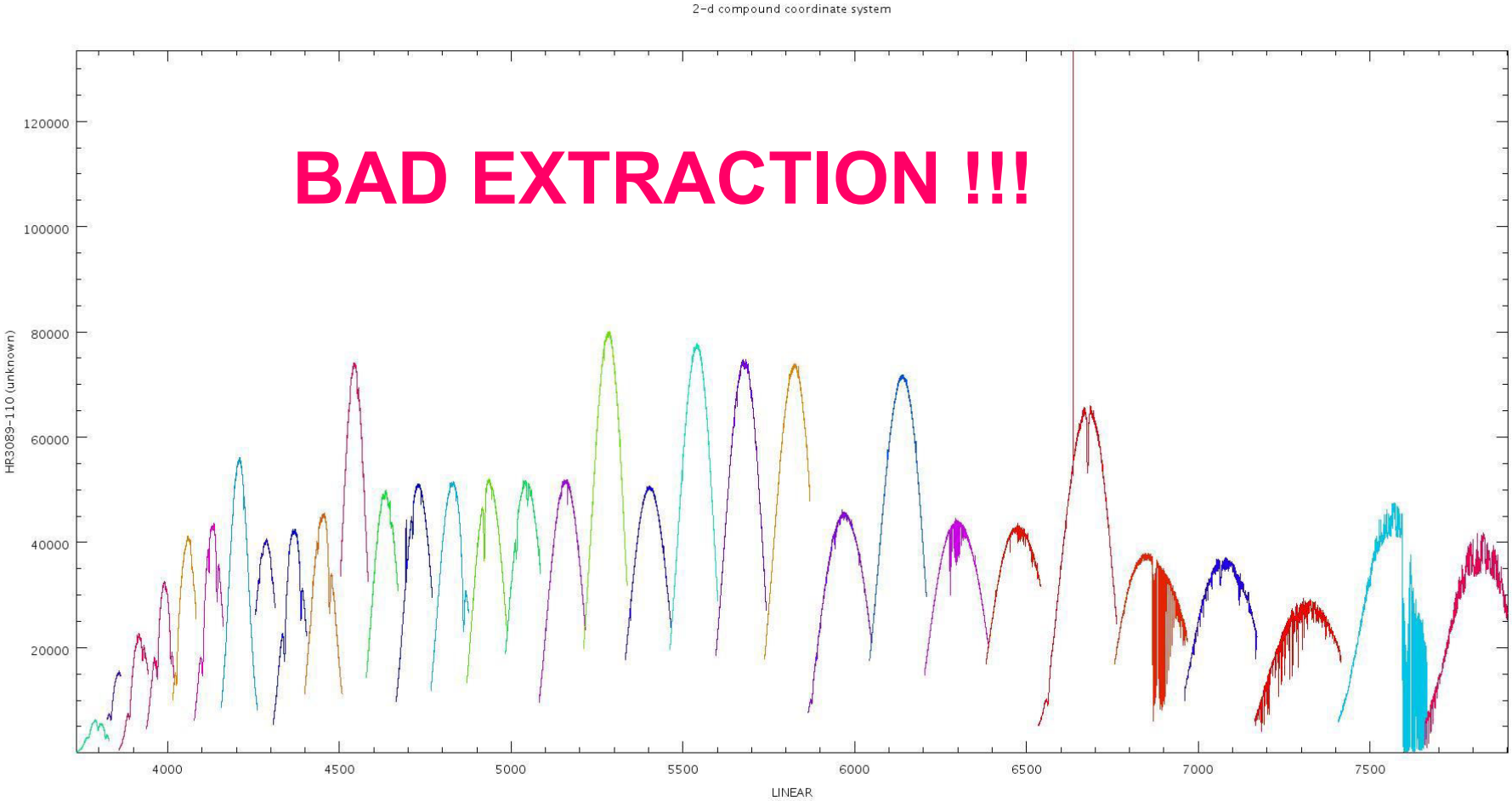
SPECTROSCOP EFFICIENCY



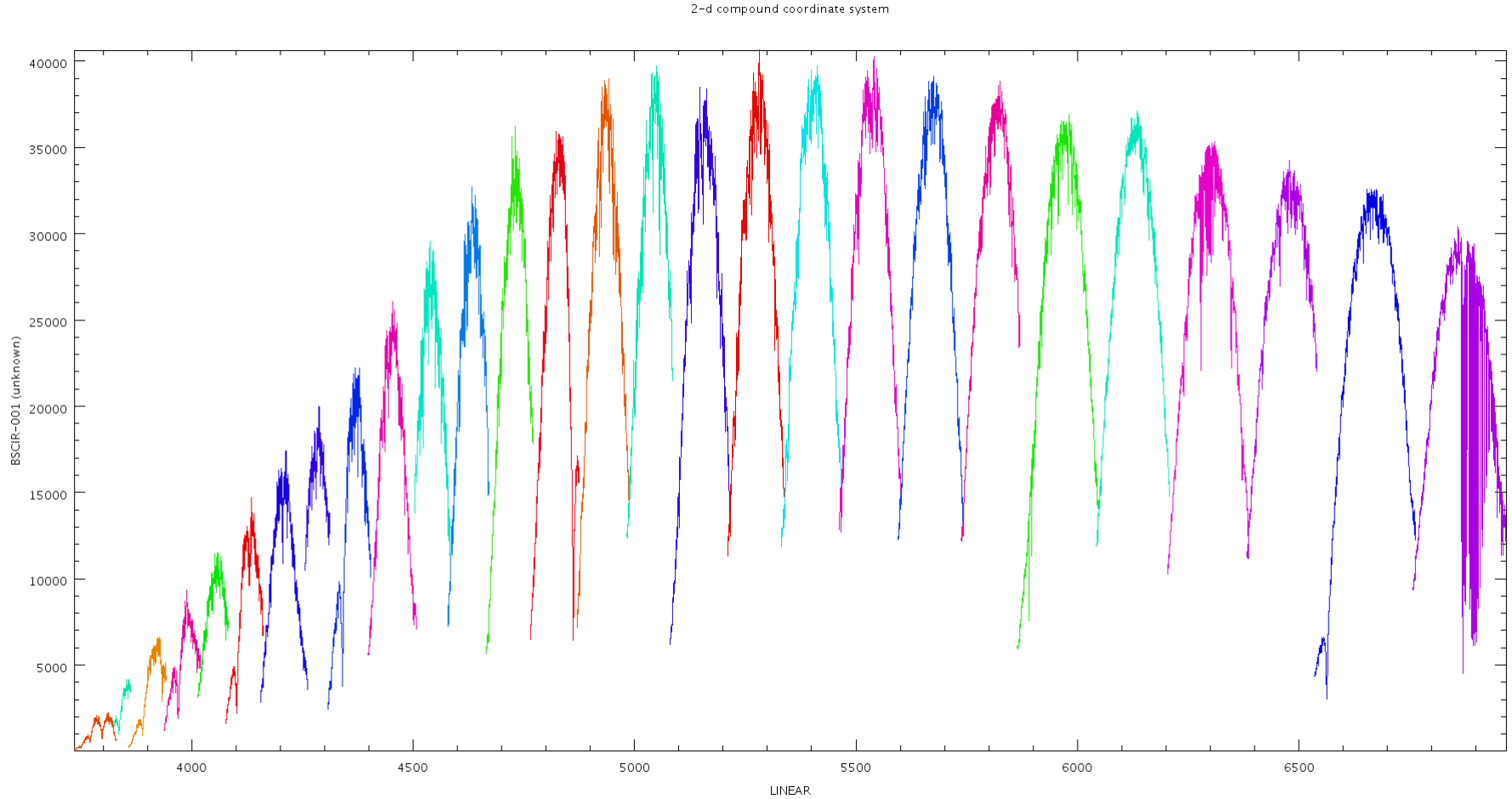
APERTURE DEFINITON



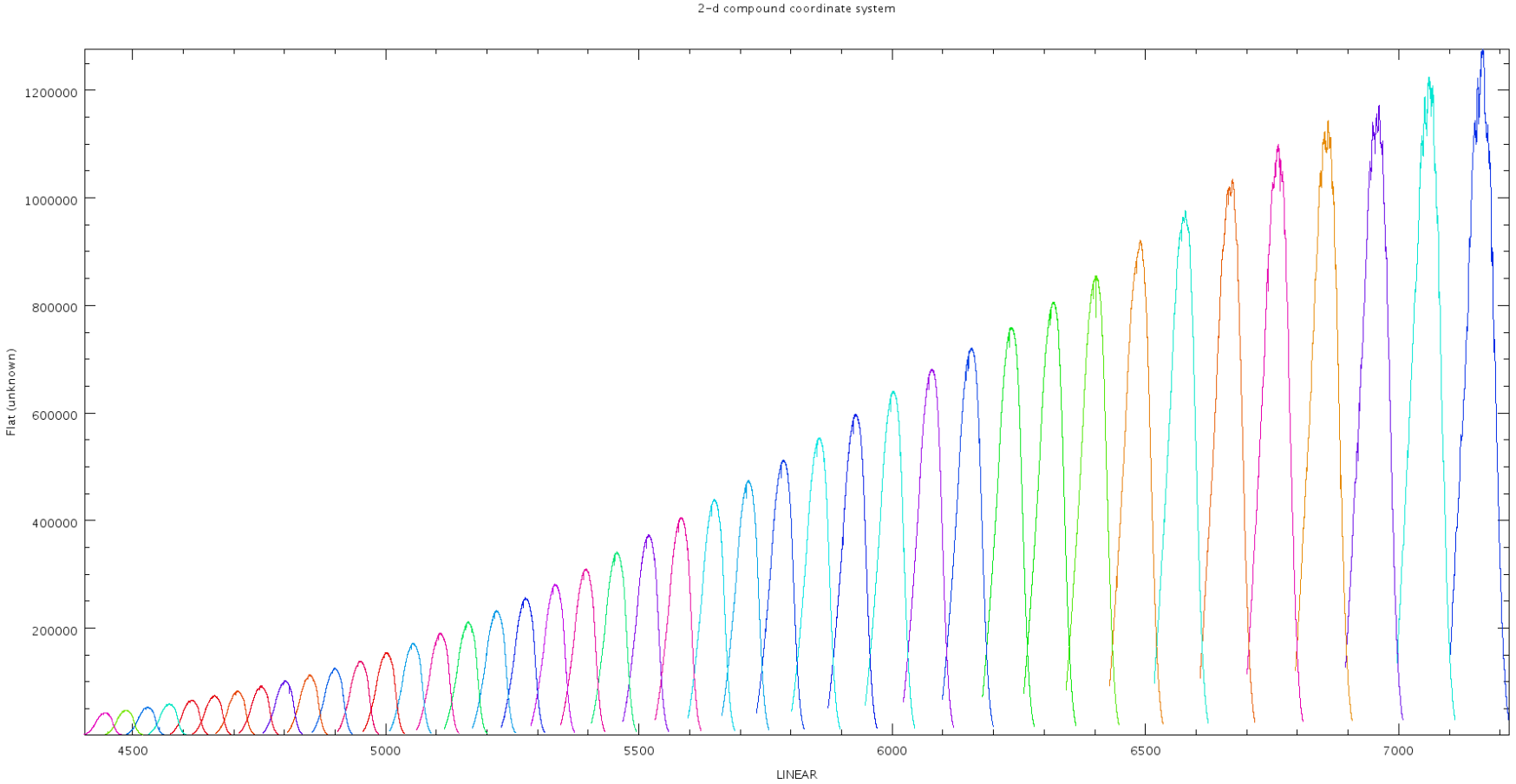
APERTURE DEFINITON



APERTURE DEFINITON

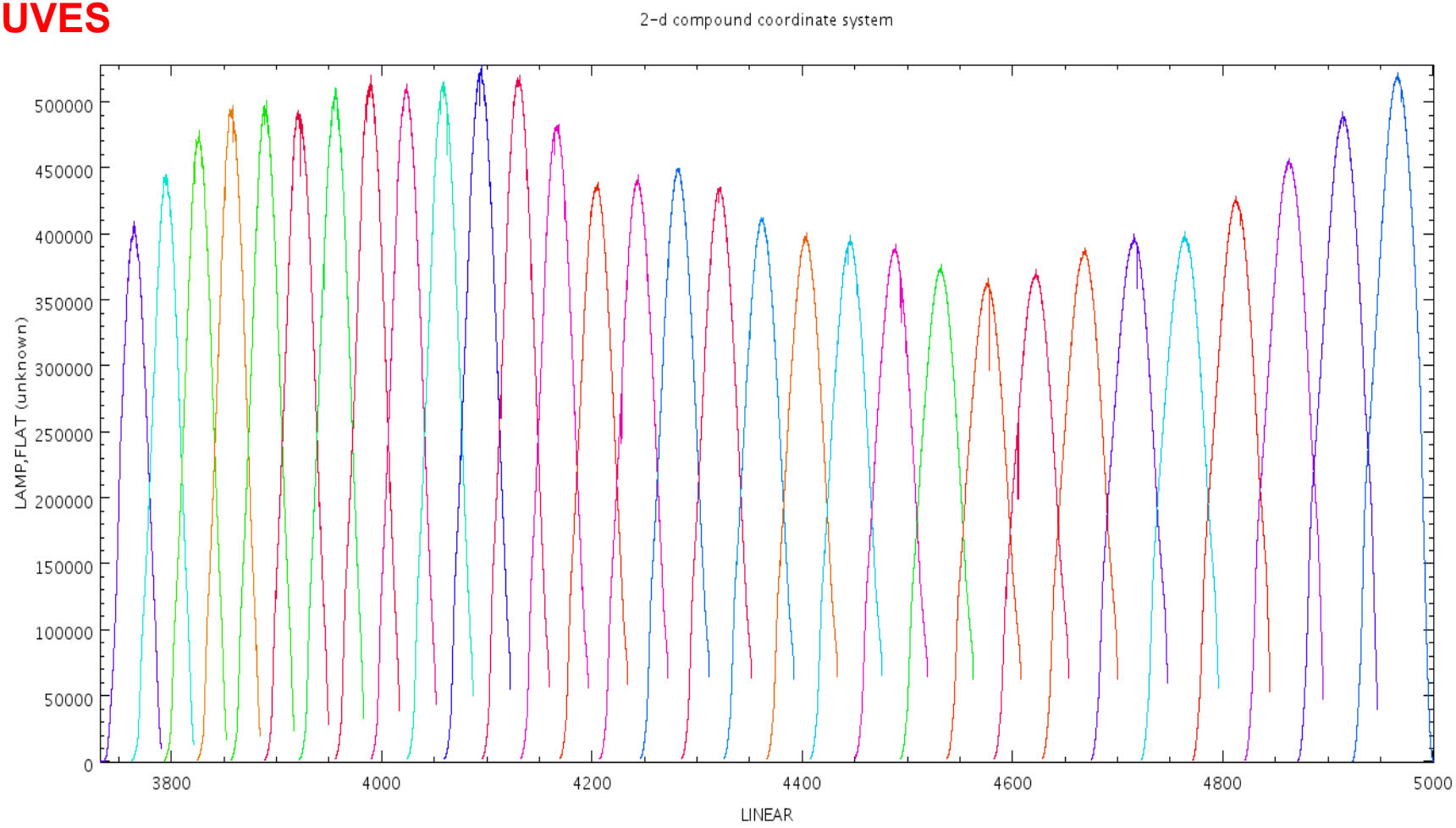


APERTURE DEFINITON



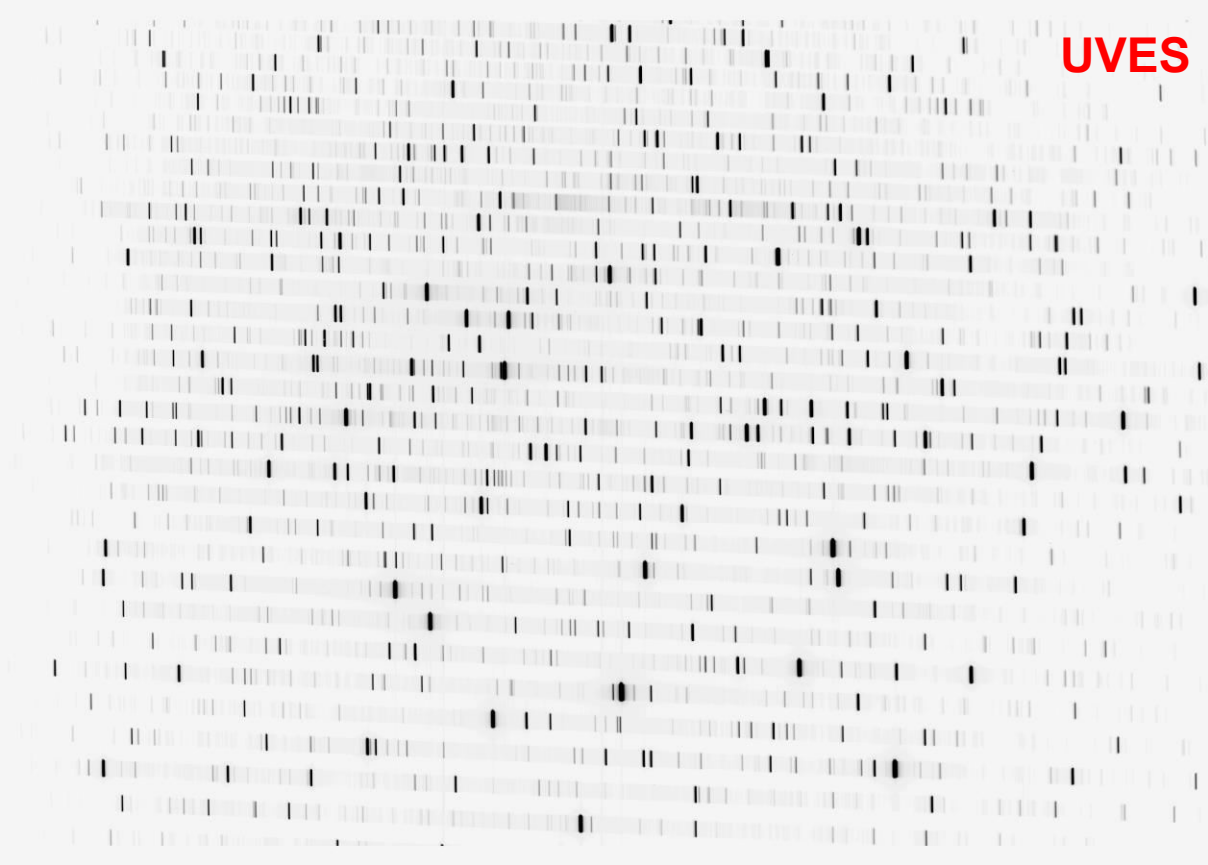
APERTURE DEFINITON

UVES



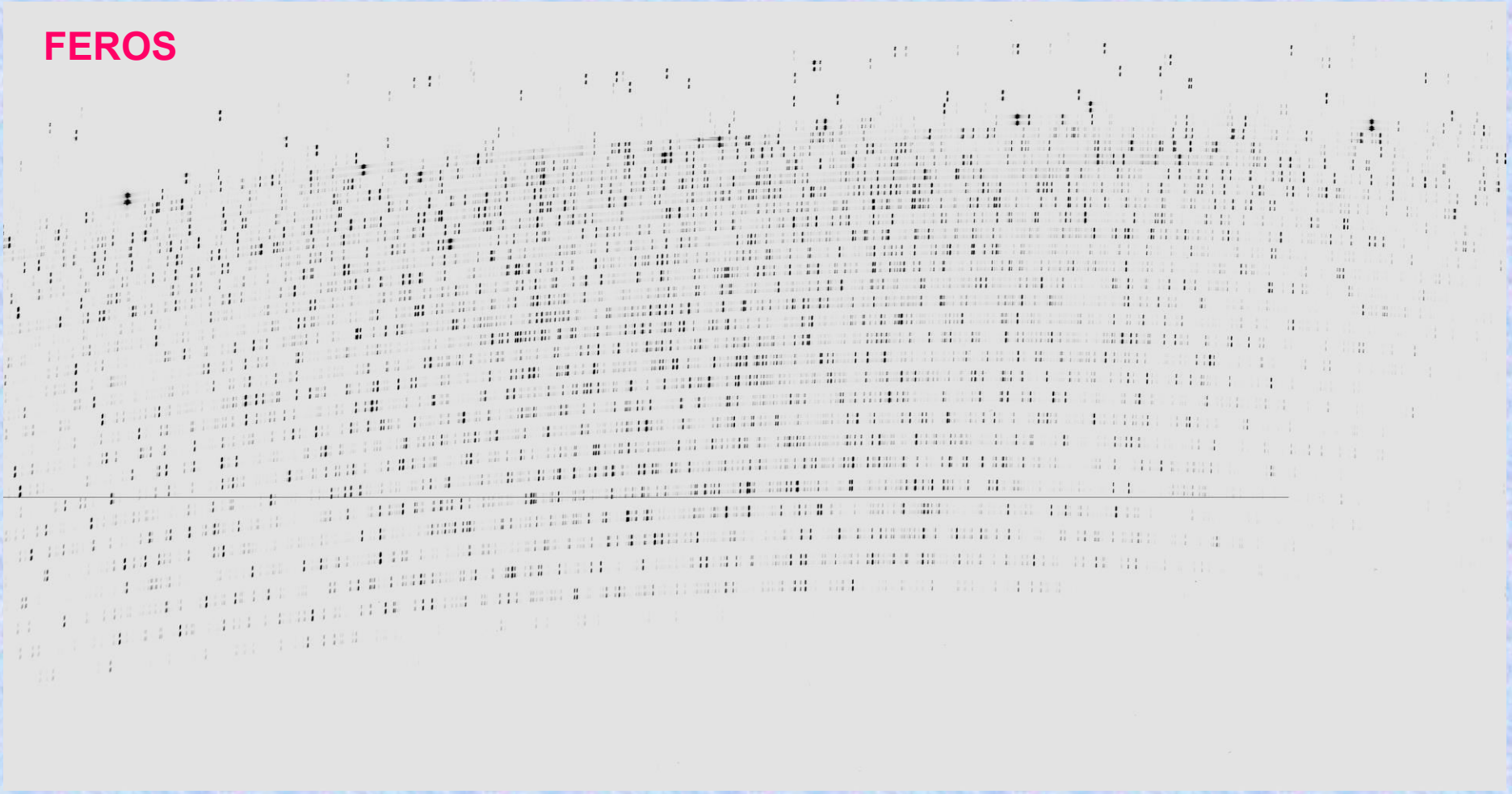
