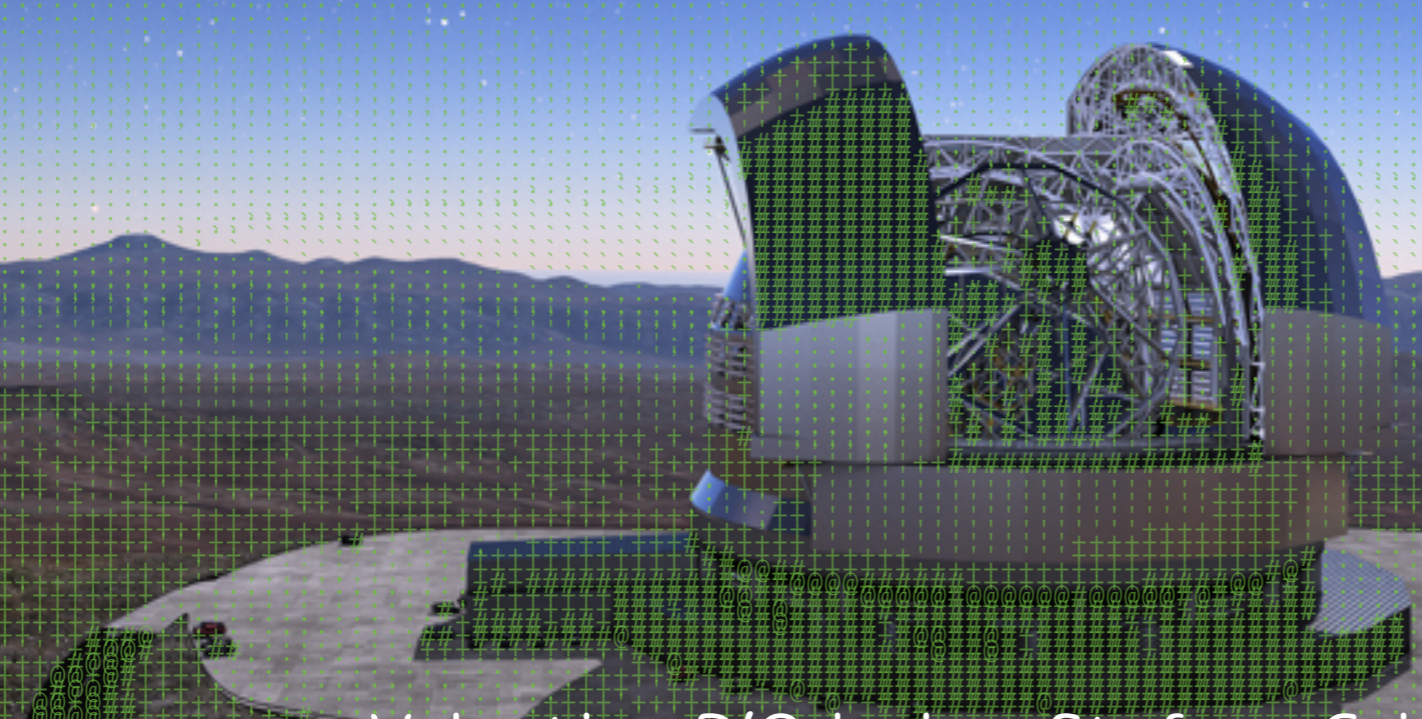


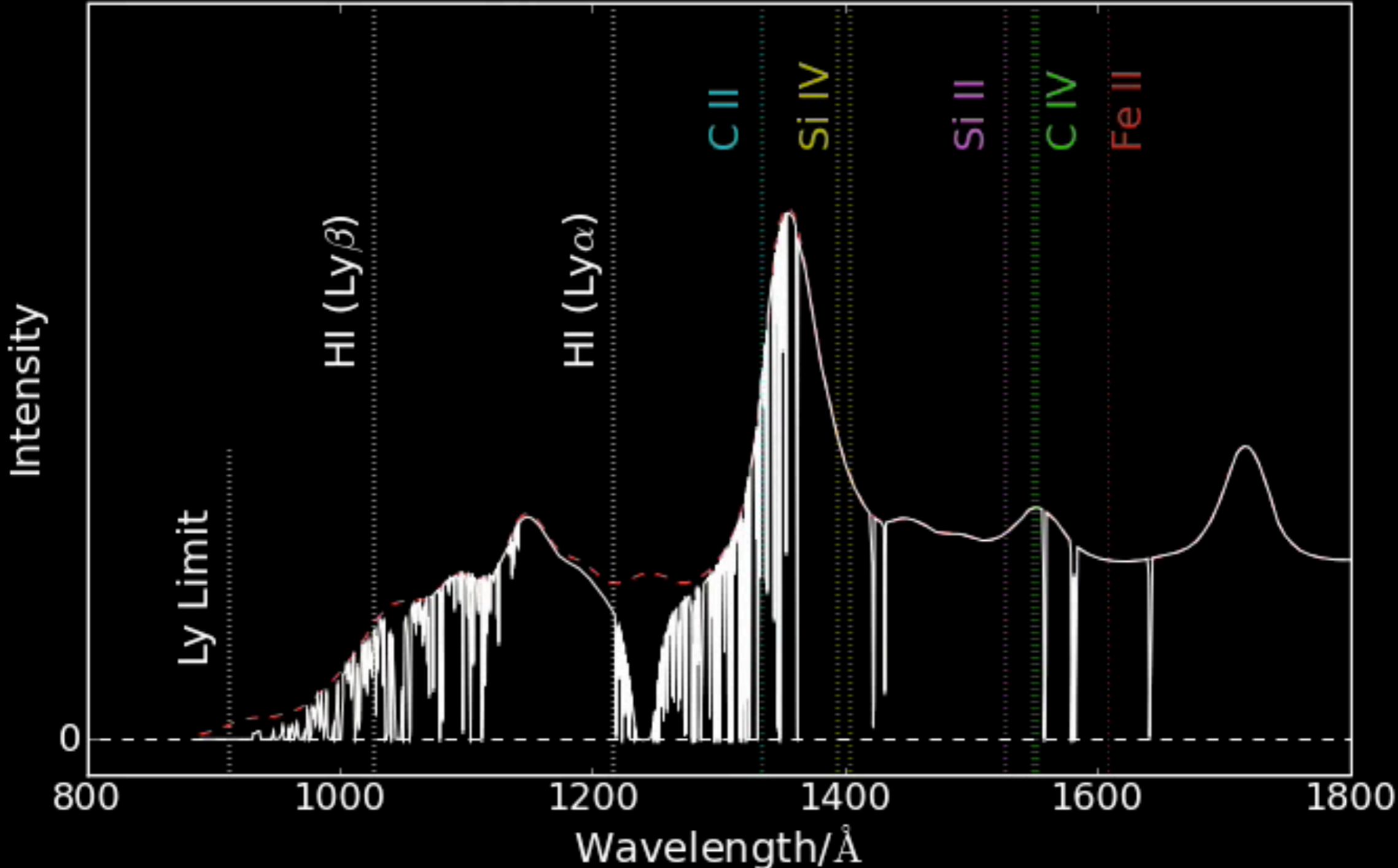
2018 ICT Workshop – Catania, 10–14 September 2018

From the ESPRESSO DAS to Astrocook: spectral analysis towards the ELT era

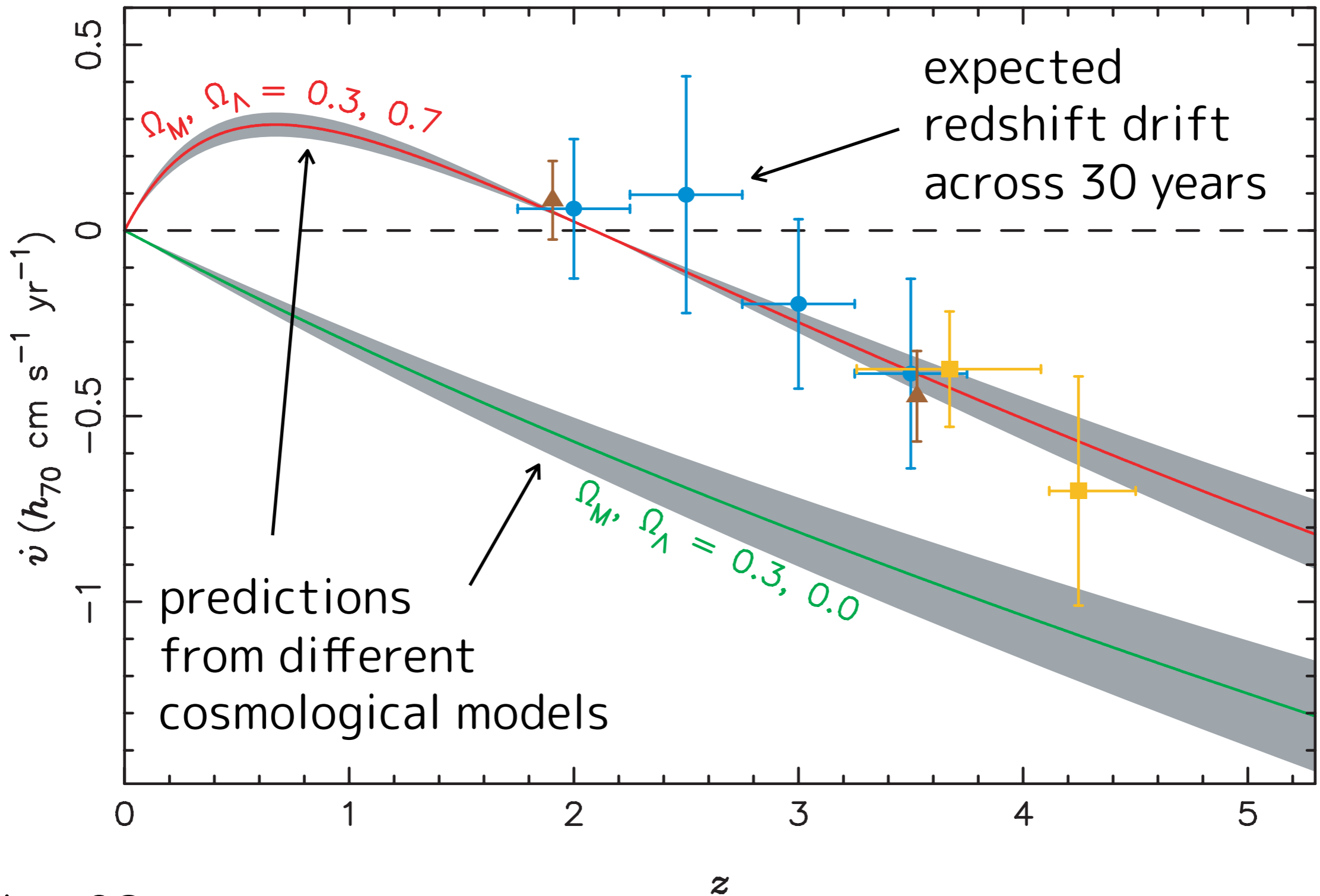


Guido Cupani
+ Valentina D'Odorico, Stefano Cristiani, Giorgio Calderone,
Paolo Di Marcantonio, Giuliano Taffoni
INAF–Osservatorio Astronomico di Trieste

