Searching for extragalactic transients with SPT-3G

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The Transient and Variable Universe

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What is SPT-3G?

Third generation receiver on the 10 meter South Pole Telescope

Since 2018: running a multiyear survey focused on cosmology (CMB powerspectra & lensing), point sources, and clusters

Why use a CMB telescope for transients?

SPT is optimized for both **CMB** and point sources

- **observe where CMB peaks (95 / 150 / 220 GHz)**
- **low noise (μK)**
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- **high resolution (1’ beam)**
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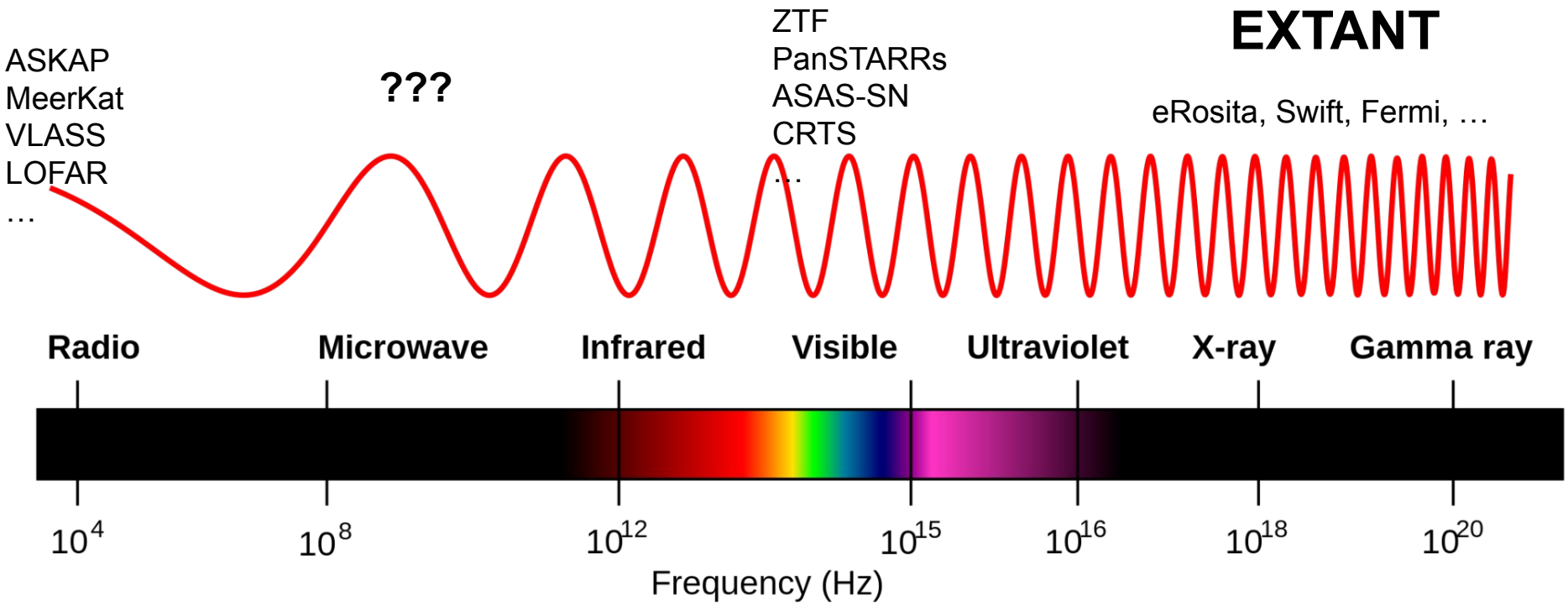
for every point in our field: 12 hour cadence, 3-band lightcurves with 6 / 7 / 25 mJy noise levels from 2019 – 2024+