WAVELENGTH CALIBRATION

- Th-Ar
- Th-Ar-Ne
- Iodine cell

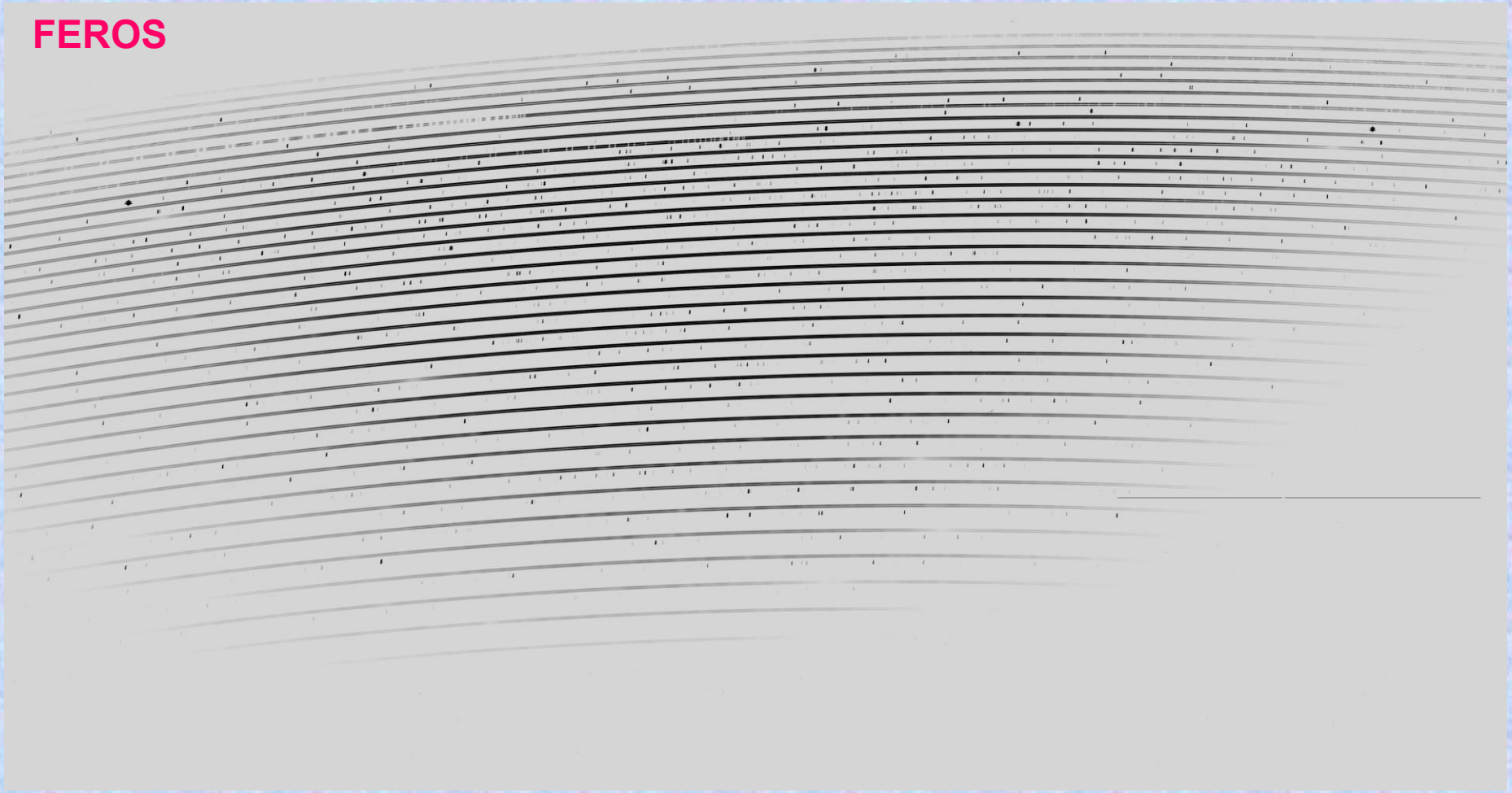


- The best precision for RV as possible !!!

WAVELENGTH CALIBRATION

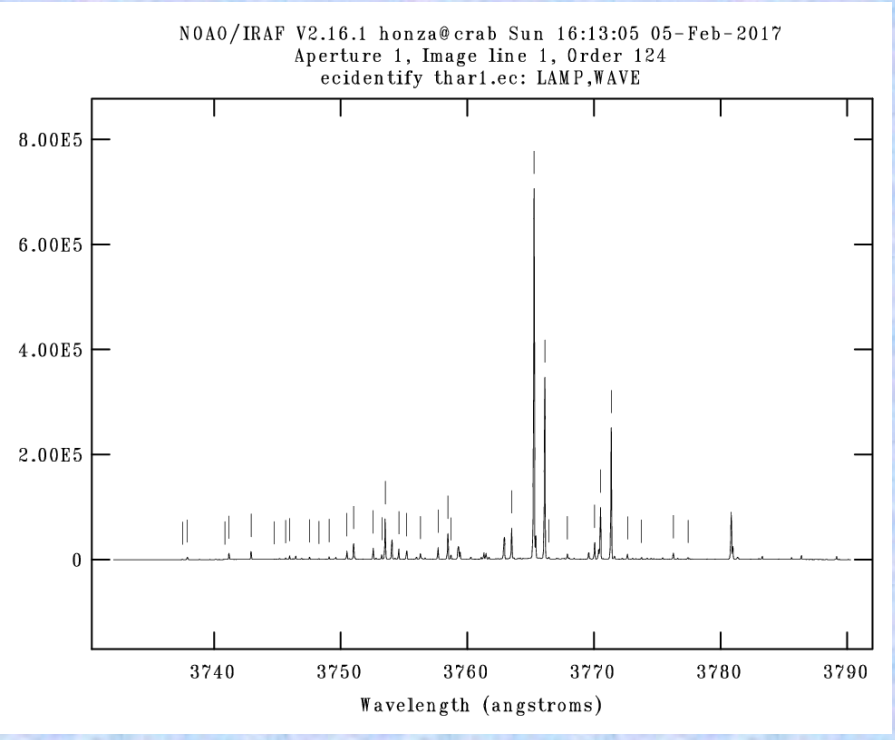


WAVELENGTH CALIBRATION

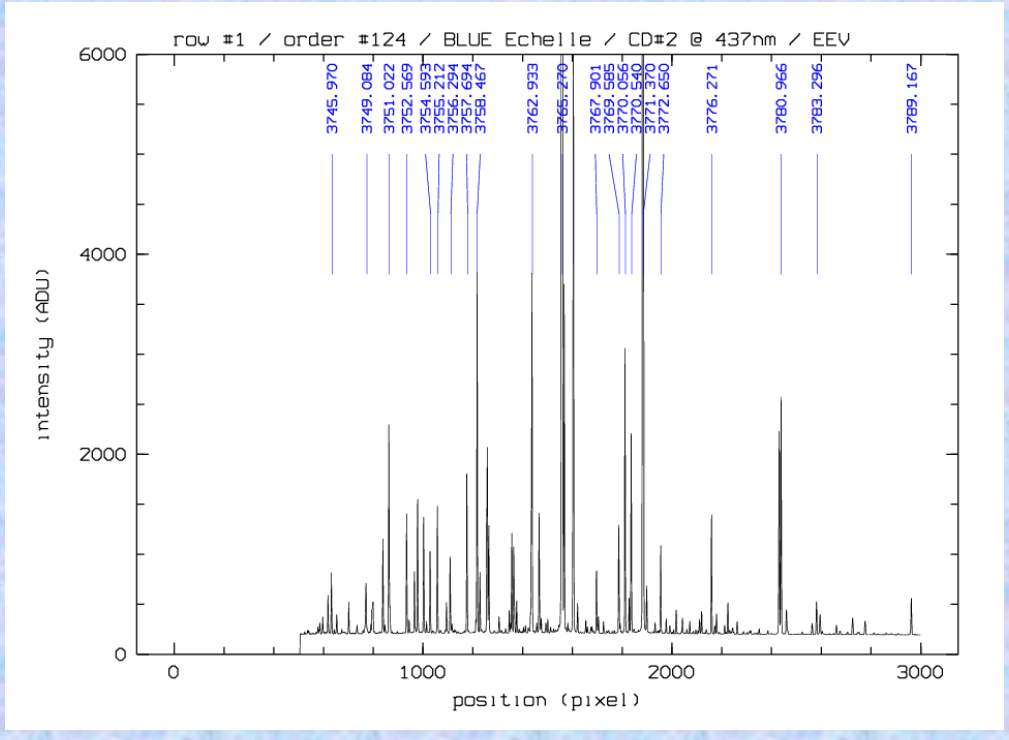


WAVELENGTH CALIBRATION

UVES (real spectrum)

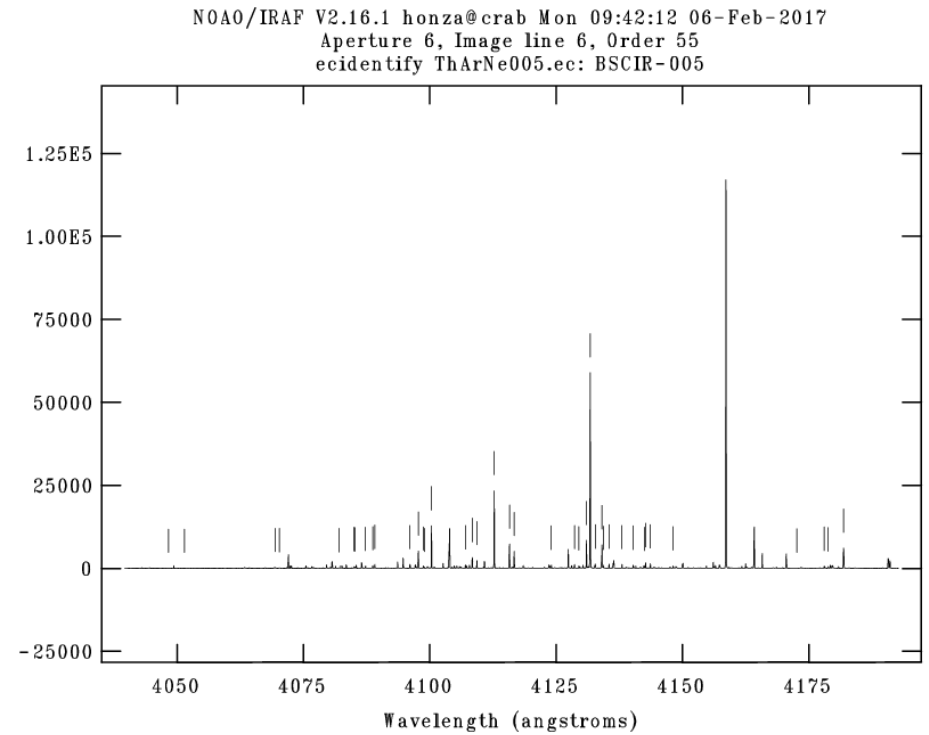


(from manual)