Credits: Andrew Pontzen



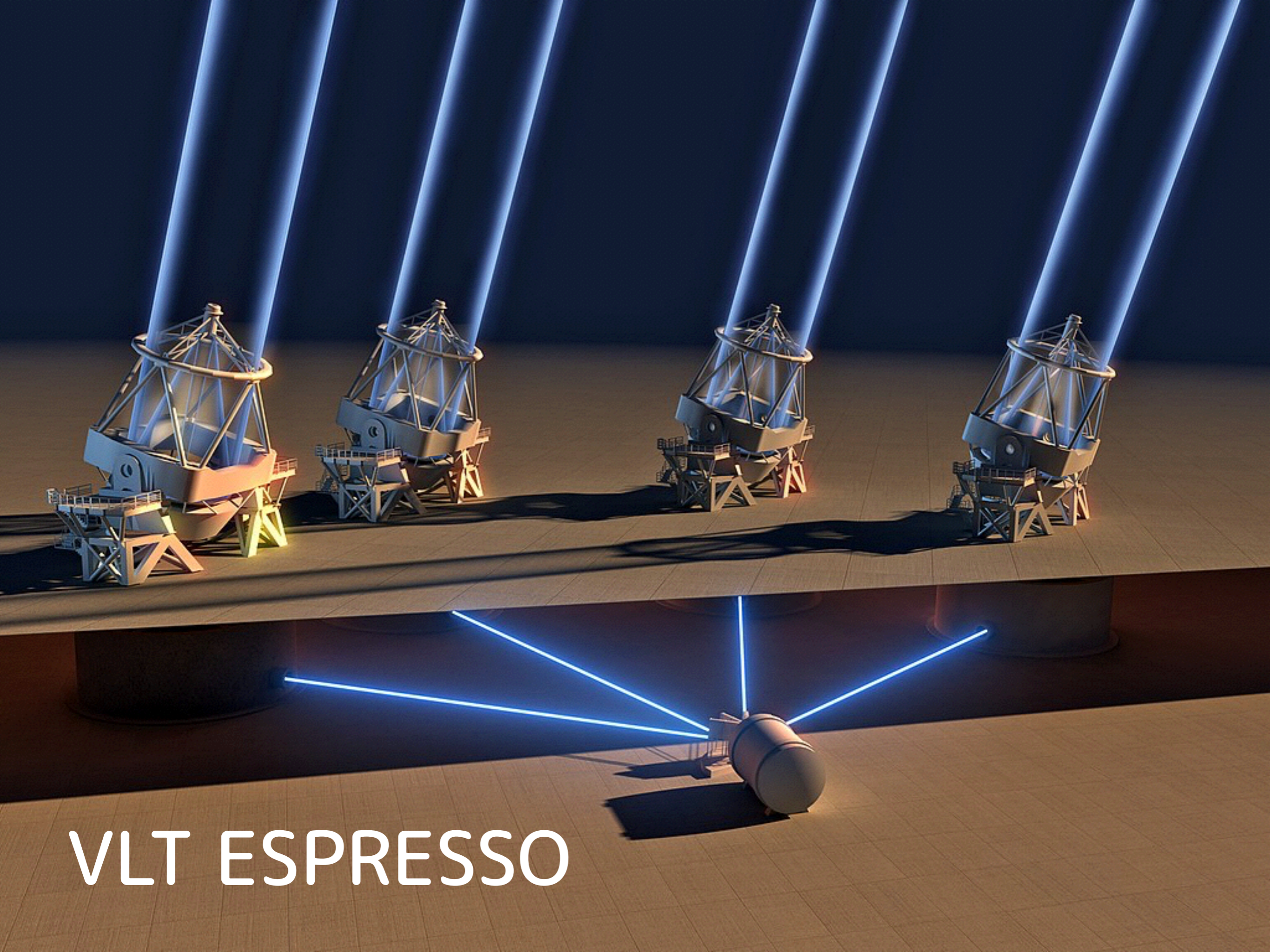
Sandage Test



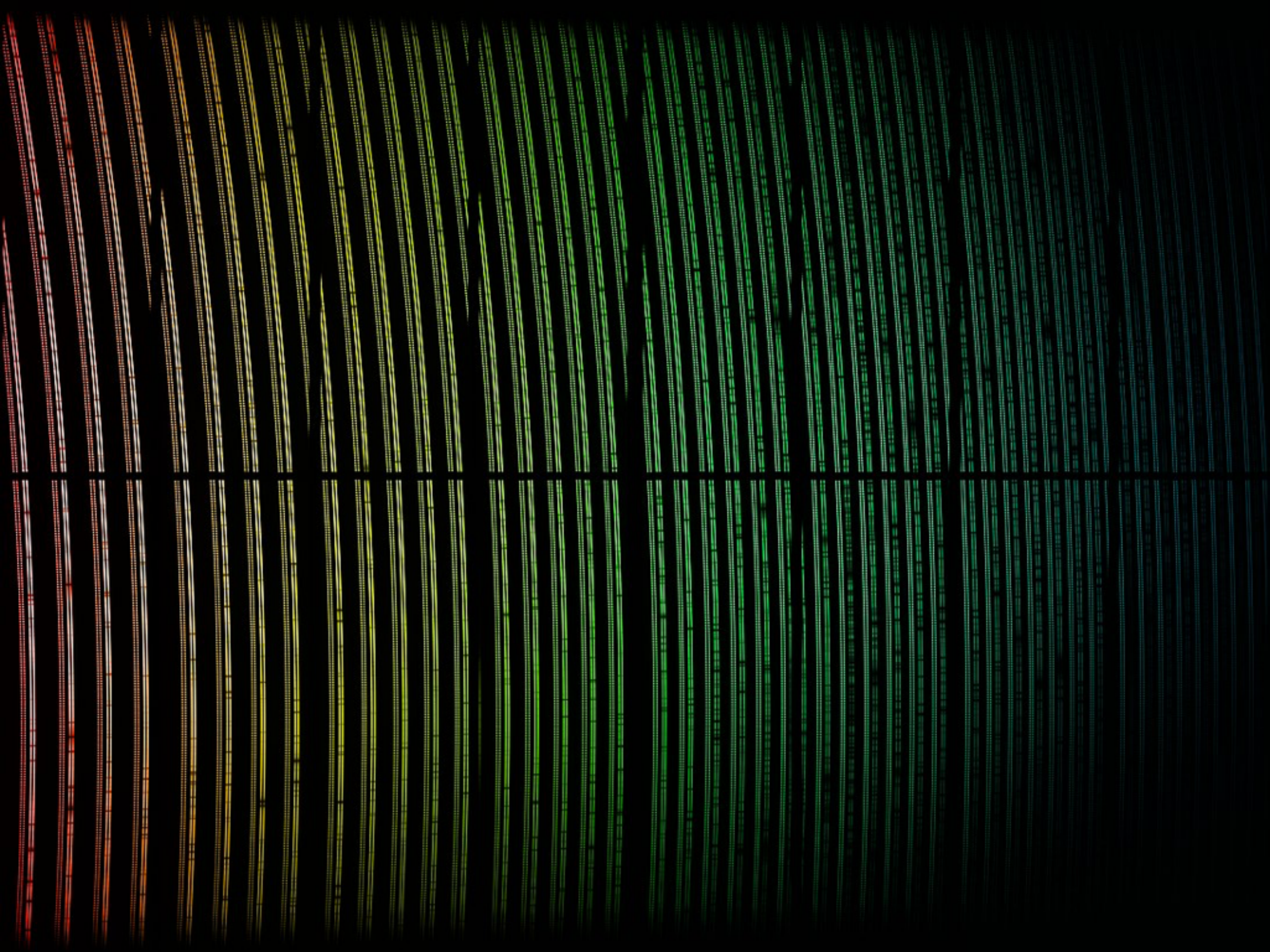


- Efficiency
- Resolution
- Stability
- Flexibility
- ...

