The ESO Exposure Time Calculator

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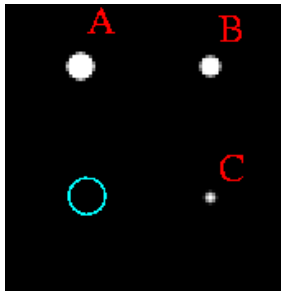
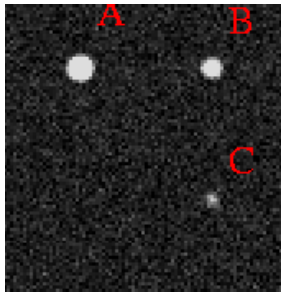
ETC Software engineers:	Lars Lundin, David Huerta (former: Gurvan Bazin)

Time is precious

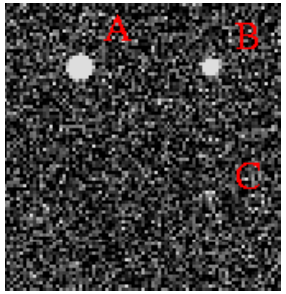
Signal-to-noise



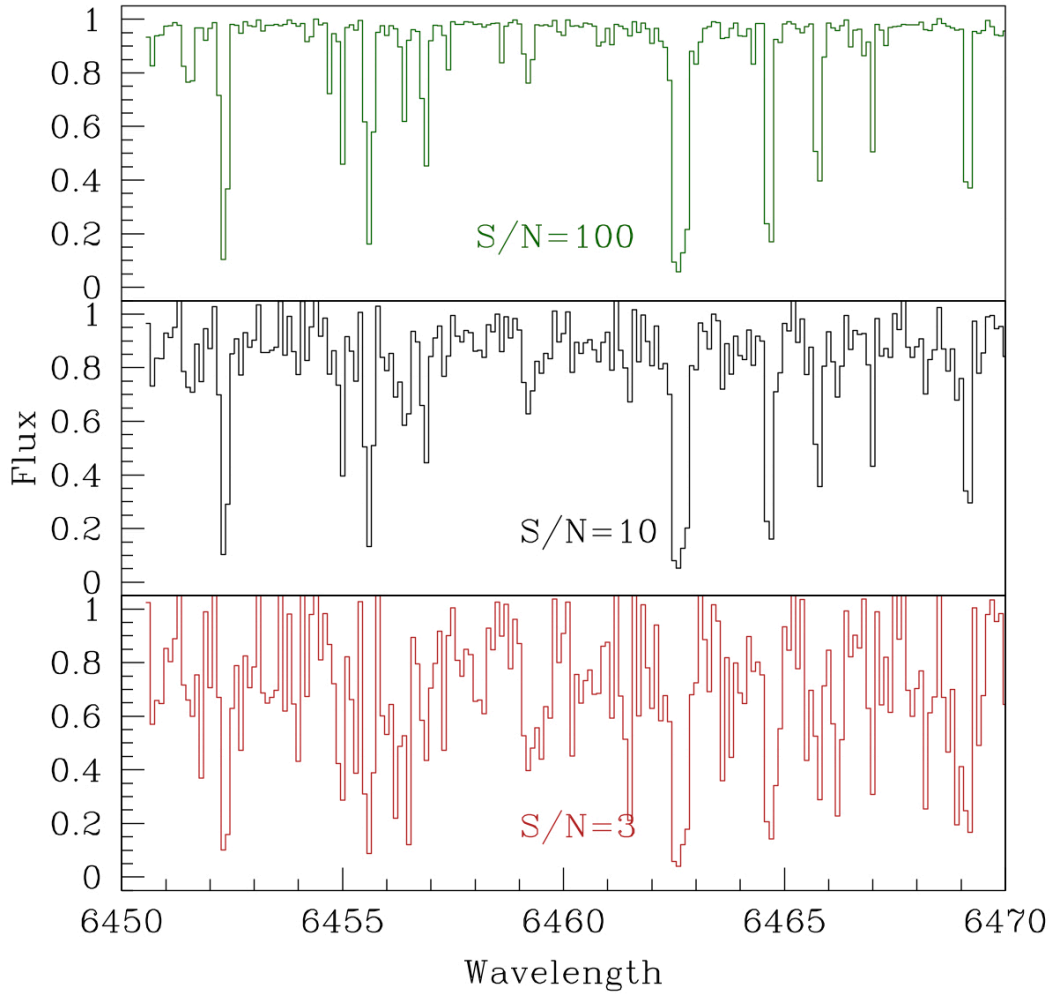
t ~ 1111 s



t ~ 11 s

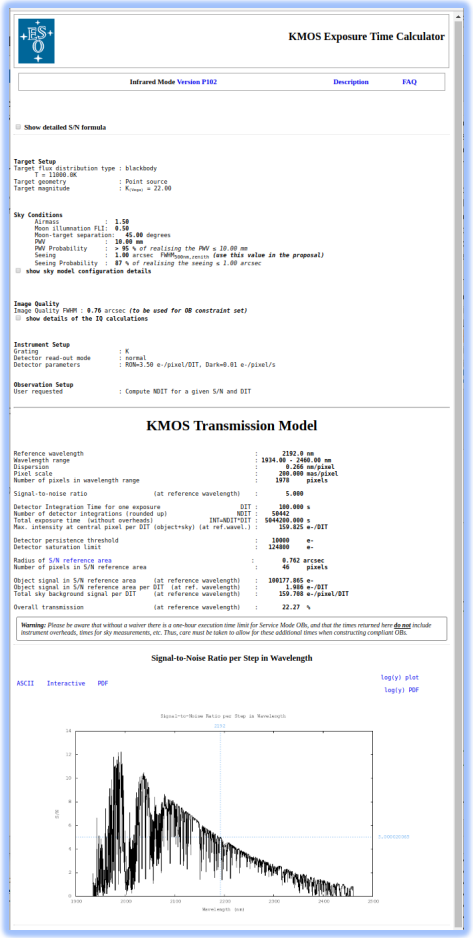


t = 1 s



What is an ETC?

- Predict **exposure time** to get required quality (**S/N**)
- Phase 1 - call-for-proposals (NOW!)
- Phase 2 - planning obs. details (making OBs)
- Astron. community / ESO
  - before, during, after observations
  - instrument studies, development, commissioning
- Doesn't include overheads!

