Radial Velocity Precision of CHORUS with Different Pupil Slicing Designs

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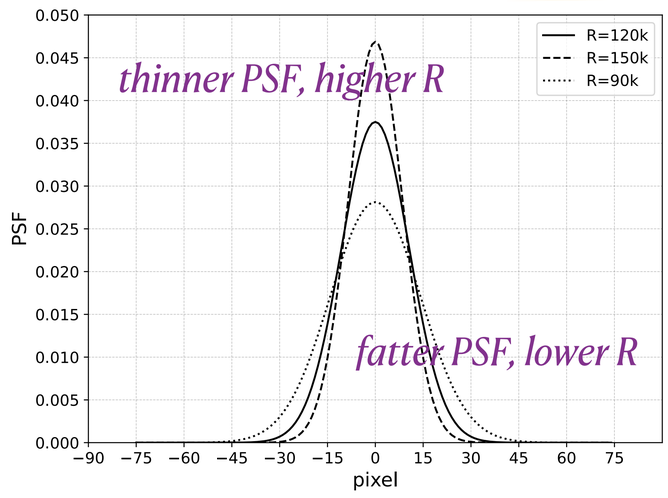
Canarian **H**ybrid **O**ptical high-**R**esolution **U**ltra- stable **S**pectrograph (**CHORUS**) is a high-resolution spectrograph developed under Chinese and Spanish astronomical cooperation, and will be installed on the **G**ran **T**elescopio de **C**anarias (**GTC**) in 2027.

Aim to reach RV precision of <***0.3 m/s***, with ***R>100k*** in the visible band (400nm - 780nm)

• PSF & Pupil Slicing



star light → cross-section of the fiber

pupil slicing → smaller PSF

Point **S**pread **F**unction (PSF)

But there is *wavelength loss* for 3-slice setting in the red band.

Fatter PSF can cause resolution loss.

We need **higher spectral resolution** to reach **higher RV precision**.

• Methodology

spectrum of given star (*Kurucz's solar template* as an example)

→ add Doppler shift, convolved with PSF, add noise, resampled to CCD

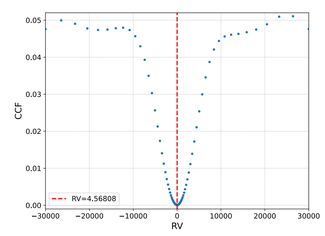
→ **synthesize spectrum**

→ Cross-Correlation Function (CCF)

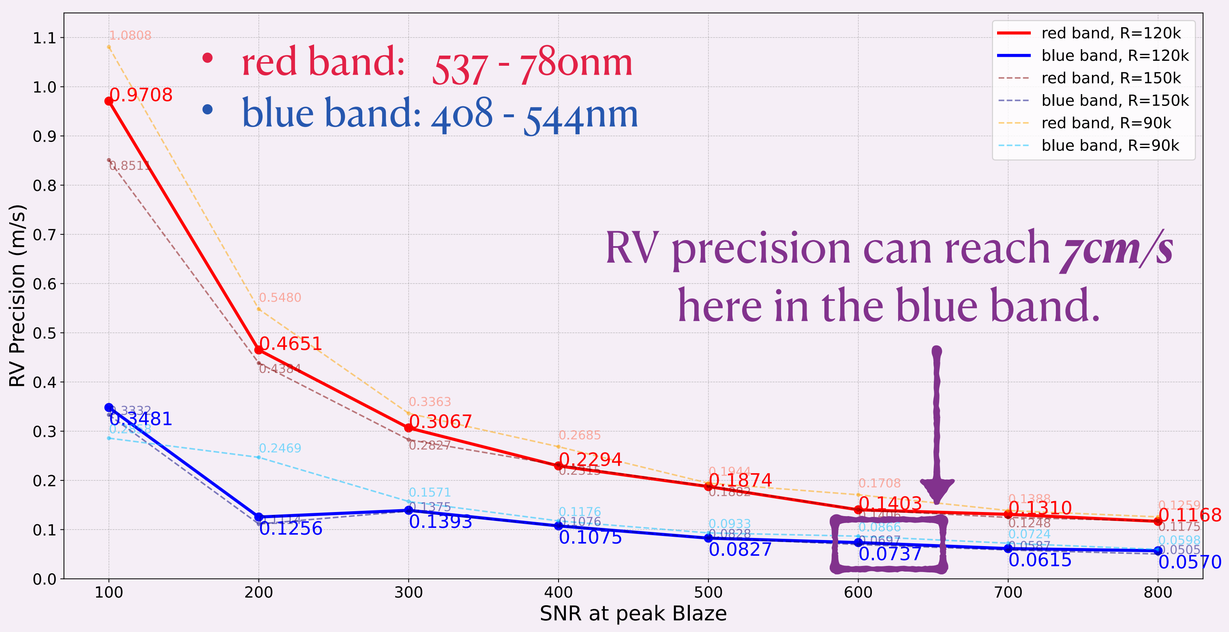
→ **extract RV, compare precision**

$$\mathrm{CCF} = \left(f_{temp} - f_{obs}\right)^2$$

True RV is at min CCF.