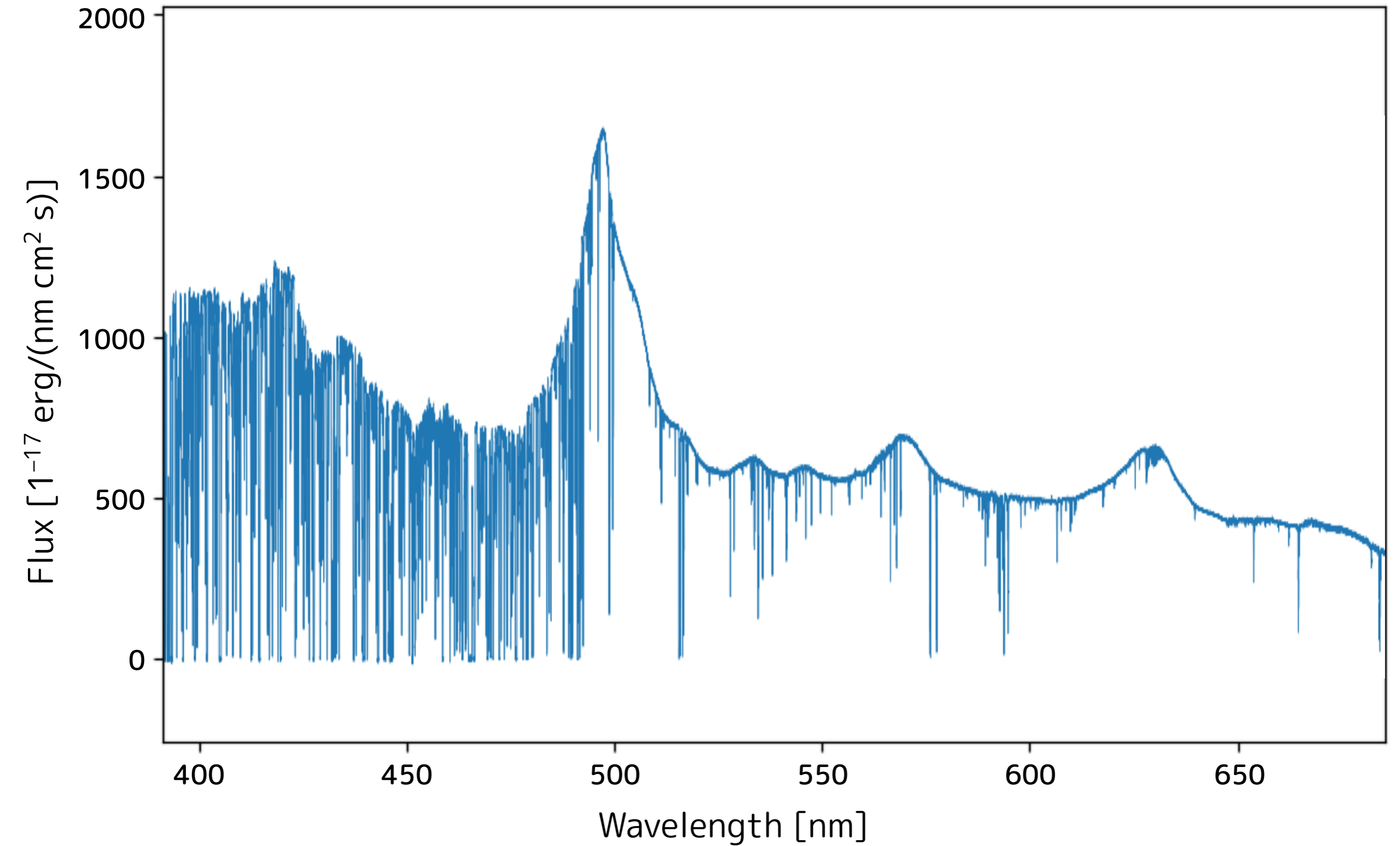
- Reliability
- Repeatability
- Scalability
- Flexibility
- ...

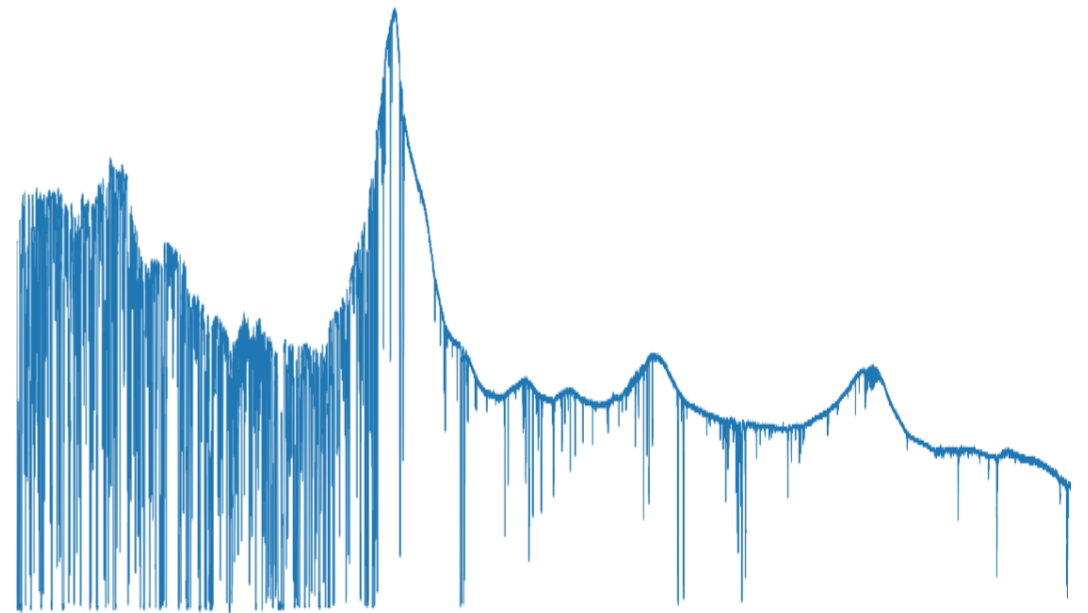
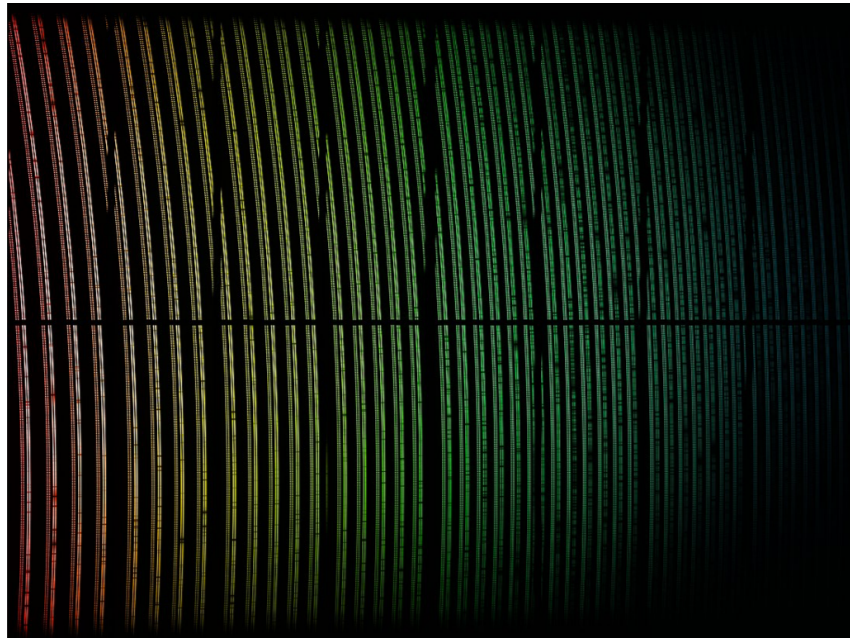


VLT ESPRESSO



HE 0940-1050



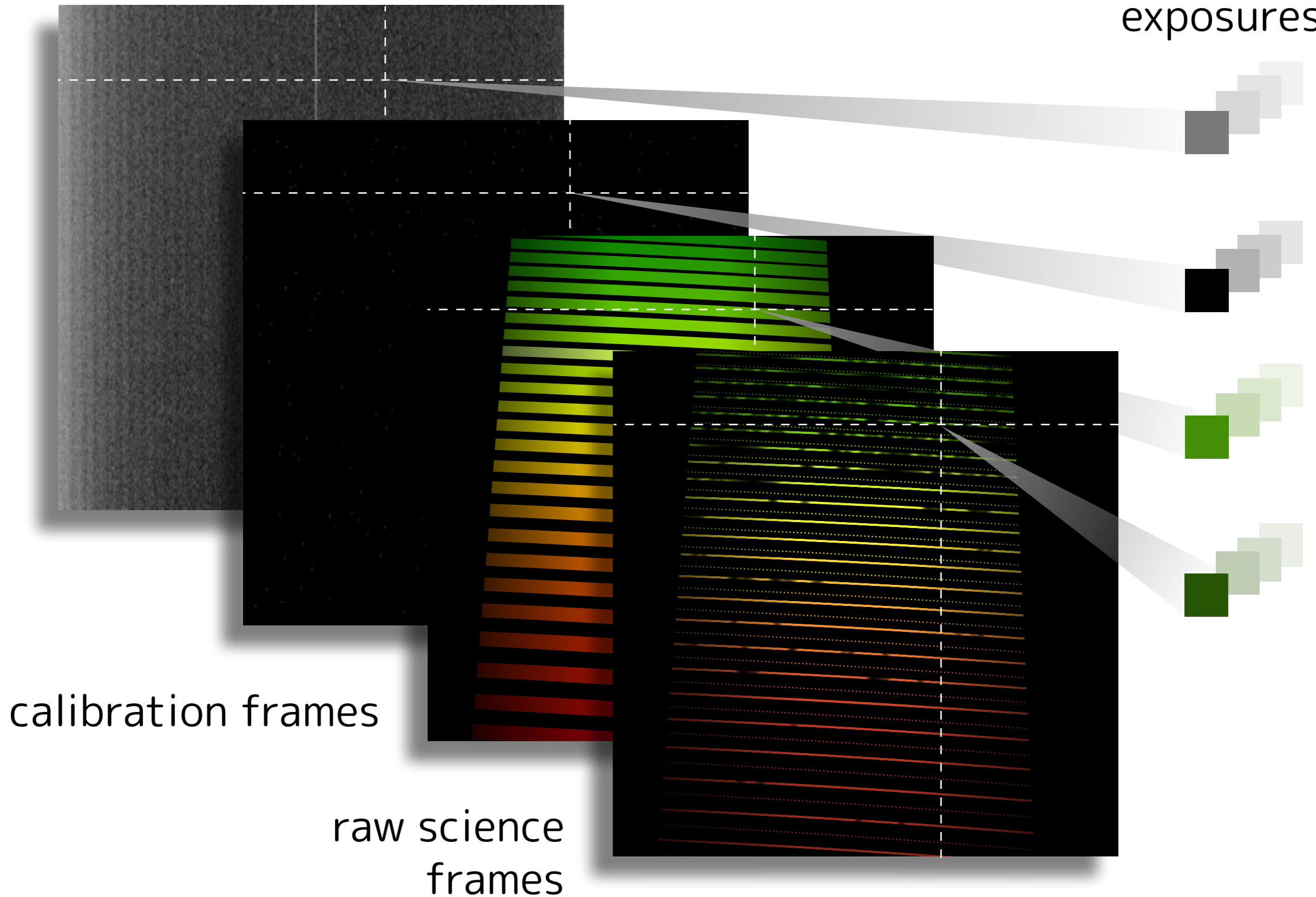


- Remove bias
- Remove cosmics
- Remove background
- Perform flat-fielding
- Convert to physical units

- Co-add exposures
- Detect absorption lines
- Fit emission continuum
- Fit absorption systems
- ...

