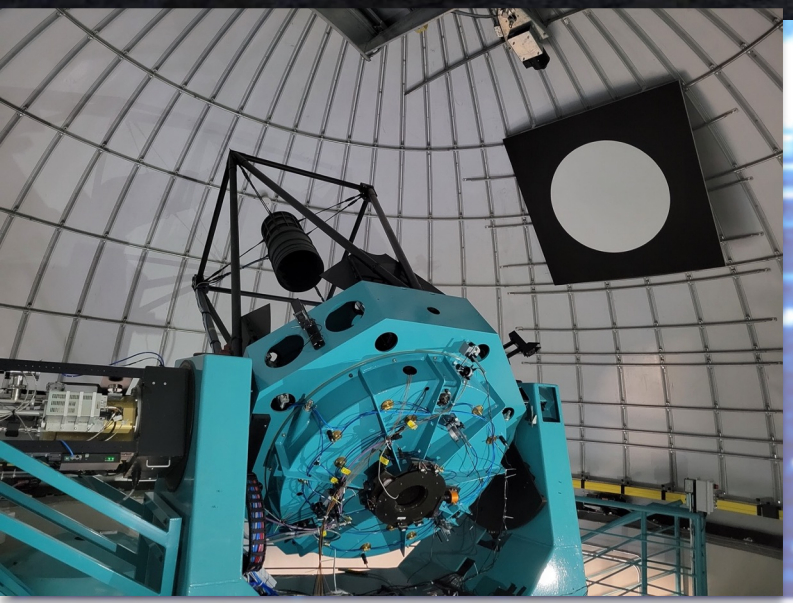
Equivalent widths and Bouguer lines (airmass-extinction curves)



Sylvie Dagoret-Campagne*, Jérémy Neveu, Marc Moniez,

Laurent Le Guillou, Martin Rodriguez Monroy

Dominique Boutigny (computing with DM-stack@CC)

IJCLab & LPNHE @ IN2P3-CNRS

LSST France, Annecy, May 16-18, 2022

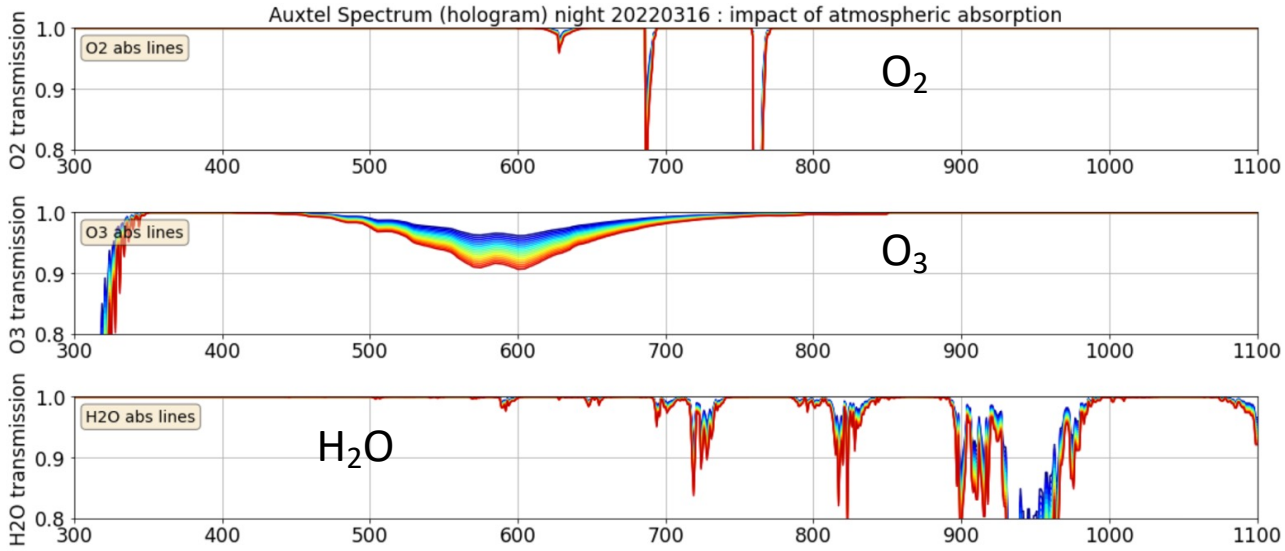
Outline of the talk

- **March 2022 data : dedicated to Equivalent width and airmass effect**
  - Night 03/16 : target ETA1DOR (bright standard)
    - Nice stellar absorption lines
  - Night 03/17 : target MuCOL (bright standard)
    - large range in airmass

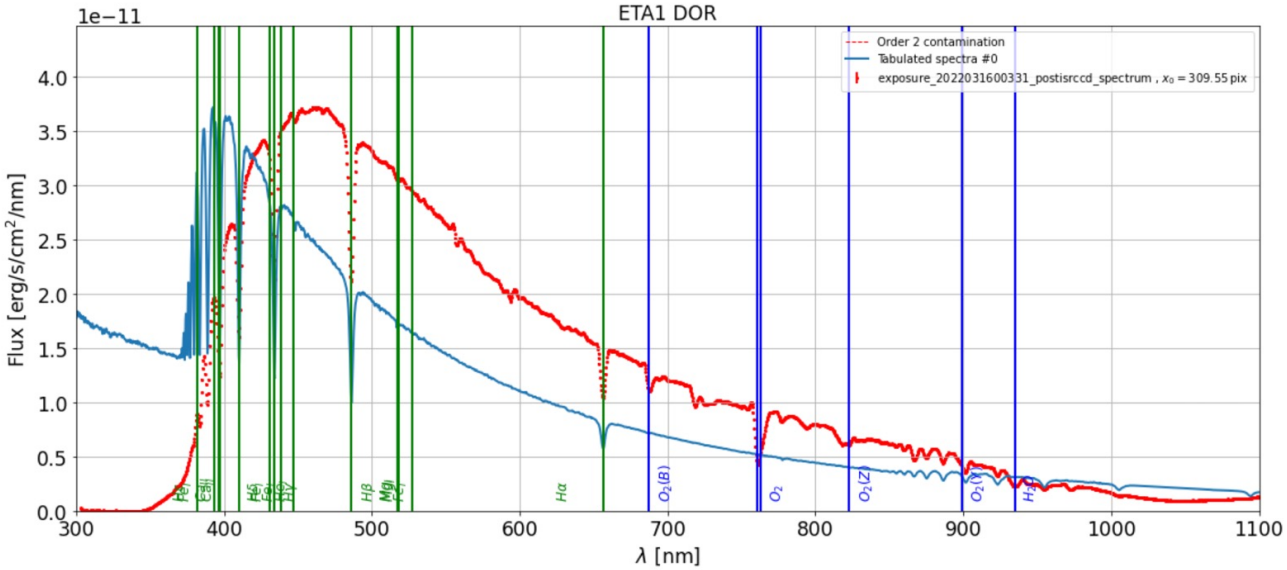
- **Effect of atmospheric extinctions**
  - Equivalent width
  - Extinction lines

ETA1 DOR (V = 5.6 mag)

Libradtran atmospheric transparency simulation absorption pattern (Rayleigh scatt and aerosols scatt)