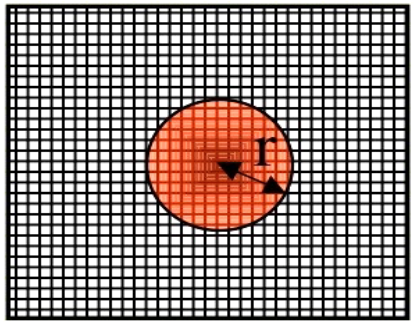


Signal

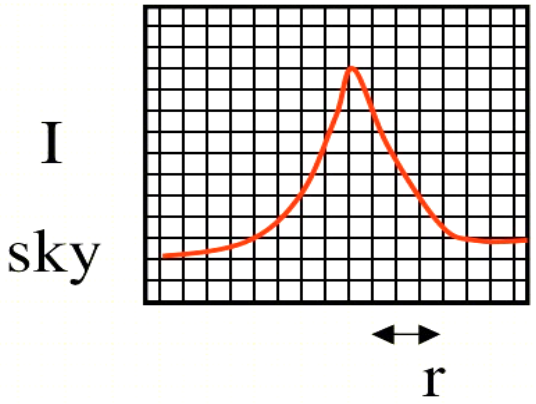
- Signal=$R_* \bullet t$ (t: time)

detected e-/second

- Consider the case where we count all the detected e- in a circular aperture with radius r.



Radius: large enough to encompass all flux, but not too big to reduce noise.



PSF

Non-AO: Gaussian with FWHM ~ seeing

Source: Michael Bolte (UCOLICK)

Noise sources

$\sqrt{R_* \cdot t}$ $\Rightarrow$ shot noise from source

$\sqrt{R_{sky} \cdot t \cdot \pi r^2}$ $\Rightarrow$ shot noise from sky in aperture

$\sqrt{RN^2 \cdot \pi r^2}$ $\Rightarrow$ readout noise in aperture

$\sqrt{\text{Dark} \cdot t \cdot \pi r^2}$ $\Rightarrow$ shot noise in dark current in aperture