*from March – November

The transient survey landscape



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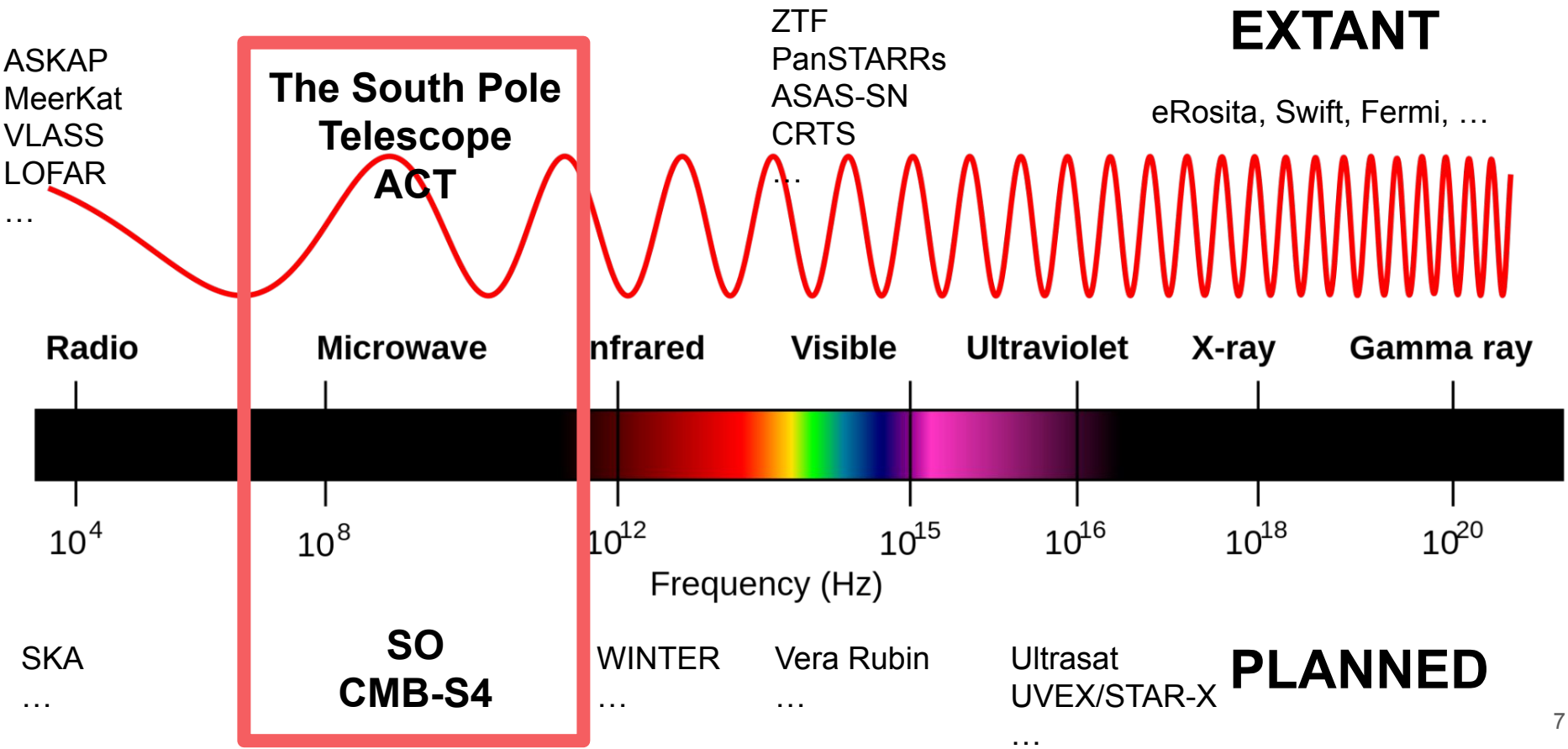

The science case for untriggered millimeter transients

Theory	Observation
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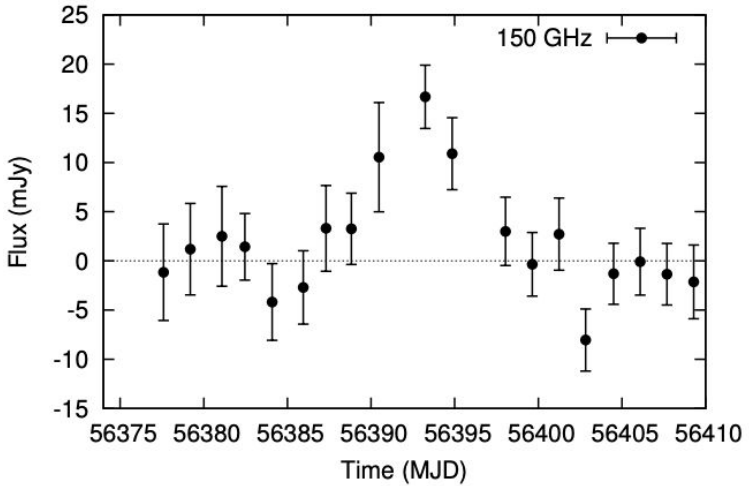
(2015) Metzger et al: 3rd gen CMB instrument should detect ~10 GRBs	

Whitehorn et al 2016

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Theory	Observation
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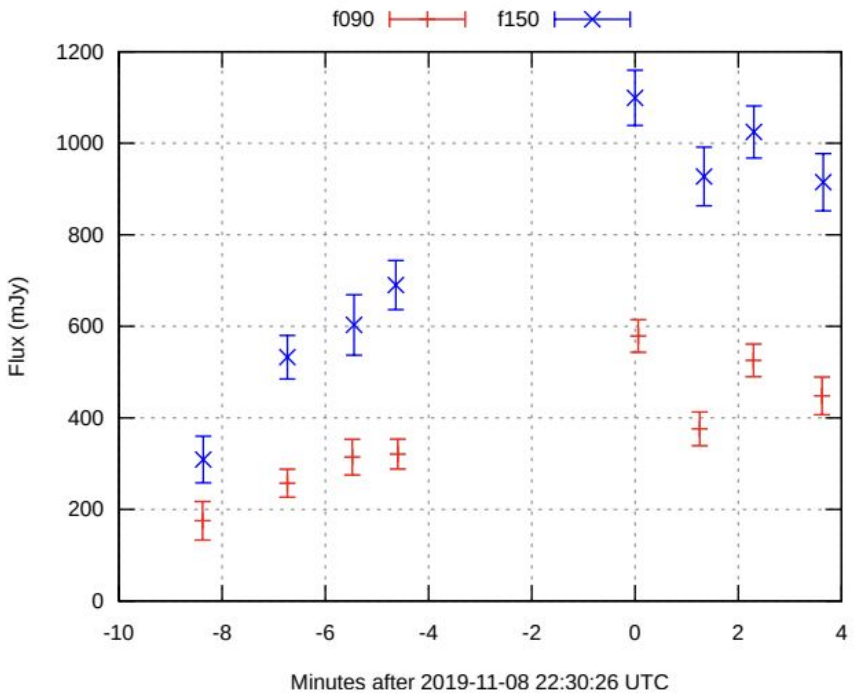