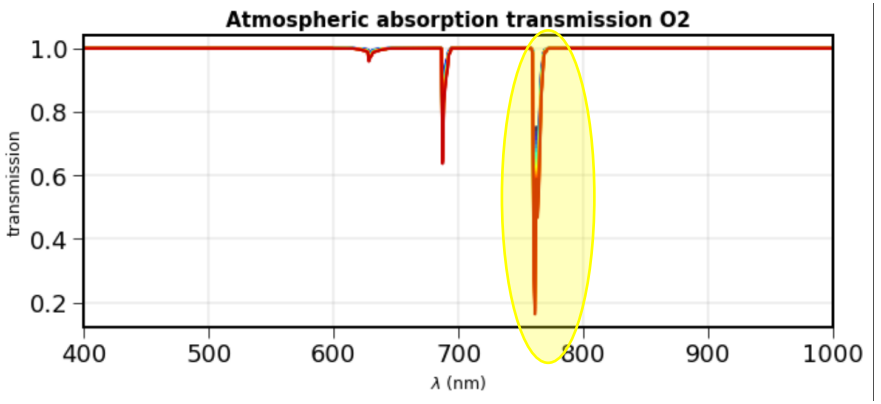


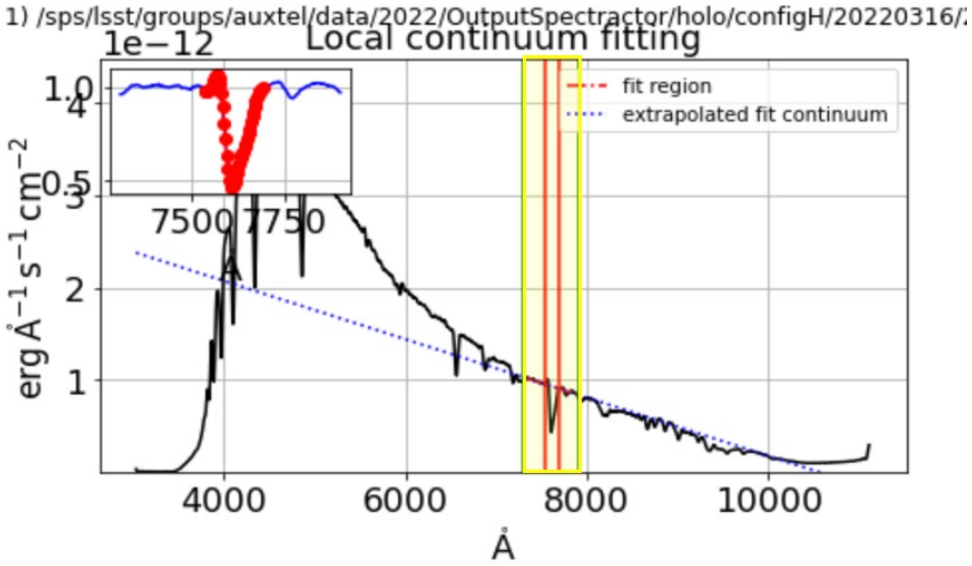
ETA1DOR spectrum (reconstructed with Spectractor)



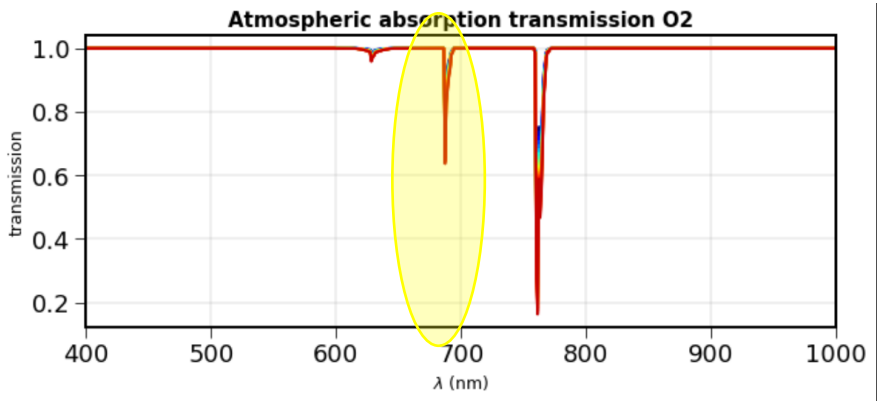
Examples of Equivalent width measurement for O_2