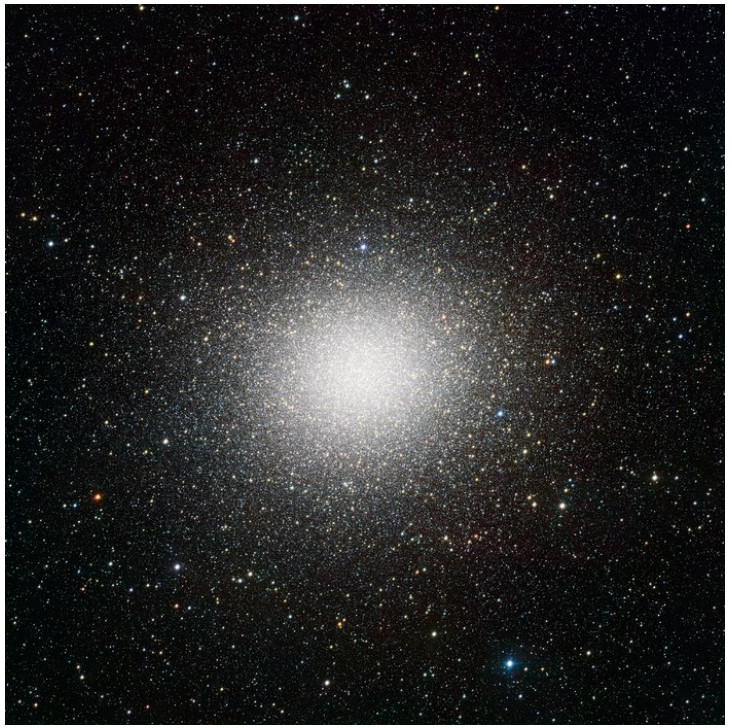
R_* = e^-/sec from the source

R_{sky} = e^-/sec/pixel from the sky

RN = read noise (as if RN^2 e^- had been detected)

Dark = e^-/second/pixel

Source: Michael Bolte (UCOLICK)



Credit:ESO/INAF-VST/OmegaCAM. Acknowledgement: A. Grado, L. Limatola/INAF-Capodimonte Observatory

Signal-to-noise

S/N for object measured in aperture with radius r: n_{pix}=# of pixels in the aperture= πr^2

Noise from the dark current in aperture

$$\text{Signal} \leftrightarrow R_* t$$

$$\text{Noise} \leftrightarrow \left[\underbrace{R_* \cdot t}_{\sqrt{(R_* \cdot t)^2}} + \underbrace{R_{\text{sky}} \cdot t \cdot n_{\text{pix}}}_{\text{Noise from sky } e\text{- in aperture}} + \underbrace{\left(RN + \frac{\text{gain}}{2} \right)^2 \cdot n_{pix}}_{\text{Readnoise in aperture}} + \text{Dark} \cdot t \cdot n_{\text{pix}} \right]^{\frac{1}{2}}$$

All the noise terms added in quadrature
Note: always calculate in *e*-

Source: Michael Bolte (UCOLICK)

Exposure Time Calculators

Target Input Flux Distribution

Template Spectrum	A0V (Pickles)	Redshift z = 0.00	Target Magnitude and Mag.System: V = 20.00 Vega / AB
MARCS Stellar Model	Teff=4000 log(g)=-0.5 [Fe/H]= 0 M= 1		
Upload Spectrum	Select...		
Blackbody	Temperature: K		*Magnitudes are given per arcsec² for extended sources*
Power Law	Index: $F(\lambda) \propto \lambda^{index}$		
Emission Line	Lambda: nm Flux: 10^{-16} ergs/s/cm² *(per arcsec² for extended sources)* FWHM: nm		

Spatial Distribution: Point Source / Extended Source

Sky Conditions

Override almanac sky parameters and use instead typical fixed sky model parameters except Moon phase and airmass

Moon FLI: 0.50 Airmass: 1.50

Seeing/Image Quality:

Seeing: 1.00 arcsec *FWHM in V-band at zenith* ***(use this value in the proposal)***

Probability ***87%*** *of realising the seeing ≤ 1 arcsec*

IQ: arcsec *FWHM at the airmass and wavelength of observation* ***(to be used for the OB constraint set)***

Instrumental Setup

Resolution: Standard / High

Filter: v_HIGH

Detector: MIT red-optimized CCD / E2V blue-optimized CCD

Readout mode: 200kHz,2x2,low

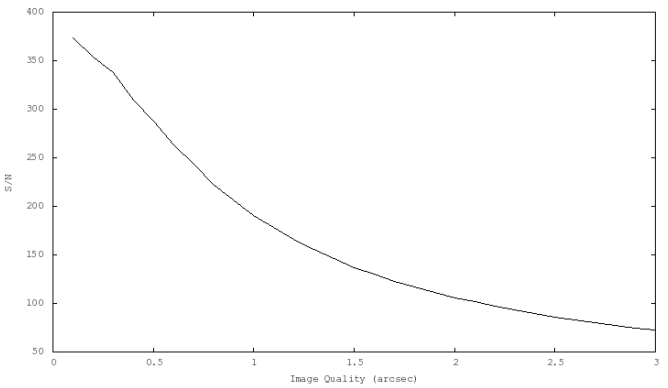
Polarimetry: No Polarimetry / Linear or Circular Polarisation

