Fabry Pérot etalons for high precision wavelength and radial velocity calibration.

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Introduction

The radial velocity technique is one of the most powerful-extrasolar planets search method. For detecting Earth-like planets, it is necessary to reach a precision less than 10 cm/s (results already obtained for HARPS). Fabry Pérot etalons allow the production of optimally and regularly spaced calibration lines covering all orders of the spectrograph and so it is now offered as an observing mode on ESO's ESPRESSO spectrograph and SPIROU; practically, we extend the method used for the optical to the infrared. In the present poster, it will be shown the first results of this calibration system, i.e., the simulations of different fiber diameters and different light distributions on the fiber heads, the set-up and the future objectives to test in the observatory in Geneva.

Simulation and Methods

1. As for the work suggested by Schäffer et al., we described the theoretical transmission funcion of a Fabry Perot interferometer as:

$$I = \frac{1}{1 + F_{Eff} sin^2(\delta/2)} \tag{1}$$

with the coefficient of finesse F_{Eff} and the phase shift δ.
In the present simulation the reflectance finesse is $F_R = 12$.

2. We verify the RV-stability through the derivative of v. Basically, the RV-stability, $\frac{\partial v}{\partial c}$ is proportional to relative changes of the main parameters n (index of refraction), l (distance of the mirrors), and $cos\theta$ (the angle between the optical axes of the FP and the light passing through it.):

$$\frac{\partial v}{c} \sim \frac{\partial \lambda}{\lambda} \sim \frac{\partial r}{r} \tag{2}$$

with r (the radius) linked to n, l, $cos\theta$

Conclusion

The final aim is to investigate the sharpness of the fiber related to the RV-performance of Fabry Perot Etalons.
For reaching optimum flux, finesse, efficience and stability, they are mandatory:

1. "Small" fibers
2. On axis alignment of the fiber

References

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Results

As expected from theory, the results of this simulations underline that for small fibers, the peaks should achieve to 1, while for the larger fiber the transmission at the peak decreases, the area under the peak remains the same and the peak width increases, and this imply a reduction of effective finesse.

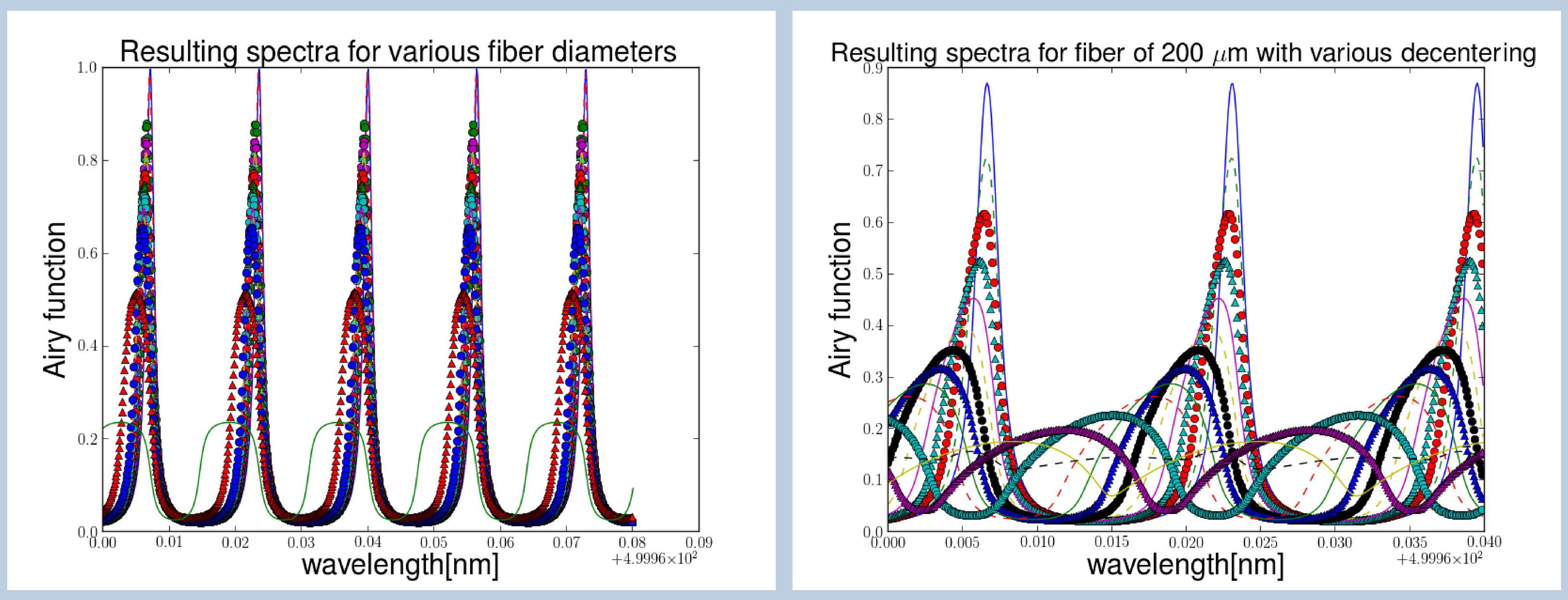

Figure 1: Simulation of transmission spectra of a Fabry Perot for different fiber diameters (50, 100, 200, 210, 220, 230, 240, 250, 260, 270, 280, 290, 300, 400, 600 μm) assuming the centered on the optical axis of the FP (left).; Simulation of transmission spectra of Fabry Perot assuming a fiber of 200 μm with these decentering 20, 100, 150, 200, 250, 300, 350, 400, 450, 500, 600, 700, 800, 1000 μm (right).