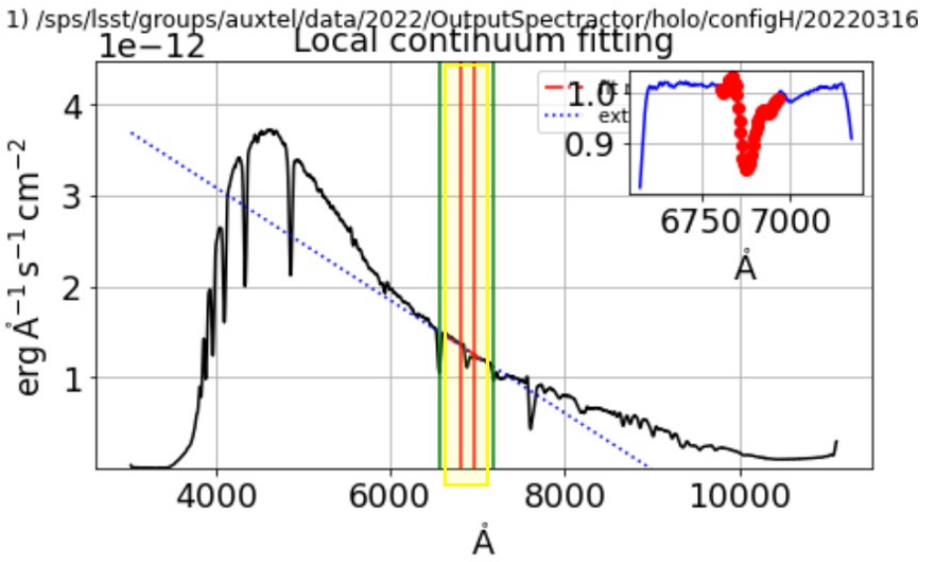
O_2(λ ~760 nm) absorption line





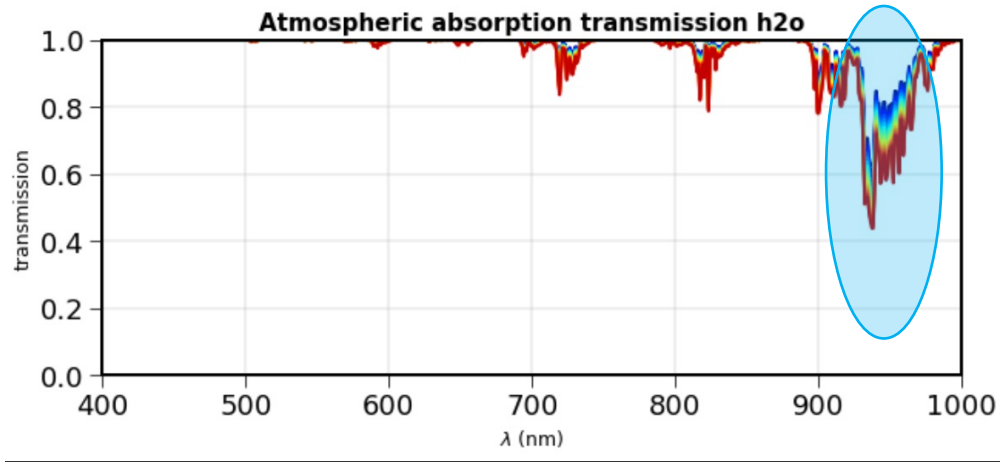
O2B(λ ~687 nm) absorption line

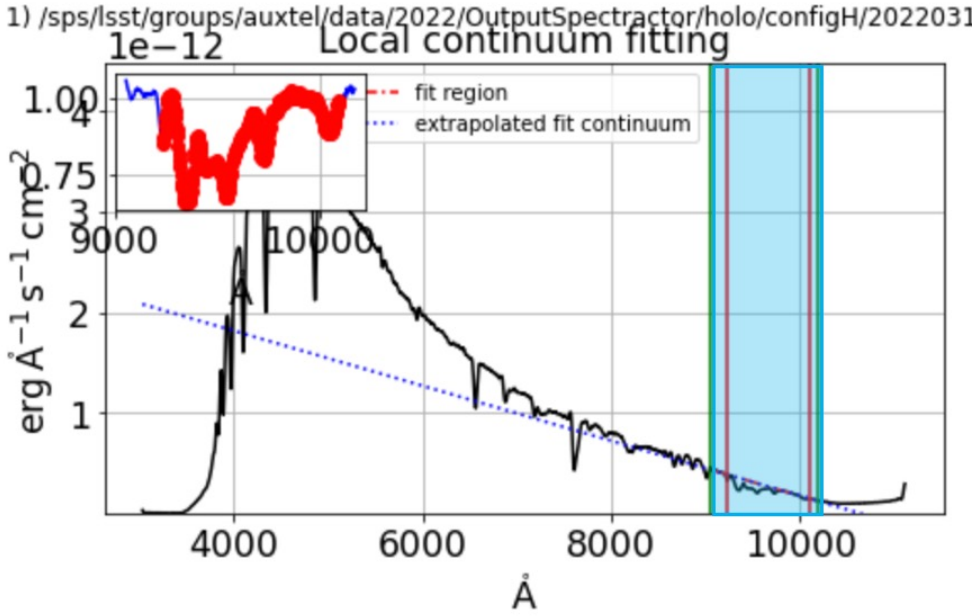




Examples of Equivalent width measurement

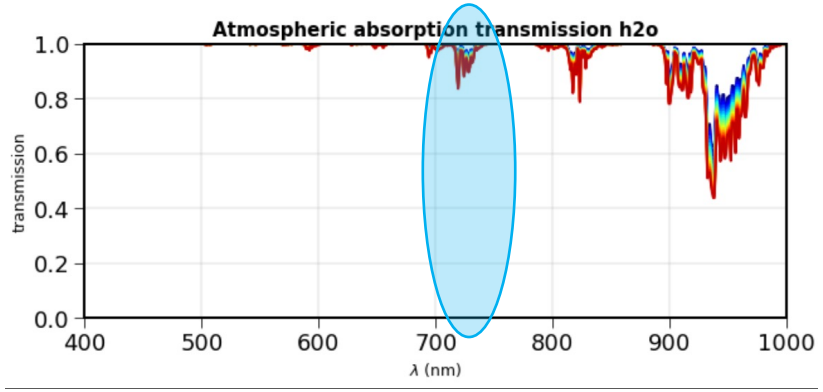
$H_2O(\lambda>900$ nm) absorption line

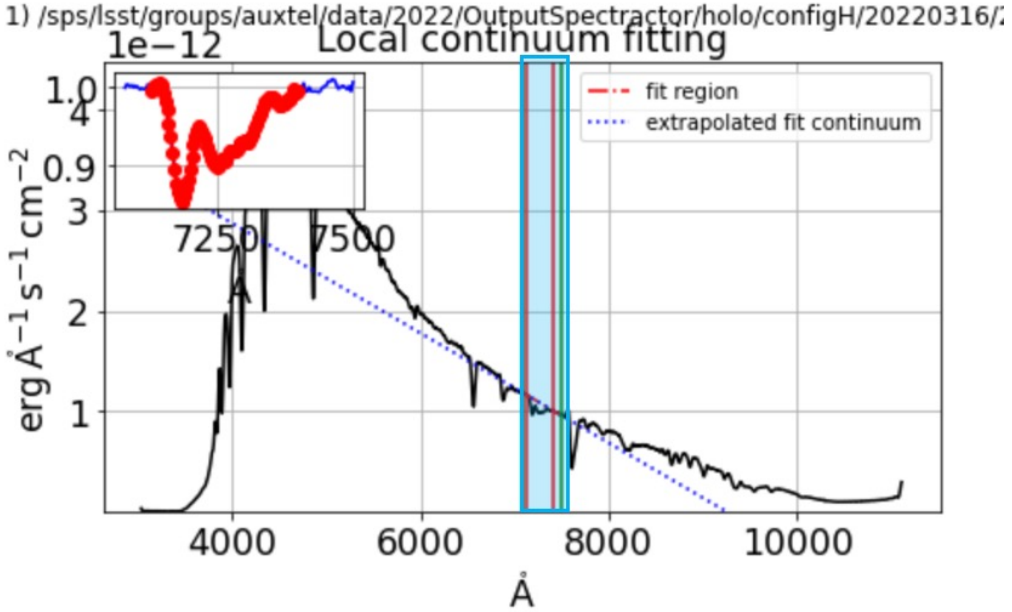


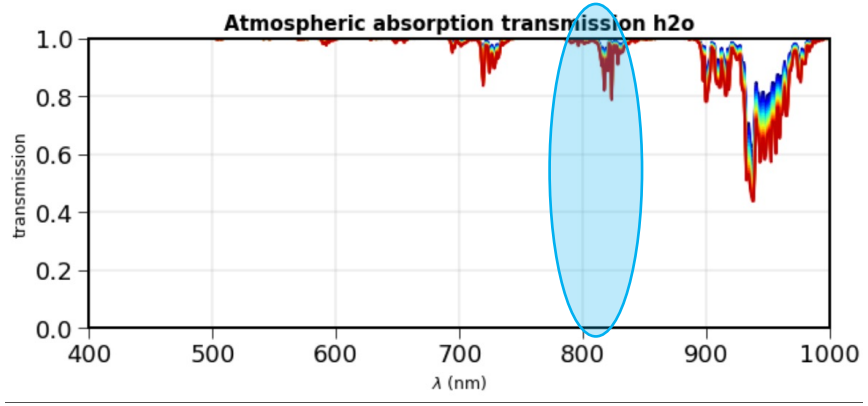


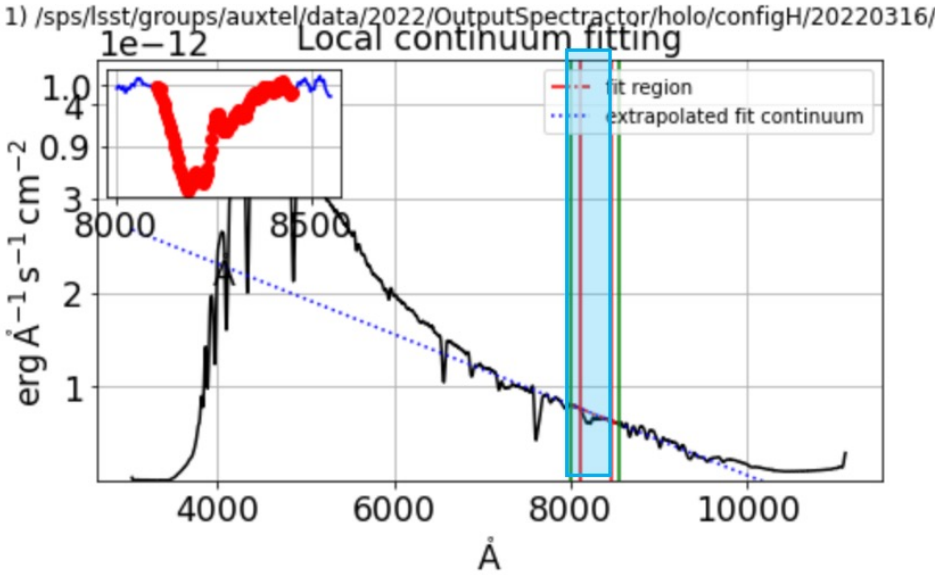
But very small signal/noise ratio due to low CCD transmission at $\lambda>900$ nm