Results

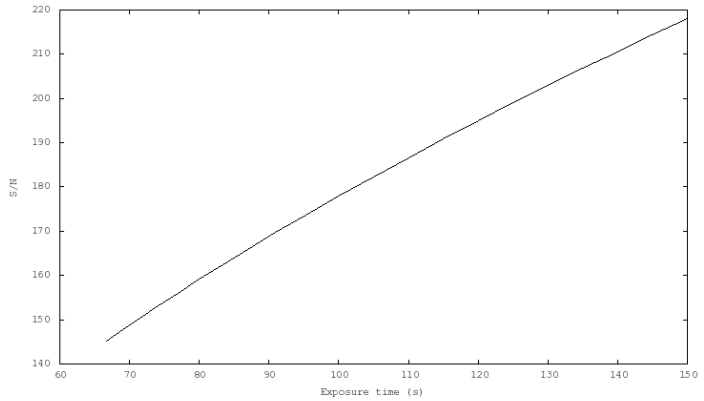
S/N:

Exposure Time: 100.0 s

S/N vs Seeing



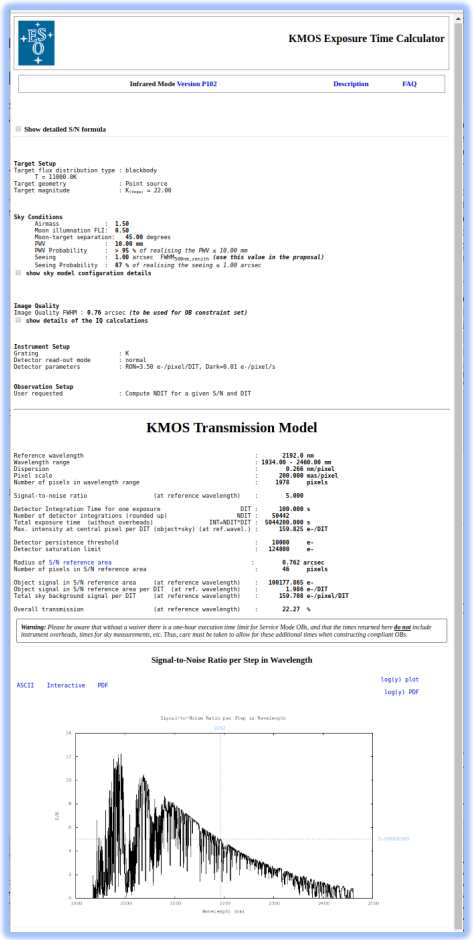
S/N vs Exp. Time



ESO ETCs

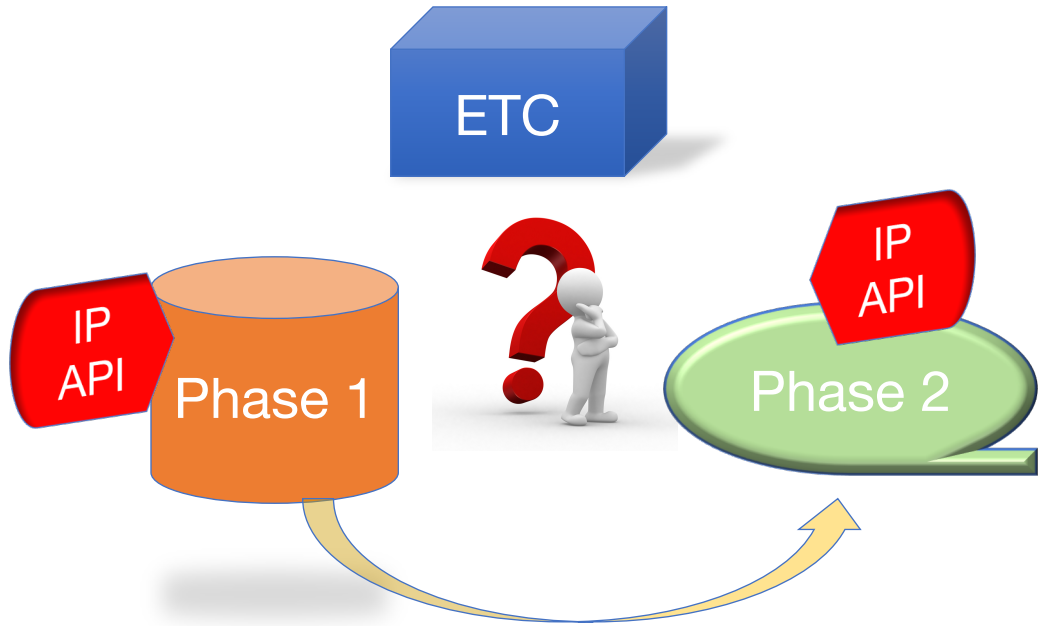
www.eso.org/observing/etc

