The EsoReflex workflow to reduce ESPRESSO data

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Abstract

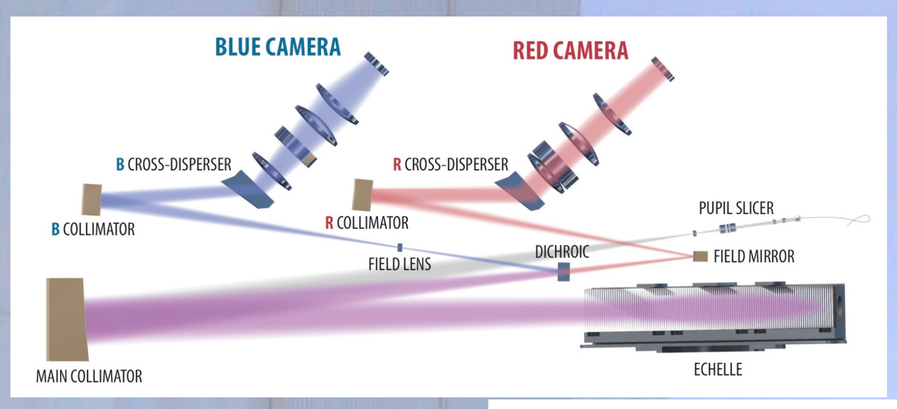
ESPRESSO, the Echelle SPectrograph for Rocky Exoplanets and Stable Spectroscopic Observations installed at the incoherent combined Coudè facility of the VLT, started operations at the end of October 2018. The corresponding data can be processed by a dedicated pipeline developed by the ESPRESSO consortium and can be reduced at the user's desktop using an EsoReflex workflow. EsoReflex is an environment that provides an easy and flexible way to reduce VLT/VLTI science data using the ESO pipelines. This paper describes the challenges, the data reduction chain and the solutions adopted in the implemented workflow to support users reducing ESPRESSO data.

ESPRESSO scientific goals

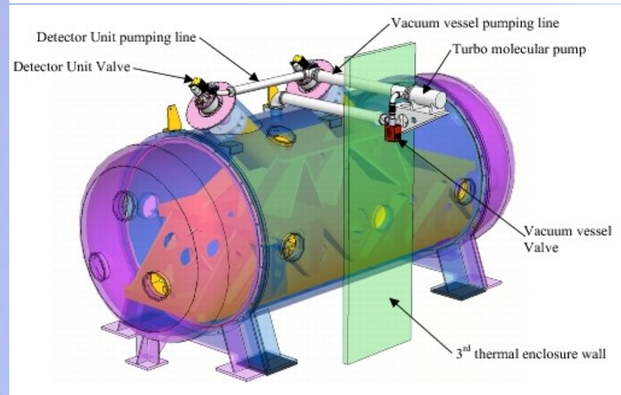
- Search of rocky planets with radial velocity technique.
- Study of variability of cosmological constants.
- Determination of abundances in stars of nearby galaxies.

Instrument features

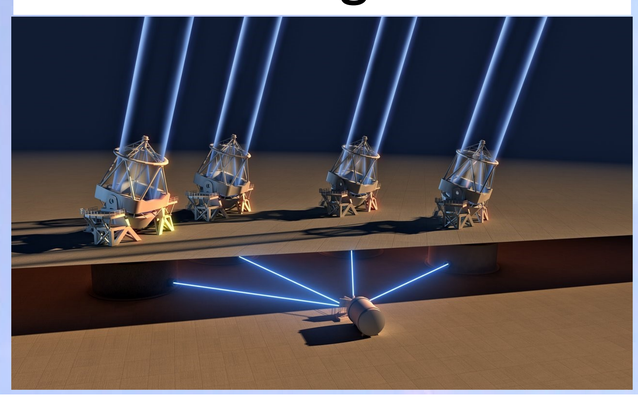
- High resolution cross dispersed fiber fed spectrograph.
- Stiff structure. Temperature and pressure control (1mK, 1umBar).
- Spectral range: 380-780nm, two arms (380-550nm/550-780nm).
- Several Calibrators (ThAr, FP, LFC) for high density line coverage.
- Telescope area can combine light from up to four UTs, multi modes.



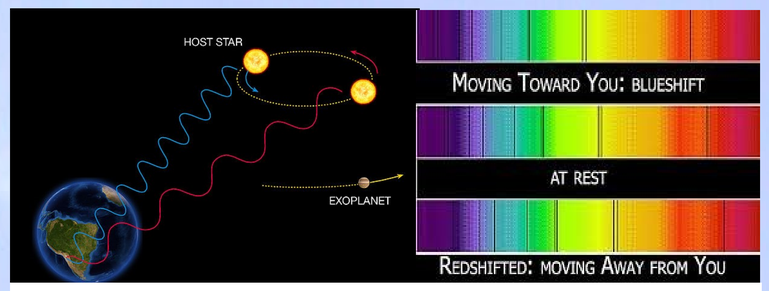
ESPRESSO Instrument



4UT Configuration

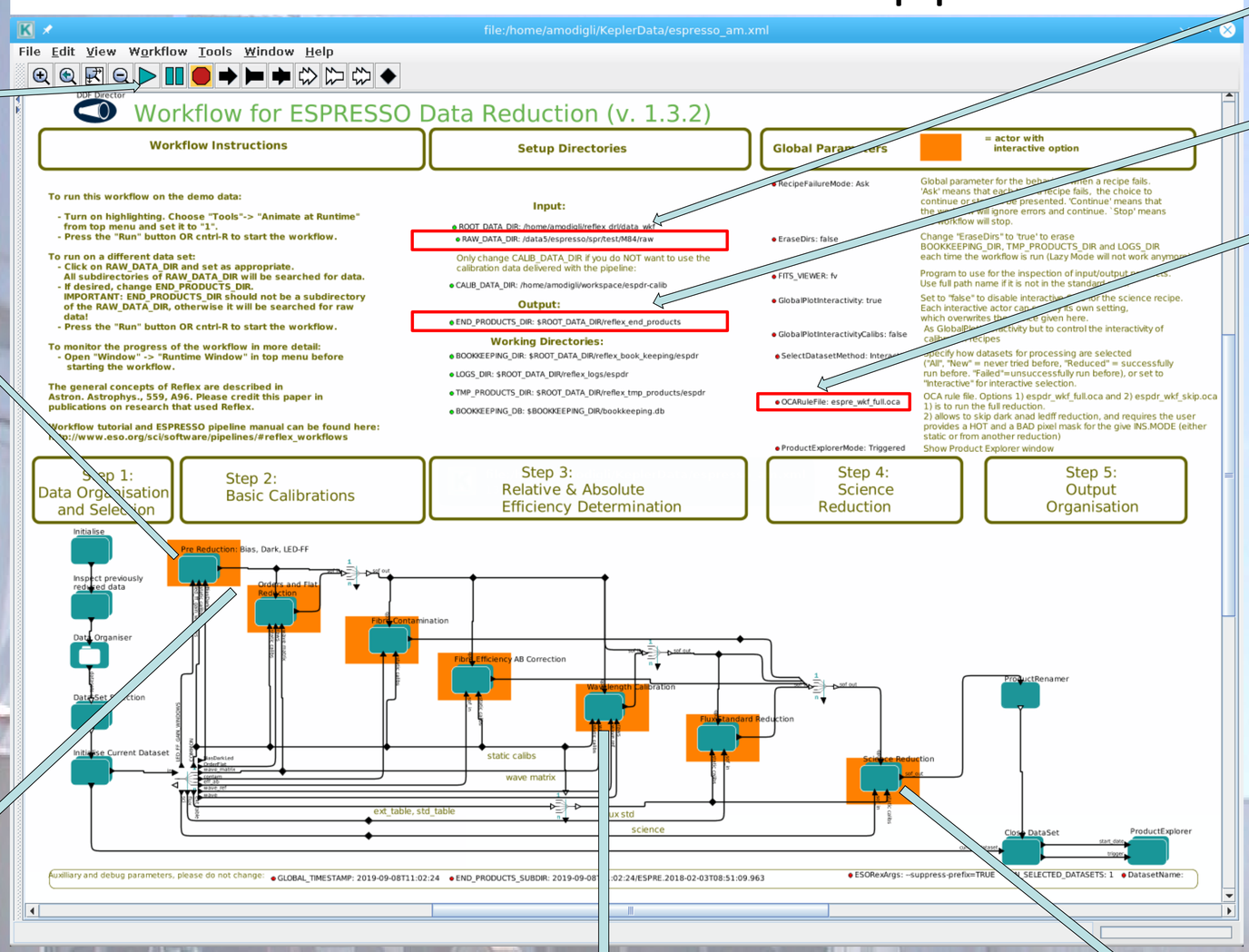


Challenges	Solutions
Wavelength calibration at 10 cm/s	2 Fibers, T, P stable, stiff structure, RV using several lines, wide spectral range, drift correction, large detectors, daily calibrations, good line catalog, accurate line model and fit.
Wavelength calibration stability	T, P stable, stiff structure, use of Laser Fiber Comb
Large collecting area	Combine light from several UTs
Data Reduction Speed	Use of OpenMP



Radial Velocity Technique

EsoReflex GUI for the ESPRESSO pipeline



Start reduction

Input Data

Final Product

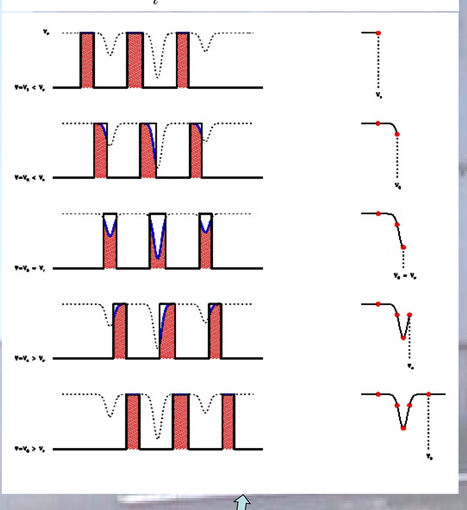
Data Organisation

Features

- Can skip dark & led data reduction.
- Some (instrument-mode dependent). parameters set from a static table.
- Interactivity at any reduction step.

CCF Computation

$$CCF(v) = \sum_i A[\lambda(i)] \, . \, M[\lambda(i)\,(1 + v/c)]$$



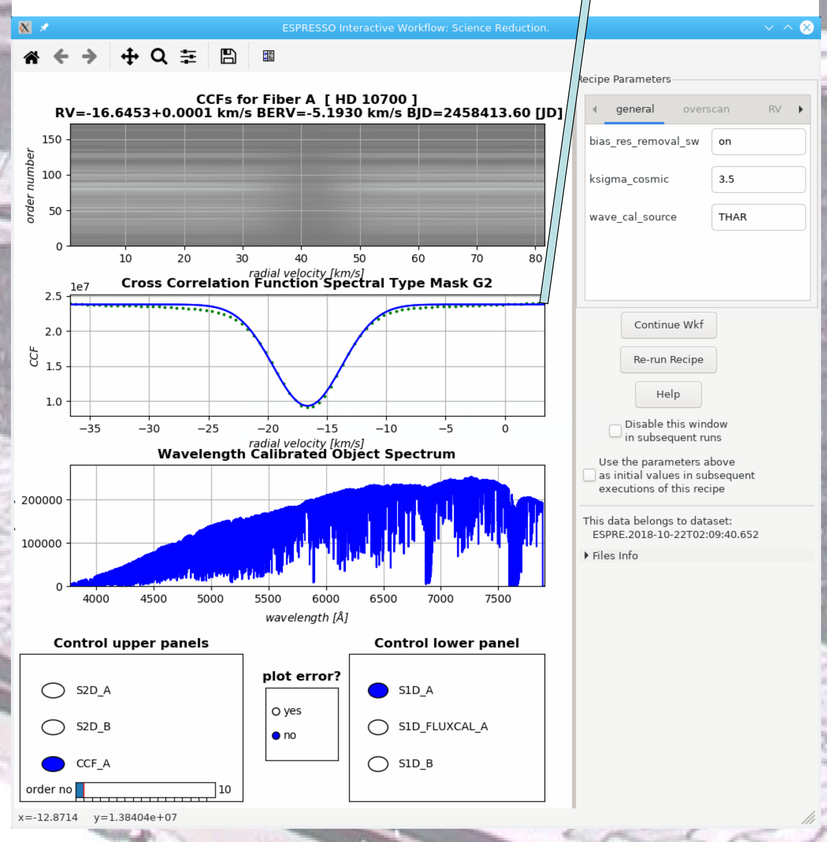
To improve speed

- Use of OpenMP in frame stacking, overscan correction.
- Possibility in the workflow to skip dark and led data reduction (using static solutions).

Wavelength Calibration

- Combines ThAr & FP (6 peaks fit) wave solution.
- One calibration fiber to correct day-night drifts.
- Possibility to use Laser Fiber Comb.
- Barycentric correction (use of BEPOP library).

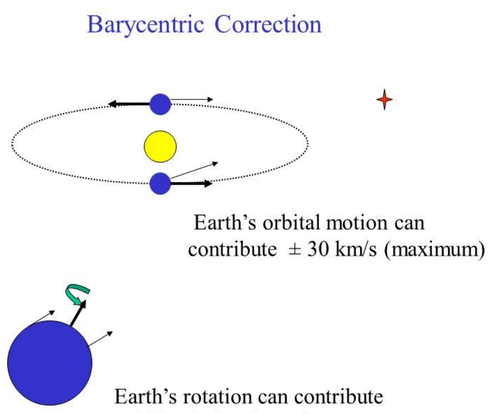
Science Reduction GUI



HW & SW Requirements

- >= 32 GB RAM.
- >= 4 CPUs.
- >= 1 TB SSD.
- gcc 8.3.1 or newer.

Barycentric Correction



References

- www.eso.org/pipelines
- Freudling et al, A&A, 2013, 559A..96F.
- Pepe et al, Proc. of the SPIE, 77350F (2010).
- Sosnowska et al, ADASS XXIV 2015 ASPC..495..285.