Higher precision on H_2O bas band at λ=730 nm and λ=820 nm

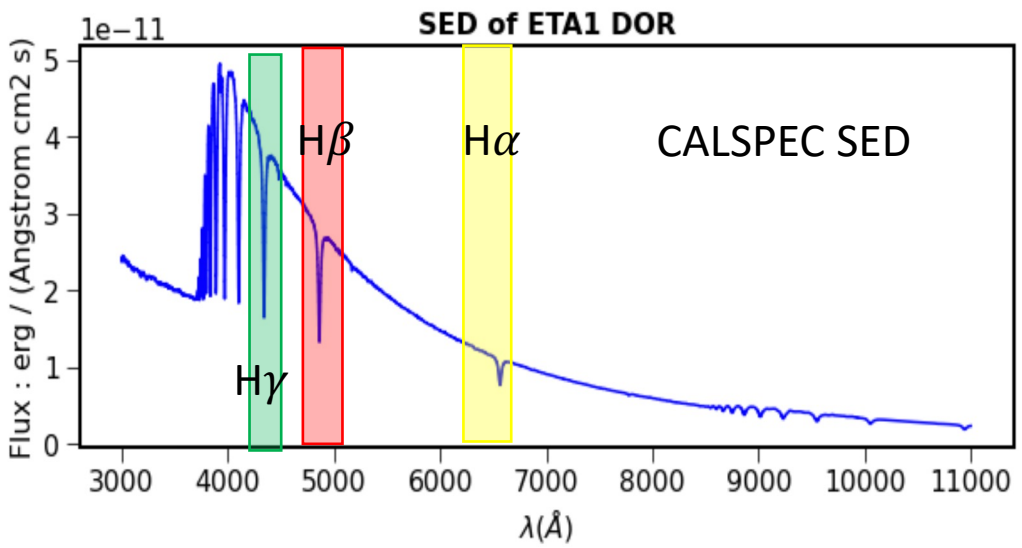




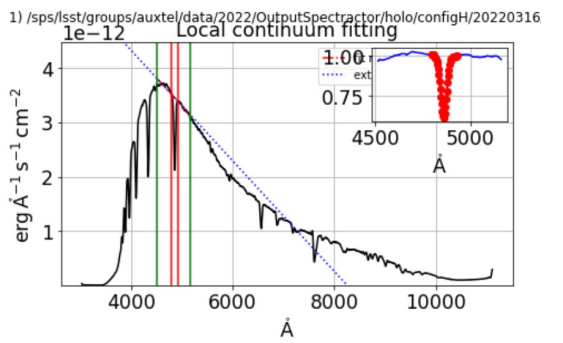


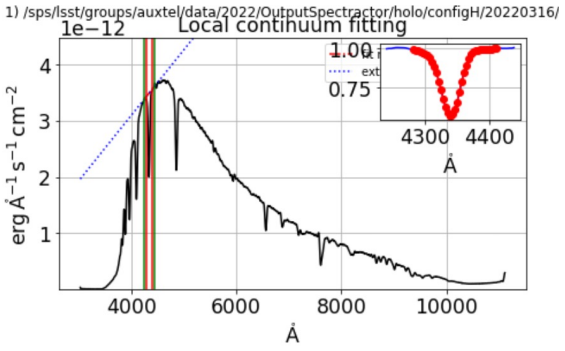


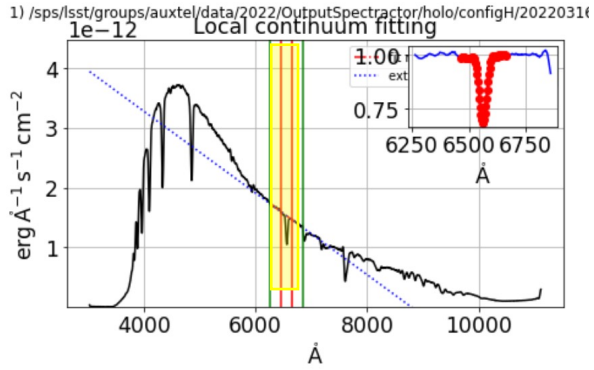
Equivalent width for Stellar absorption line for ETA1 DOR