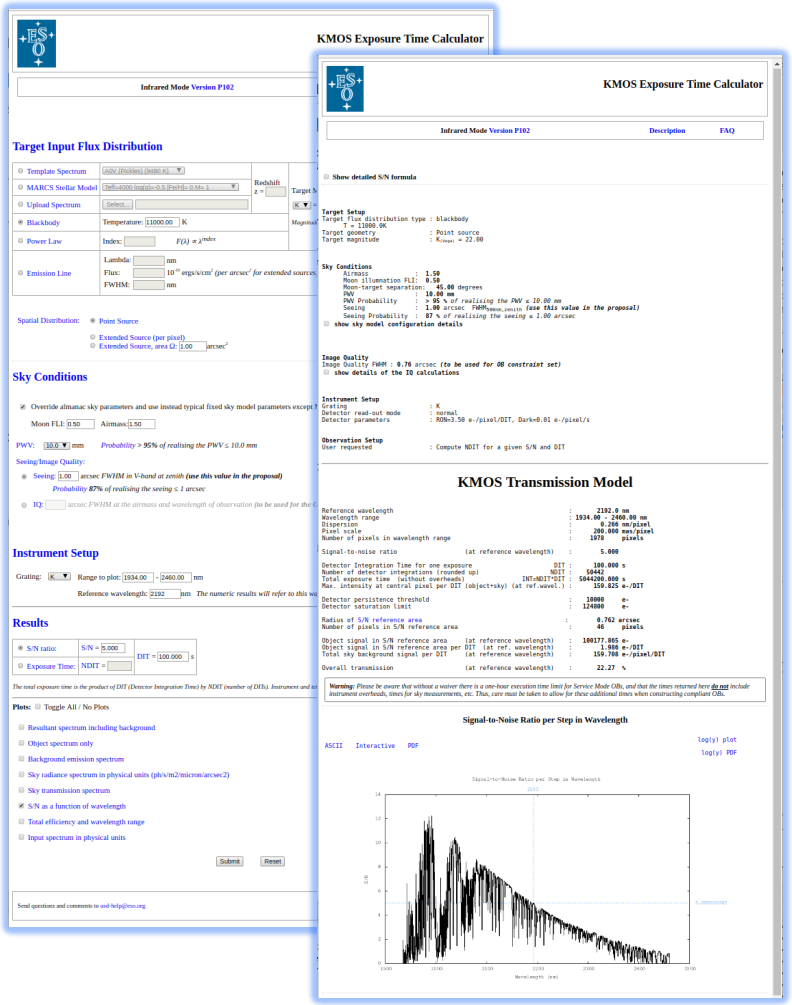
etc.eso.org



Current situation

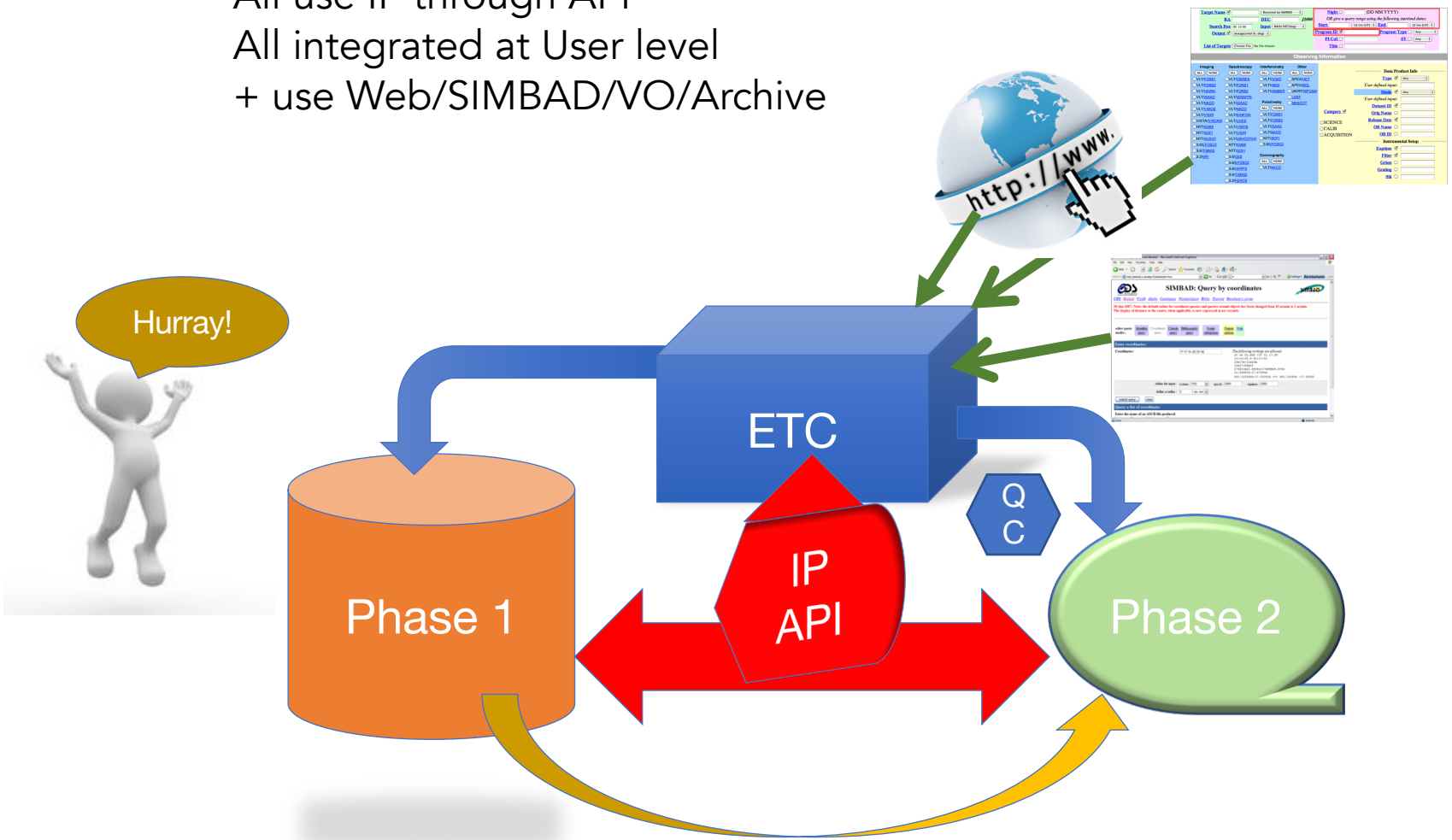
- Phase 1/2 is online, use similar look & feel
- ETC is still independent – different look & feel; no links to P1/P2