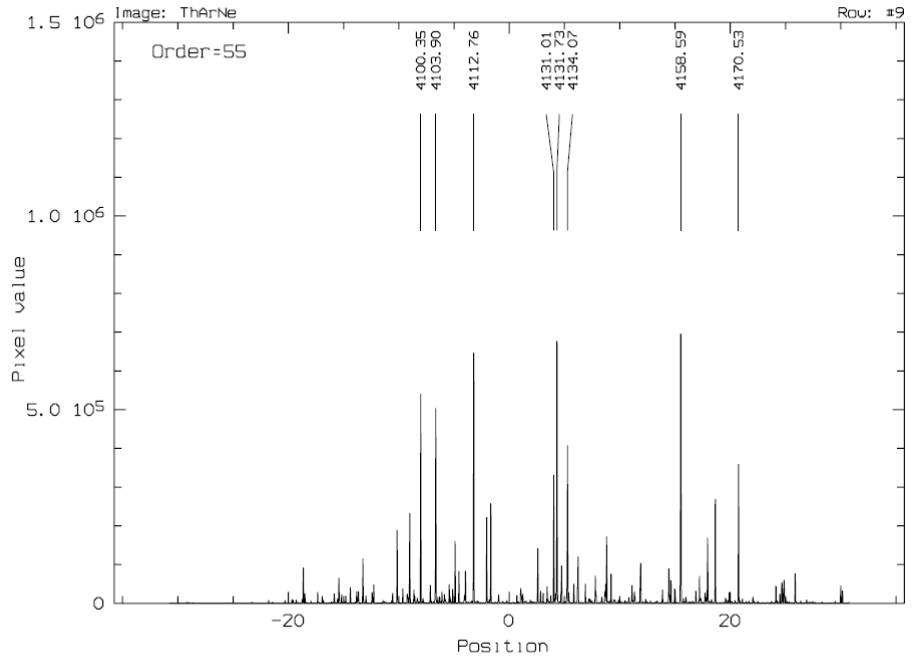


WAVELENGTH CALIBRATION

FEROS (real spectrum)

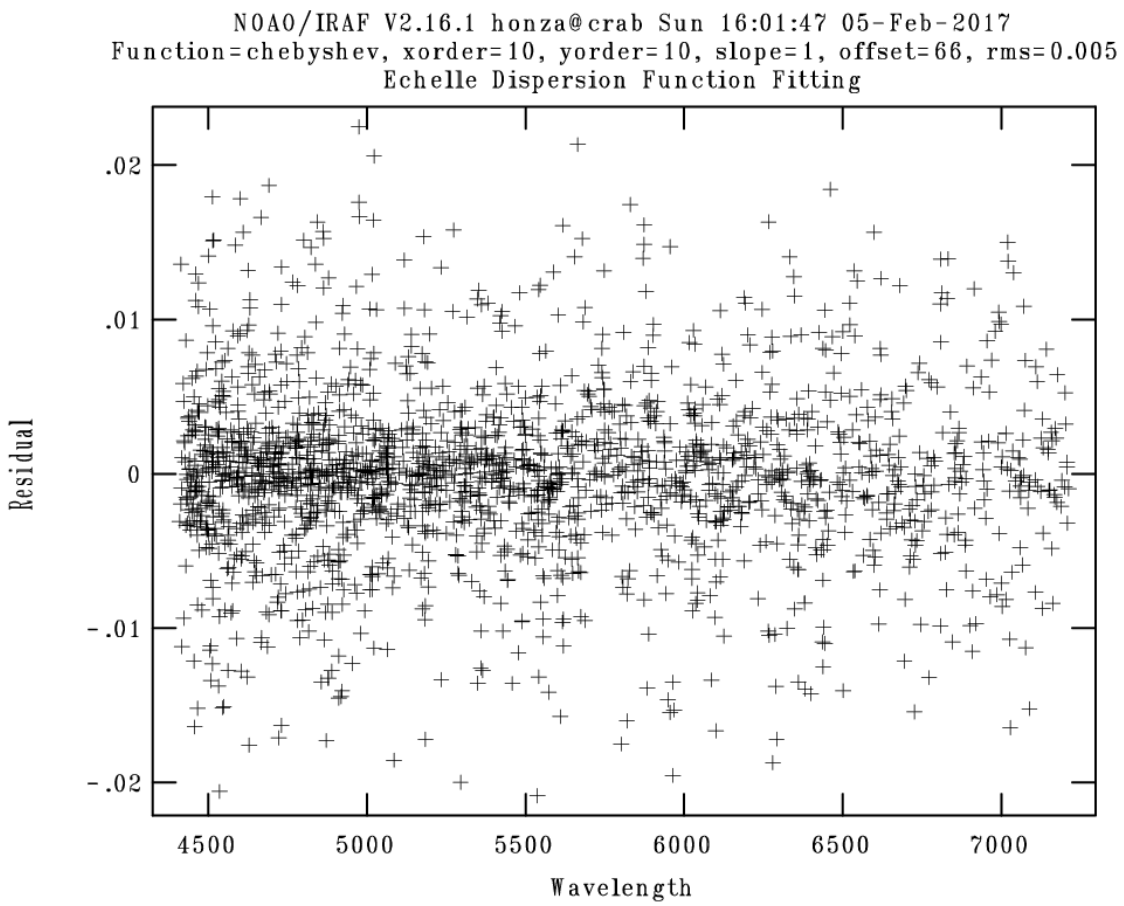


(from manual)