CALSPEC SED

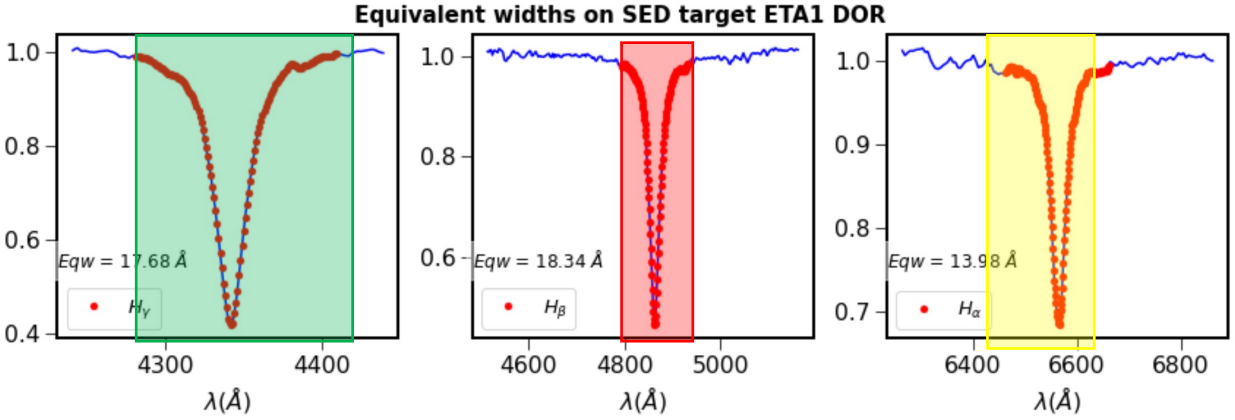


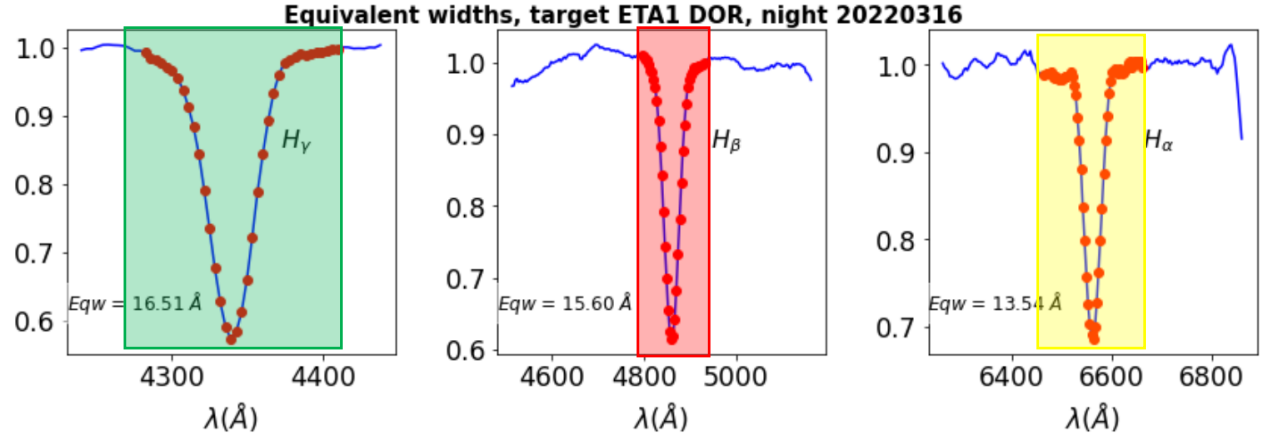




Auxtel spectrum data

Auxtel abs line Data

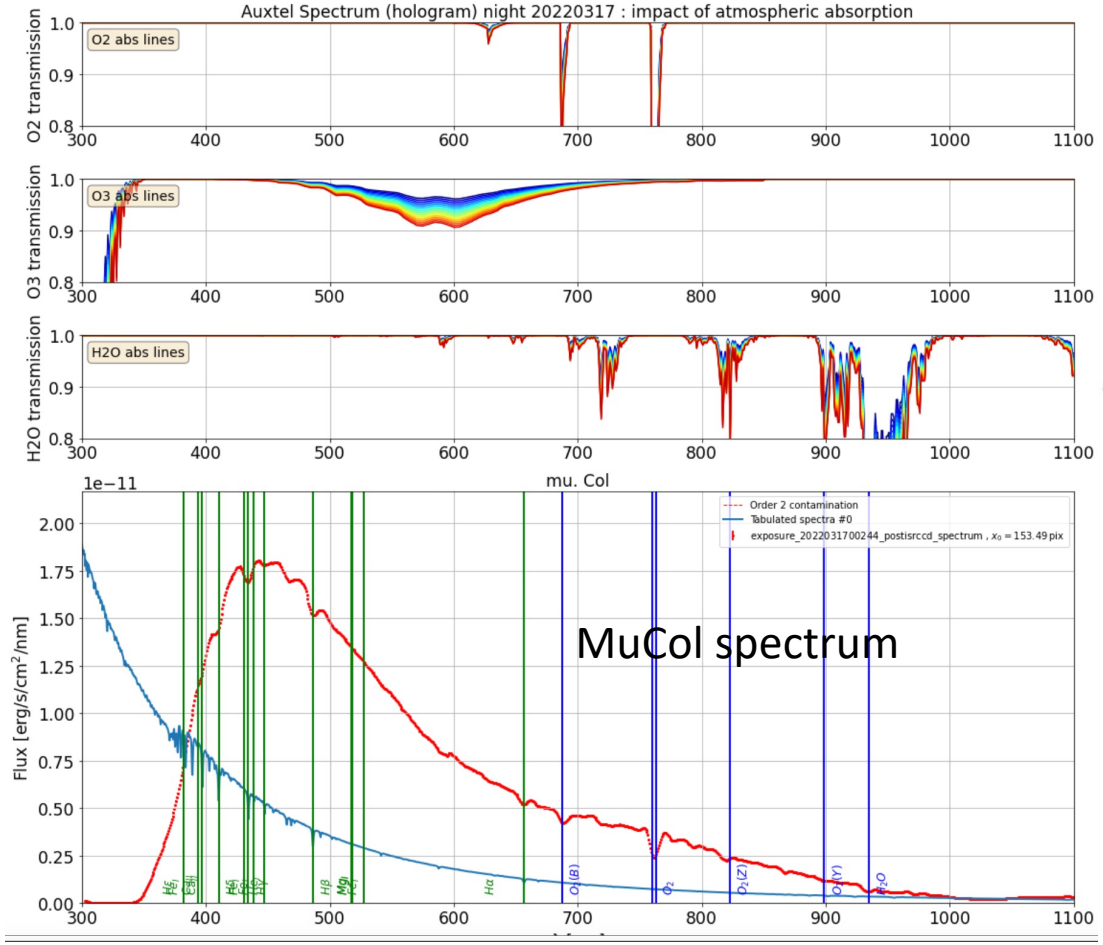




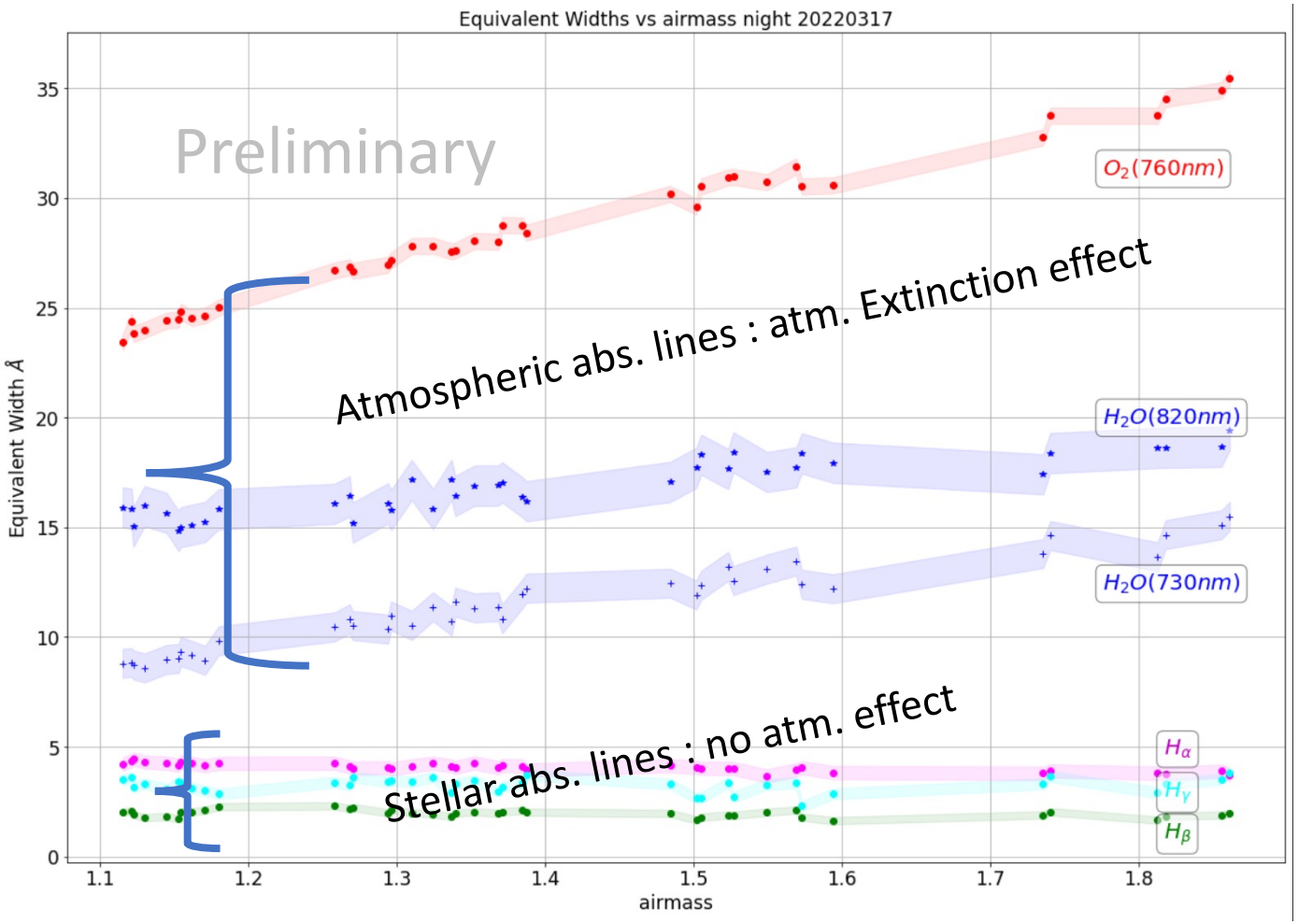
Impact of airmass on equivalent width (MuCol : V=5.2 mag)

(Data with large airmass range)