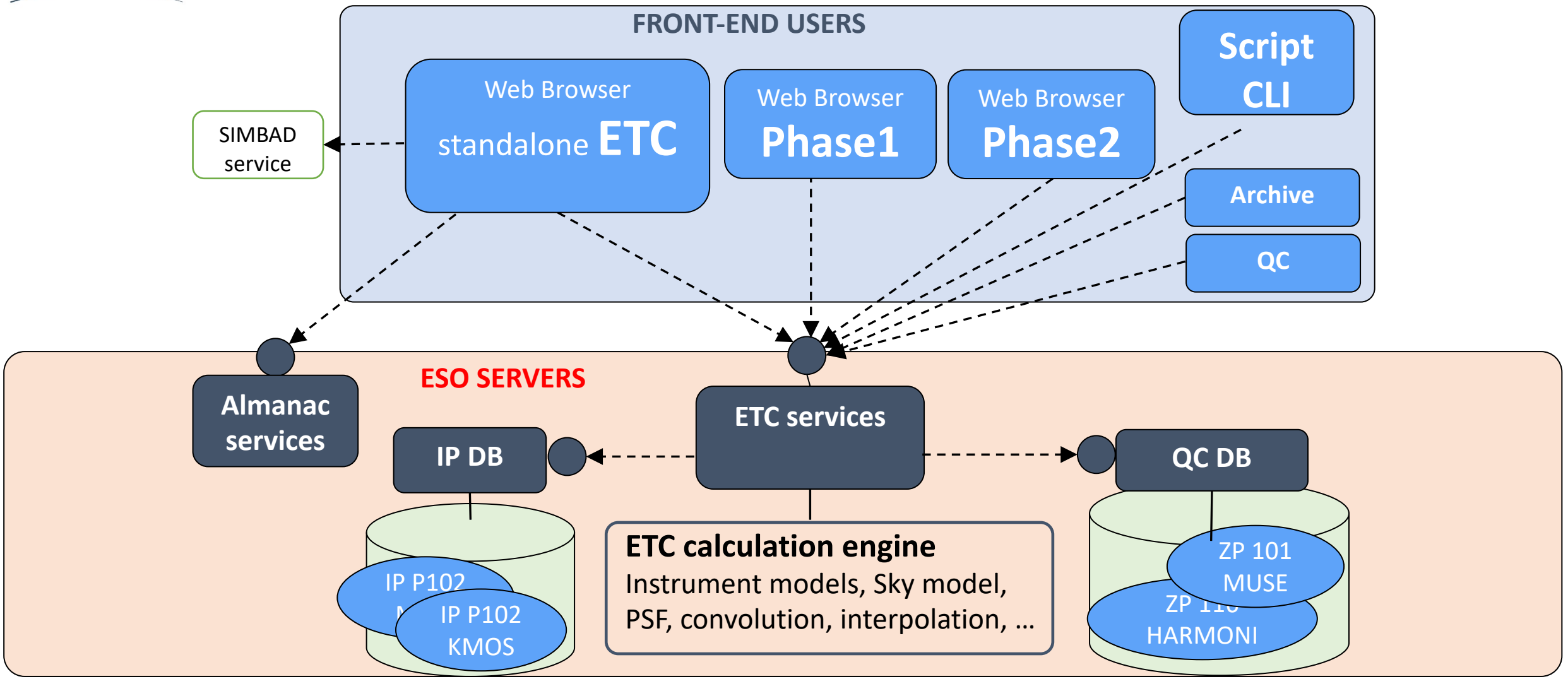


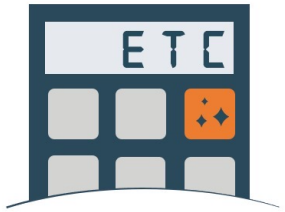
Ideal → ETC 2.0

All use IP through API
All integrated at User level
+ use Web/SIMBAD/VO/Archive



ETC 2.0 clients and resources