Pixel conservation

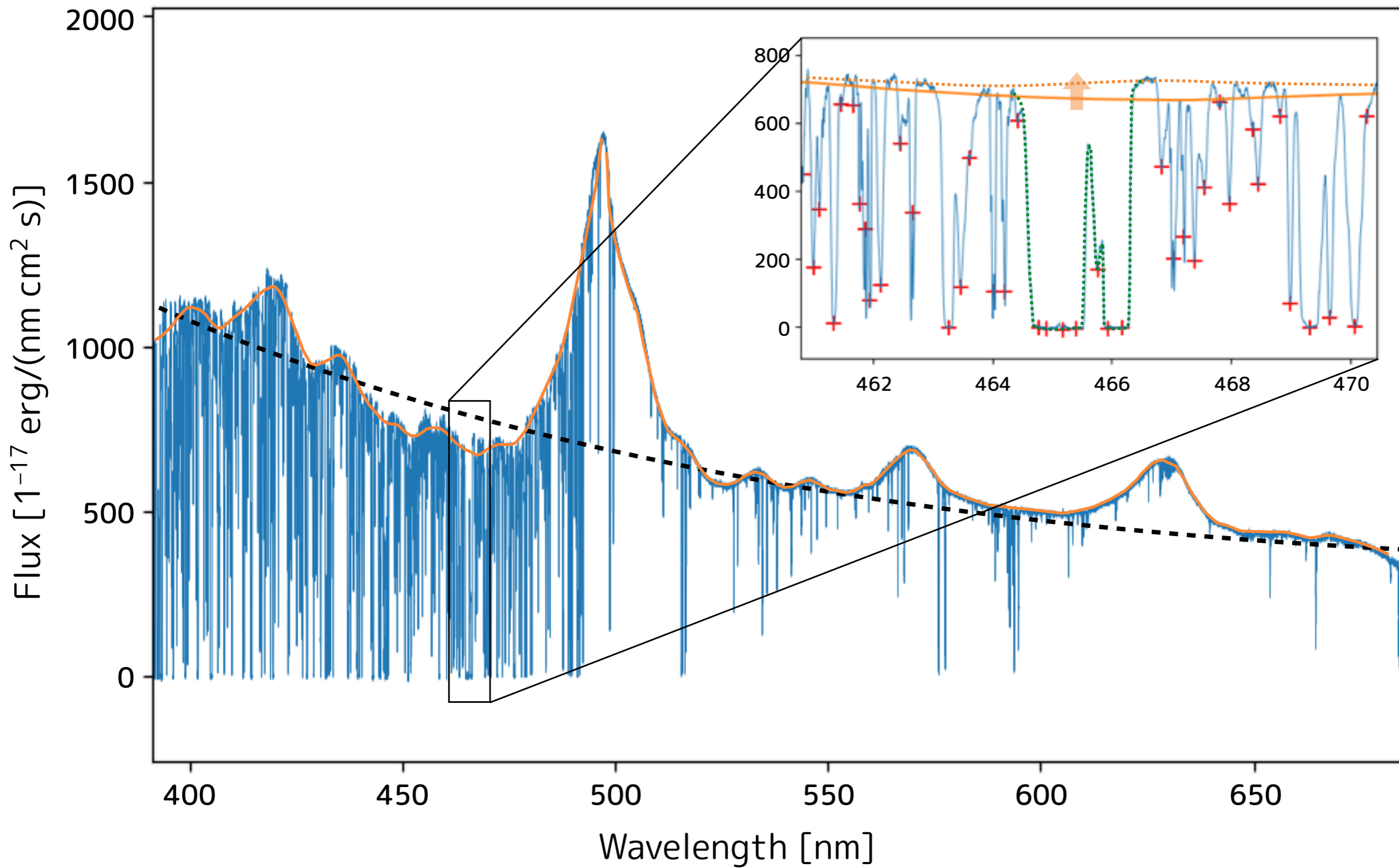
several
exposures



calibration frames

raw science
frames

HE 0940-1050



ESPRESSO Data Analysis Software

The screenshot displays the Reflex Interactive App interface for ESPRESSO data analysis. The main window is divided into several functional areas:

- Transitions Table:** A table listing spectral lines with columns for Line ID, Rest-frame, Redshifted, and Osc. strength.
- System f Plot:** A plot of Normalized flux vs. Wavelength (500-580 nm) showing the system's response function.
- Line fitting:** Two plots showing the fit for CIV_1548 and CIV_1550 lines, with a chi-squared value of 1.47.
- Recipe Parameters:** A panel for configuring the analysis recipe, including hwidth, par-range, and edit-time.
- Lines Table:** A detailed table of fitted lines with columns for #, Line ID, Wavel., Redshift, error, constr., Col. d., error, constr., Therm. br., error, constr., Turb. br., error, and constr.
- Workflow Diagram:** A diagram showing the data processing pipeline: Preparation (Data Storage) -> Analysis (Fit Lines) -> Close Systems (Product Explorer).
- General Parameters:** A panel for setting global parameters like VEL_STEP_UVES, RESOL_UVES, and GLOB_RESOL.

Transitions Table:

Line ID	Rest-frame	Redshifted	Osc. strength
NiII_1454	145.4842	484.5029	0.0323
CoII_1466	146.6211	488.2891	0.031
SiII_1526	152.6707	508.4359	0.133
CIV_1548	154.8204	515.5950	0.1899
CIV_1550	155.0781	516.4532	0.09475
Cl_1560	156.03092	519.6264	0.0774
SiI_1562	156.2001	520.1898	0.3758
CoI_1574	157.45508	524.3692	0.025
ZnI_1589	158.9561	529.3680	0.1219
FeII_1608	160.84511	535.6590	0.0577
FeII_1611	161.12005	536.5746	0.00138
SiI_1625	162.57058	541.4053	0.0852
SiI_1631	163.117	543.2250	0.2051

Lines Table:

#	Line ID	Wavel.	Redshift	error	constr.	Col. d.	error	constr.	Therm. br.	error	constr.	Turb. br.	error	constr.
1	CIV_1548	515.3881	2.328942	0.000007	CIV-z-000	13.6116	0.0480	CIV-N-000	6.3957	0.4687	CIV-b-000	0.0000	0.0000	F
2	CIV_1548	515.4175	2.329132	0.000000	CIV-z-001	10.0000	0.0000	CIV-N-001	2.0000	0.0000	CIV-b-001	0.0000	0.0000	F
3	CIV_1548	515.4255	2.329183	0.000004	CIV-z-002	14.4585	0.0531	CIV-N-002	10.3663	1.0836	CIV-b-002	0.0000	0.0000	F
4	CIV_1548	515.4689	2.329464	0.000004	CIV-z-003	13.9370	0.0232	CIV-N-003	7.4255	0.4858	CIV-b-003	0.0000	0.0000	F
21	CIV_1548	515.5004	2.329667	0.000030	CIV-z-004	12.0629	0.2505	CIV-N-004	4.8300	4.0612	CIV-b-004	0.0000	0.0000	F
19	CIV_1548	515.5404	2.329926	0.000011	CIV-z-005	13.2252	0.1055	CIV-N-005	5.3259	0.7852	CIV-b-005	0.0000	0.0000	F
5	CIV_1548	515.5604	2.330055	0.000013	CIV-z-006	13.2751	0.1138	CIV-N-006	6.9966	1.8811	CIV-b-006	0.0000	0.0000	F
11	CIV_1548	515.5980	2.330297	0.000003	CIV-z-007	13.8057	0.0215	CIV-N-007	9.6949	0.5971	CIV-b-007	0.0000	0.0000	F
14	CIV_1548	515.6555	2.330669	0.000004	CIV-z-008	14.2349	0.0088	CIV-N-008	19.4702	0.5632	CIV-b-008	0.0000	0.0000	F
16	CIV_1548	515.7334	2.331172	0.000004	CIV-z-009	13.6913	0.0114	CIV-N-009	14.6851	0.4601	CIV-b-009	0.0000	0.0000	F
23	CIV_1548	515.7818	2.331485	0.000008	CIV-z-010	12.4963	0.1526	CIV-N-010	3.1035	1.6256	CIV-b-010	0.0000	0.0000	F
18	CIV_1548	515.8012	2.331610	0.000034	CIV-z-011	12.4990	0.1668	CIV-N-011	8.7662	3.6338	CIV-b-011	0.0000	0.0000	F

General Parameters:

- VEL_STEP_UVES: 3.0
- RESOL_UVES: 45000
- VEL_STEP_XSH: 1.6
- RESOL_XSH: 6200
- VEL_STEP_HARPS: 1.0
- RESOL_HARPS: 115000
- GLOB_VEL_STEP: 3.0
- GLOB_RESOL: 45000
- LINE_VEL_STEP: 10

Instructions:

- Turn on highlighting: 'Tools' > 'Animate at Runtime...', set to '1'
- Edit ROOT_DATA_DIR to point to your data (subdirs will be searched)
- Edit END_PRODUCTS_DIR to your preferred location (N.B.: must not be a subdir of ROOT_DATA_DIR)
- Run the workflow: ▶ or ctrl-R
- Monitor the progress: 'Window' > 'Runtime Window -'