Simulated absorption transmission contribution

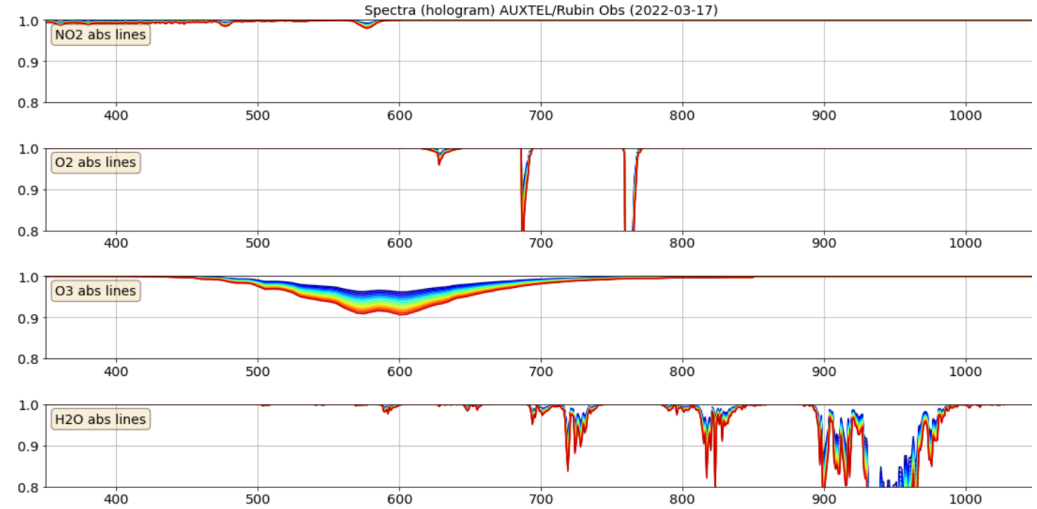


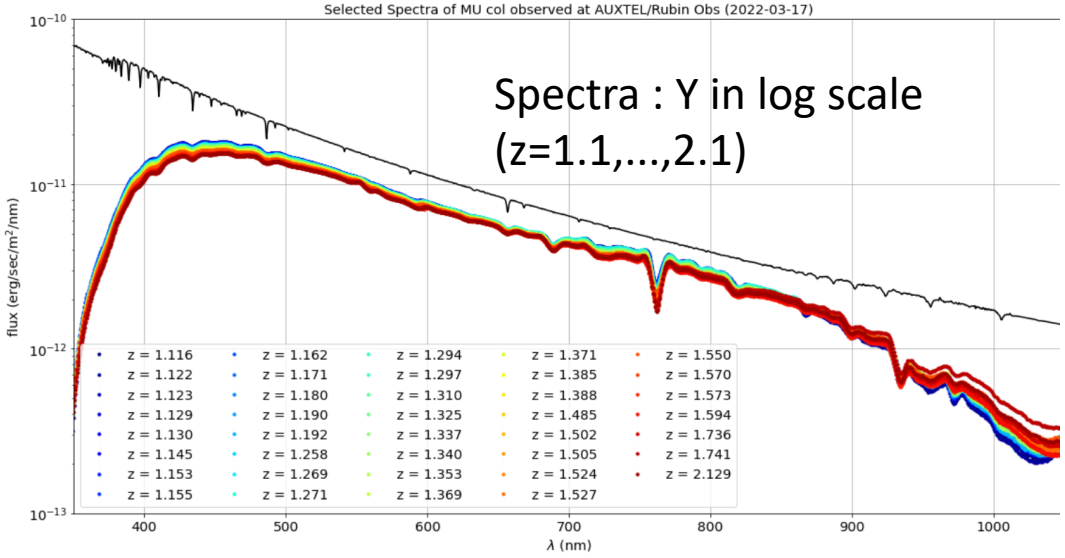
MuCol equivalent width vs airmass



Atmospheric extinction lines : Bouguer lines

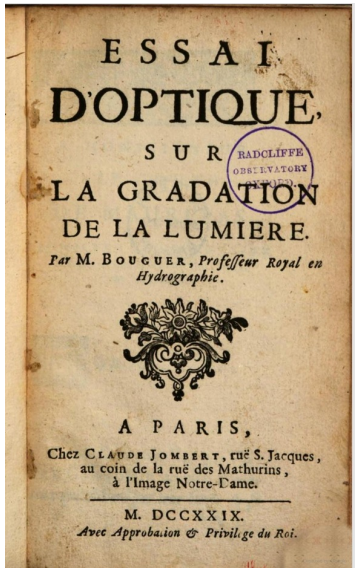
Simulation of atmospheric abs. Patterns (z=1,…, 2.5)

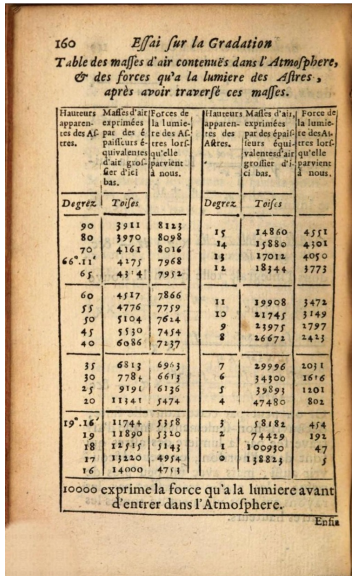




Spectra : Y in log scale
(z=1.1,…,2.1)

Pierre Bouguer
(1698-1758)

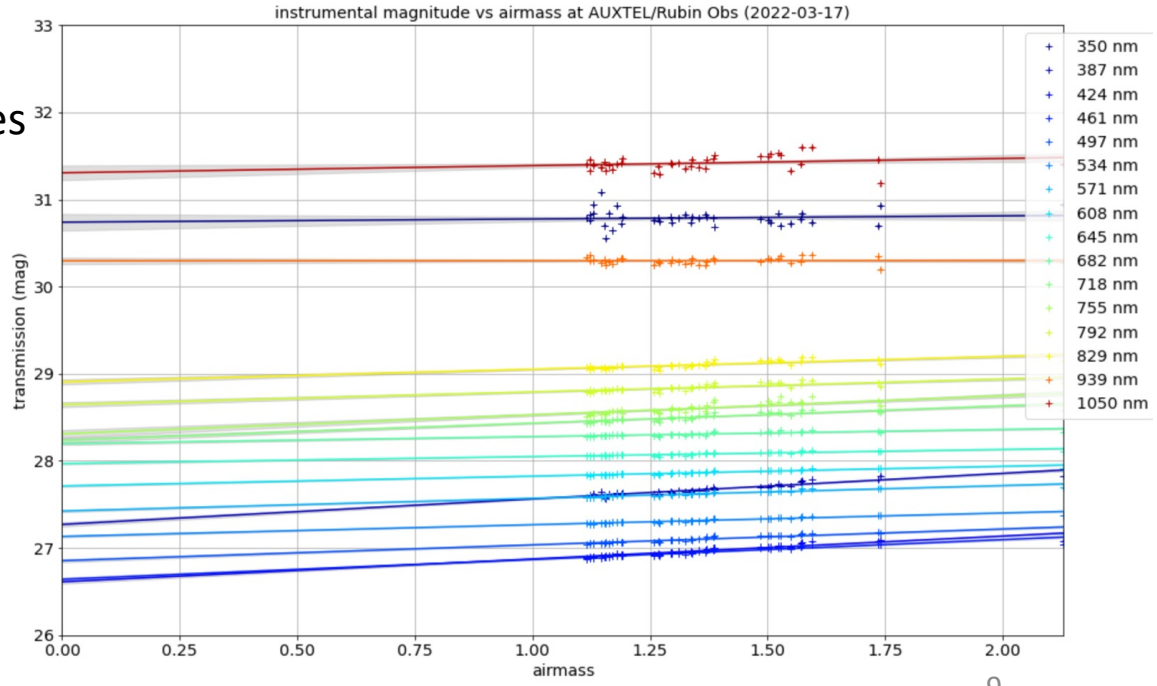




Bouguer Law
Better known as Beer-Lamber Law

(1729)