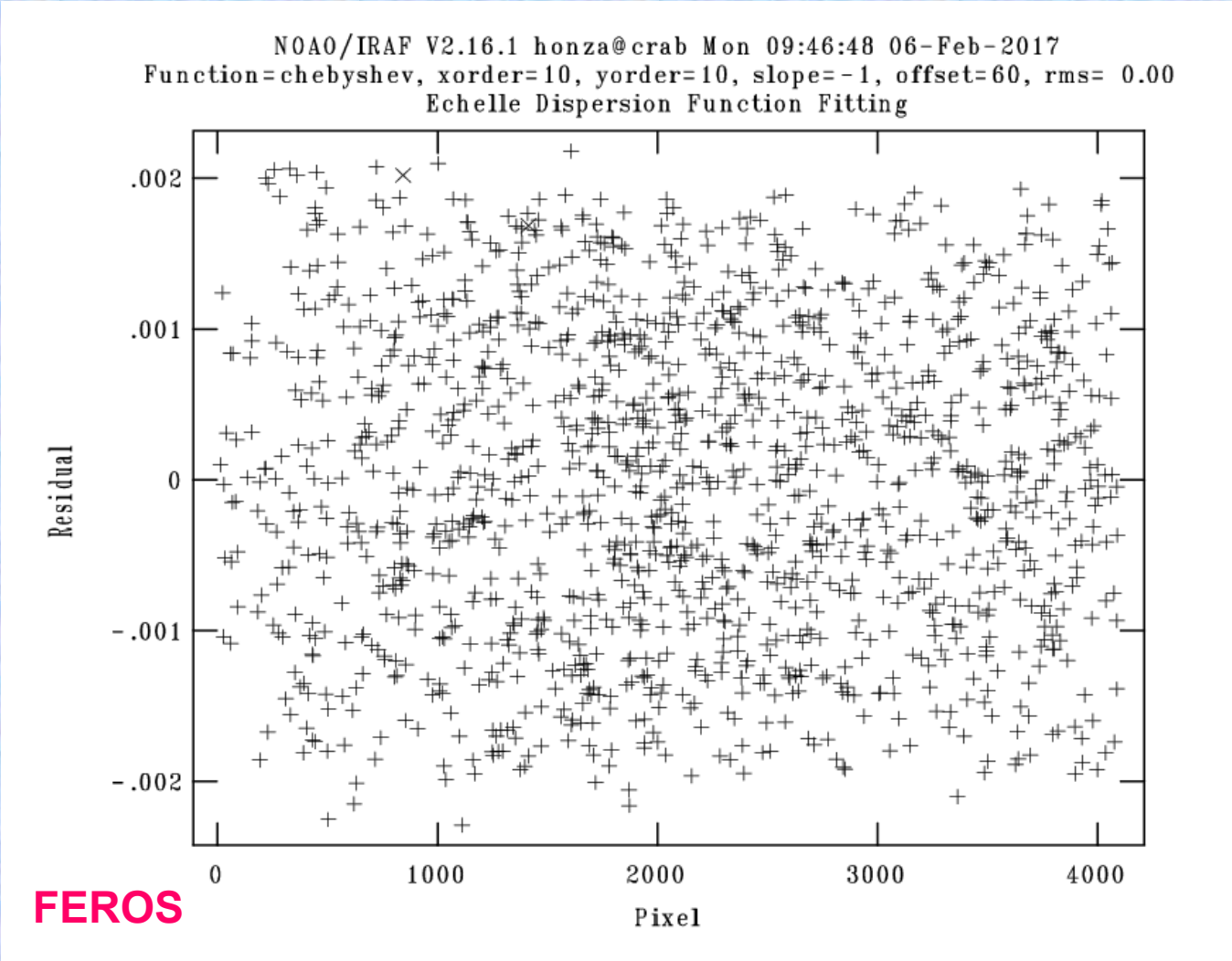


WAVELENGTH CALIBRATION

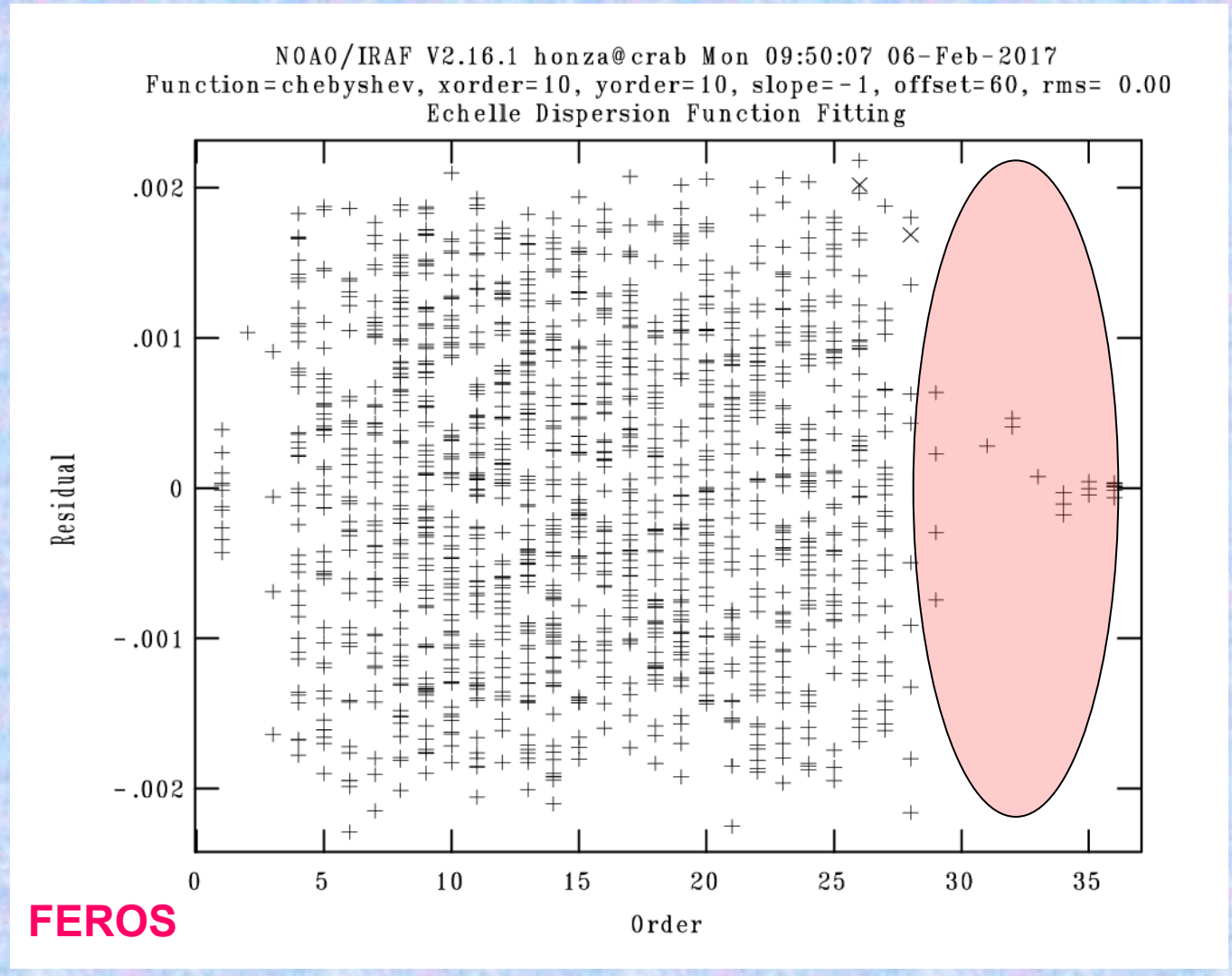
TUG



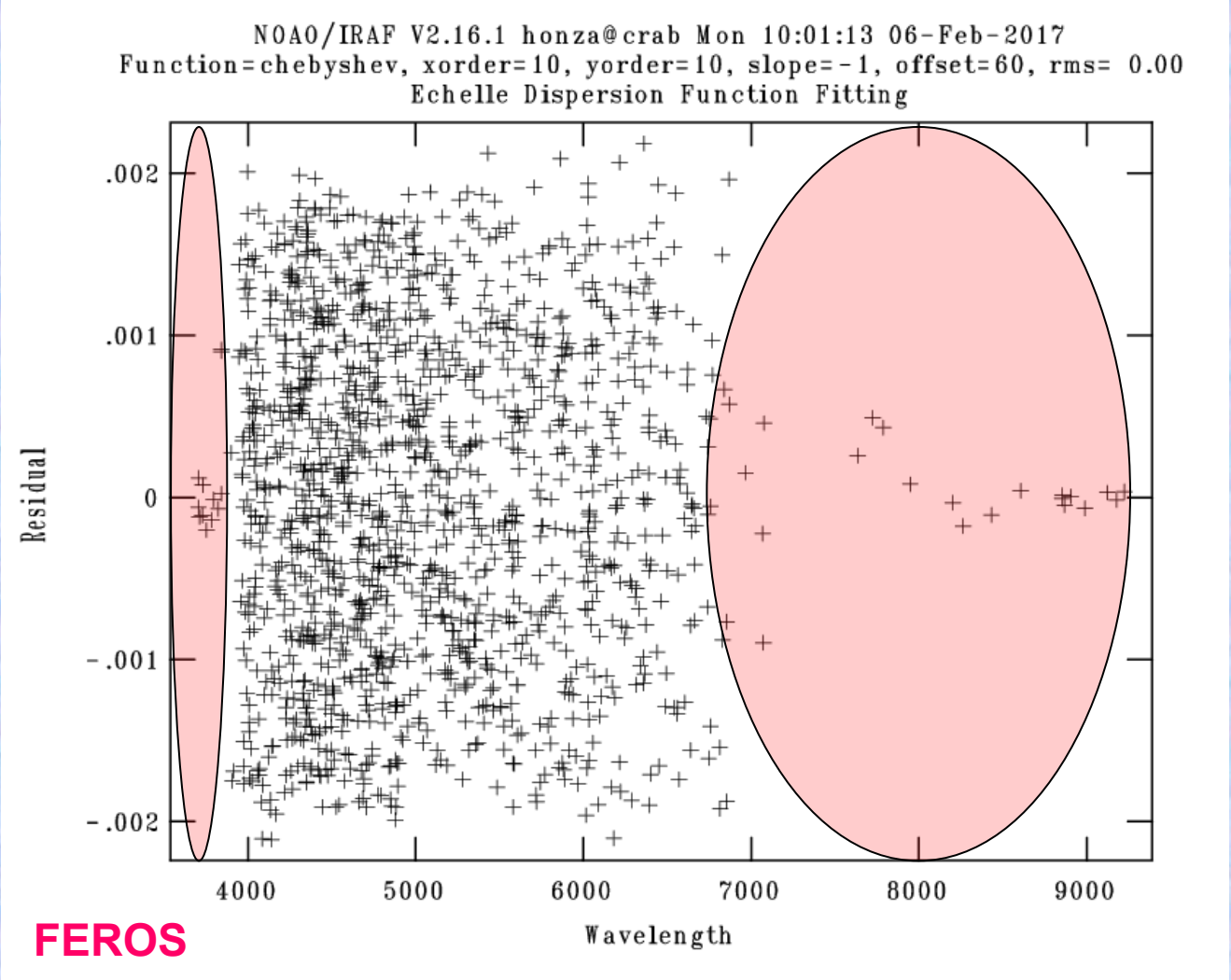
WAVELENGTH CALIBRATION



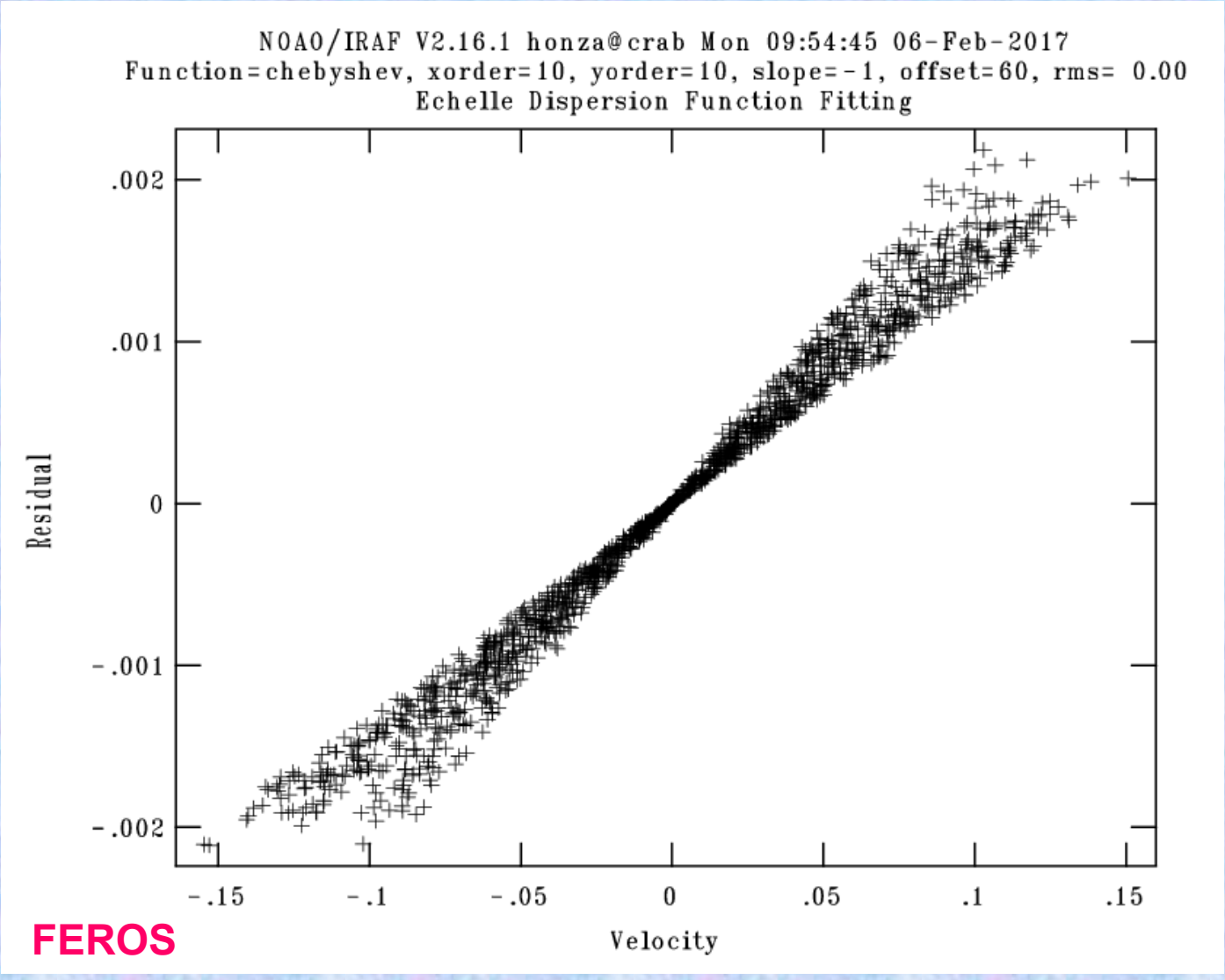
WAVELENGTH CALIBRATION



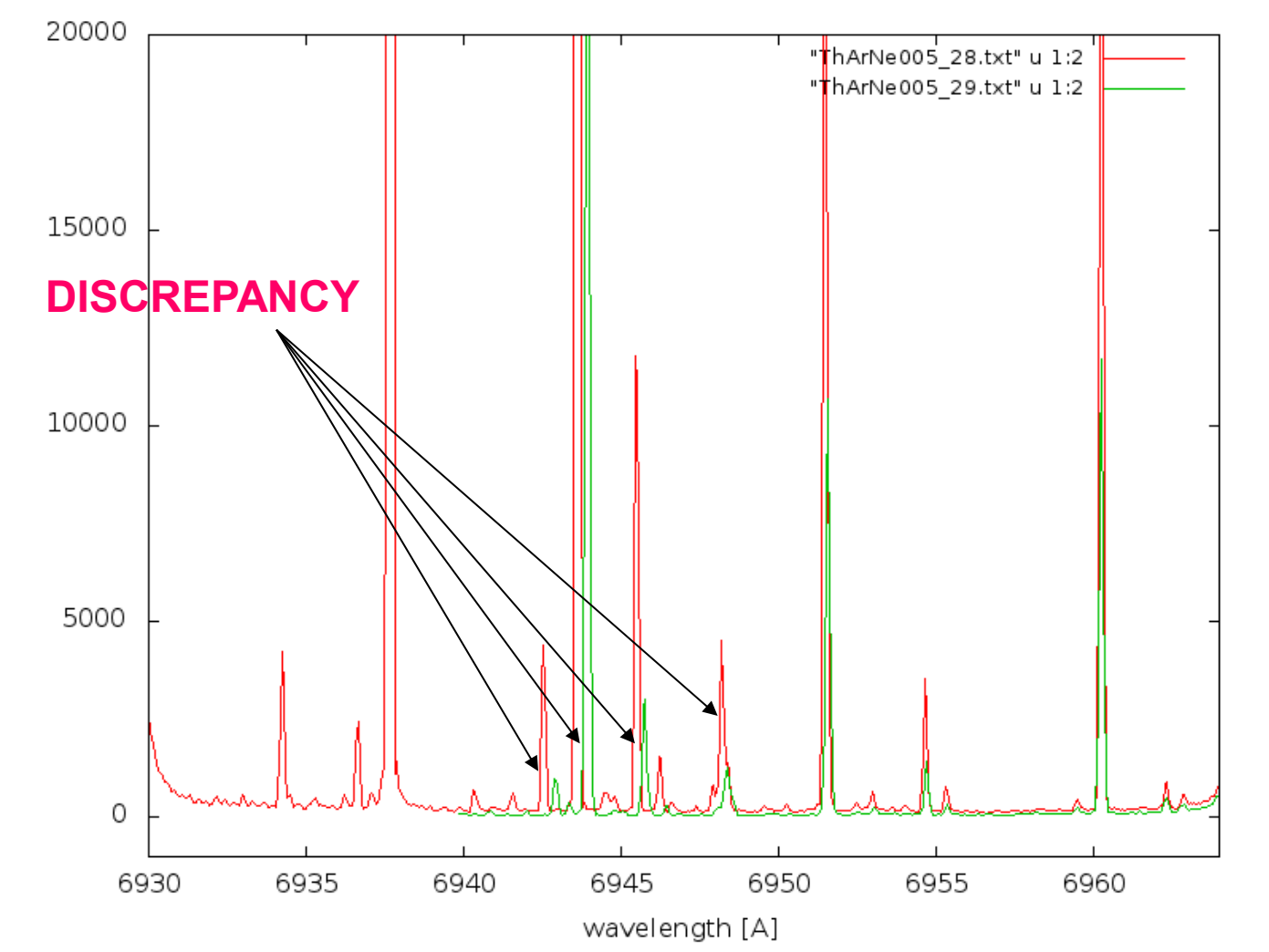
WAVELENGTH CALIBRATION



WAVELENGTH CALIBRATION

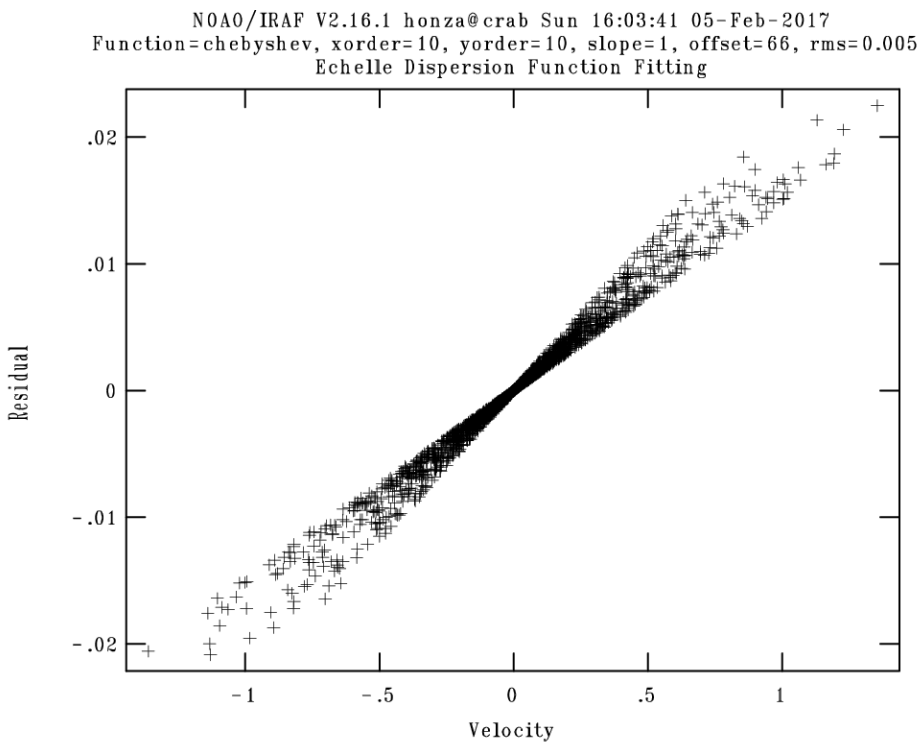


WAVELENGTH CALIBRATION

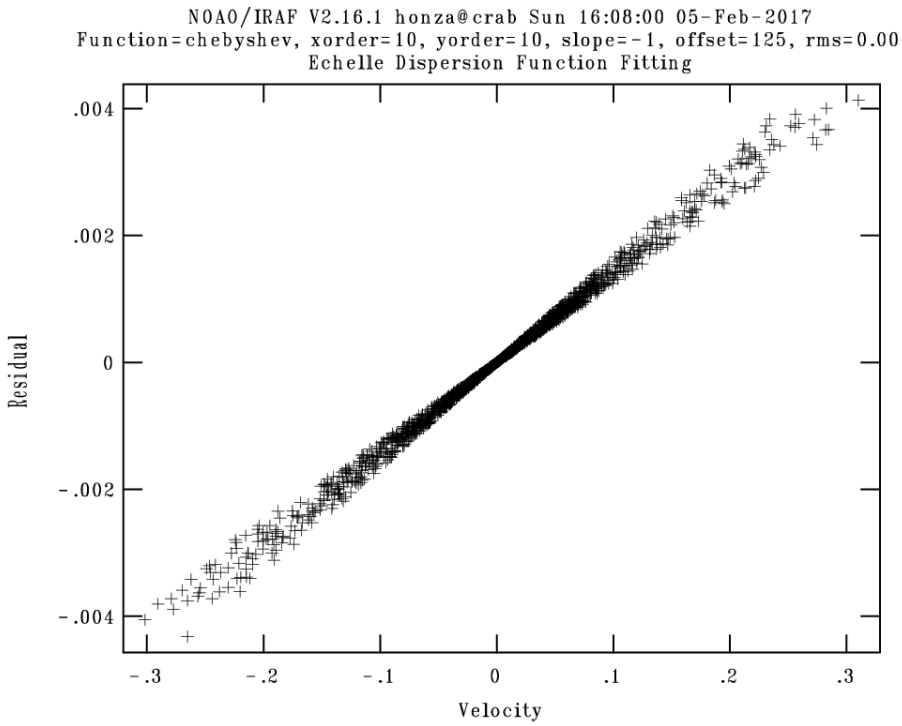


WAVELENGTH CALIBRATION

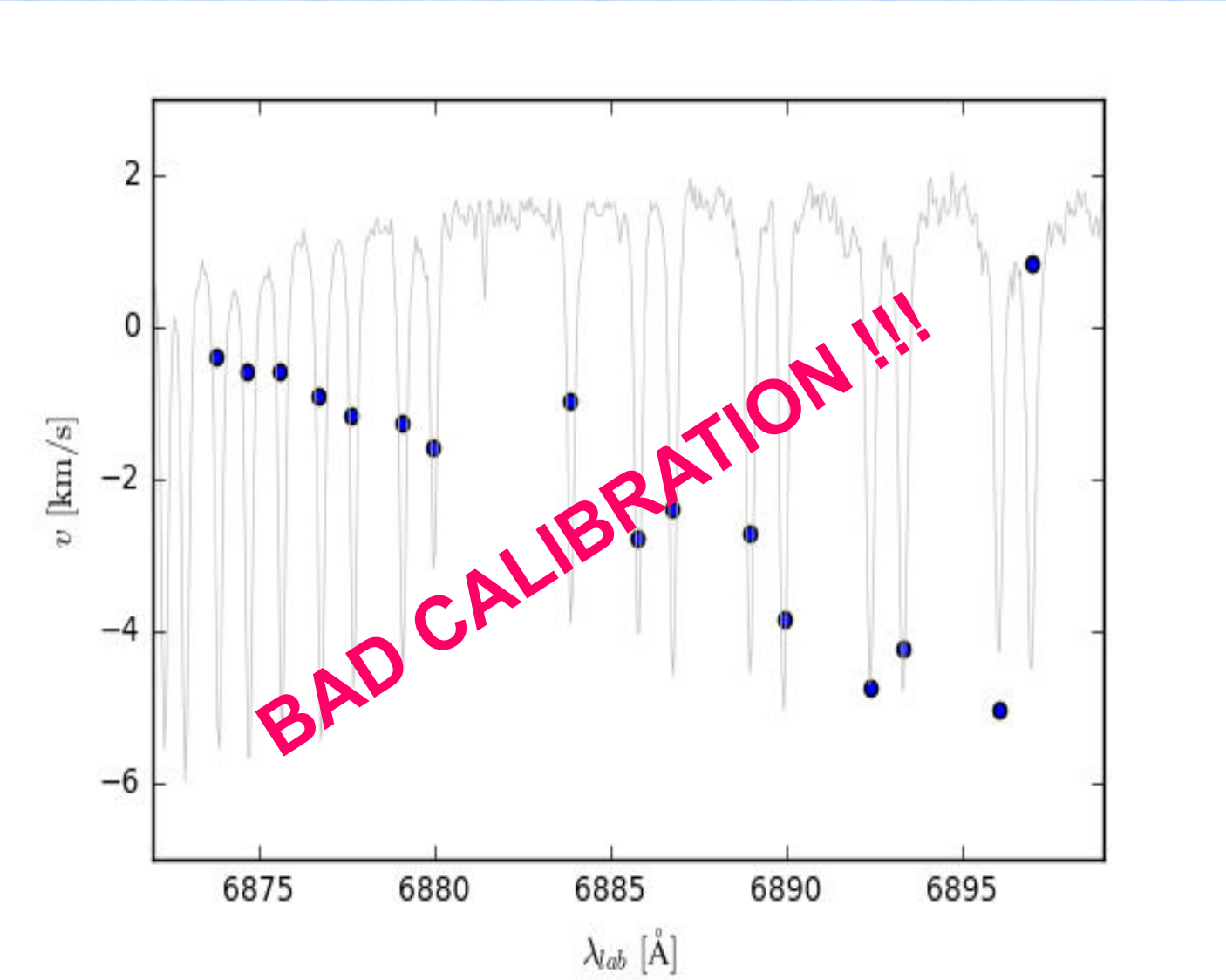
TUG (0.04 A/pix)



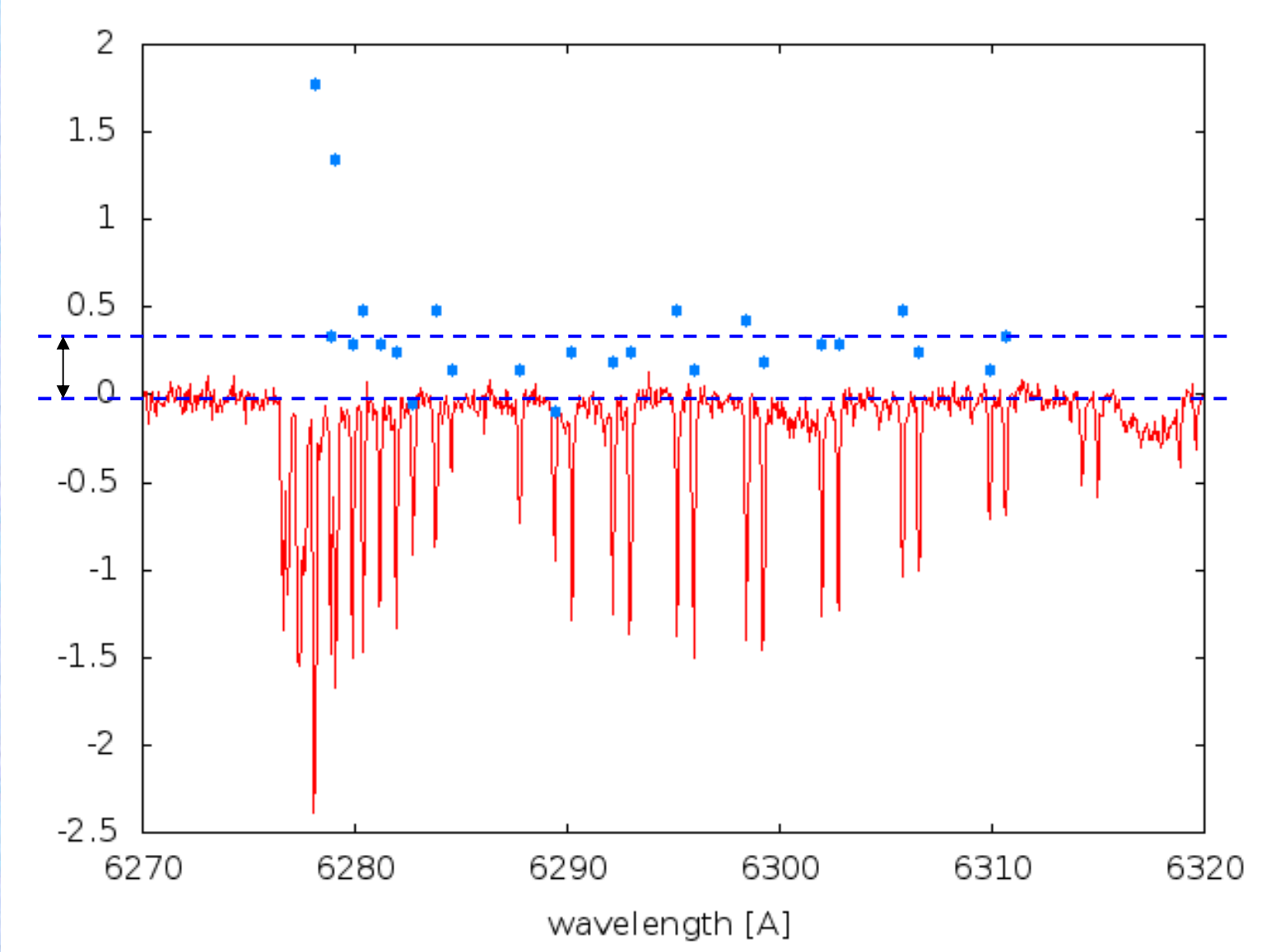
UVES (0.02 A/pix)



TELLURIC LINE AS STANDARDS



TELLURIC LINE AS STANDARDS



HELIOCENTRIC / BARYCENTRIC VELOCITY CORRECTION

Barycentric Velocity Correction (beta)

This online applet runs barycorr from Wright & Eastman (2014) which calculates the barycentric velocity correction for each UTC with a maximum error of 2.4 mm/s, compared to TEMPO2 (See Figures 2 and 3). Mouse over the inputs for an explanation and the required precision of inputs for desired precision of output. For 3 m/s precision, all optional fields can be ignored.