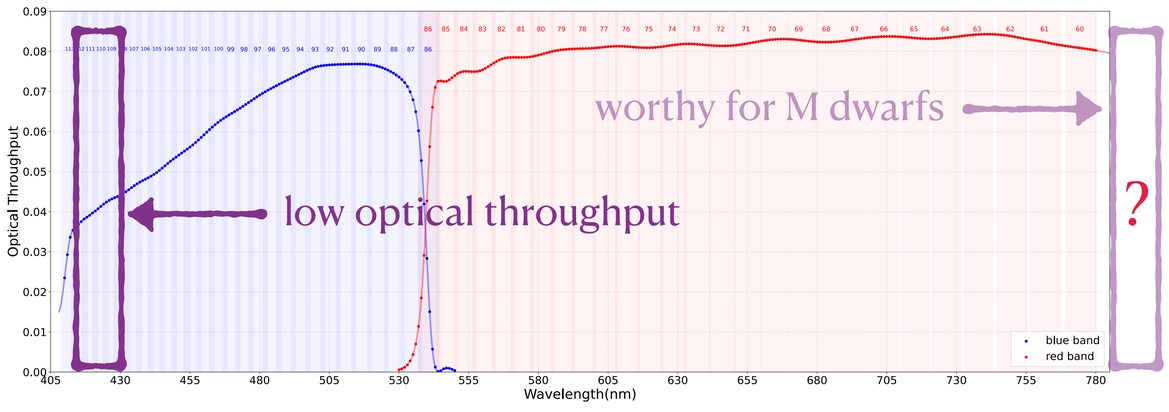
• RESULTS: As SNR rising, which extend can RV precision reach for 3-slice setting?

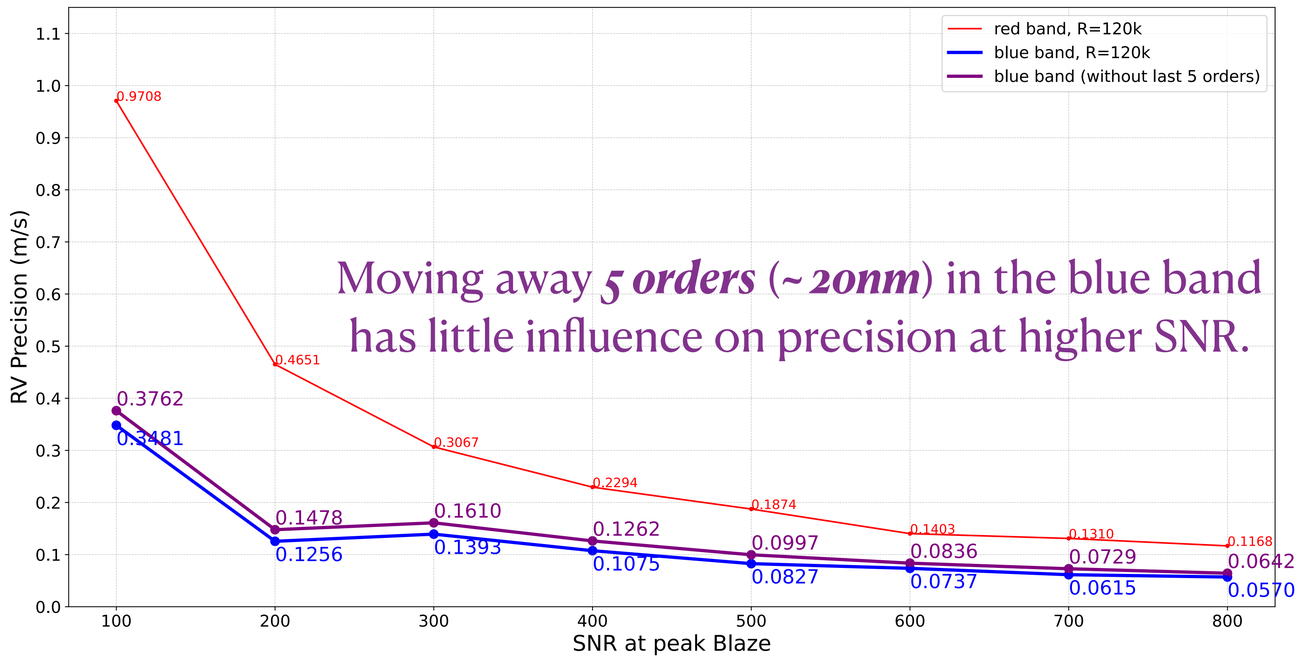


1. **Precision in the blue band higher and preciser** than that in the red band: more absorption lines in blue for the Sun
2. **Choosing R=120k is the most economic for 3-slice setting.** Compared with R=90k assumption, precision at given R=120k is ~1cm/s better; while compared with R=150k, precision does not improve significantly.
3. We expect to reach **RV precision of *lower than 10cm/s*** at reasonable SNR.

• Ongoing Works

Can we move some blue orders to UV band to have ***more wavelength coverage in the red band*** ?





1. **RV precision in the red band** needs further estimation.
2. This simulation is based on **the Sun (G dwarf)**. What is the case for other stellar types, like **M dwarf** ?
3. **Compared with ESPRESSO**, what RV precision is expected to reach under this design?

Scan for appendix: