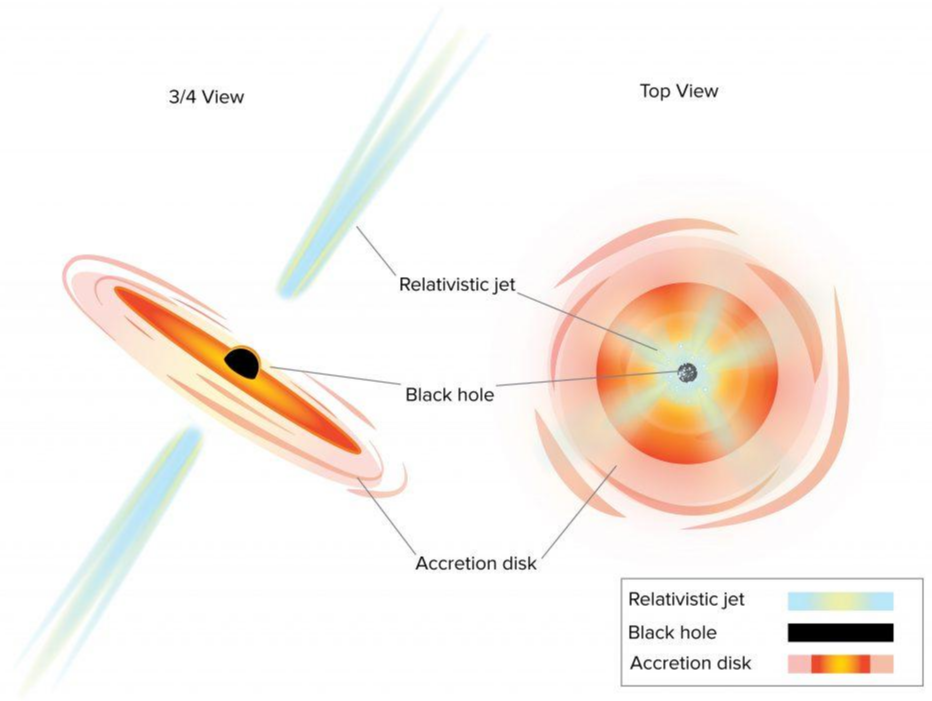
Optical and gamma-ray duty cycle of extreme blazars

Julian Hamo, with Julien Peloton and Jonathan Biteau

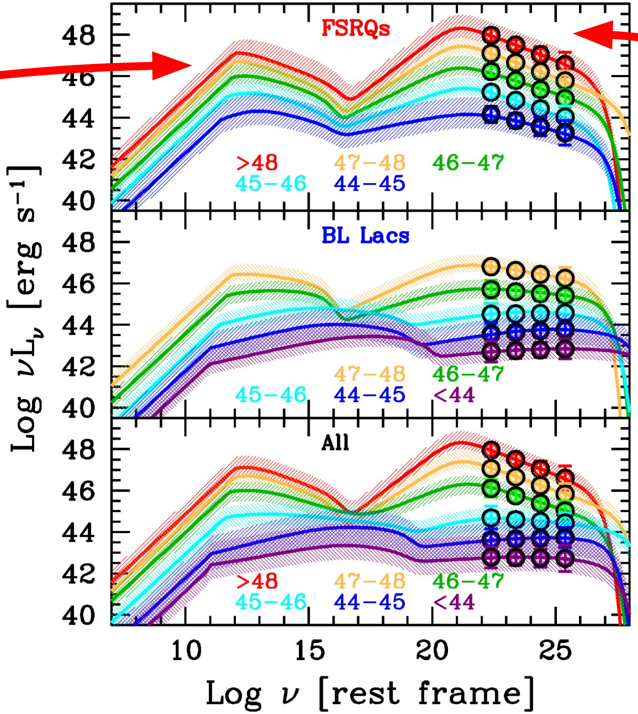
Blazars? What is it?

From AGNs to blazars

- Radio-loud jetted AGN
- Jet pointing the line of sight
- Extremely bright compared to the host galaxy (up to 10-100 times)
- Extremely variable (~min to years)



Blazar SED



VERA C. RUBIN OBSERVATORY

Optical to X-rays:
Synchrotron radiation

CTAO

X-rays to **gamma-rays**:
Inverse Compton radiation

The *Fermi* blazar sequence from Ghisellini et al., MNRAS 2017

Gamma-ray observatories

Fermi-LAT satellite

Fermi
Gamma-ray
Space Telescope

- Started in 2008
- Orbits in 3 hours
- Energy range: 100 MeV-1 TeV
- Weekly sampled light curve production

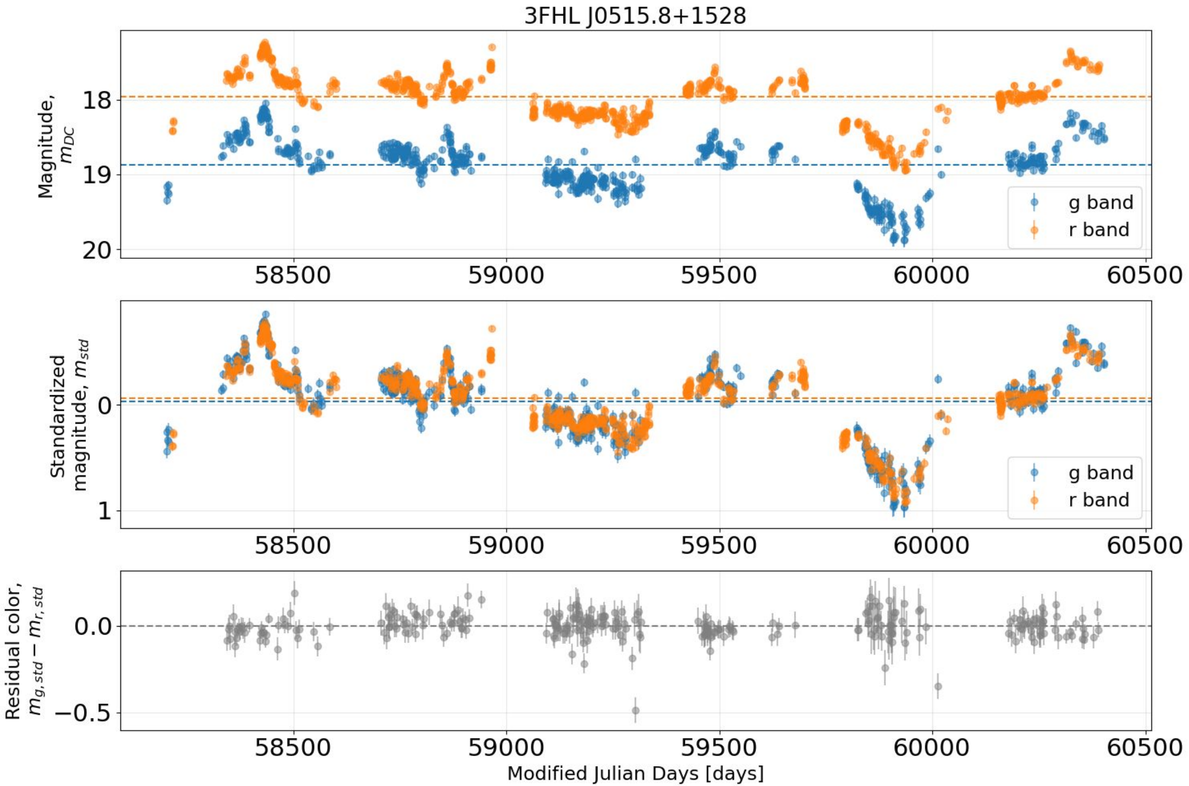
Cherenkov Telescope Array Observatory

CTAO

- 2 sites: Chile and La Palma
- Energy range: 20 GeV-200 TeV
- Energy resolution: <10%
- Sensitivity: x10 current gen.

How do we analyse them?

Standardization method



Concomitant r & g band measurements:

$\Delta t < 1h$

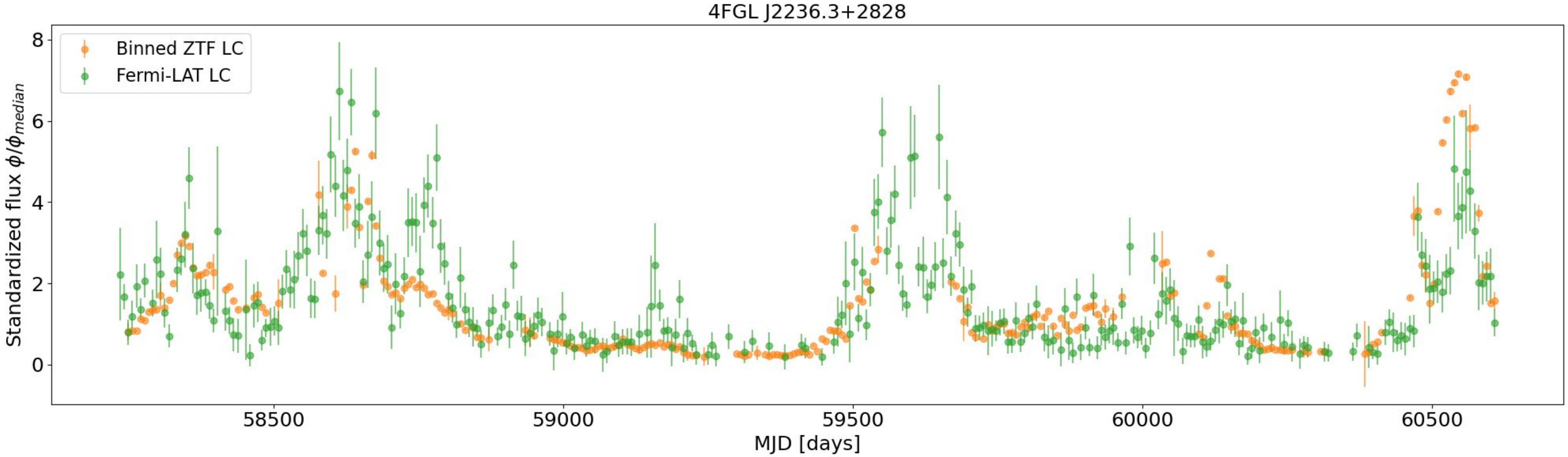
Standardization:

mag - med_{con}(mag)

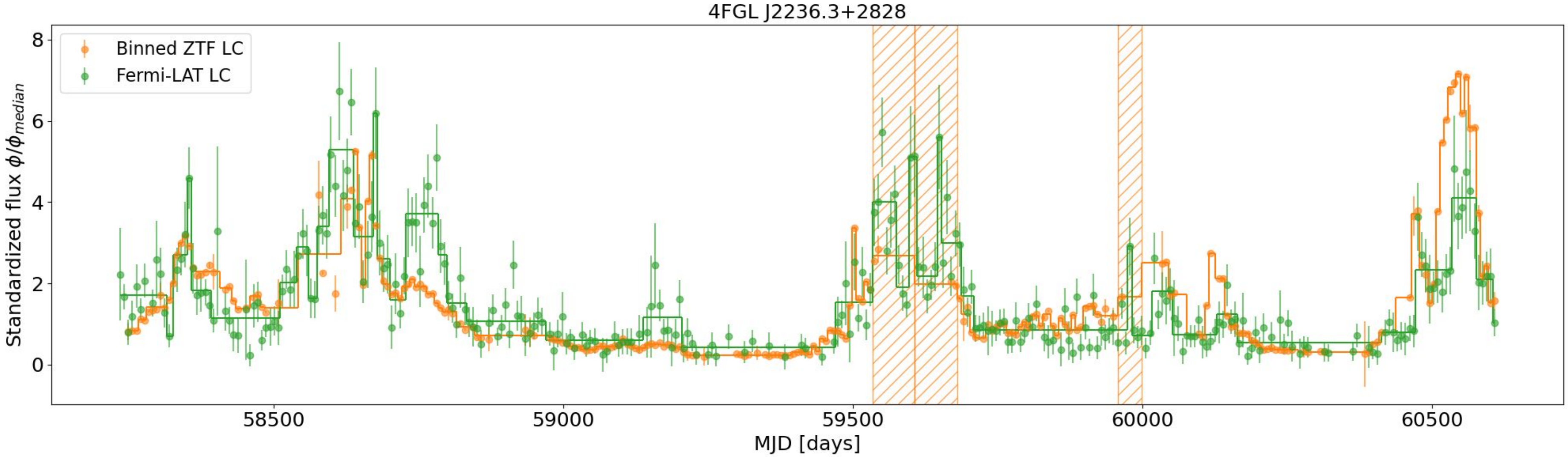
Residual color:

- Different emission processes in r- and g-band
- Minute time scale phenomena

Flare detection



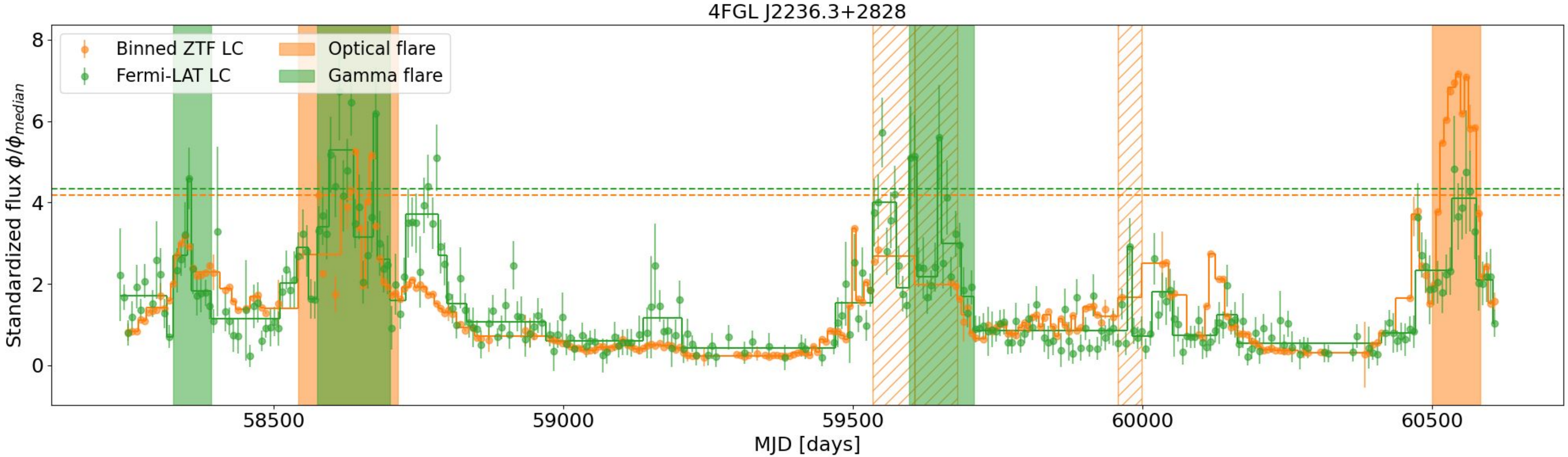
Flare detection



Independent detection of flare states:

- Bayesian block for flux state
- Only significant number of points

Flare detection



Independent detection of flare states:

- Bayesian block for flux state
- Only significant number of points
- Threshold from 95% quantile

Multi wavelength behaviour:

- Only gamma flare
- Only optical flare
- Cross bands flare

Duty cycle of blazars

	Low state [%]		High state [%]	
	Mean	Standard deviation	Mean	Standard deviation
Optical	10	11	23	12
Gamma-ray	2	14	2	6

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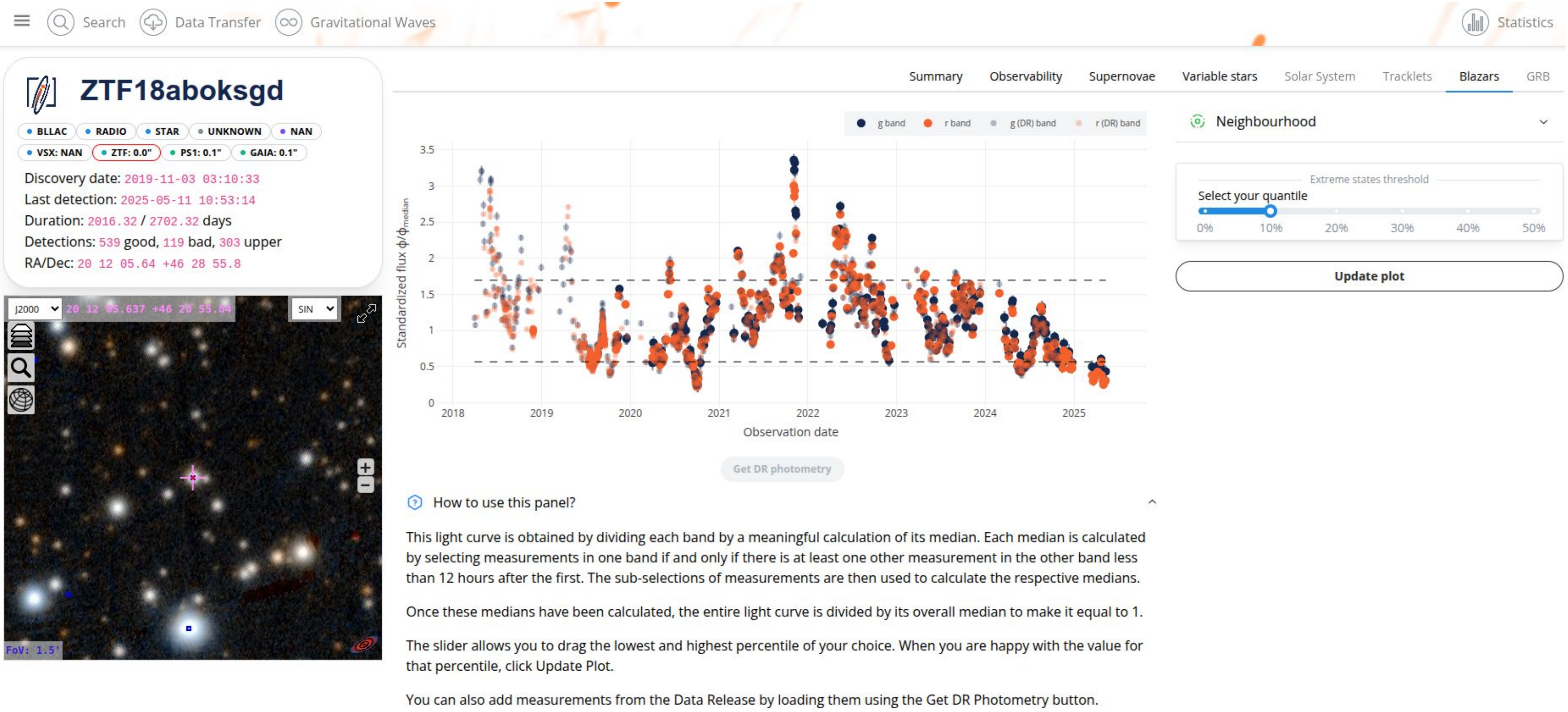
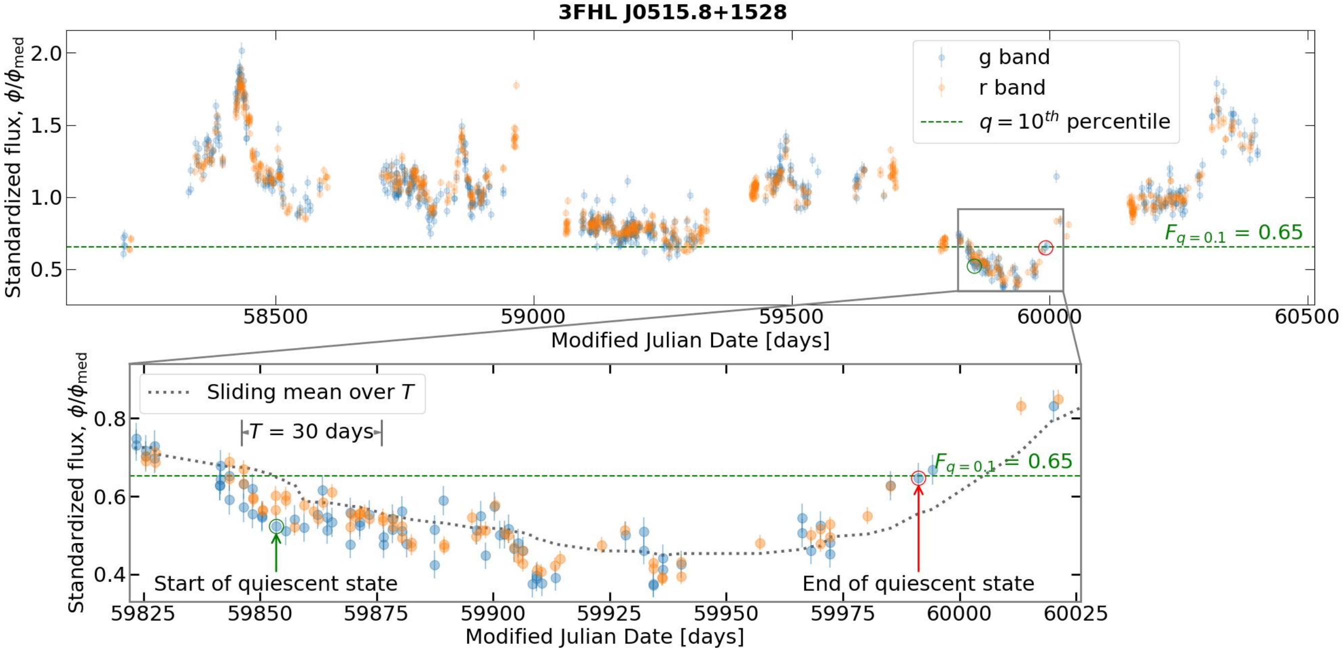
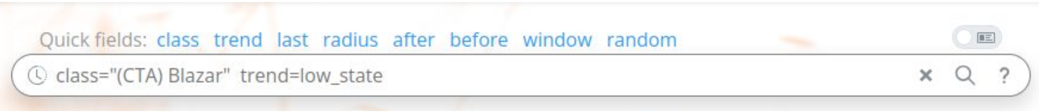
What about Fink?

Fink: standardized flux panel



Fink: low state detection





- 1st criterion: Measurement < threshold
- 2nd criterion: Mean flux of the last 30 days < threshold

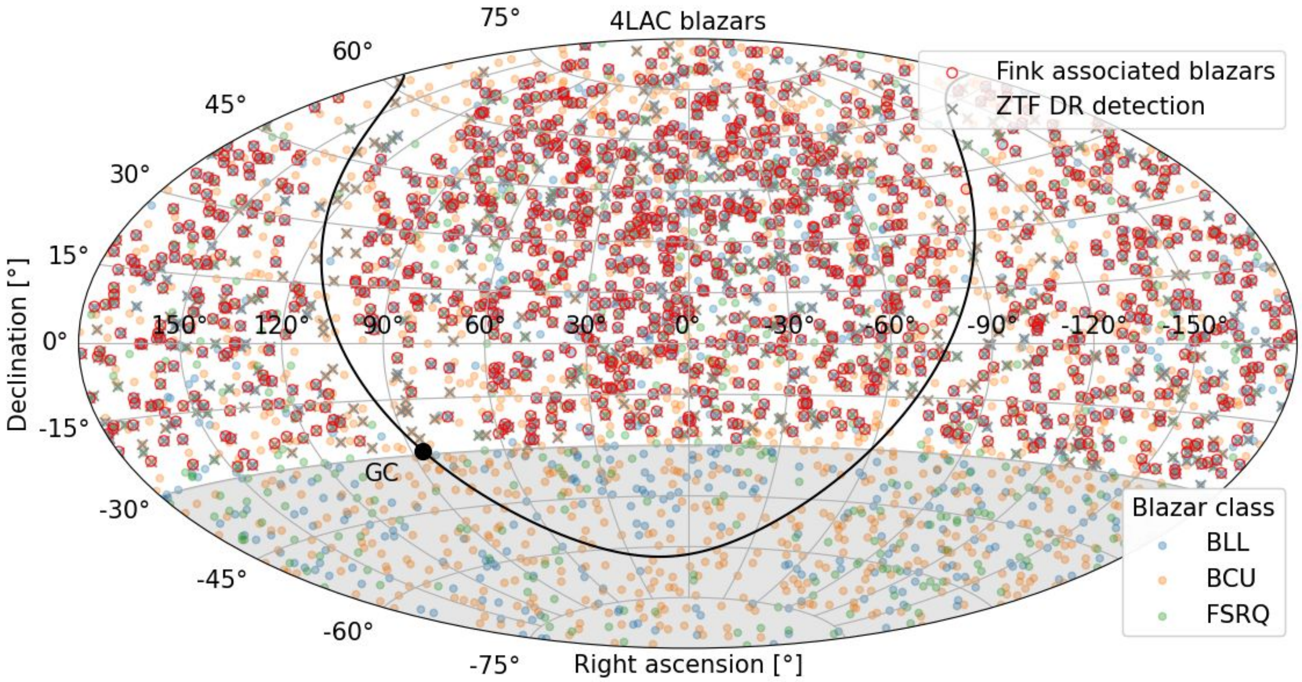
\+ **Monthly/Weekly newsletter**

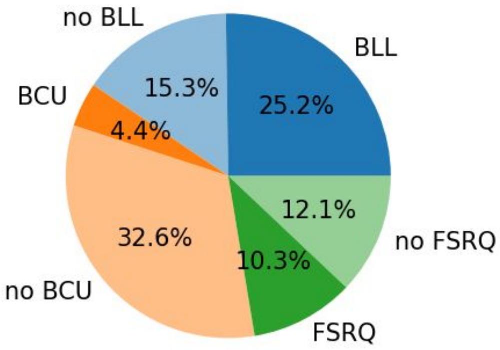
Conclusions

- Possible optical-to-γ-ray synergy for blazars - for various states
  → Fink has be chosen as the **official broker** to listen by the CTAO!
- Multi wavelength can get broader: Radio-to-optical-to-γ-ray analysis with ASKAP VAST and the CTAO
- Who is already collaborating with us?
  - Comparison with Swift X-ray data with Padova team
  - Multi-wavelength flare detection with DESY/Bochum team
  - Spectroscopic campaign for redshift determination with Paris team
  - Follow-up alerts with Astro-Colibri team

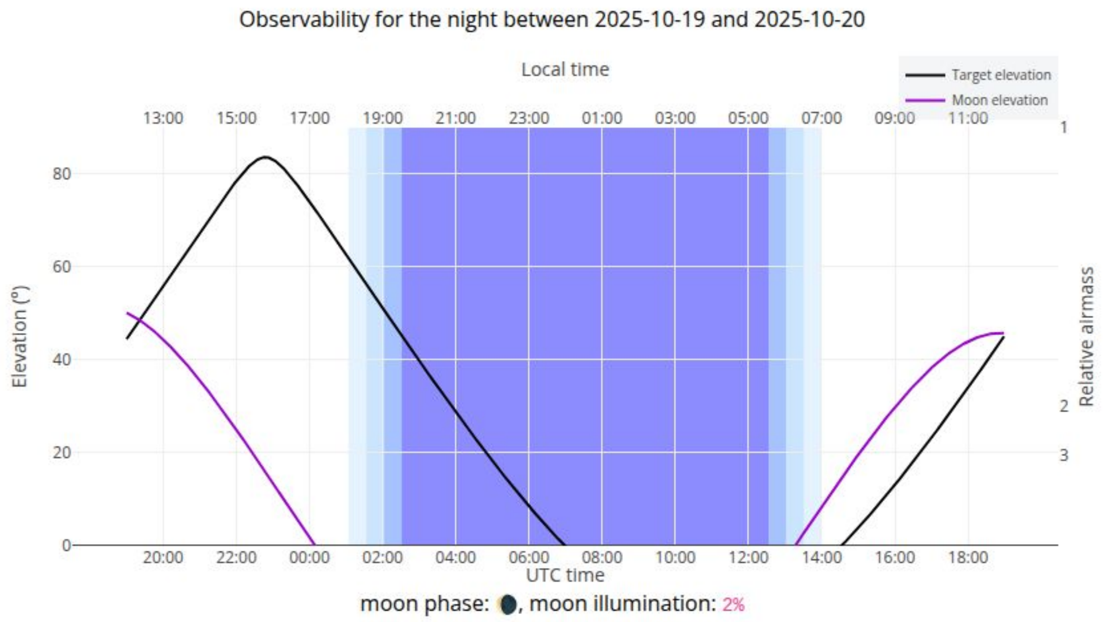
Backup slides

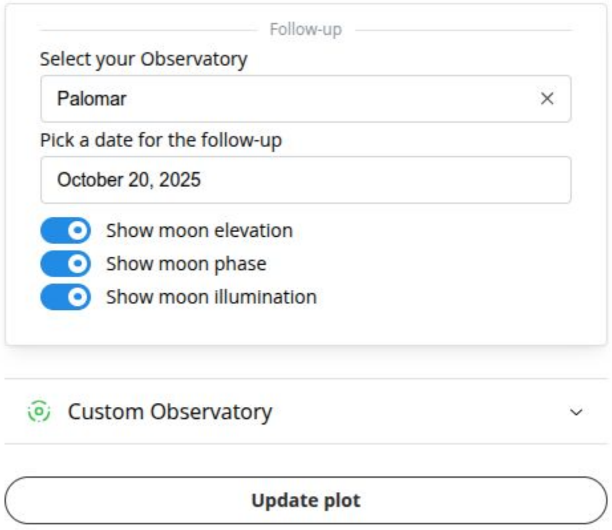
Dataset selection





Observability panel





Dynamical observability of the source for any date at any location
+ status of the Moon

Julian Hamo