For m/s precision, one should calculate the barycentric correction throughout the exposure and perform a flux and barycentric correction weighted average. This error scales as the square of the exposure time.

There is a programmatic interface to this applet. Here is an example that recreates the values found in Table 2 (Tau Ceti with coordinates in the Hipparcos Epoch), multiplied by c. The optional parameters, if not specified, will default to the values displayed here. You may also set OBSNAME to an allowed string in observatory.pro and RAUNITS to "hours" to signify the input RA is in hours instead of its default of degrees.

JD_UTCs

RA (J2000) HH MM SS.S DDD.DDD

DEC (J2000) DD MM SS.S

Earth-based observatory

Earth-based Observatory

-- or --

Latitude (degrees) Longitude (degrees E) Elevation (meters)

Only required for < 3 m/s precision

μ_α (mas/yr) μ_δ (mas/yr) Parallax (mas) RV (m/s)

0.0 0.0 0.0 0.0

Z_{meas} Epoch Tbase (days)

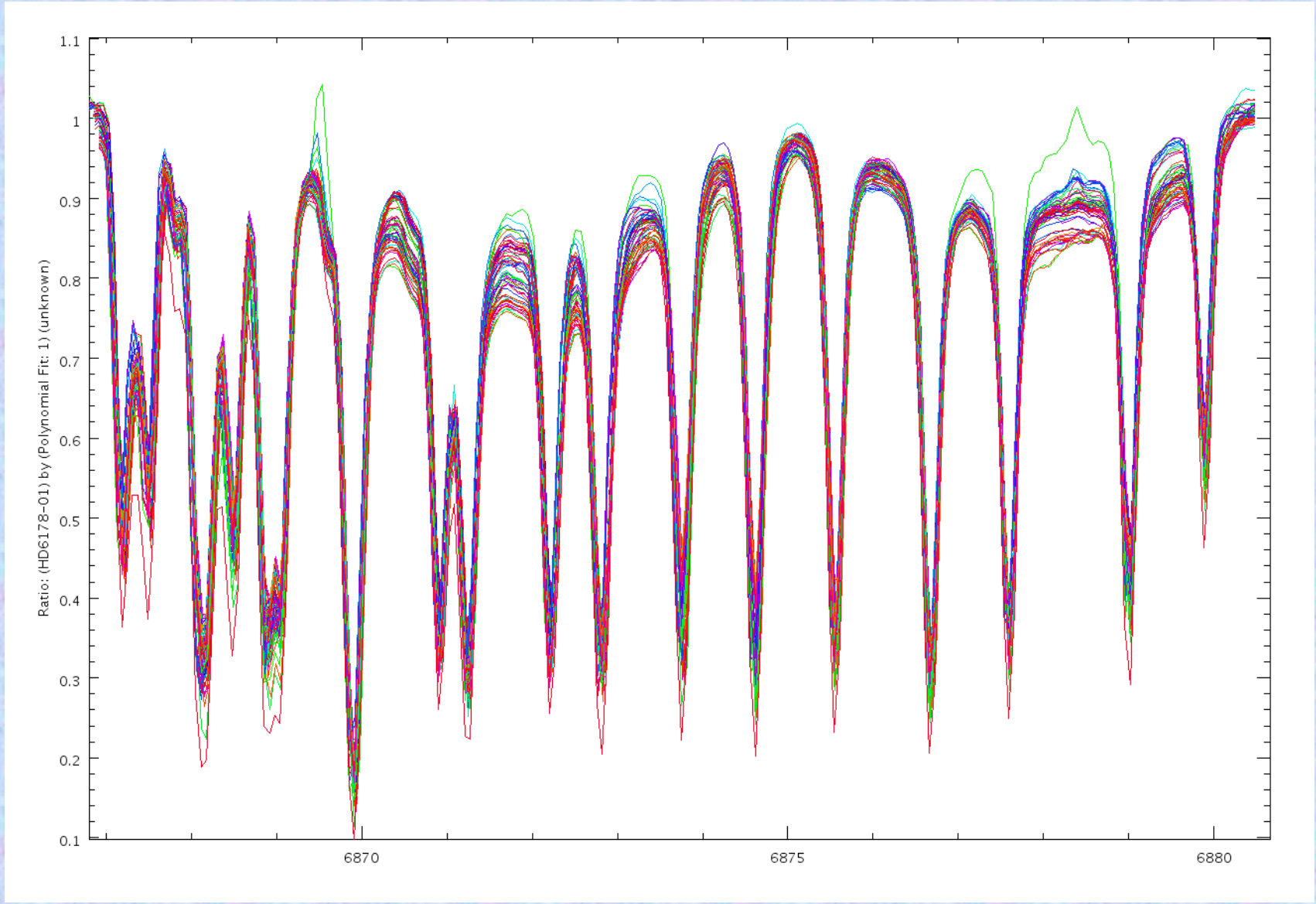
0.0 2451545.0 0.0

Odeslat -- User inputs are NOT logged

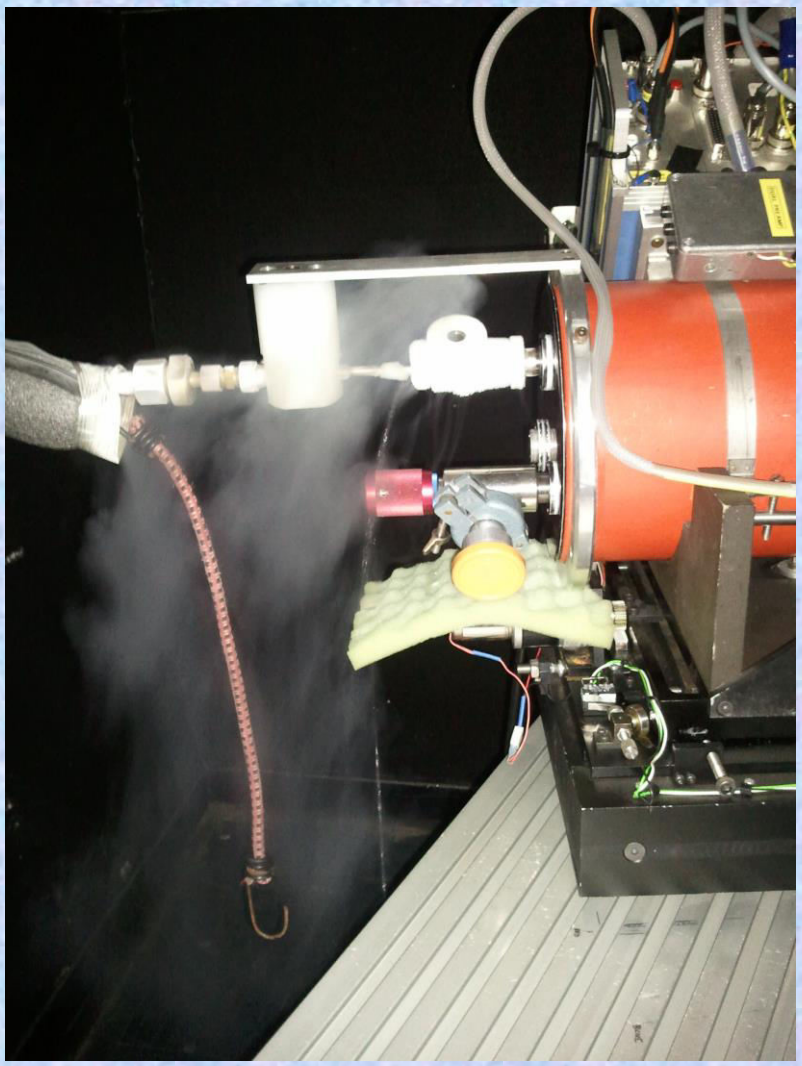
If you have made use of this calculator (or the source code) in a scientific paper, please cite our paper, which contains a more thorough explanation of the various corrections involved in this calculation.

Last revised: Apr 28, 2016 [jde/cfa]

SPECTROGRAPH STABILITY



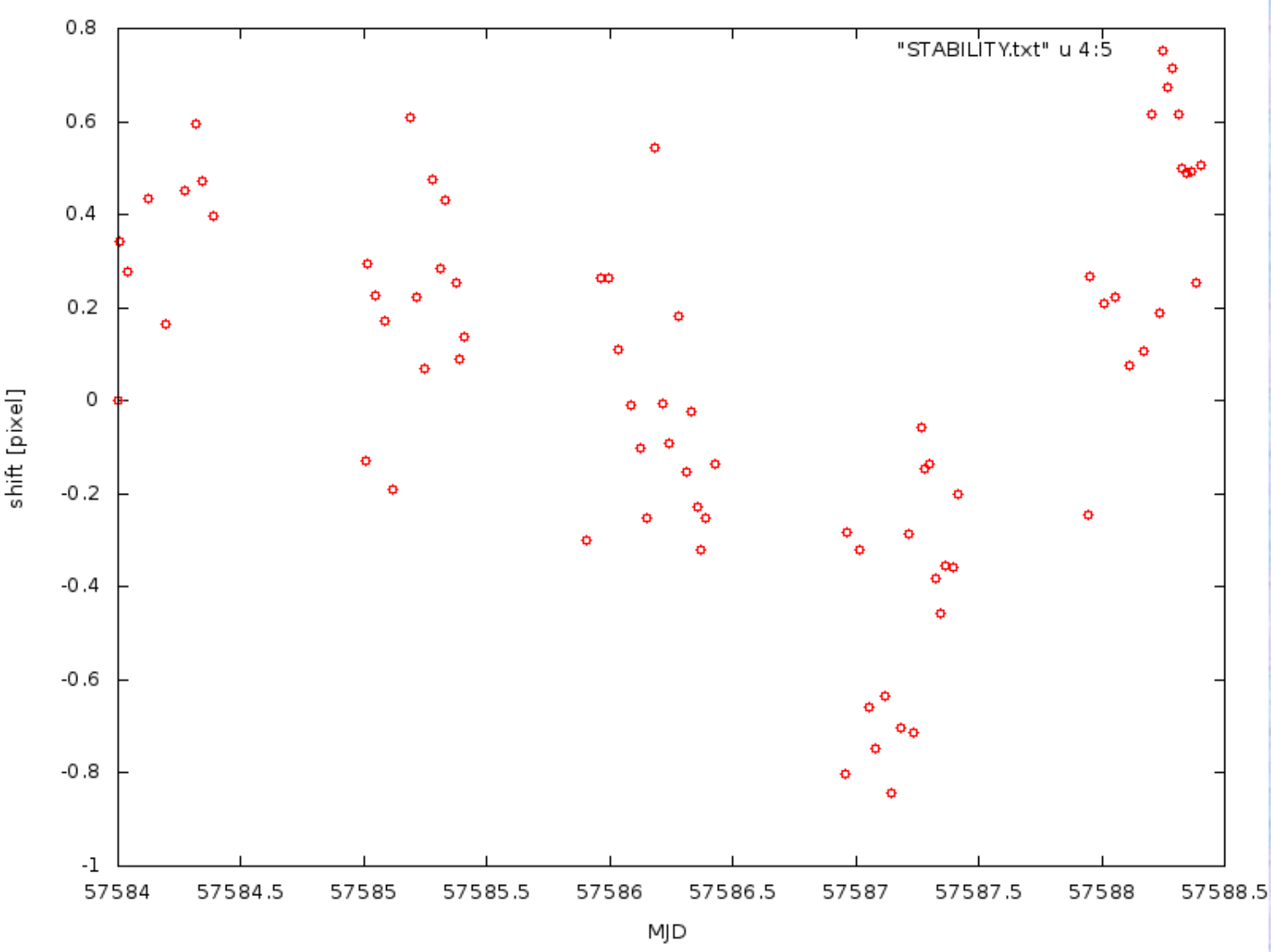
SPECTROGRAPH STABILITY



VERY STABLE
TEMPERATURE

IF NOT ….

SPECTROGRAPH STABILITY



HARPS Radial Velocities

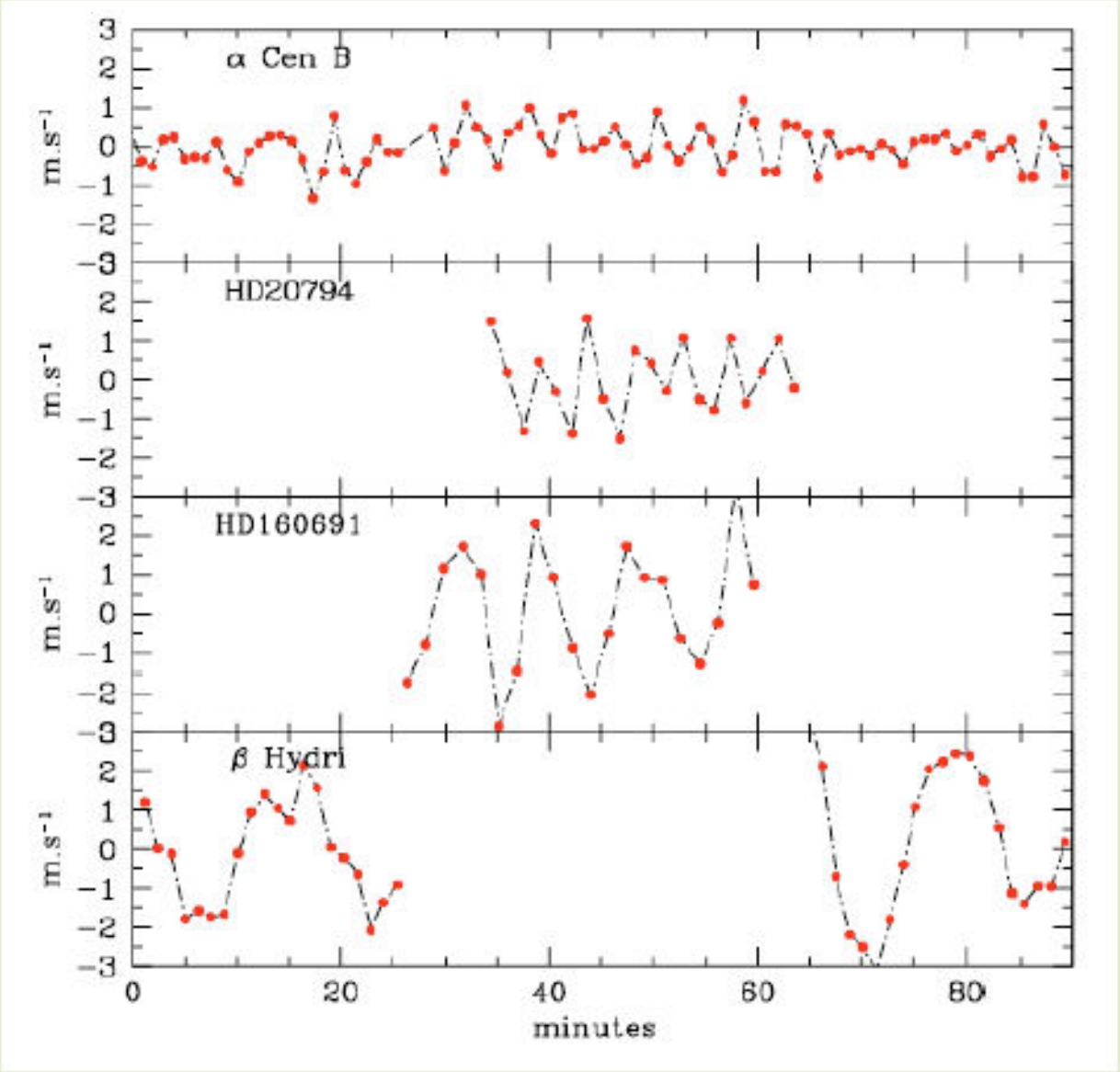
Question: What is wrong with this argument?