Magnitudes of Spectra

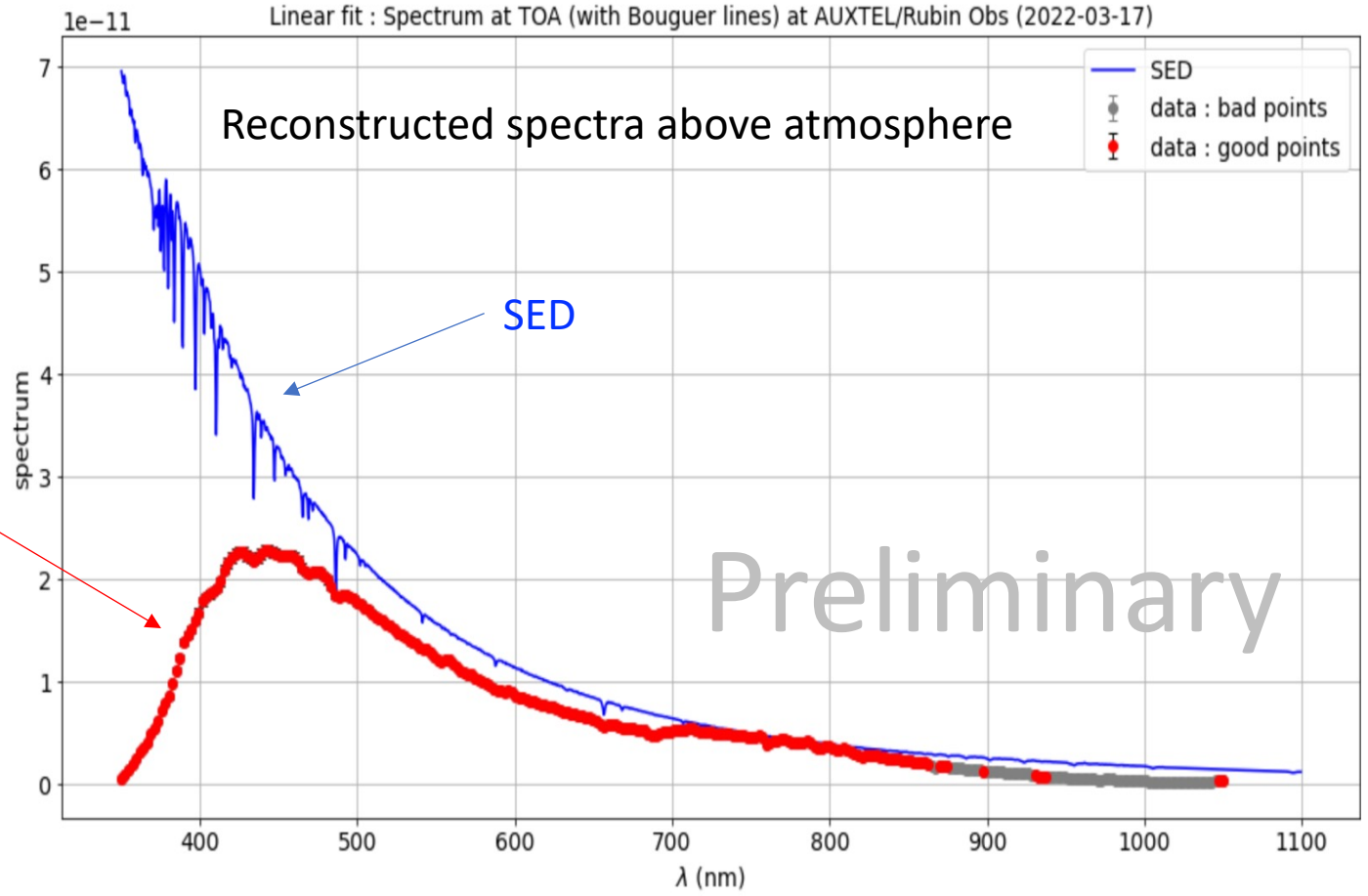


Airmass z

Bouguer lines extrapolated at the top of atmosphere

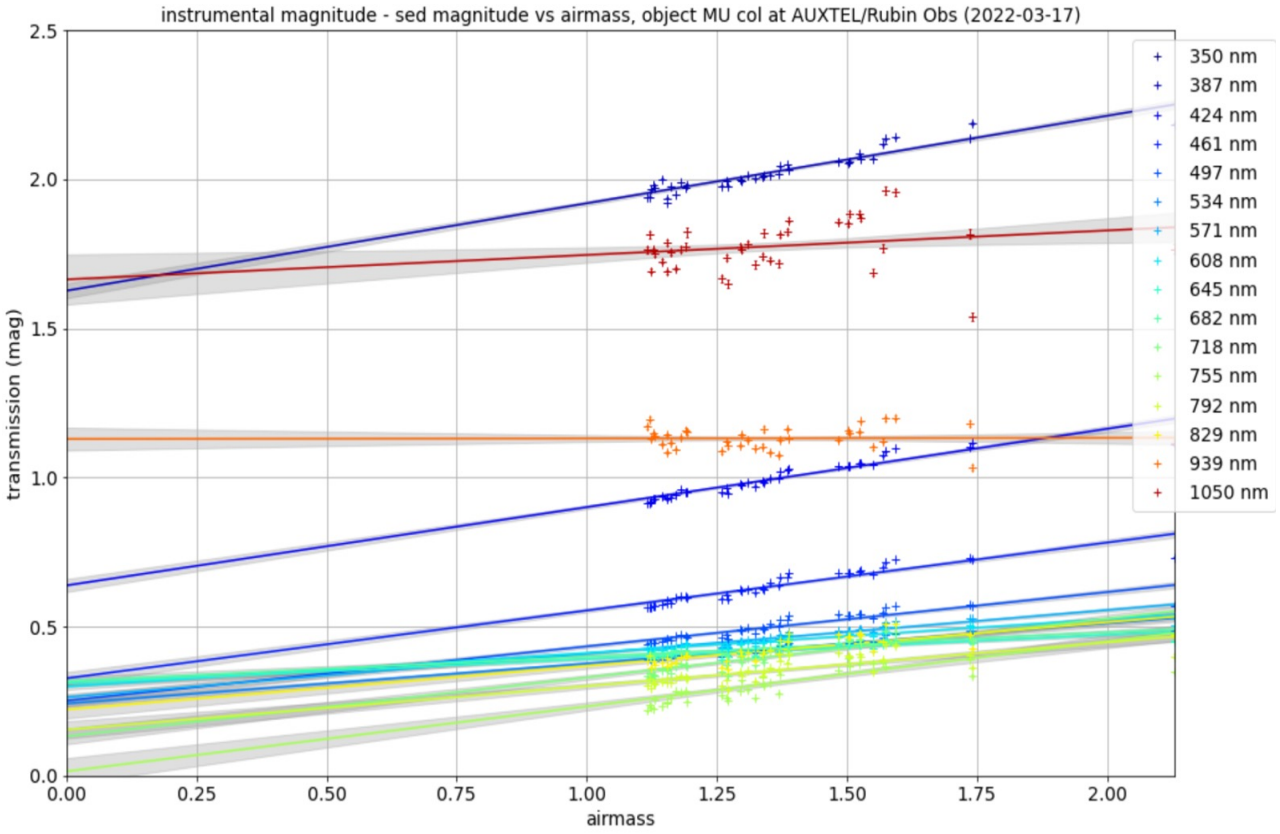
- Bouguer lines: Y axis in magnitude (log scale) on previous slide

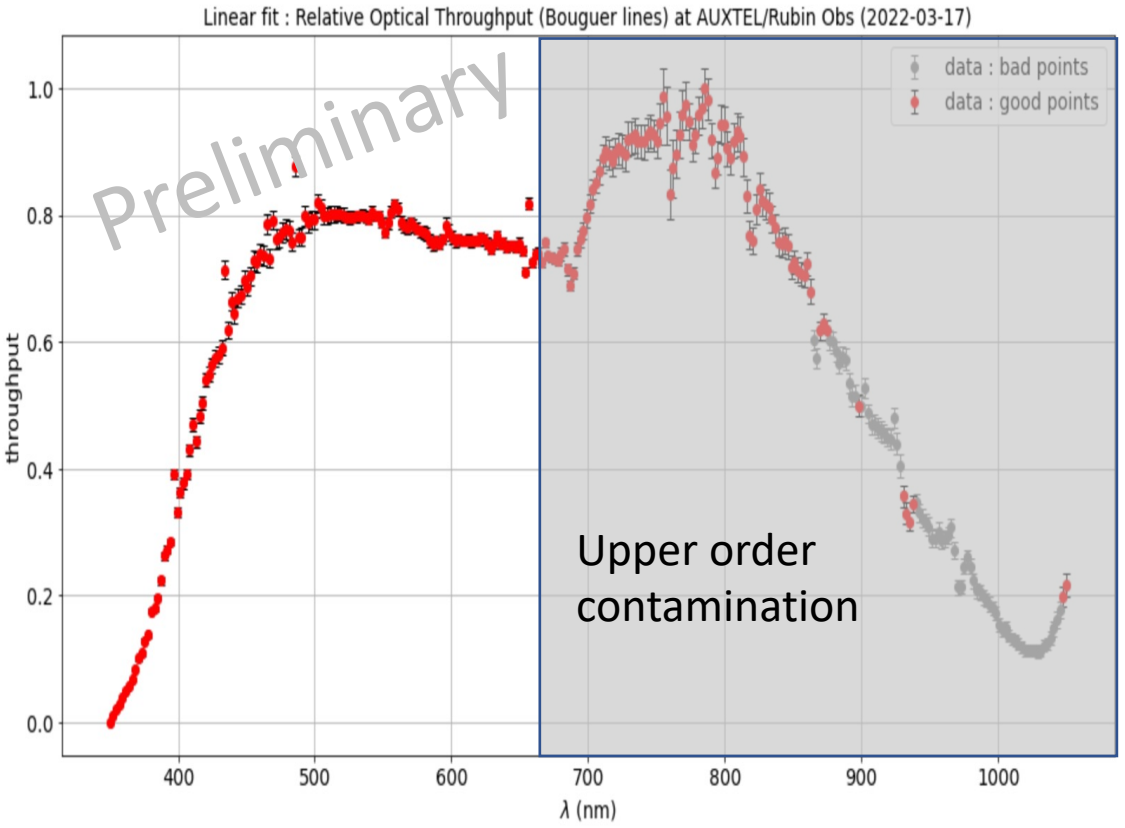
- Spectrum: Y axis in erg:cm2/s/nm (linear scale) From the Y intercept on previous slide



Total Throuput after removing SED

Subtract the known SED from previous line curves an extrapolate at airmass = 0 again