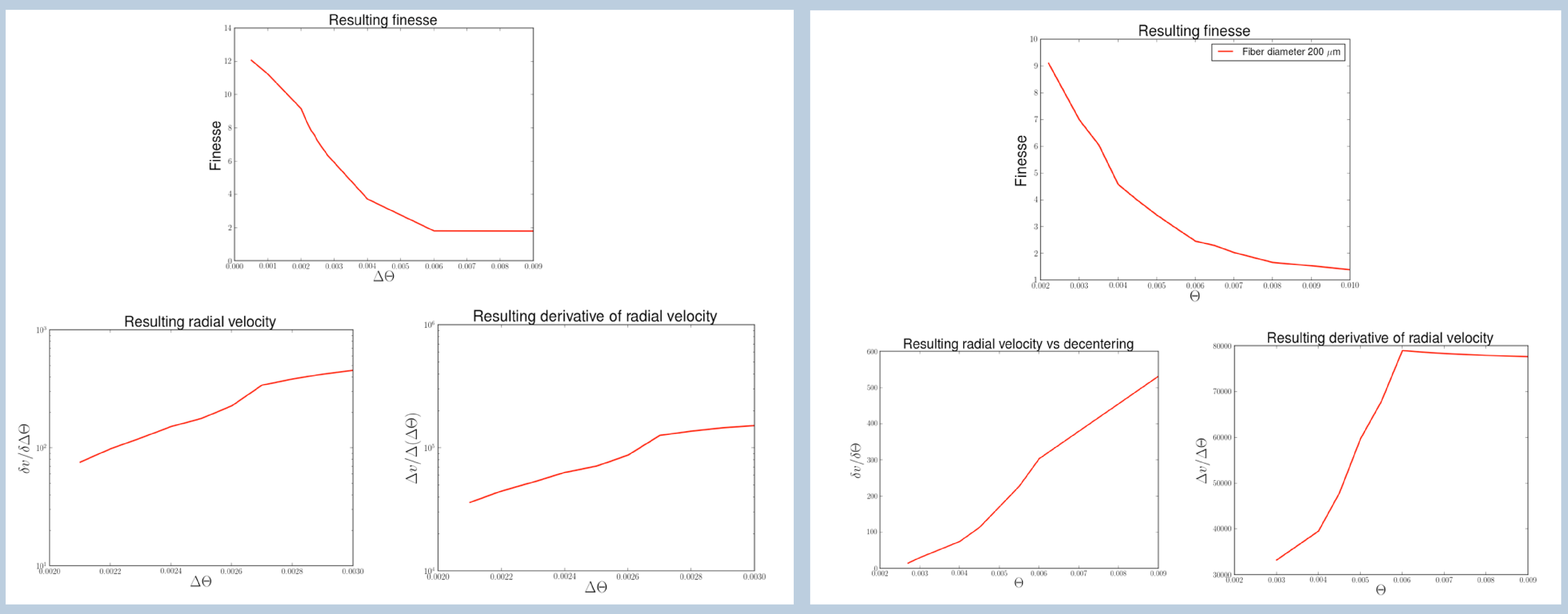

Figure 2: Resulting finesse and radial velocity as a function of the fiber diameter $\Delta\theta$ (rad) for the center fiber. For the resulting radial velocity, we take into account $\frac{\Delta\lambda = \lambda_d - \lambda_{d0}}{\lambda_{d0}} = \frac{\delta v}{c}$. To follow, the derivative of the radial velocity which is equal to the time derivative of distance, in terms of accuracy levels (left).; The same analysis but in the case of decentered set up for fibers (right).

Heading toward...

All set-up is arranged in the laboratory. (Fig. 3). The next highlights are:

1. Doing the alignment.
2. Testing the fibers.
3. Measuring the finesse.
4. Measuring the efficiency.

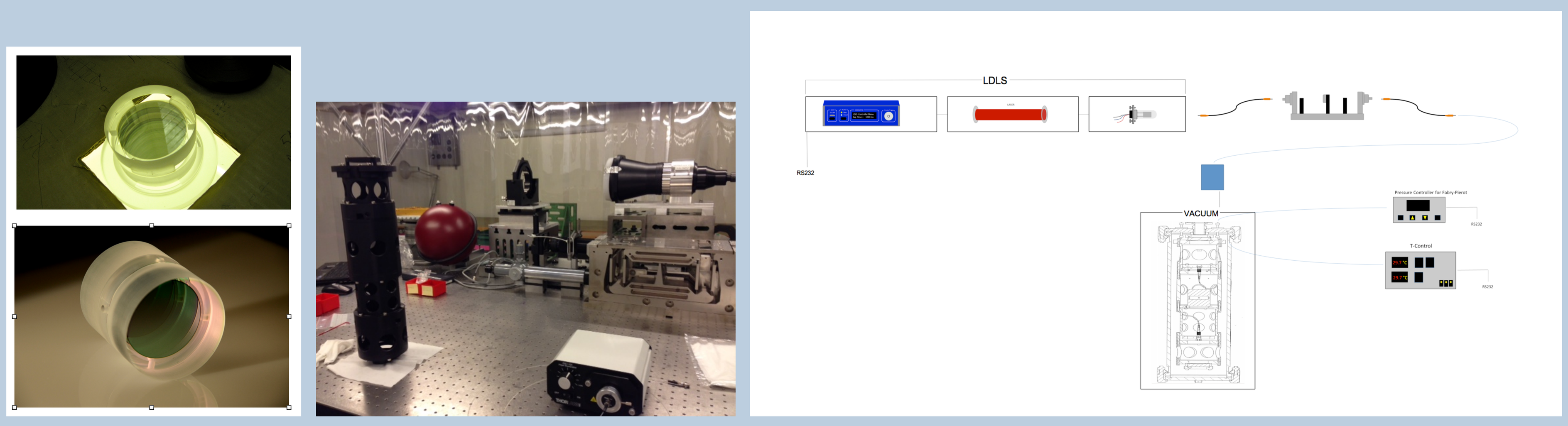

Figure 3: The FP etalons: optical (above) & infrared (bottom) (left). The working bench (middle).; Drawing of the all set up (right).

Future analysis: Testing fibers & calculating FRD and working on the data on DRS

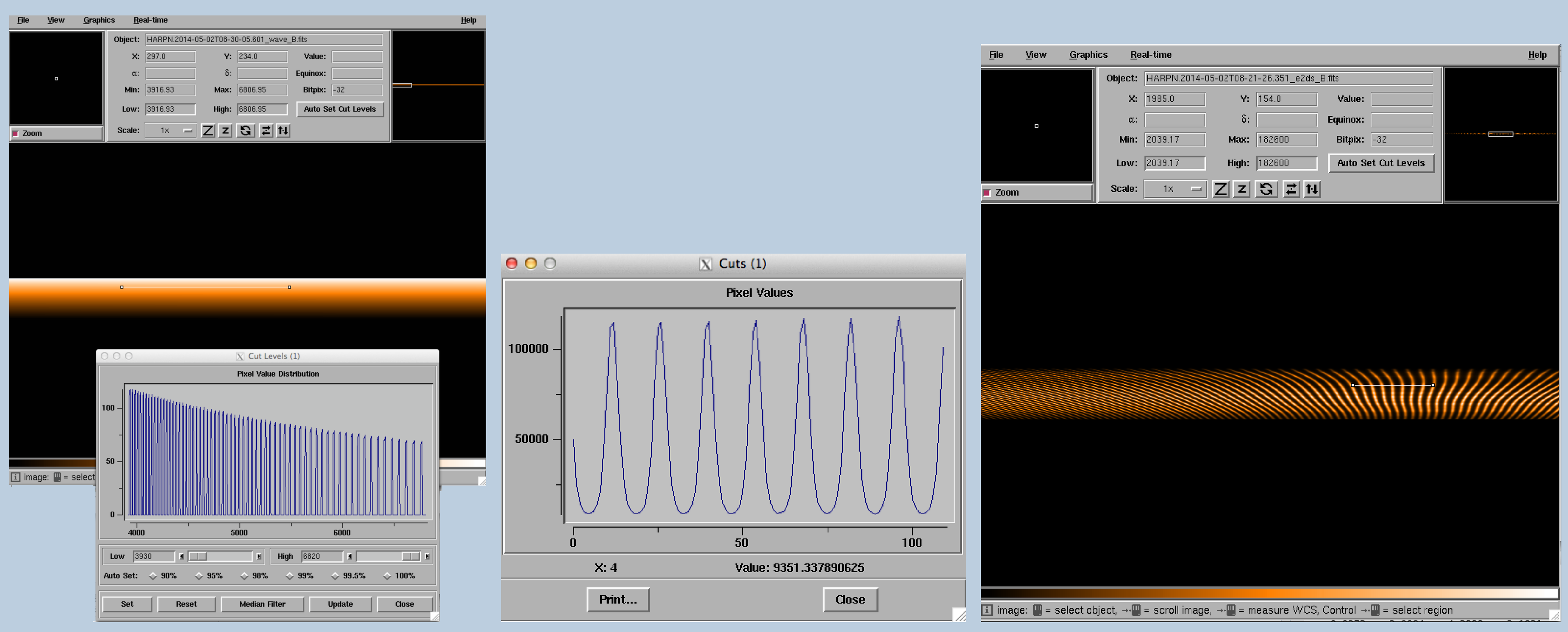

Figure 4: Calibration data for FP. It is simply to link the flux for each pixel of that certain wavelength.