Naess et al 2020

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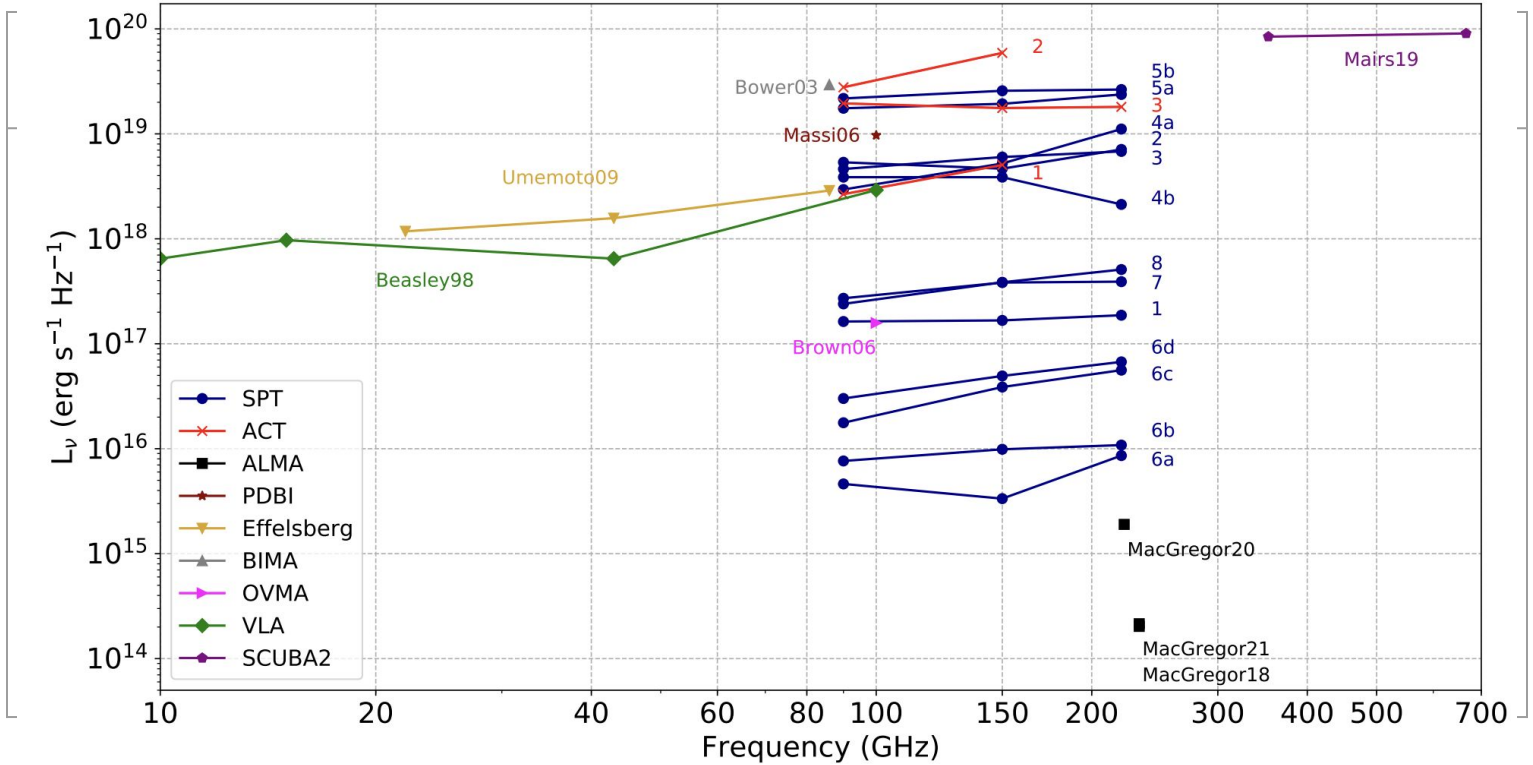

Guns et al 2021

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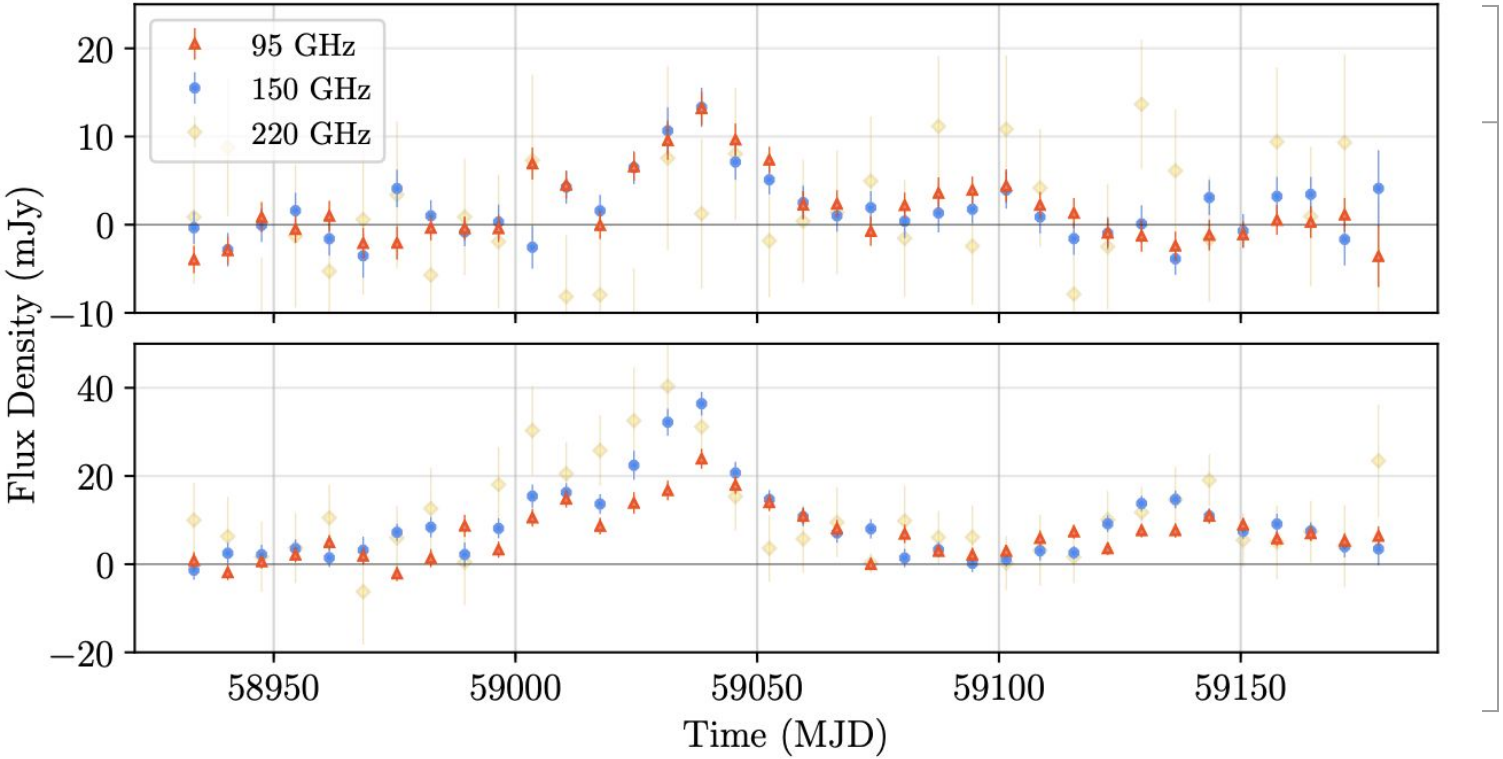

