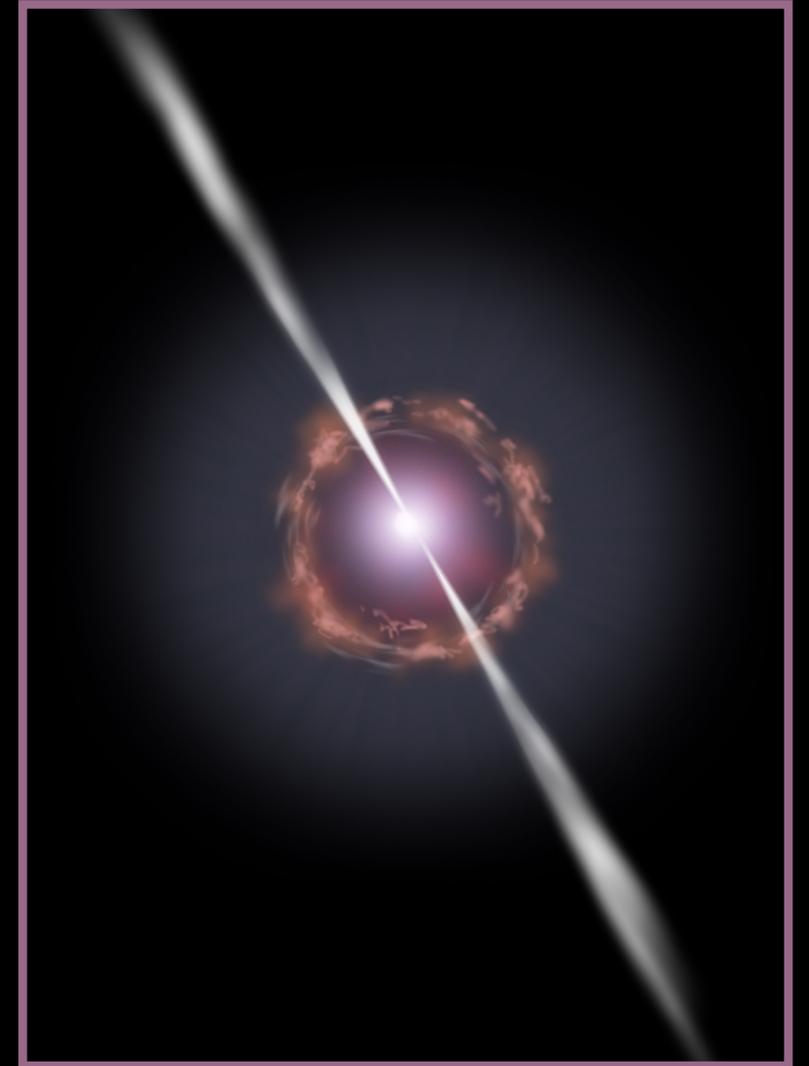
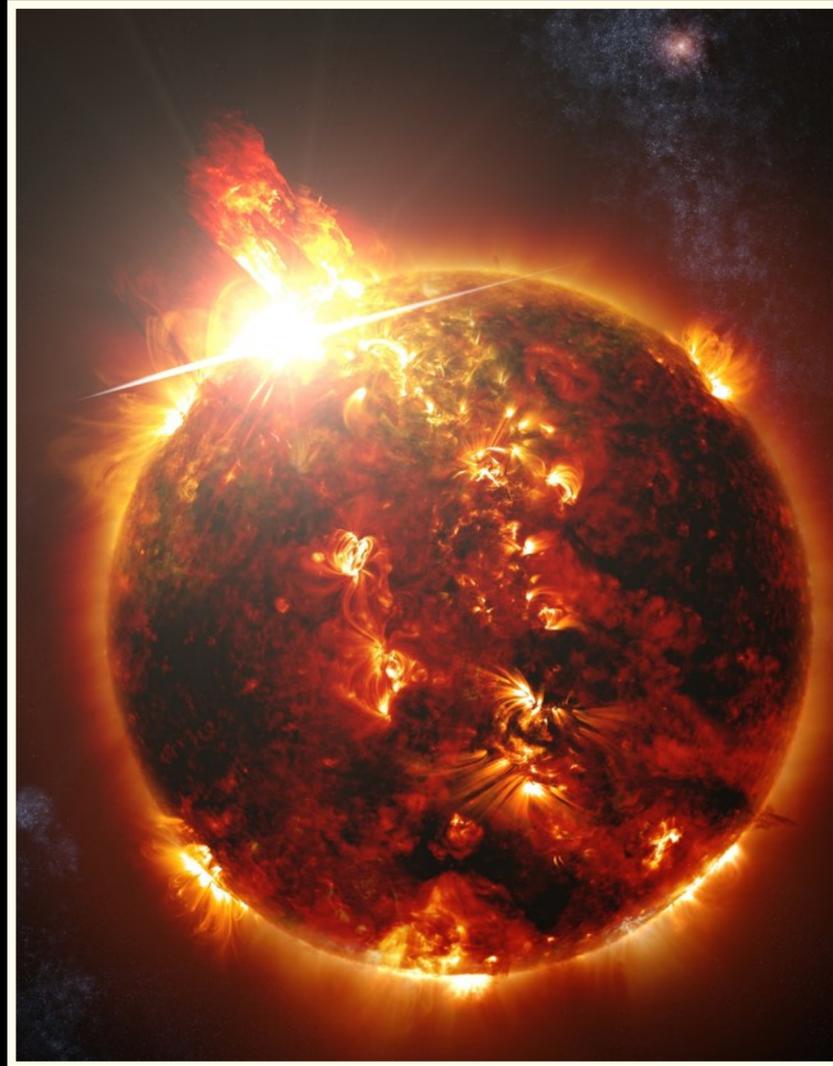


# Summary: The Dynamic Sky With CMB-S4



Anna Y. Q. Ho (Miller Fellow, UC Berkeley)

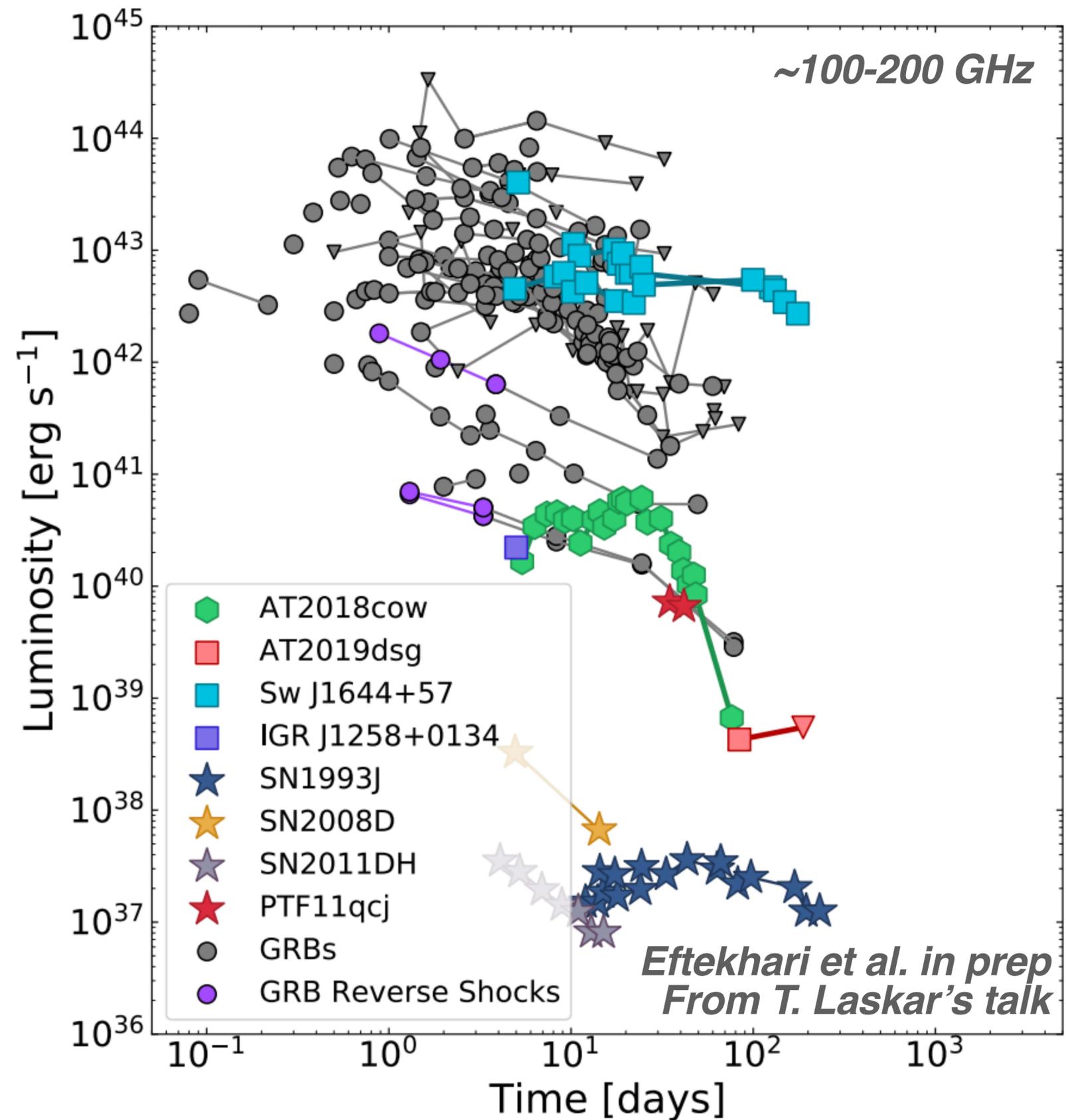
With Gregg Hallinan, Joaquin Vieira, and the sources & transients working group