DAS

Coaddition

Line detection

Continuum fit

Line
identification

Voigt fit



DAS

Coaddition

Line detection

Continuum fit

Line
identification

Voigt fit



Astrocook

<https://github.com/DAS-OATs/astrocook>

Coaddition

Doublet
detection

Continuum
guess

Incremental
Voigt fit

Redshift
match

Power-
law fit

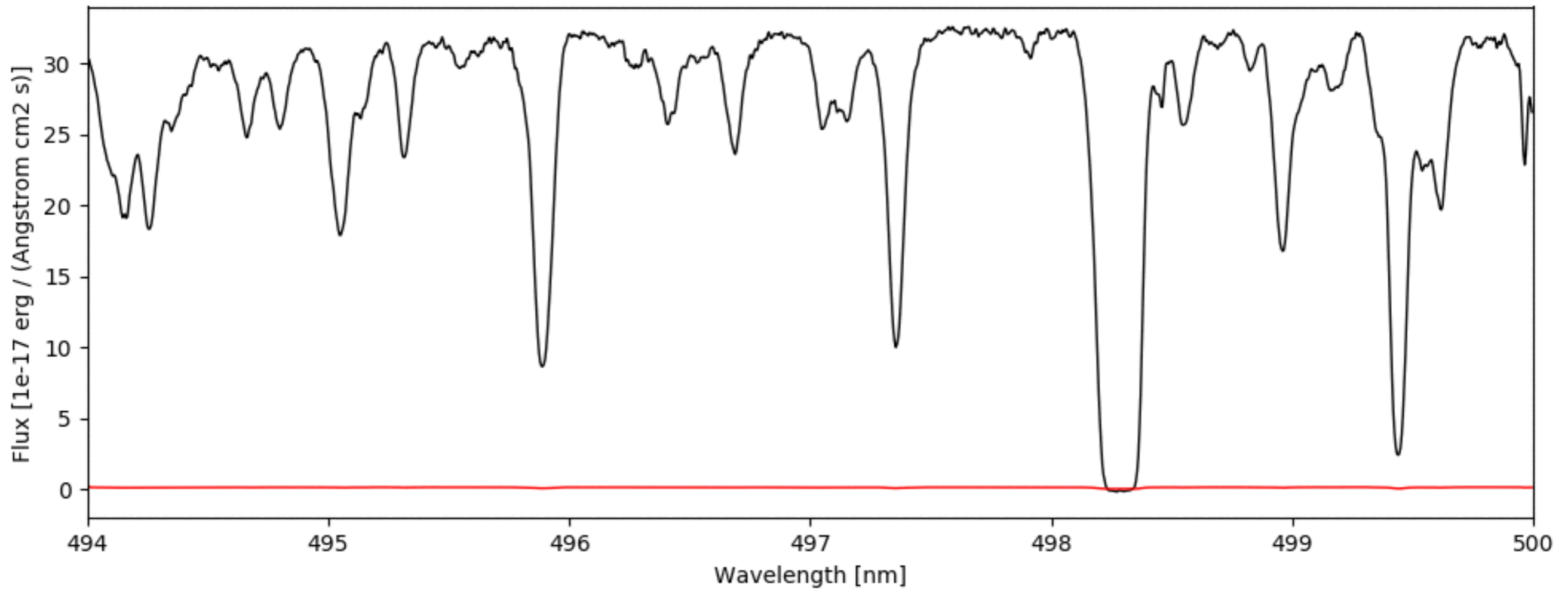
Line+
continuum fit

...



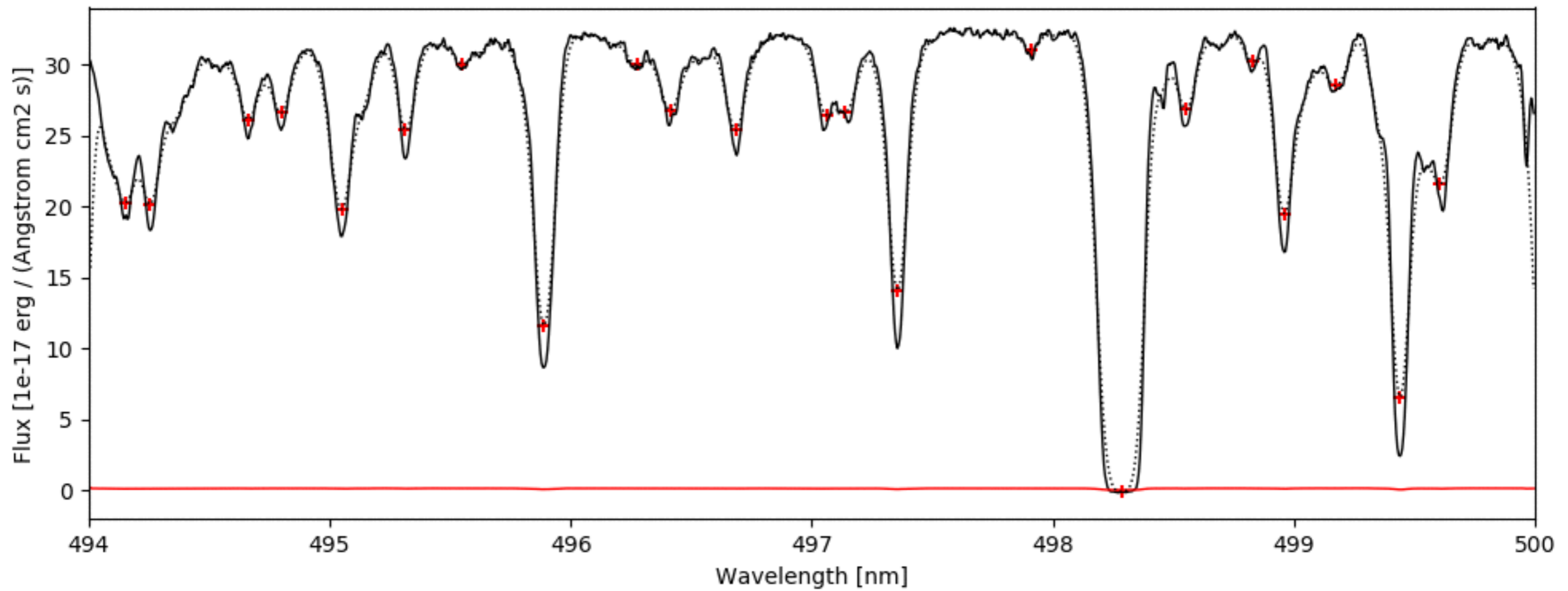
```
spec = Spec1DReader().uves(filename)
```

```
spec.plot()
```



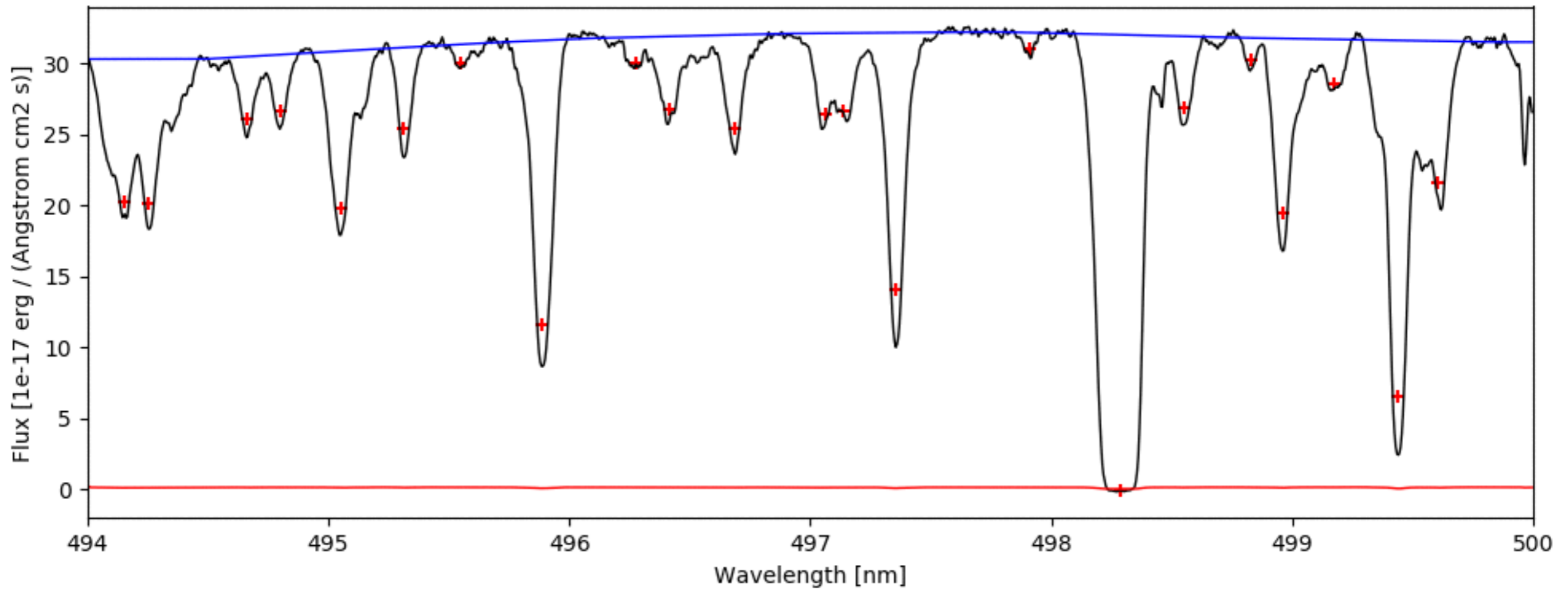
```
spec = Spec1DReader().uves(filename)
line = Line(spec)
line.find()
```

```
line.plot()
```



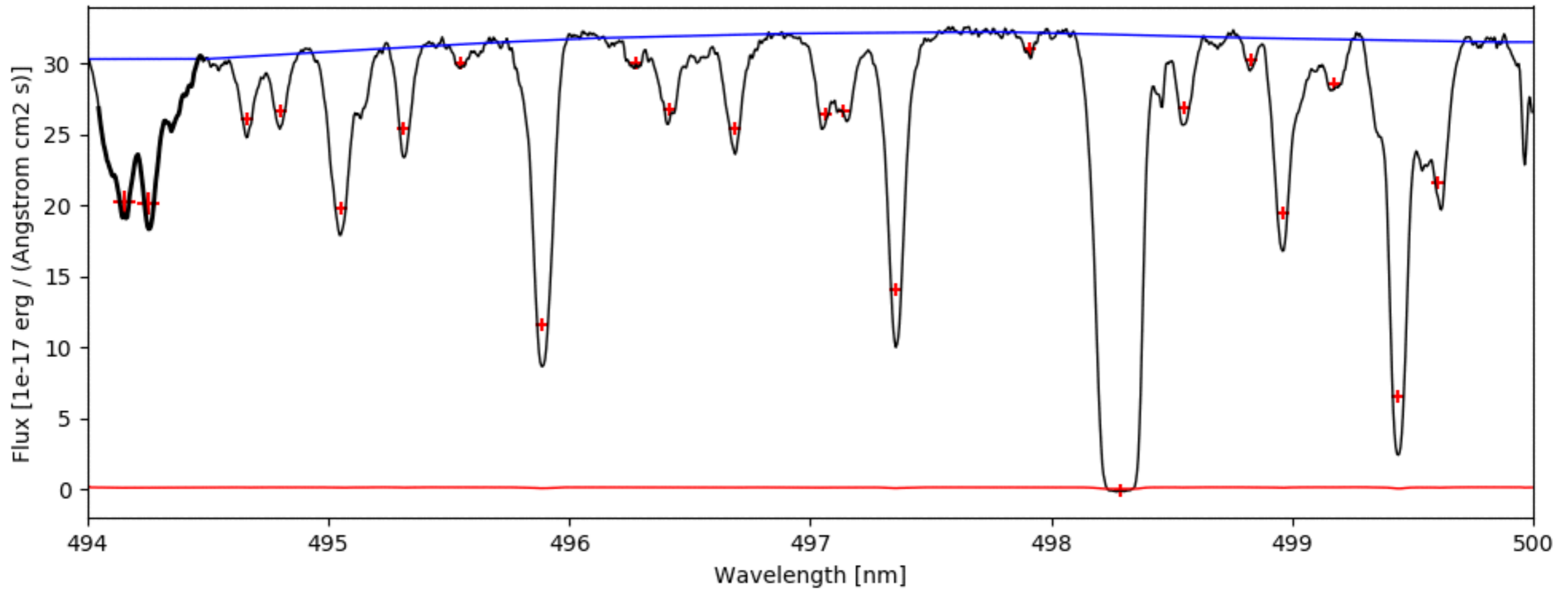
```
spec = Spec1DReader().uves(filename)
line = Line(spec)
line.find()
line.cont()
```

```
line.plot()
```