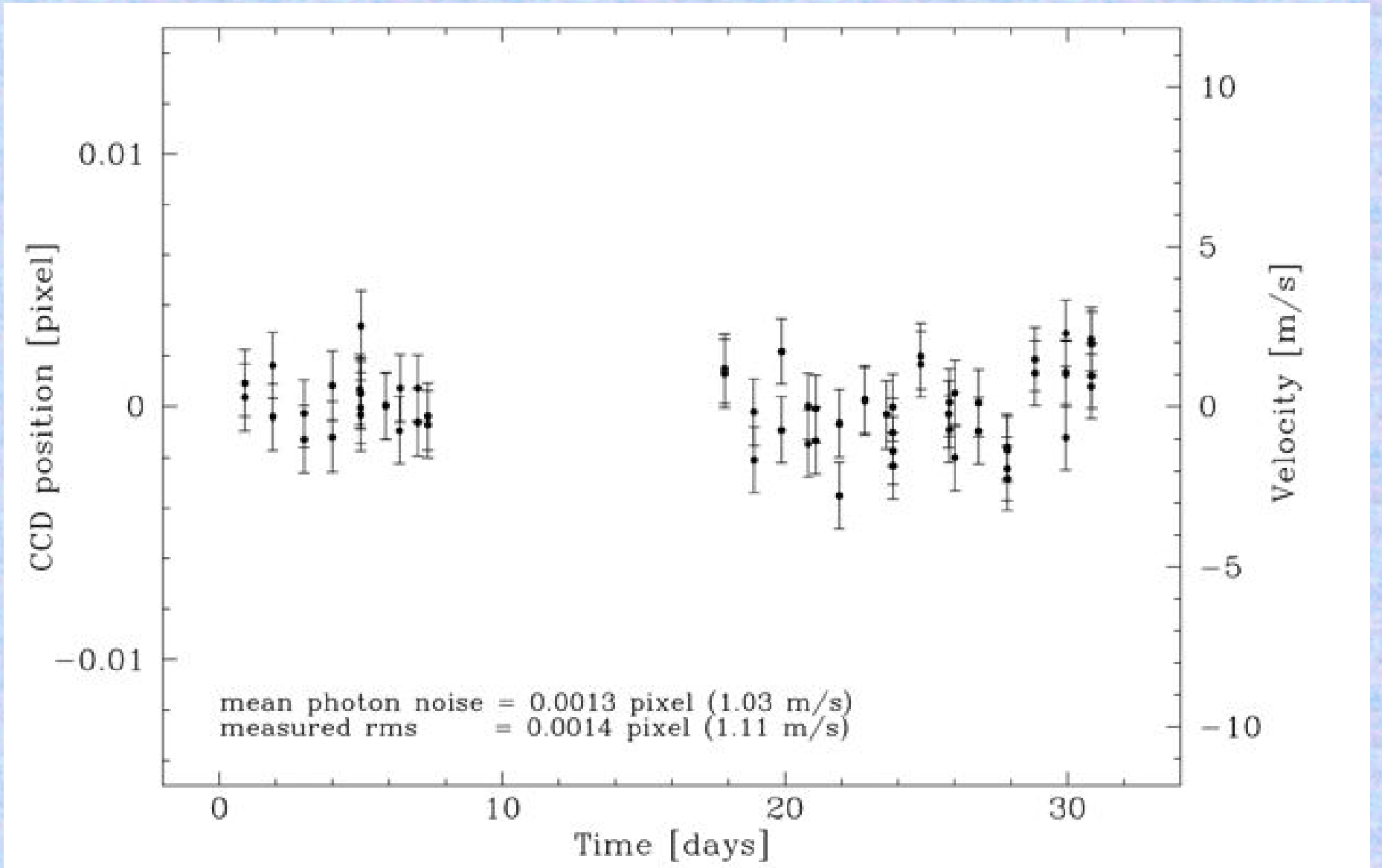
$$\Delta\lambda/\lambda = 10^{-5}$$

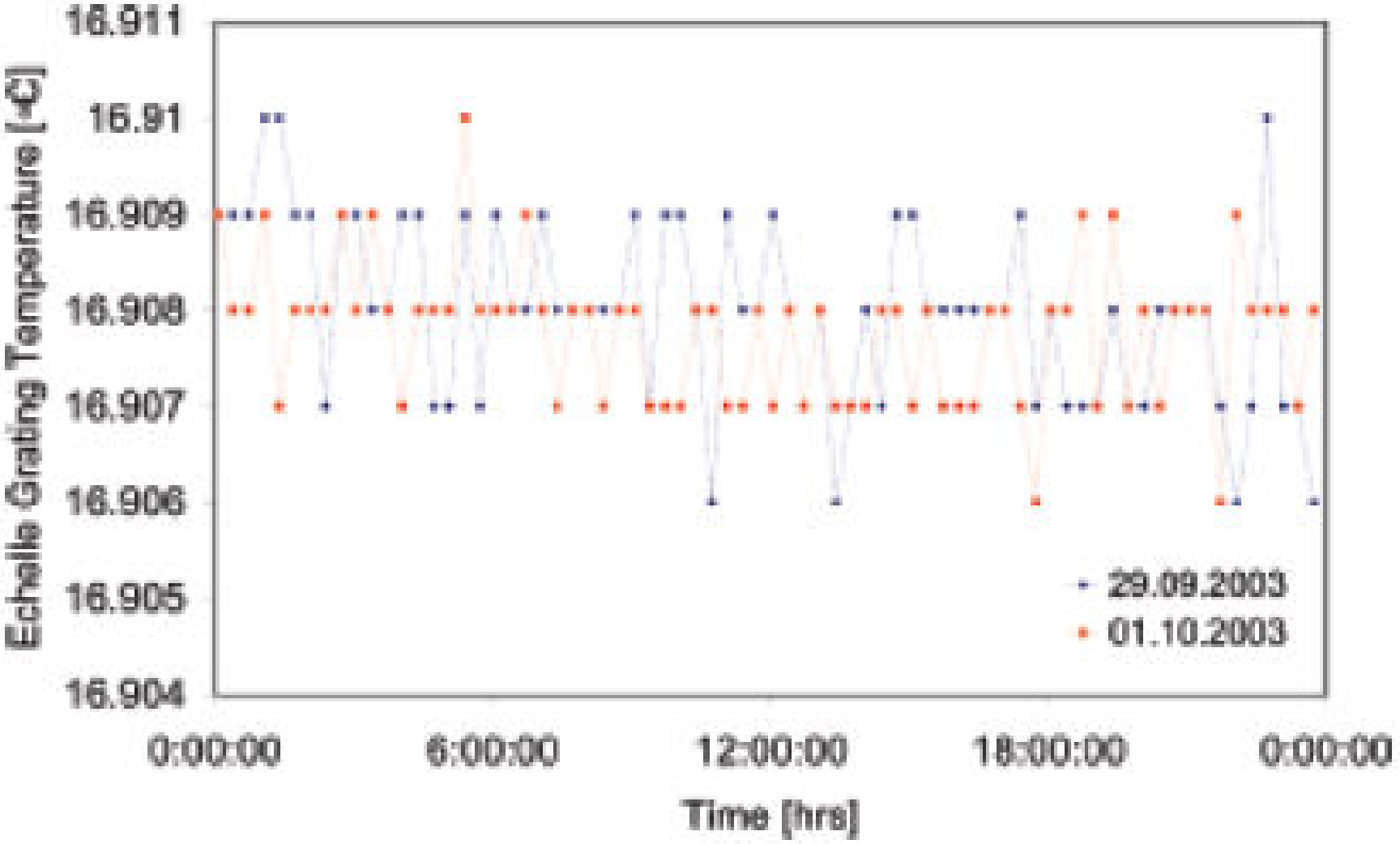
$$\Delta\lambda/\lambda = v_{min}/c$$

Therefore,

$$v_{min} = 3 \times 10^3 m/s$$

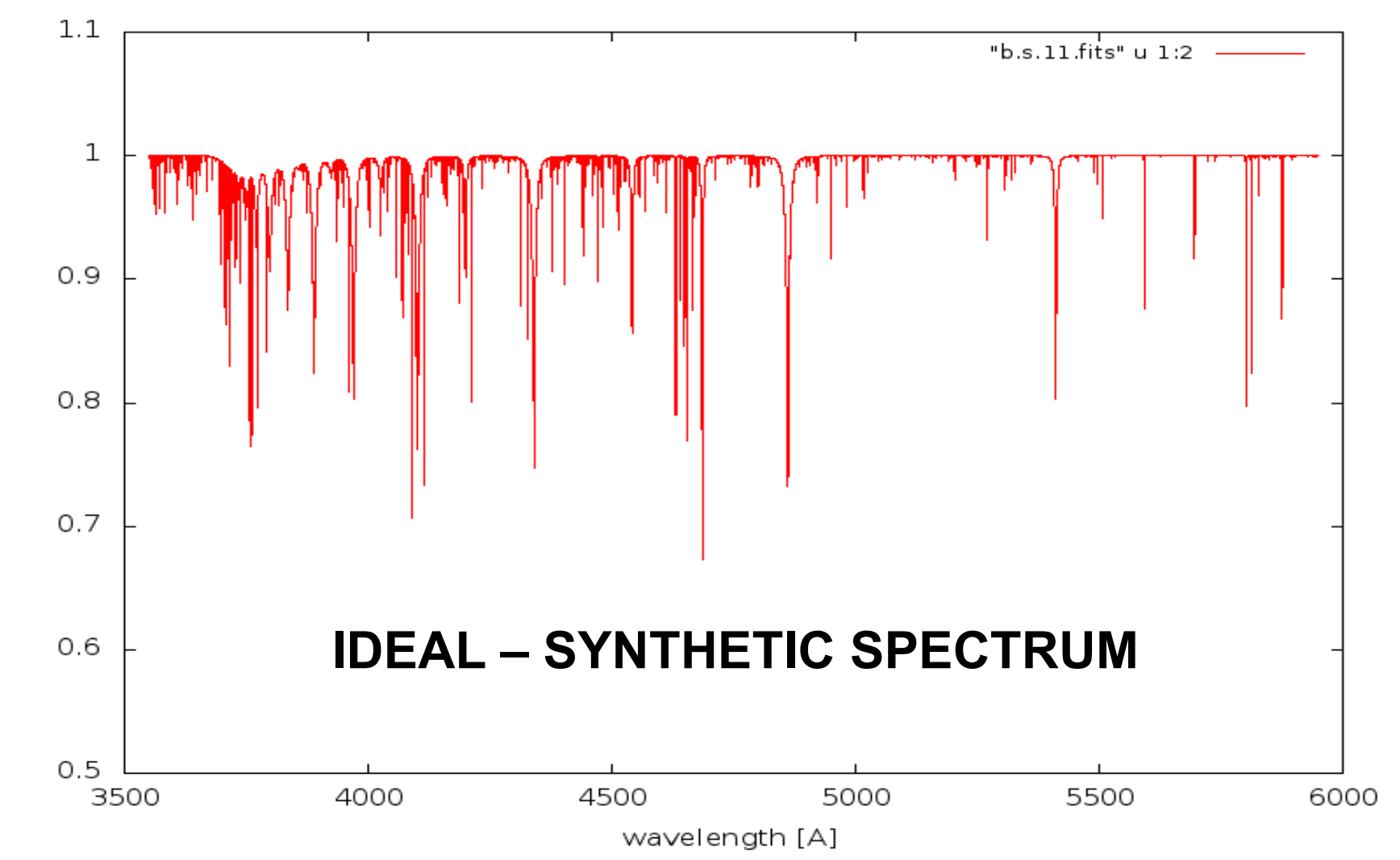



0.01
0
−0.01
CCD position [pixel]
10
5
0
−5
−10
Velocity [m/s]
mean photon noise = 0.0013 pixel (1.03 m/s)
measured rms = 0.0014 pixel (1.11 m/s)
0
10
20
30
Time [days]

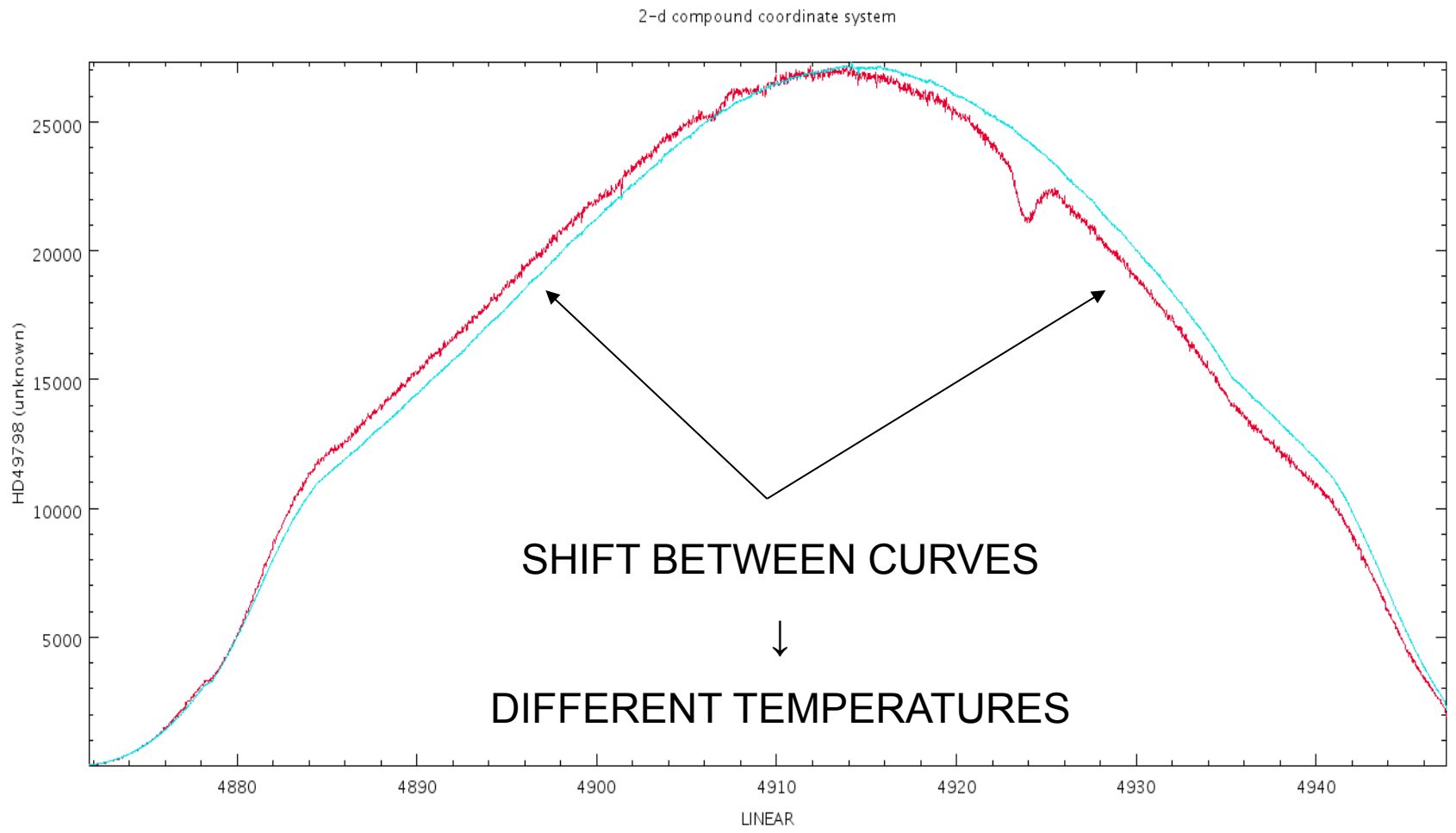

16.911
16.91
16.909
16.908
16.907
16.906
16.905
16.904
Echelle Grating Temperature [°C]
29.09.2003
01.10.2003
0:00:00
6:00:00
12:00:00
18:00:00
0:00:00
Time [hrs]

planet	planet type	major axis (AU)	period	radial velocity (m/s)
51 Pegasi b	hot Jupiter	0.05	4.23 d	55.9
55 Cancri d	gas giant	5.77	14.29 y	45.2
Jupiter	gas giant	5.20	11.86 y	12.4
Gliese 581c	super-Earth	0.07	12.92 d	3.18
Saturn	gas giant	9.58	29.46 y	2.75
Alpha Centauri Bb	terrestrial planet	0.04	3.23 d	0.510
Neptun	gas giant	30.10	164.79 y	0.281
Earth	habitable planet	1.00	365.26 d	0.089
Pluto	dwarf planet	39.26	246.04 y	0.00003