Thanks to Antonio de Ugarte Postigo, Tanmoy Laskar, Meredith MacGregor, Rachel Osten

# Extragalactic Transients

(Antonio de Ugarte Postigo & Tanmoy Laskar)

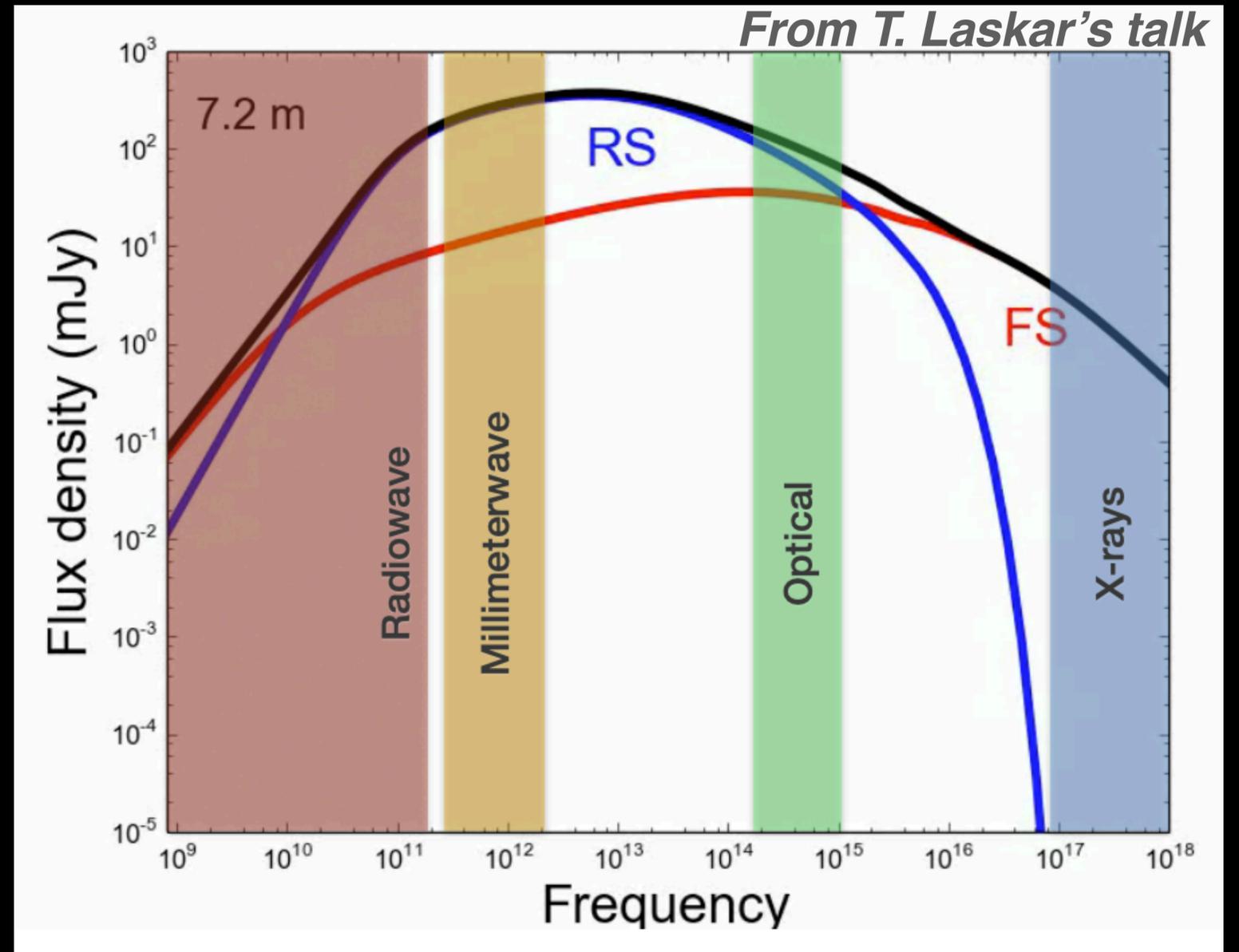
- Supernovae, tidal disruption events, GRBs, ...
- Span orders of magnitude in luminosity and timescale
- Prediction: most events detected by CMB-S4 will be on-axis long-duration GRBs ( $10^1$ - $10^2$ )



# Long-duration GRBs

(Antonio de Ugarte Postigo & Tanmoy Laskar)