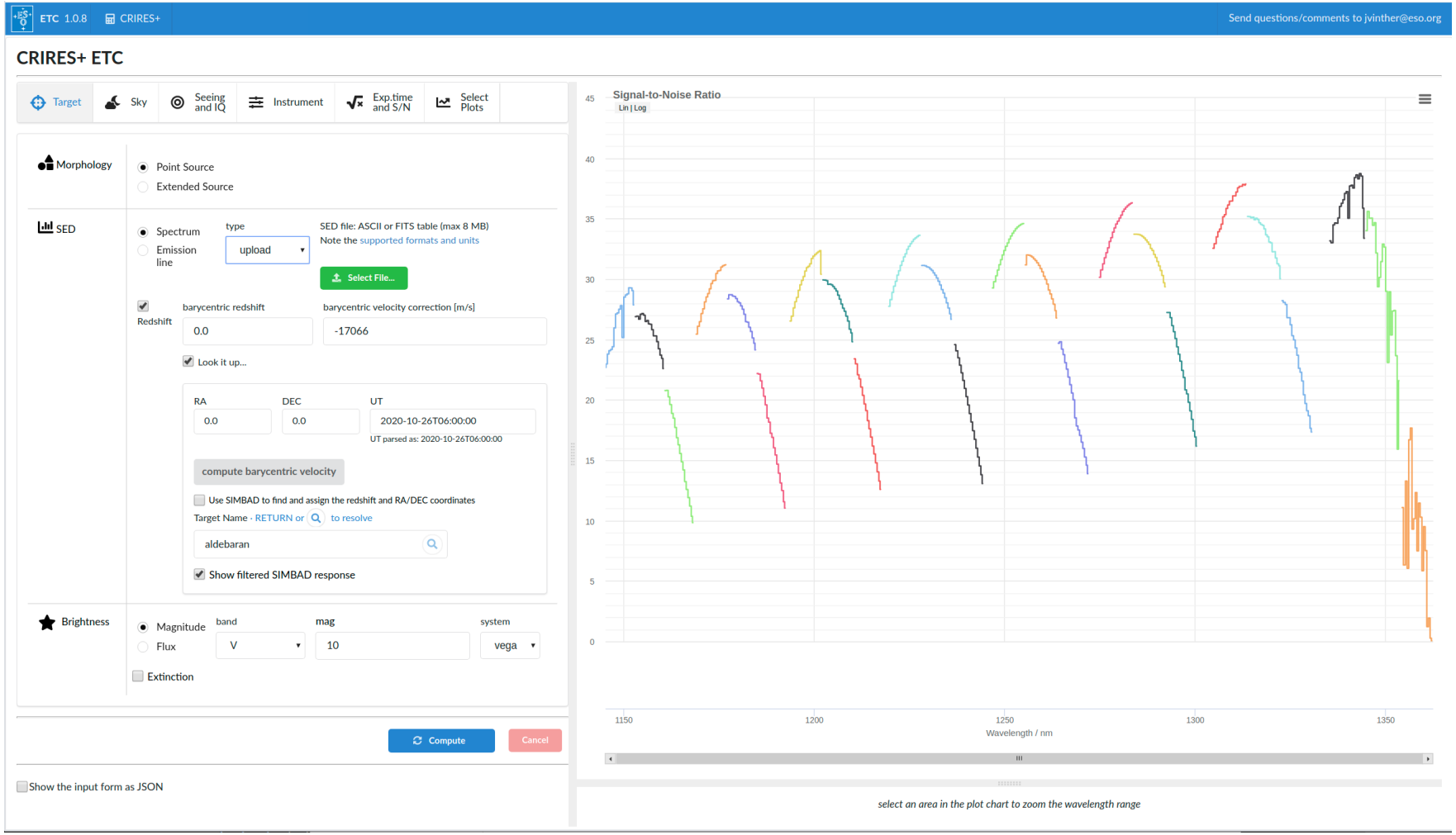
ETC 2.0 technologies

- Front-end Angular framework
  - One-page-web application framework
  - Also used in the new Phase1/2 web interface (P1/P2)
  - Follow same standards and re-use components