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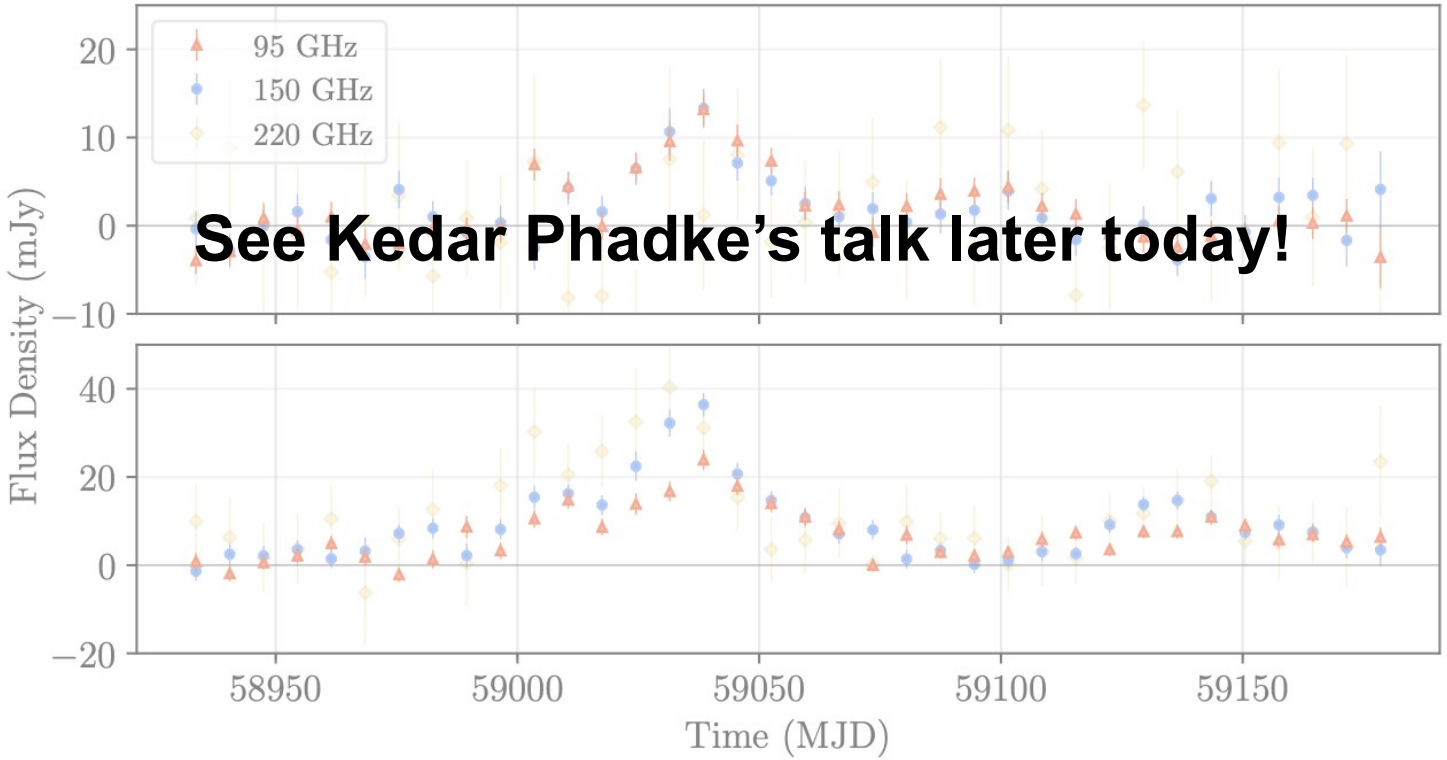