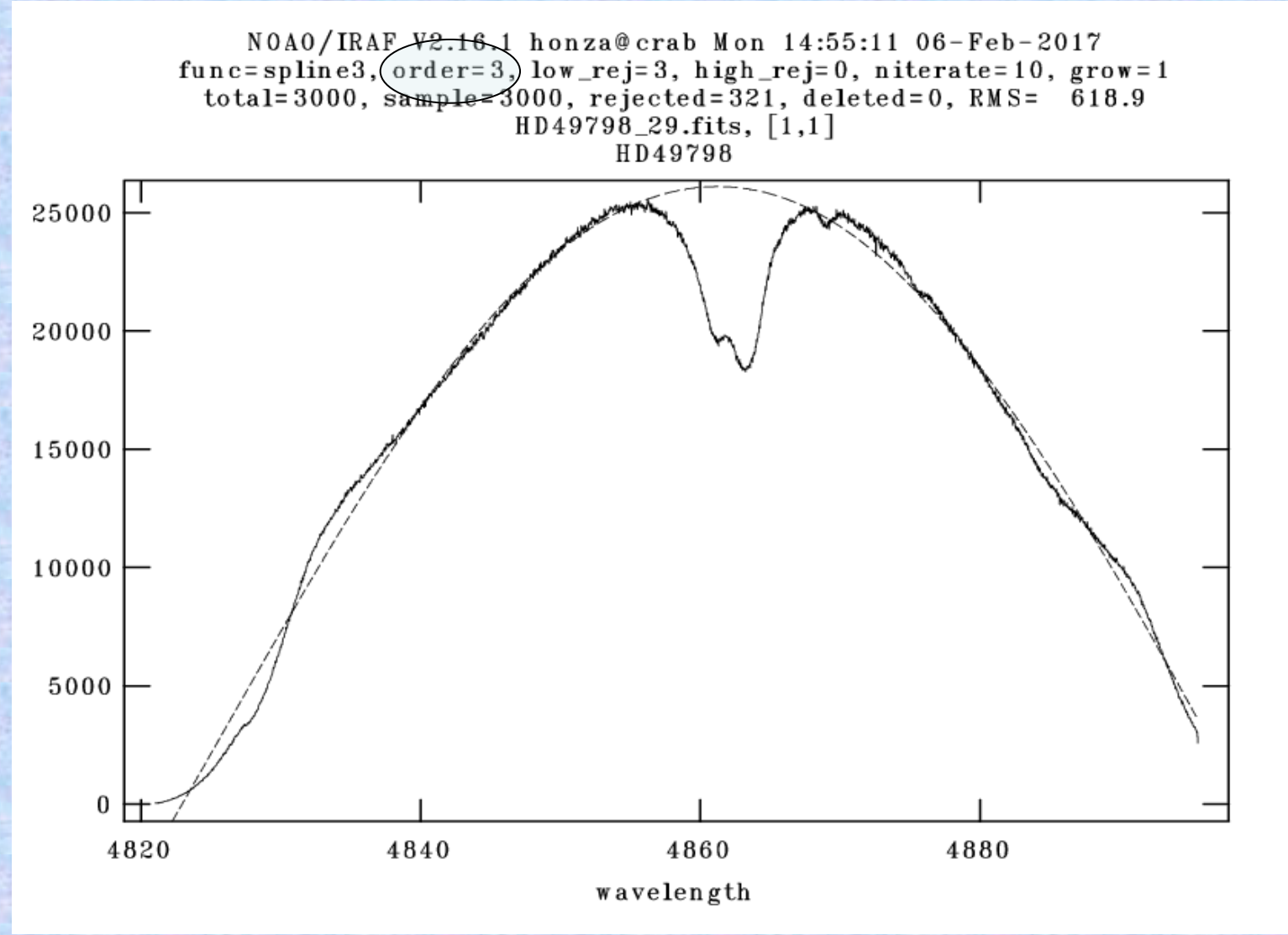
CONTINUUM NORMALISATION



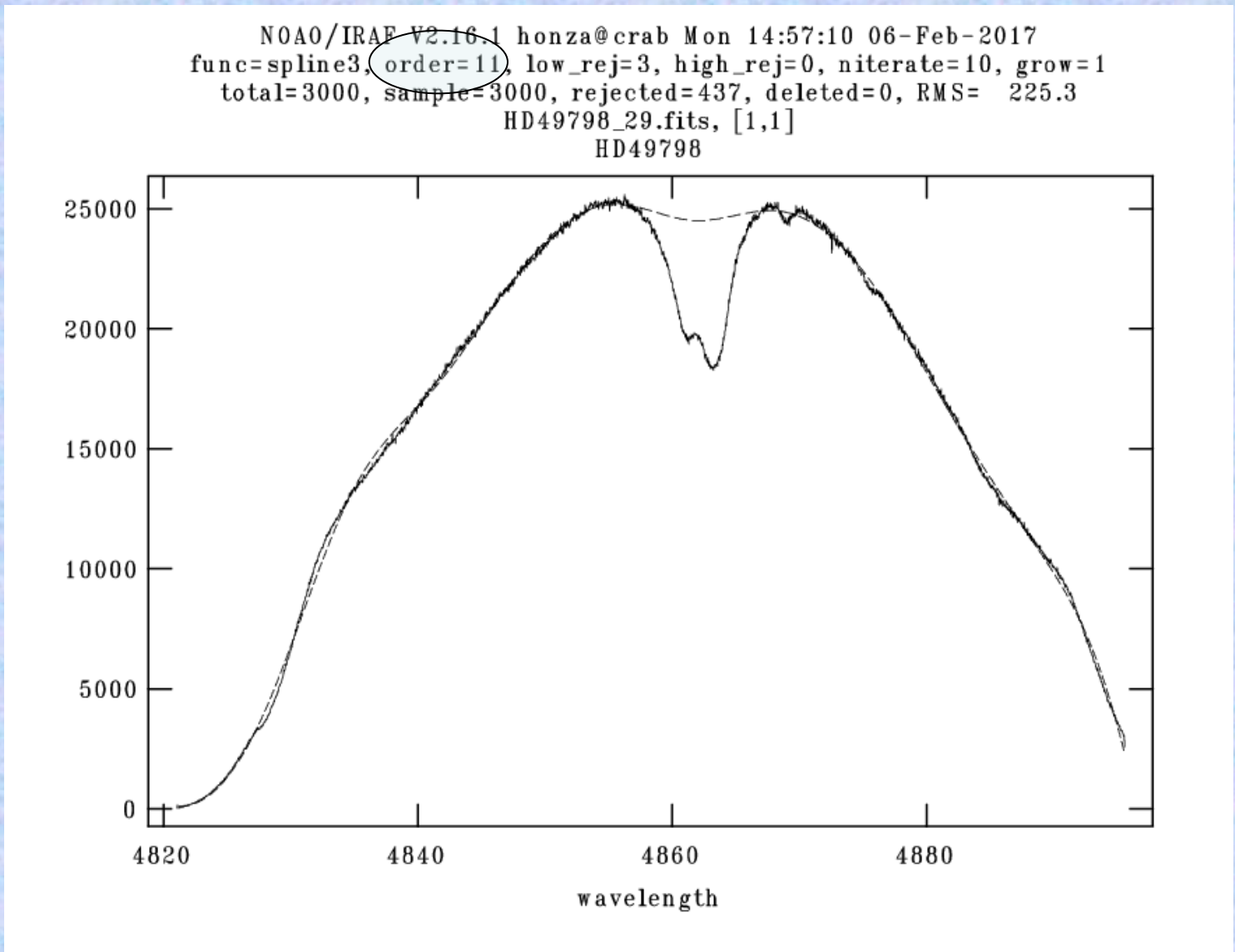
CONTINUUM NORMALISATION



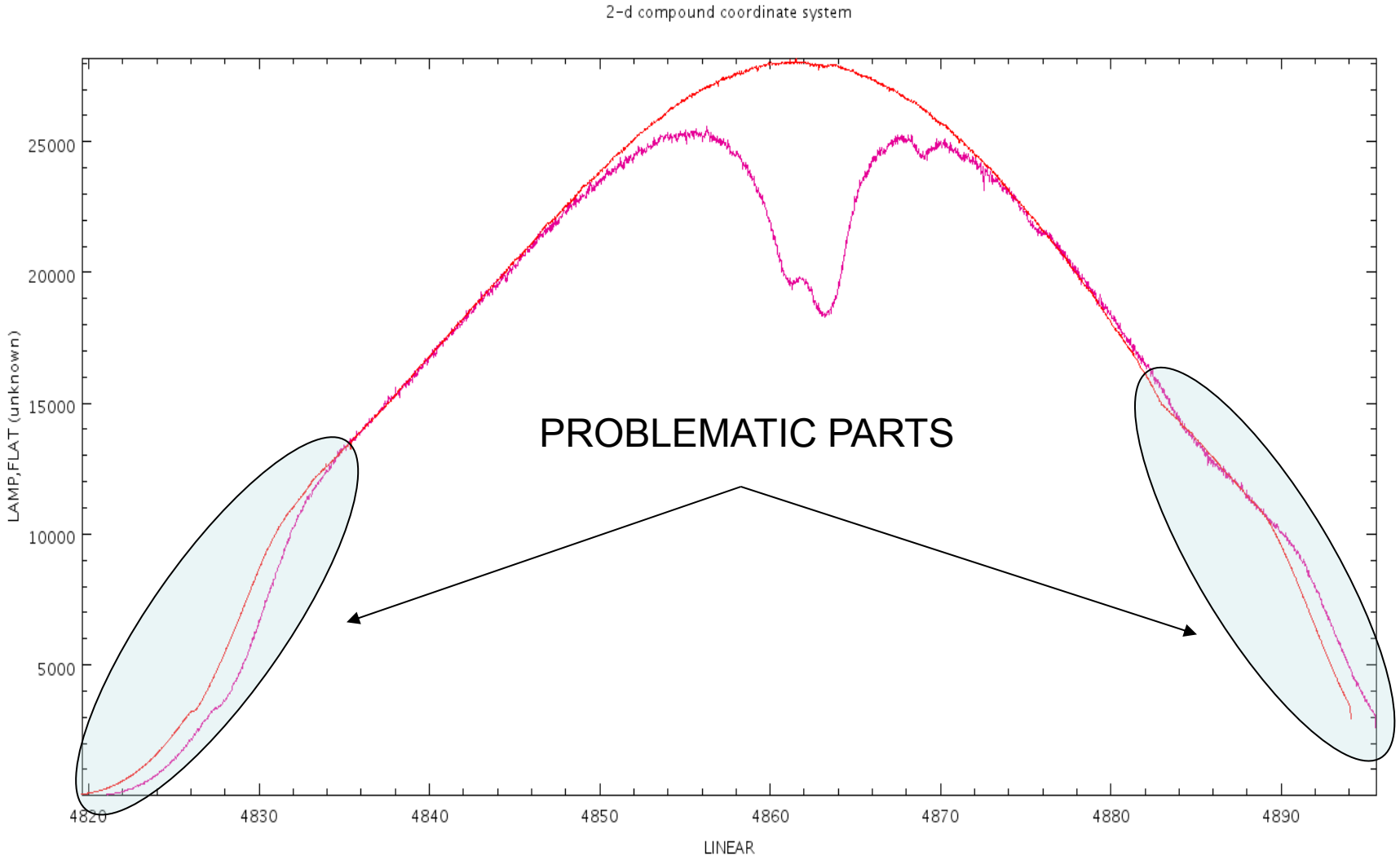
CONTINUUM NORMALISATION



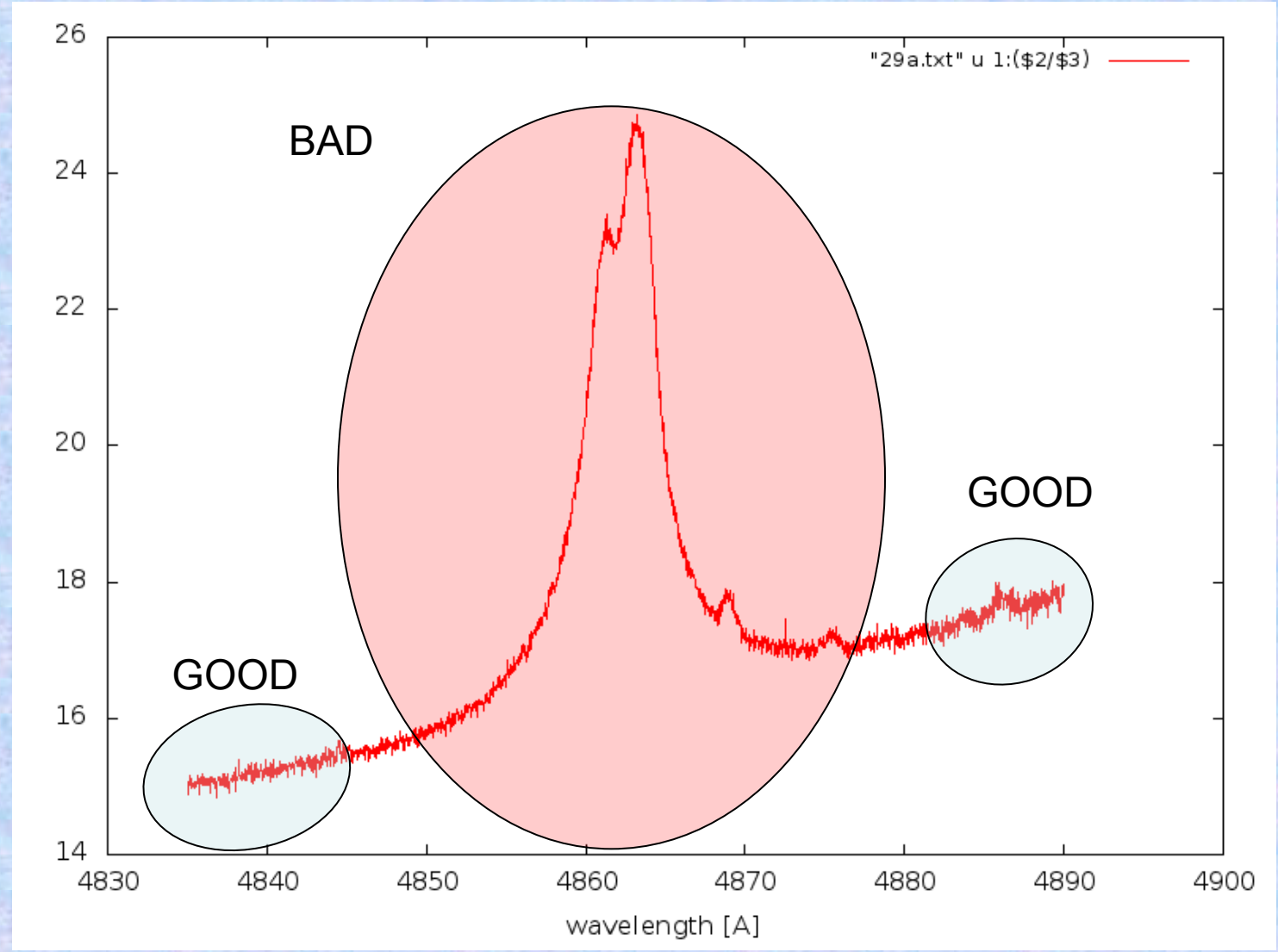
CONTINUUM NORMALISATION



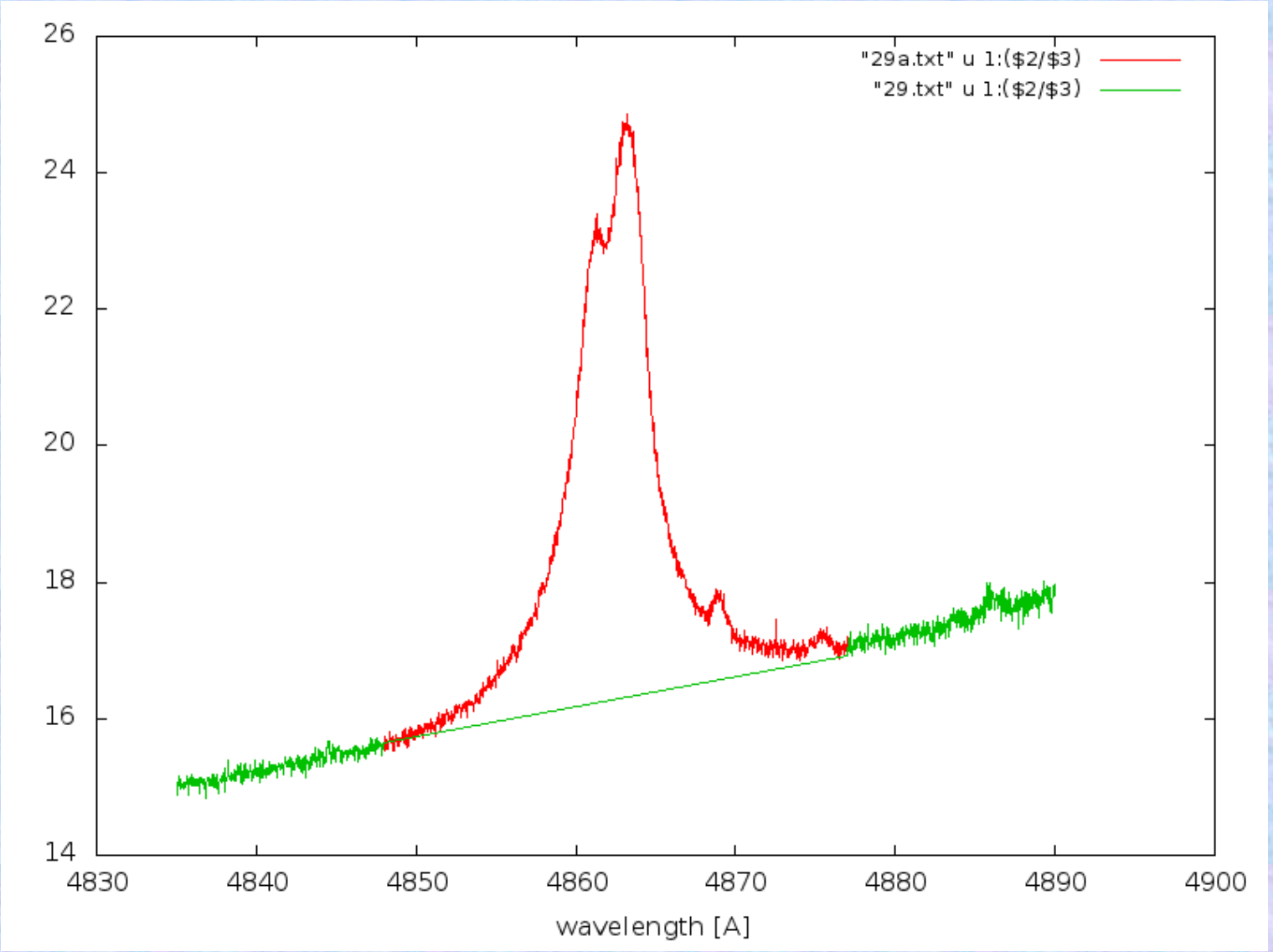
CONTINUUM NORMALISATION



CONTINUUM NORMALISATION