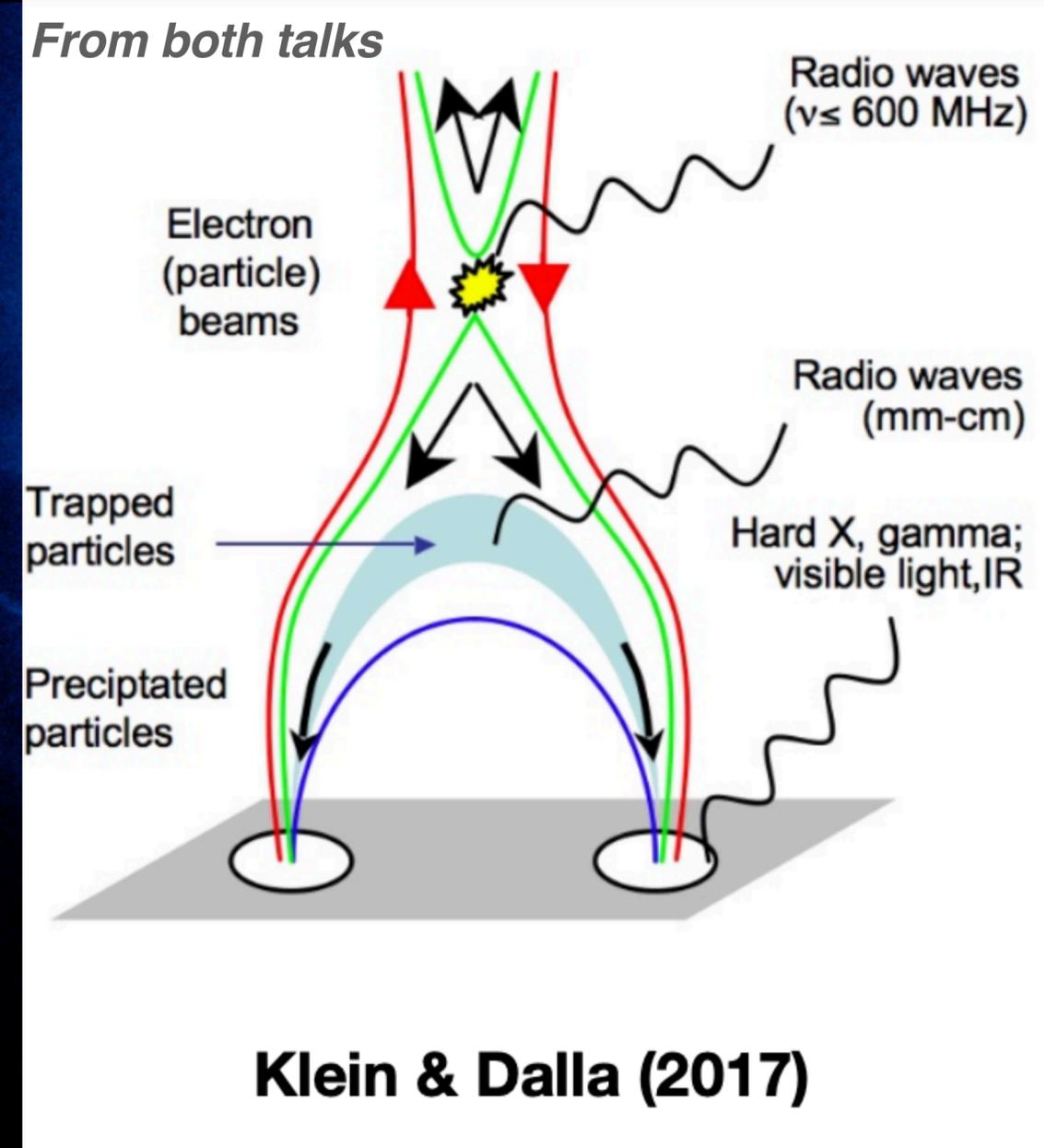
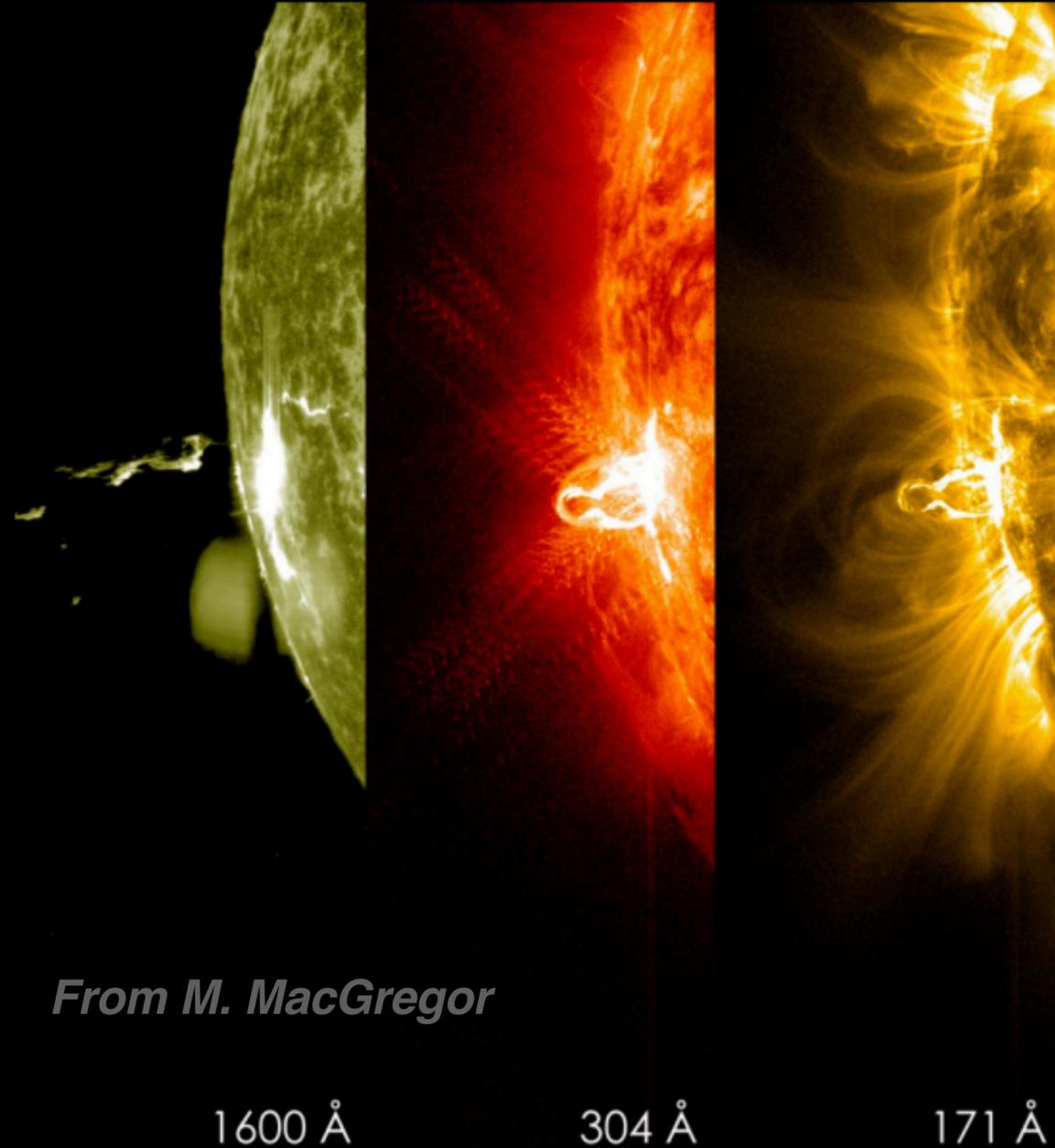
- Scientific benefits of mm observations
  - The *reverse shock* of the jet
    - Jet structure, composition, magnetization
    - Launch mechanism
    - Initial Lorentz factor
  - Negligible scintillation
- Multi-wavelength follow-up critical for modeling
  - Ideal alert timescale: 1 hour
  - 1 day still useful, 1 week too long
- Localization is essential: need interferometric follow-up