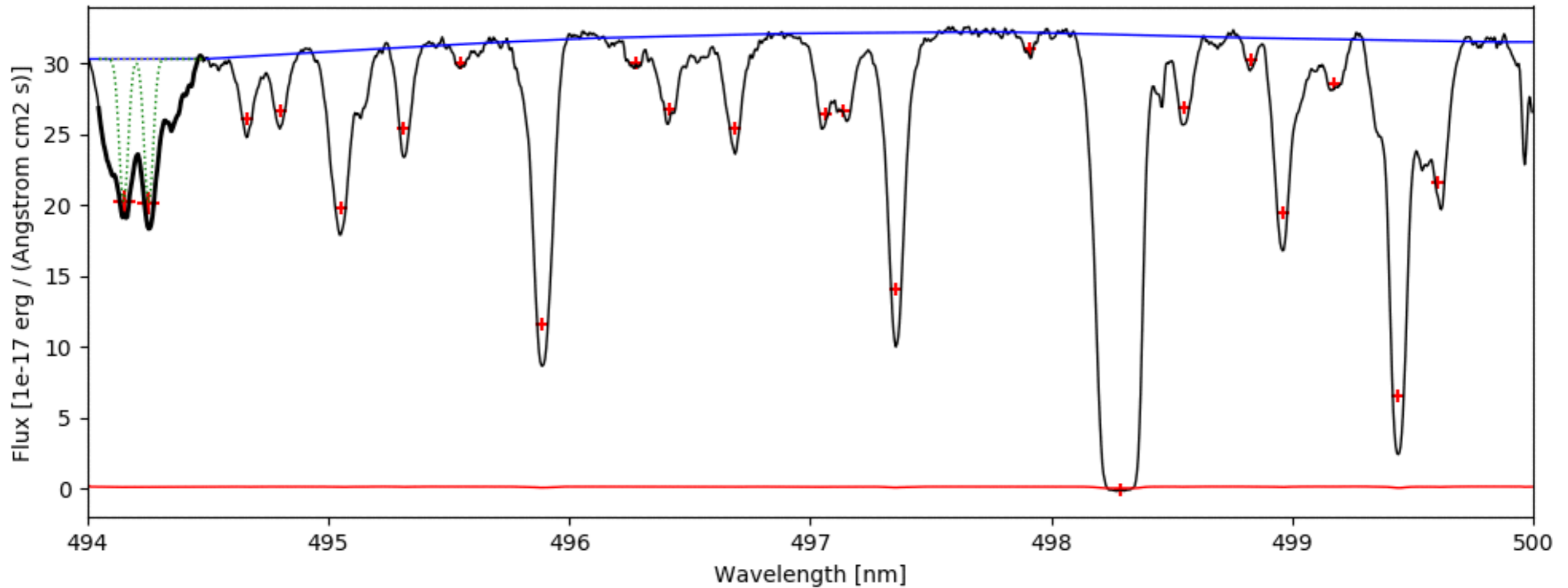

```
spec = Spec1DReader().uves(filename)
line = Line(spec)
line.find()
line.cont()
for l in line:
    group = line.group(l)
```

```
line.plot(group)
```

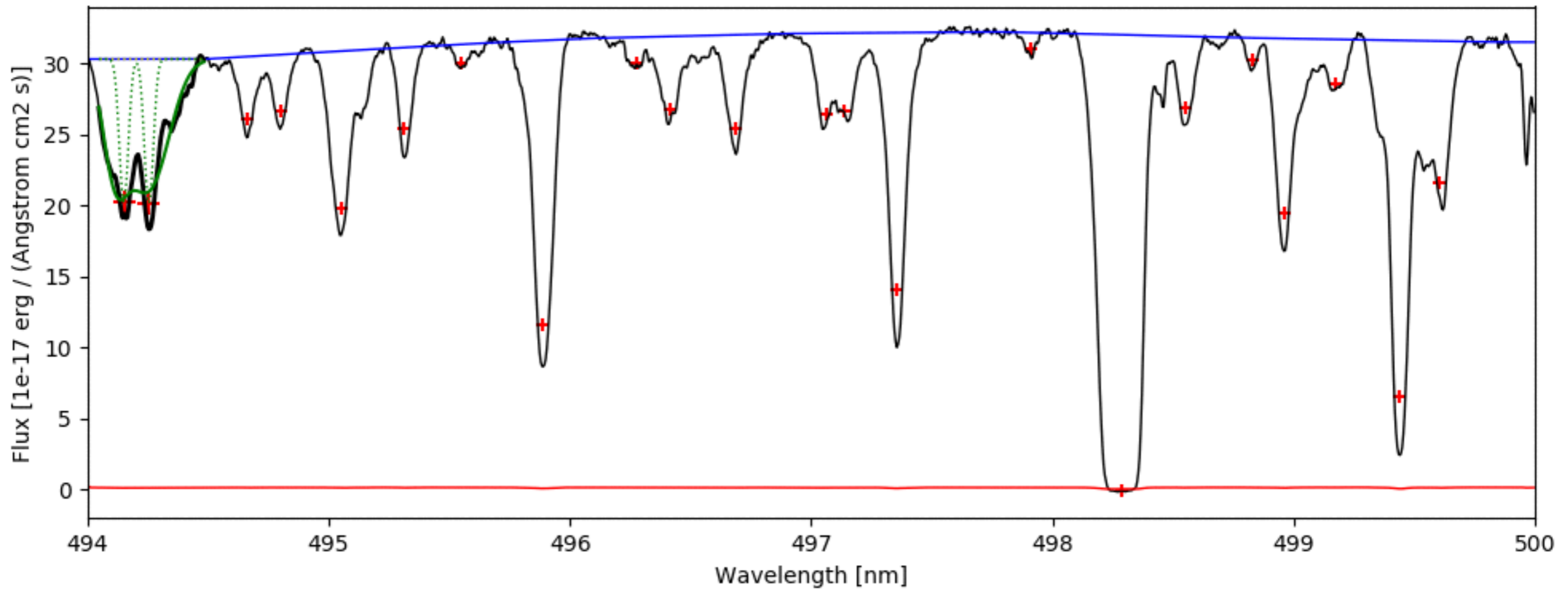


```
spec = Spec1DReader().uves(filename)
line = Line(spec)
line.find()
line.cont()
for l in line:
    group = line.group(l)
    norm_guess = line.norm(group)
    voigt_guess = line.voigt(group)
    psf = line.psf(group)

line.plot(group)
```

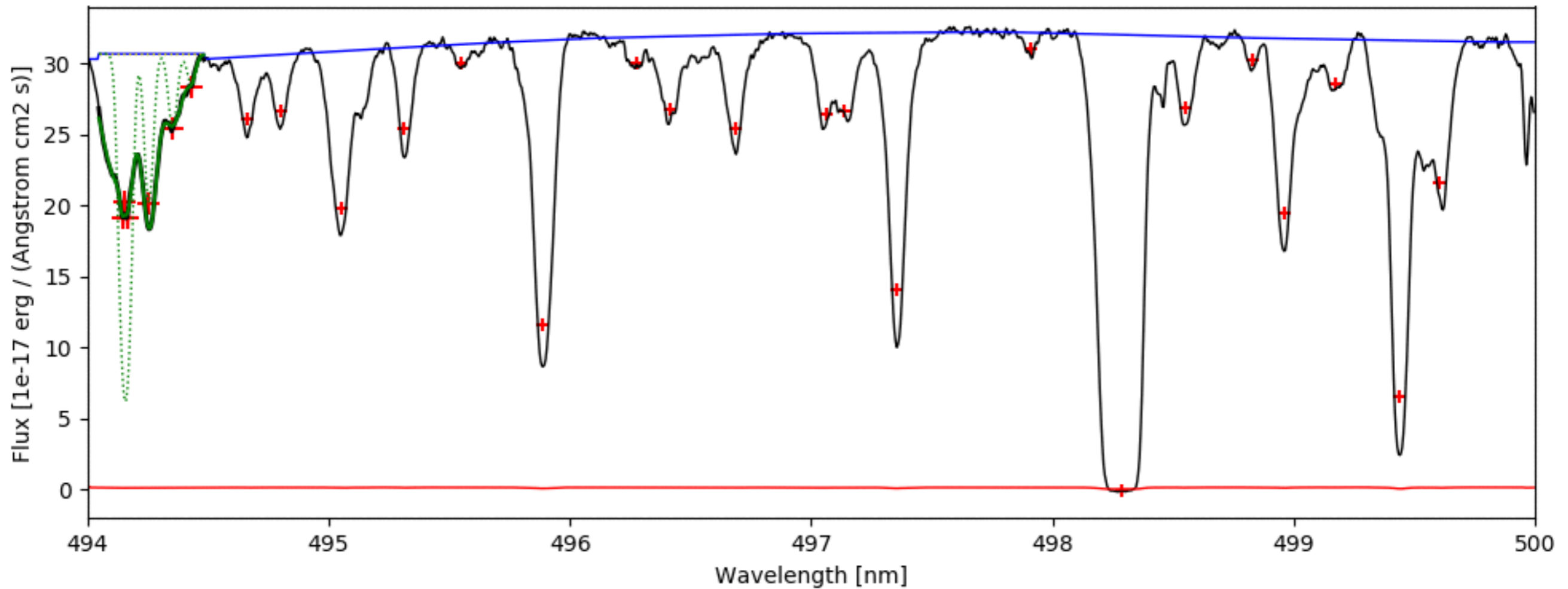


```
spec = Spec1DReader().uves(filename)
line = Line(spec)
line.find()
line.cont()
for l in line:
    group = line.group(l)
    norm_guess = line.norm(group)
    voigt_guess = line.voigt(group)
    psf = line.psf(group)
    fit = line.fit(group, norm_guess, voigt_guess, psf)
    line.plot(group)
```