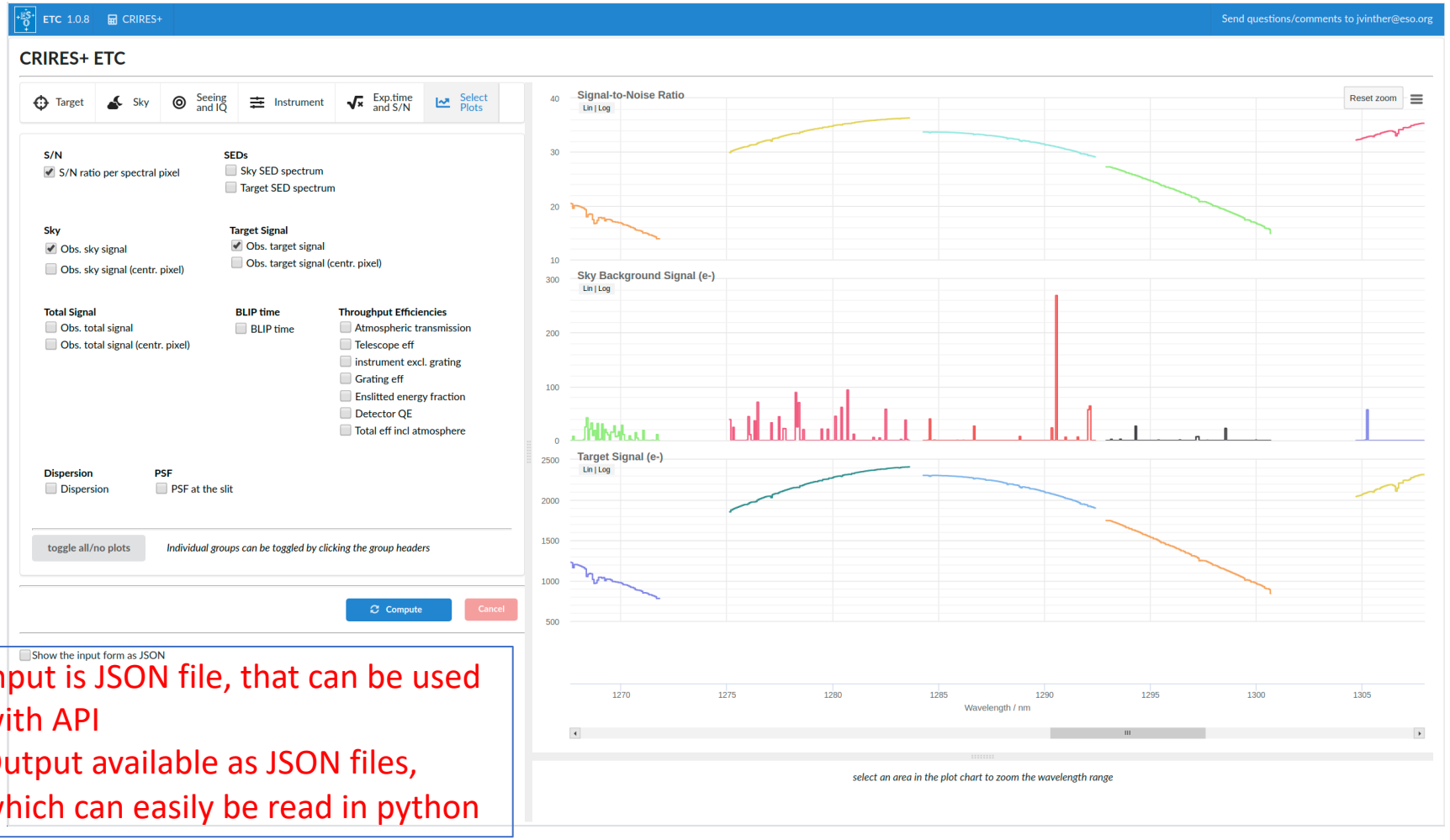
- Back-end Python
  - Concise code
  - Libs for scientific computing: NumPy, SciPy, AstroPy
  - Django web framework
    - Python
    - Routing, database abstraction layers,…

ETC 2.0

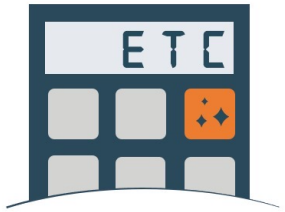
https://etctestpub.eso.org/observing/etc/crires



ETC 2.0



- Input is JSON file, that can be used with API
- Output available as JSON files, which can easily be read in python



- wget --post-file=input.json https://etctestpub.eso.org/observing/etc/etcapi/Crires2/ -O output.json
- etc_cli.py
- etc_json2ascii.py

- etc_plotreader.py

usd-help@eso.org