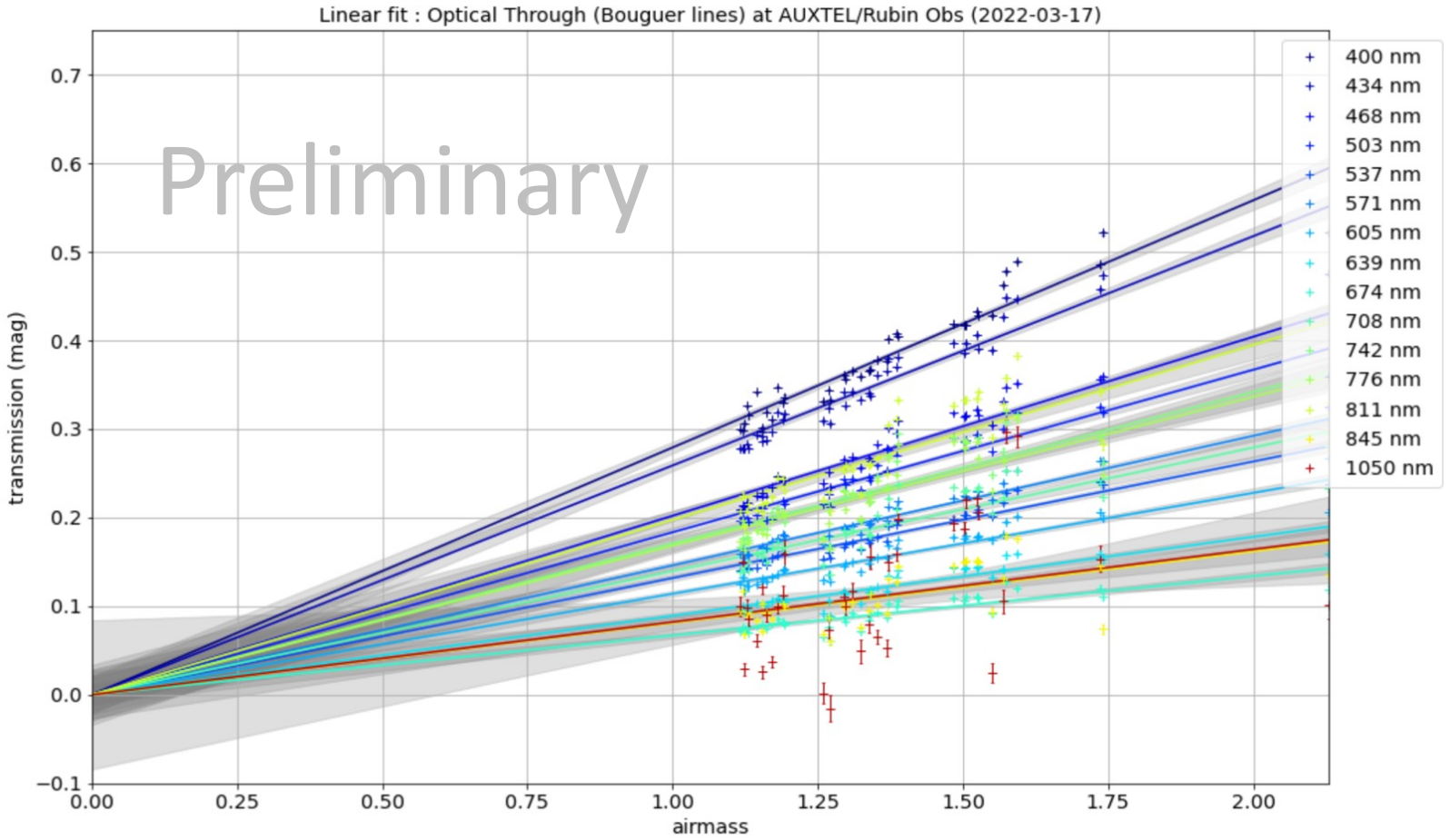




Obviously second order contamination for λ>700 nm

Pure atmospheric extinction

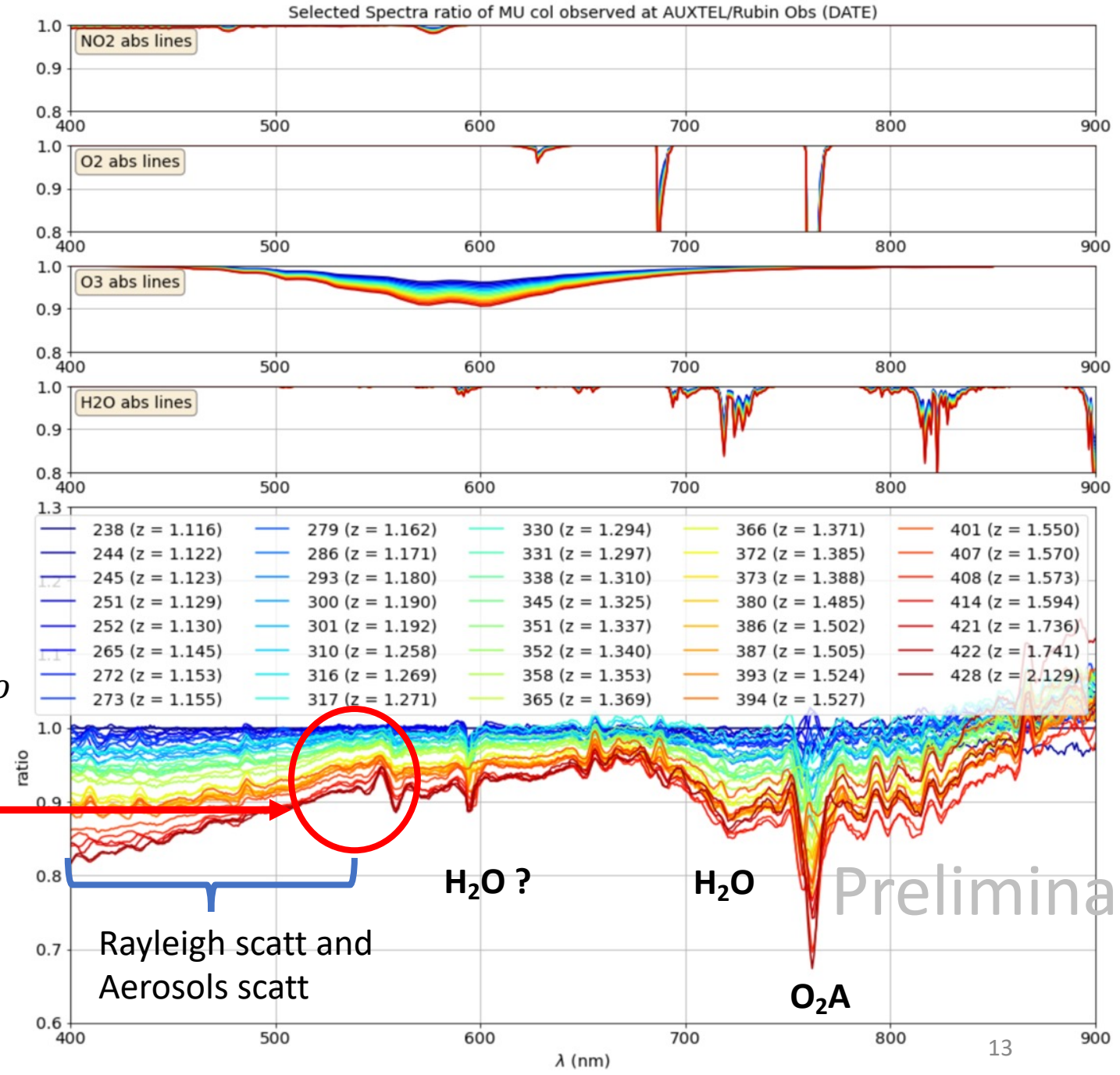
Force all Bouguer lines having their intercept at airmass = 0



- See the point scattering around the fitted straight line
- Correlation at different wavelength
- Small grey extinction ?

Spectrum ratio

Absorption features from
Atmospheric transparency simulation



- $\lambda < 550$: *Pure Rayleigh and aerosols scattering*
- No star absorption line Hα, Hβ, Hγ *in the ratio*

- CCD segment artifact

CCD segment stitching : Need flats

Work to be done

- Image reduction : Apply Flats
  - Reduce the noise structure of the spectrum.
  - See presentation of Martin R. Monroy

- Better removal of second order
  - Work on blue and red filters nights:
    - Red filter to remove second order component (piling up on red part of order 1)
    - Blue filter to see distinctly the order 1 and order 2 of the blue part of the spectrum.

In Spectractor one need the ratio order2/order1 : this ratio is poorly known from optical bench for λ<400 nm