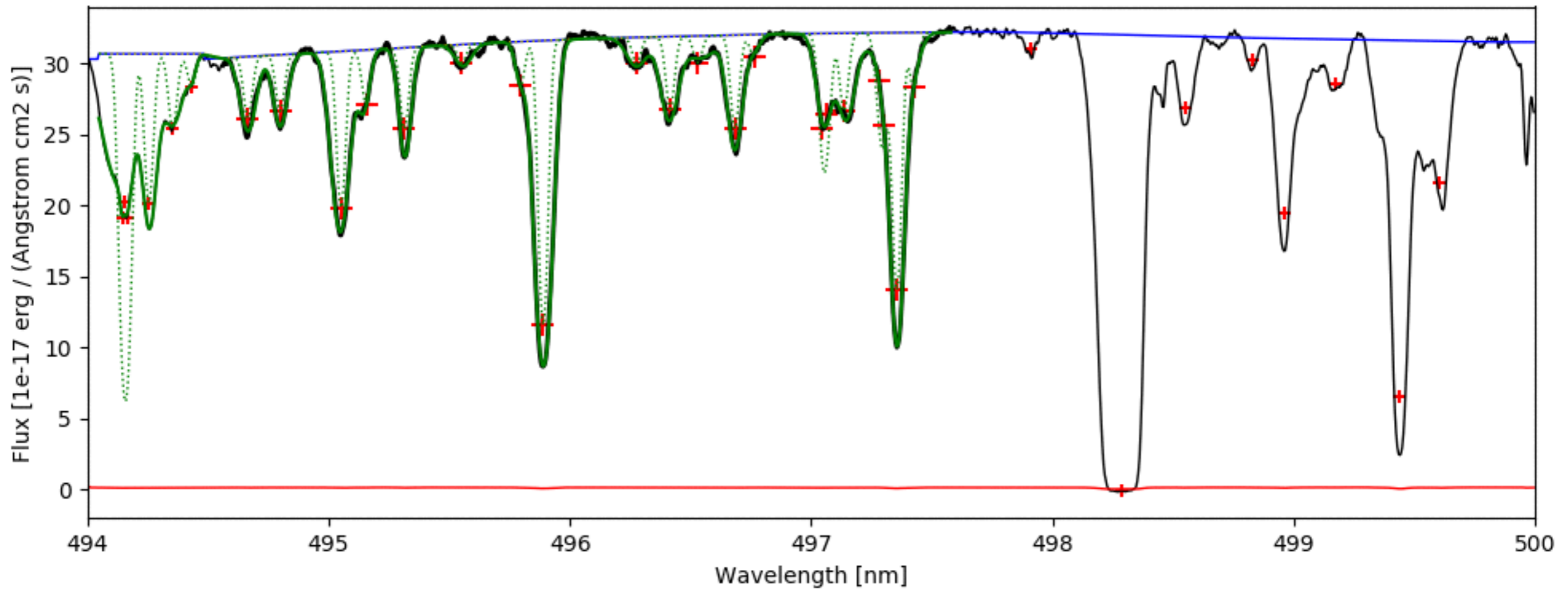
```
spec = Spec1DReader().uves(filename)
line = Line(spec)
line.find()
line.cont()
for l in line:
    group = line.auto(l)
    line.plot(group)
```

group 1, $\chi^2 = 2.14$



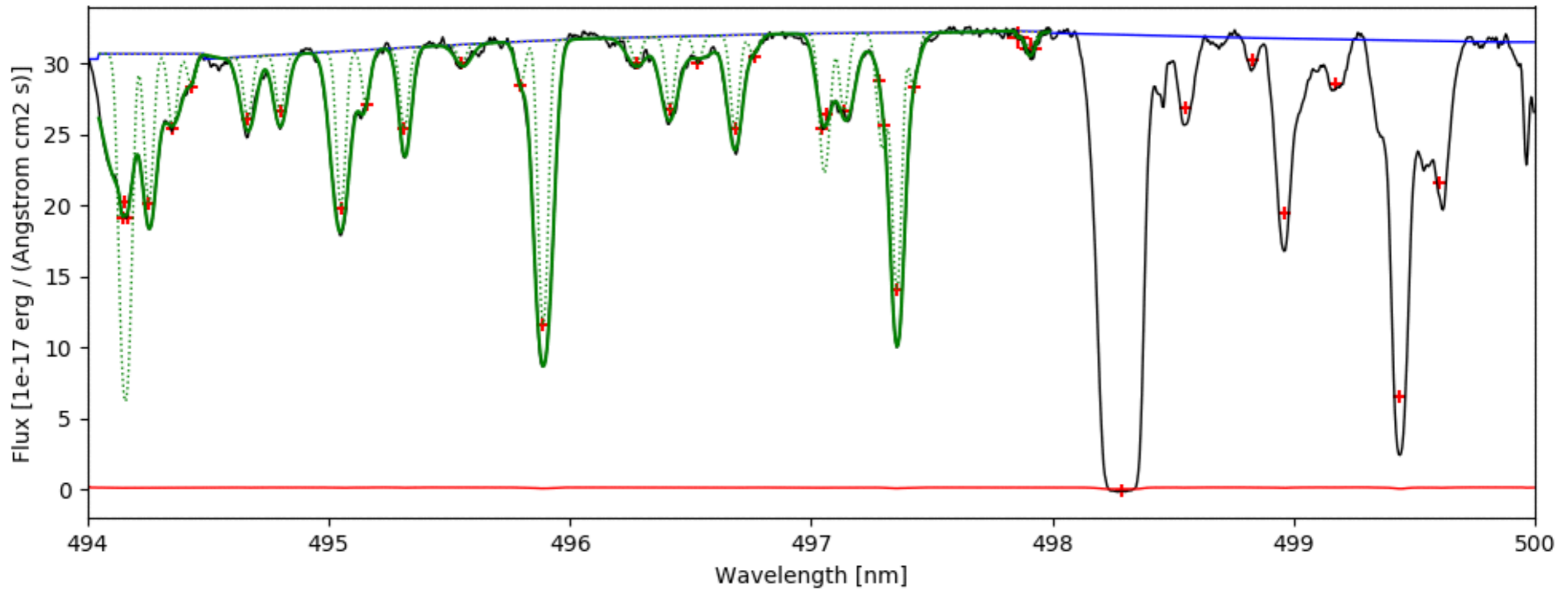
```
spec = Spec1DReader().uves(filename)
line = Line(spec)
line.find()
line.cont()
for l in line:
    group = line.auto(l)
    line.plot(group)
```

group 2, $\chi^2 = 2.91$



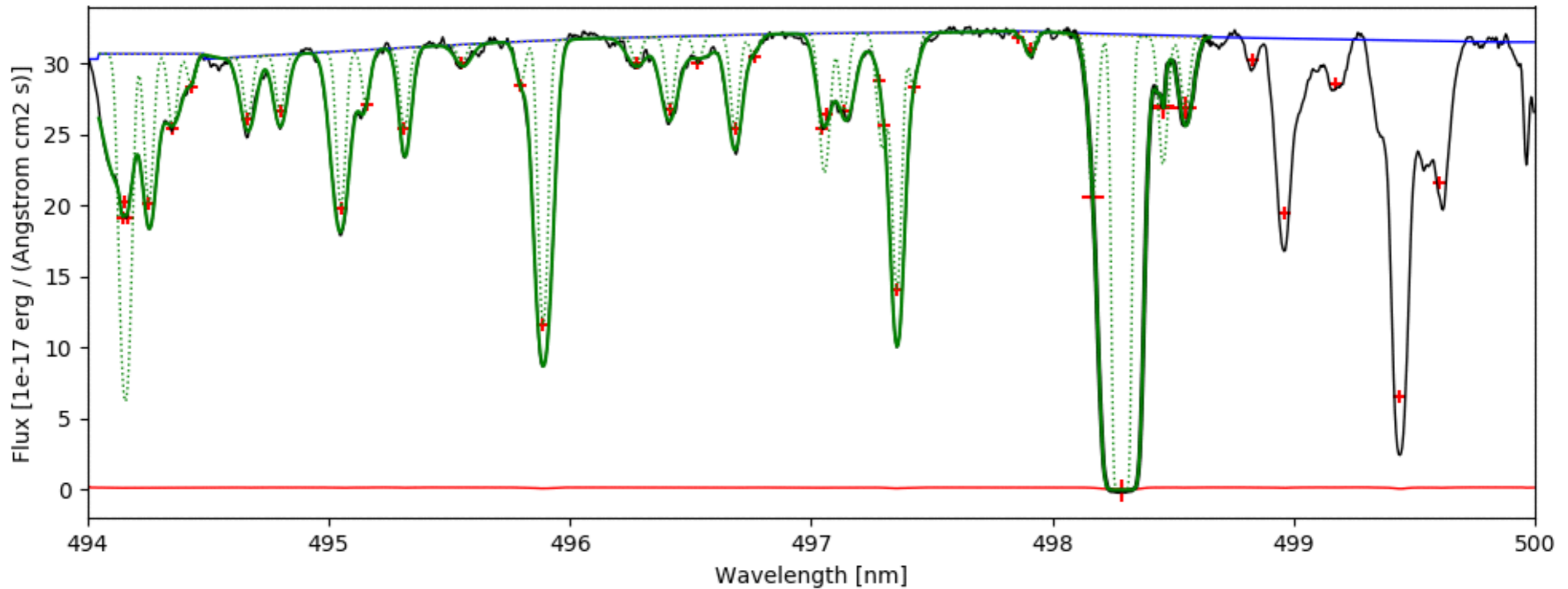
```
spec = Spec1DReader().uves(filename)
line = Line(spec)
line.find()
line.cont()
for l in line:
    group = line.auto(l)
    line.plot(group)
```