# Stellar Flares

(Meredith MacGregor & Rachel Osten)

- Occur all across the EM spectrum
- Are a fact of life for cool stars on/near the main sequence
- Interesting for exoplanet atmospheres and energy release processes

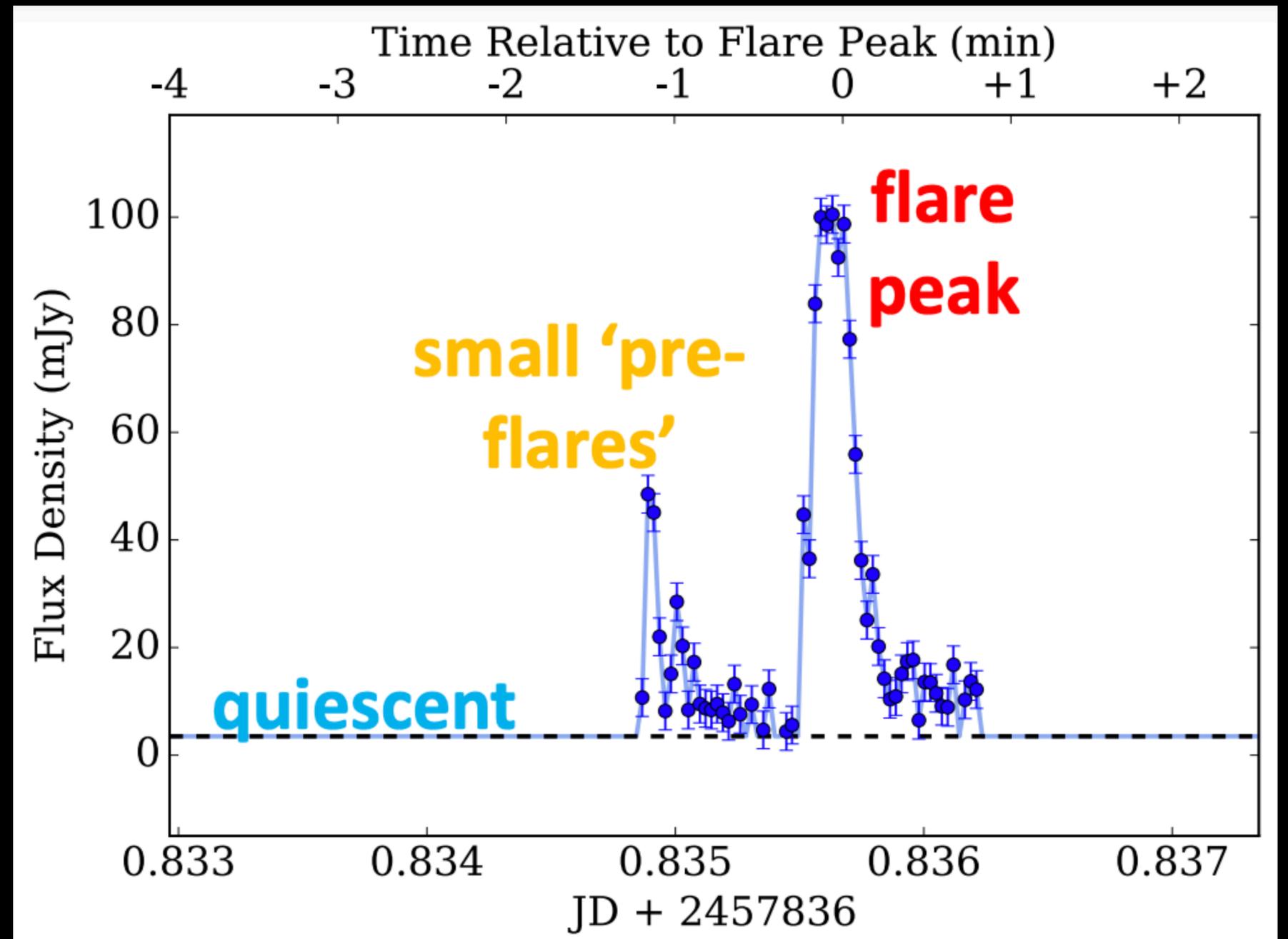


# Stellar Flares

(Meredith MacGregor & Rachel Osten)

What CMB-S4 can do

- Flare statistics (targeted observations biased)
- Particle acceleration (optically thin regime)
- SPT & ACT results: usual suspects, but energetics extreme & surprising
- Enable multi-wavelength studies of individual flares