CONTINUUM NORMALISATION



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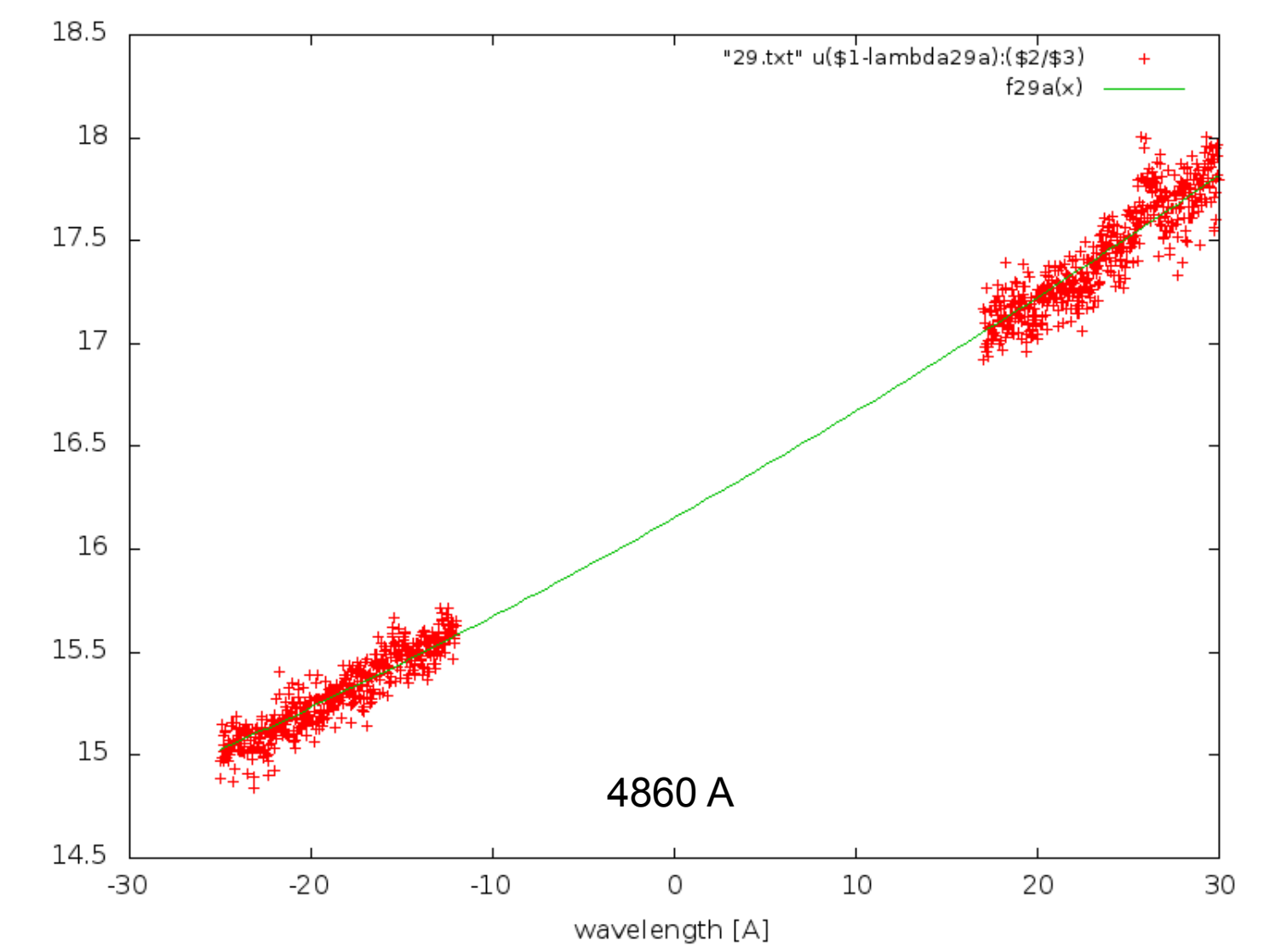
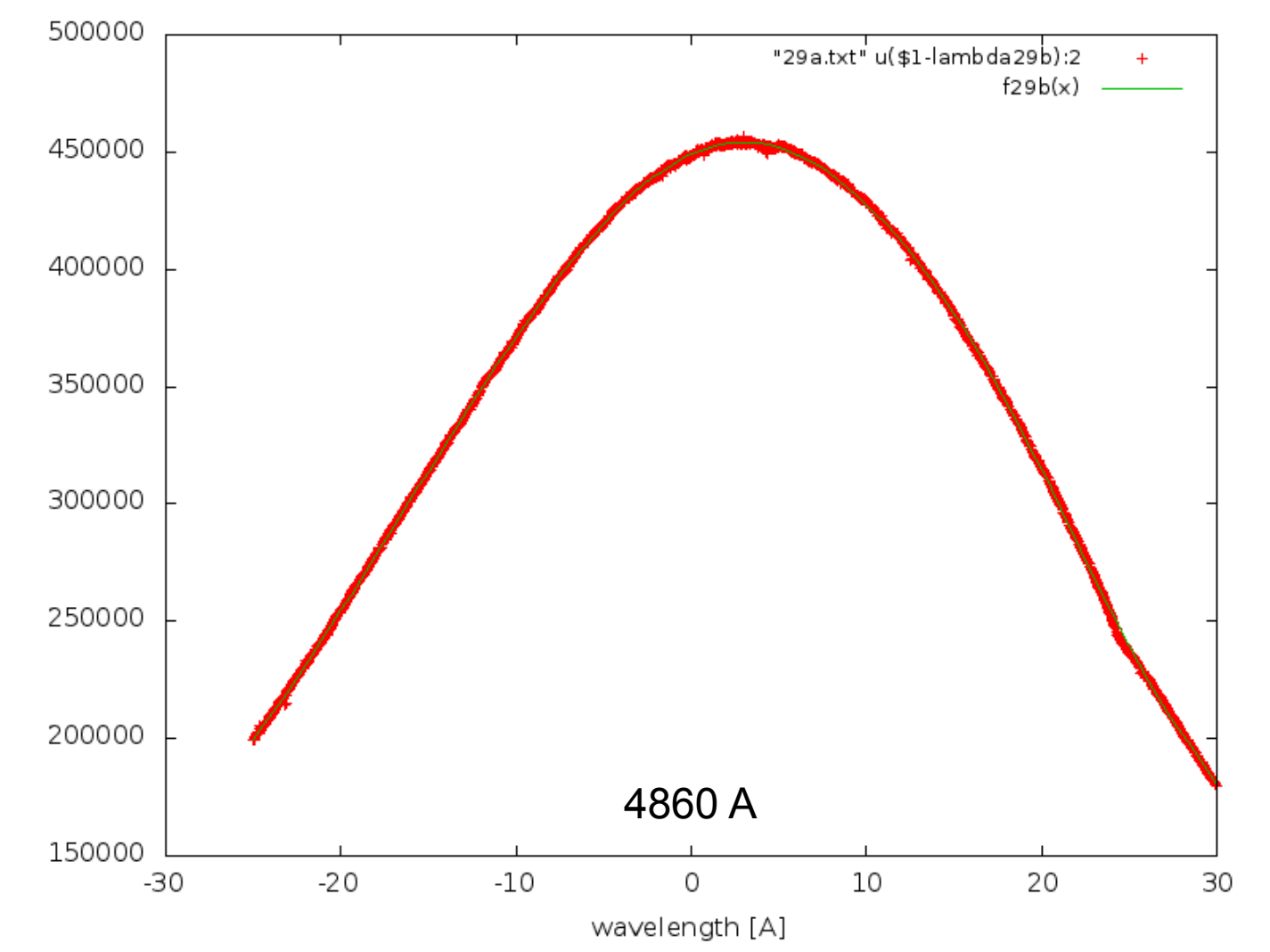
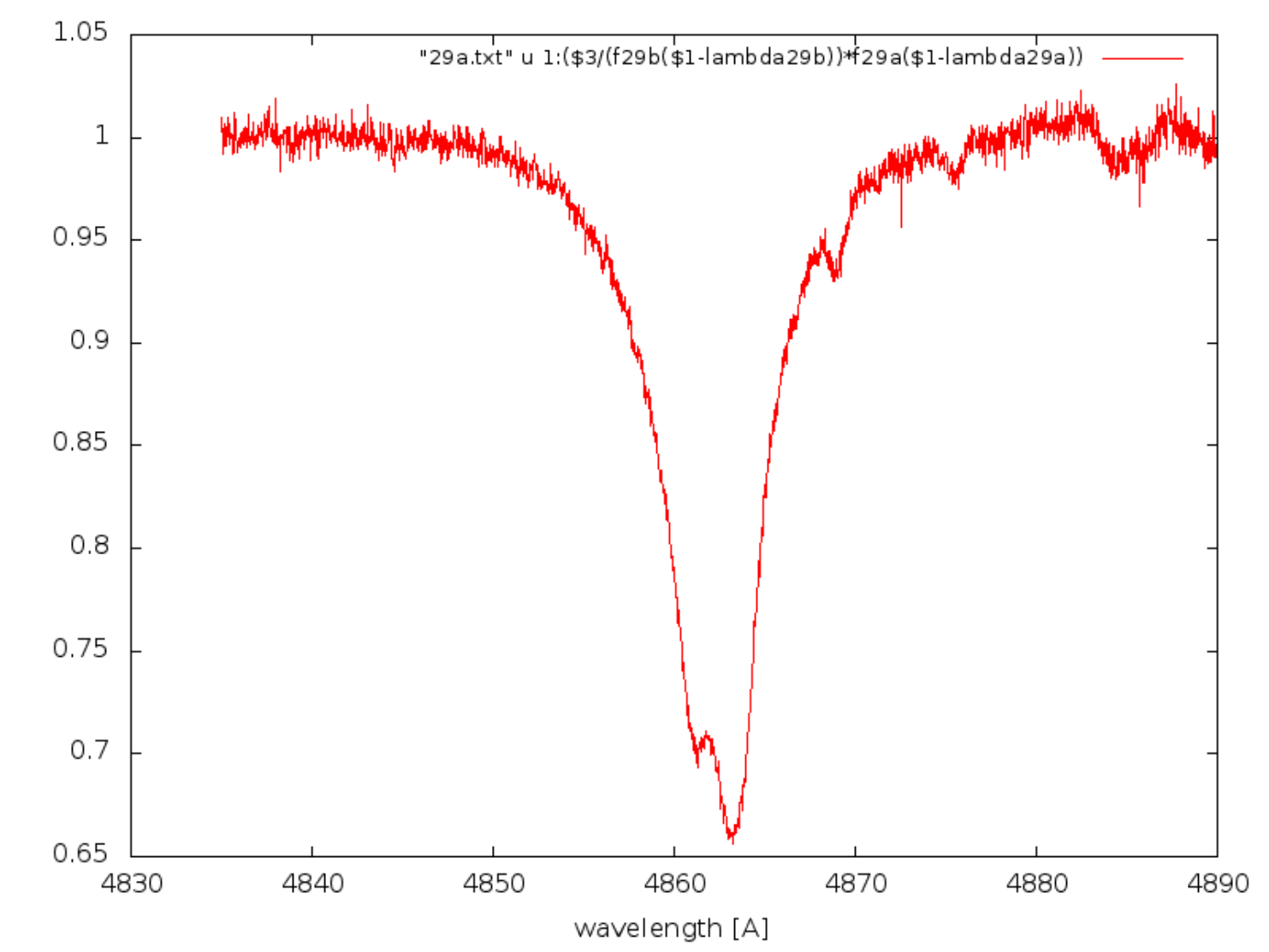


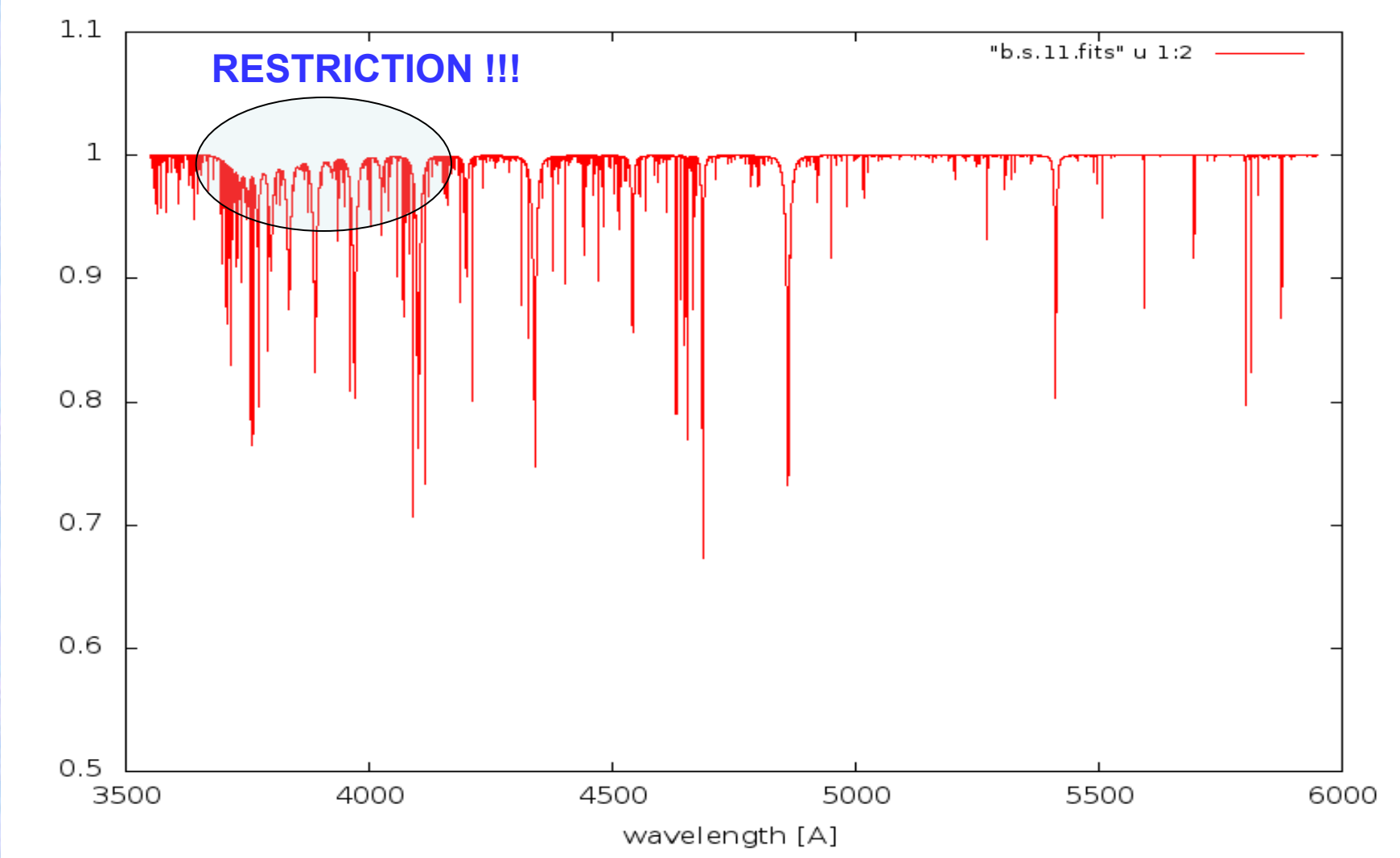
CONTINUUM NORMALISATION



CONTINUUM NORMALISATION



CONTINUUM NORMALISATION




THANK YOU FOR
YOUR ATTENTION !!!