group 3, $\chi^2 = 0.94$



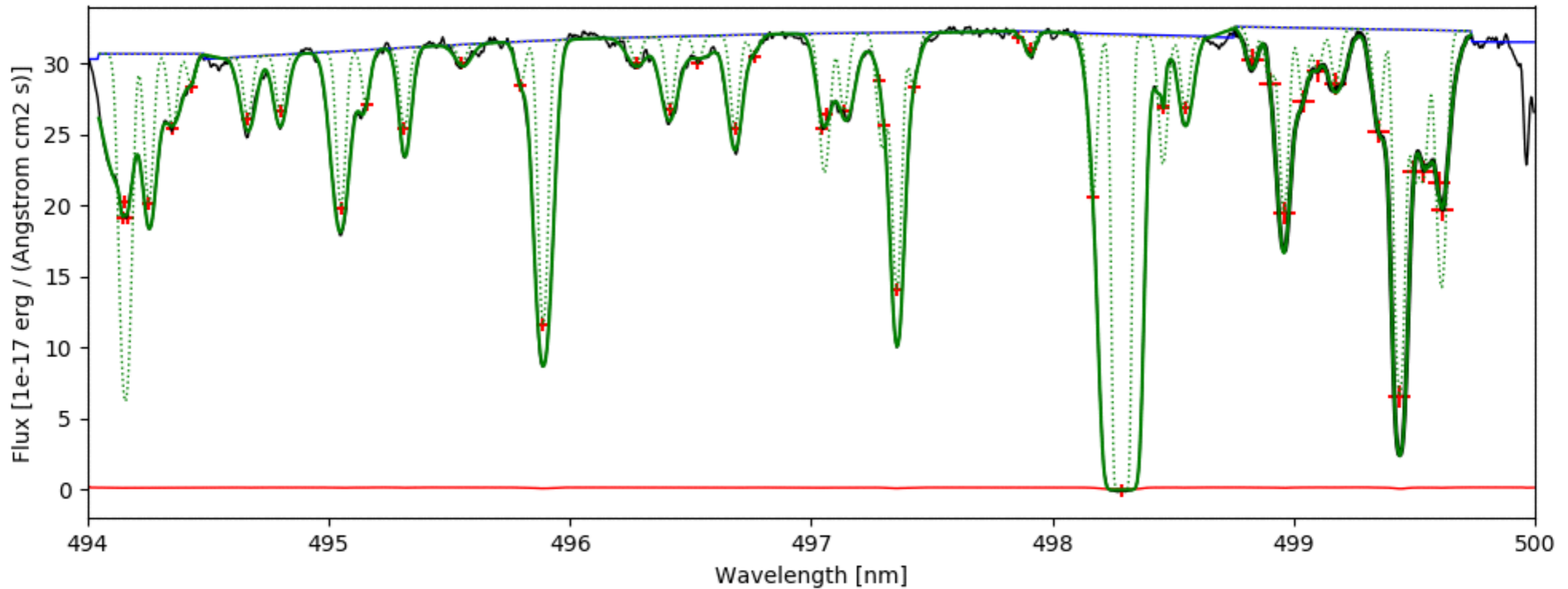
```
spec = Spec1DReader().uves(filename)
line = Line(spec)
line.find()
line.cont()
for l in line:
    group = line.auto(l)
    line.plot(group)
```

group 4, $\chi^2 = 1.98$



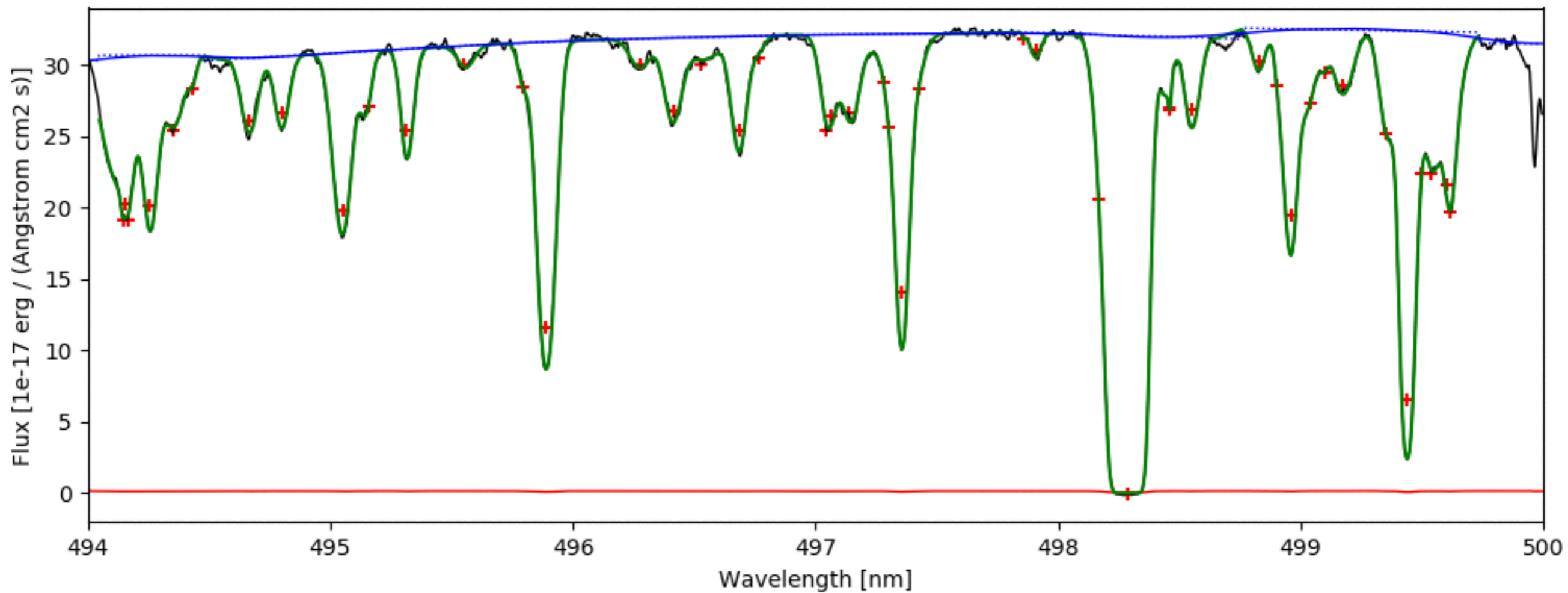
```
spec = Spec1DReader().uves(filename)
line = Line(spec)
line.find()
line.cont()
for l in line:
    group = line.auto(l)
    line.plot(group)
```

group 5, $\chi^2 = 0.97$

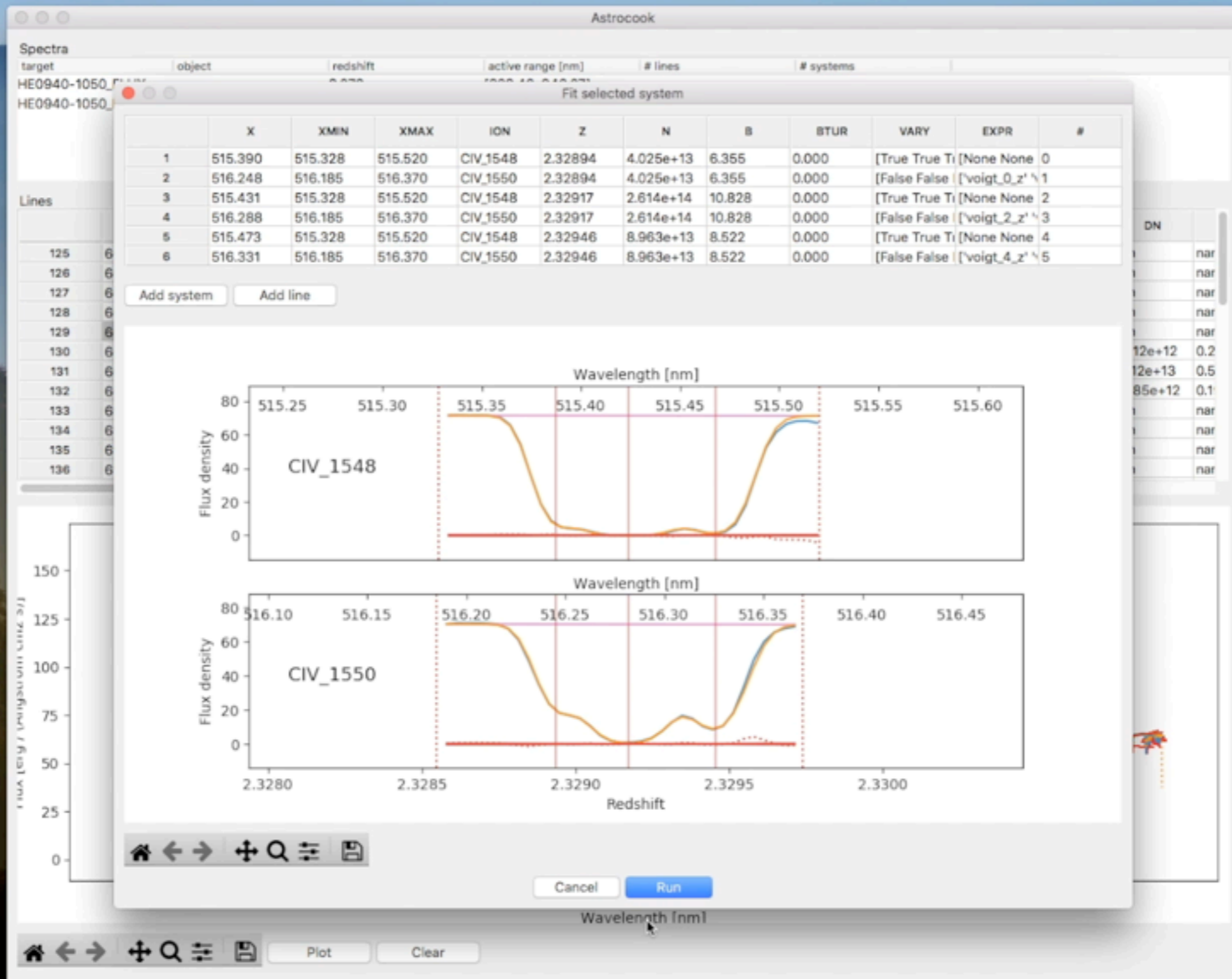



```
spec = Spec1DReader().uves(filename)
line = Line(spec)
line.find()
line.cont()
for l in line:
    group = line.auto(l)
    line.plot(group)
```

line.plot()



Astrocook



GC+17,18