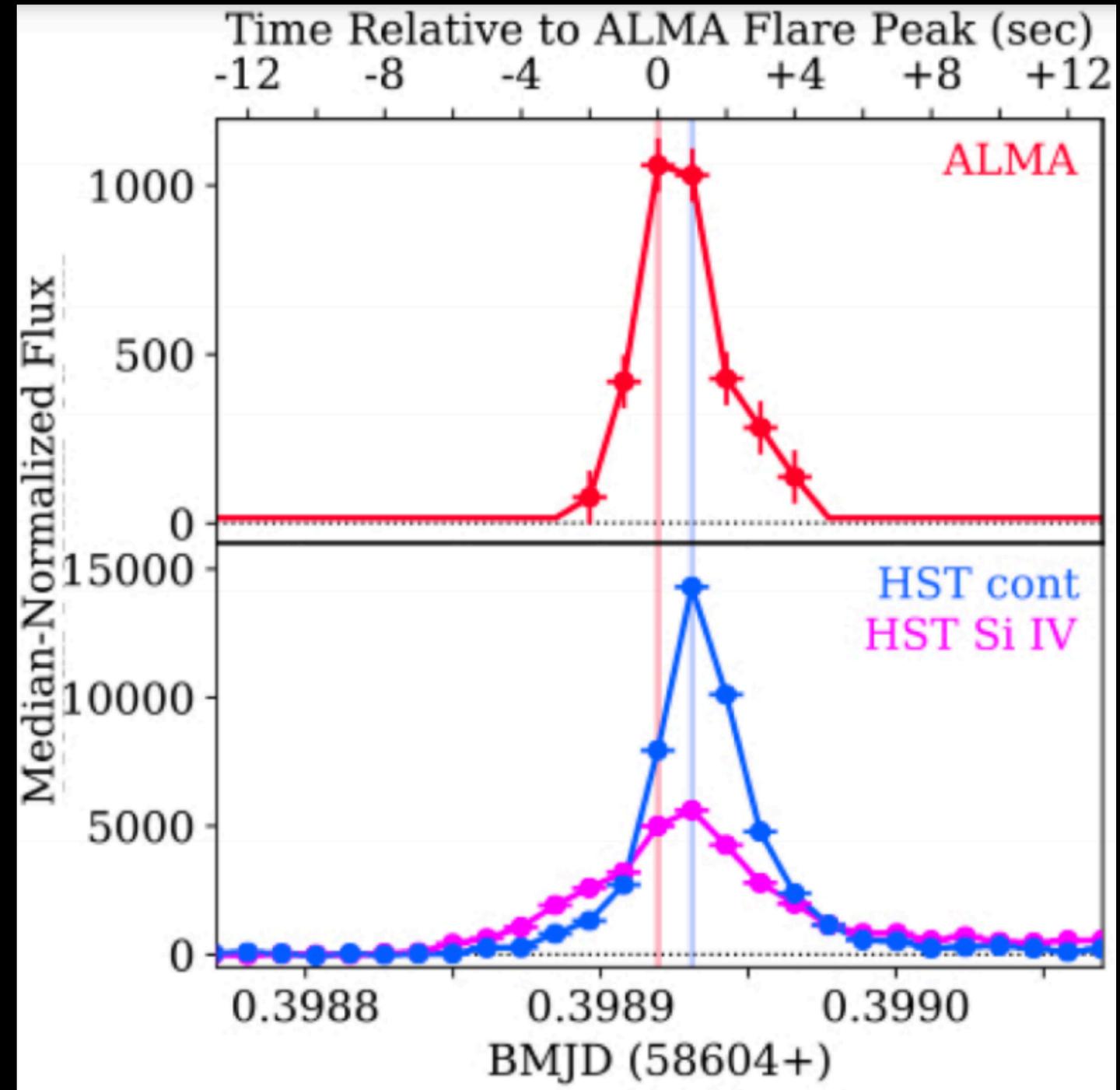
*ALMA observations (M. MacGregor et al. 2018)*

# How can this work in practice?

(Meredith MacGregor & Rachel Osten)

## Alerts?

- Challenging: flares range from 30 seconds (ALMA follow-up) to days (SPT)
- Might be possible for the longer ones (considering 1h for GRBs)
- Ideally get UV and X-rays and lower frequencies (VLA, ATCA)
- Will want to cross-match with overlapping TDA surveys at other wavelengths (ULTRASAT, ...)



ALMA + HST (M. MacGregor 2021)

# Takeaways & looking ahead

- Prioritize transient science unique to CMB-S4
  - Serendipitous discoveries (lesson from radio transient surveys, SPT/ACT)—  
amazingly energetic stellar flares, transients from new channels (e.g., Dong+2021)
- Benefit of the high-cadence deep survey from Pole
  - Earlier source discovery and identification
    - Better constraints on source age
    - Detailed light curves for young bright sources (like GRBs)
- Can we reduce the alert timescale from 1d to 1h?
- Follow-up
  - Localization is essential
  - Should propose triggered programs in advance
- Multi-wavelength archival data is important
- Practice on the SPT alert stream?