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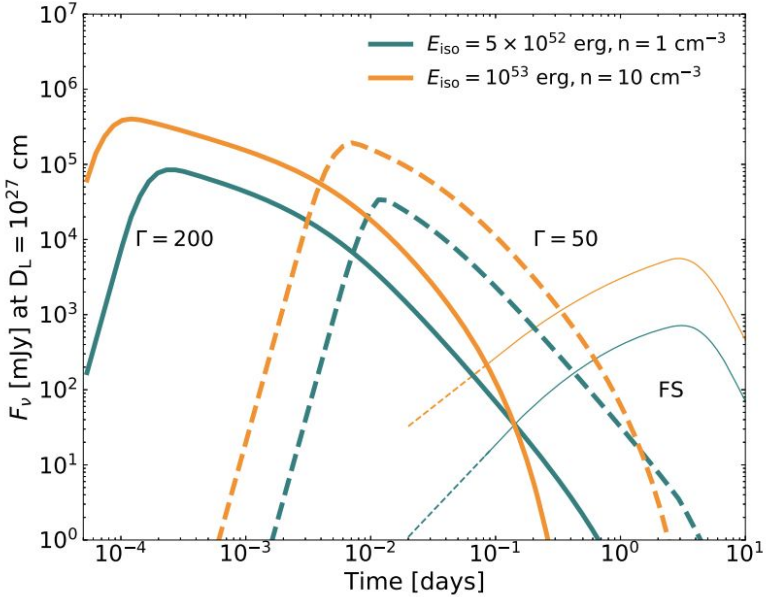
GRB reverse shocks are exciting!

- Ultrabright and brief (2 hours – 1 day)
- Directly sample GRB ejecta, clean measurement of Lorentz factor
- Peak in mm, but only handful of detections so far (none untriggered)

Occupy same parameter space as stellar flares – SPT should see them!



Eftekhari et al 2022

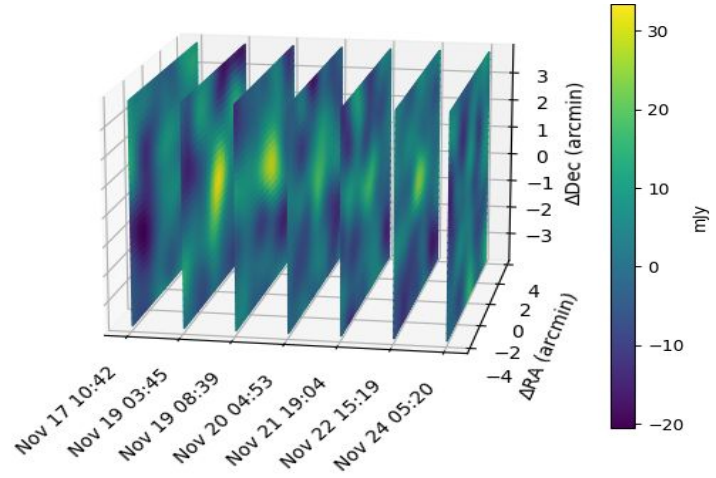
The 2019 – 2022 SPT-3G short-duration transient search

Difference from 2021 search:

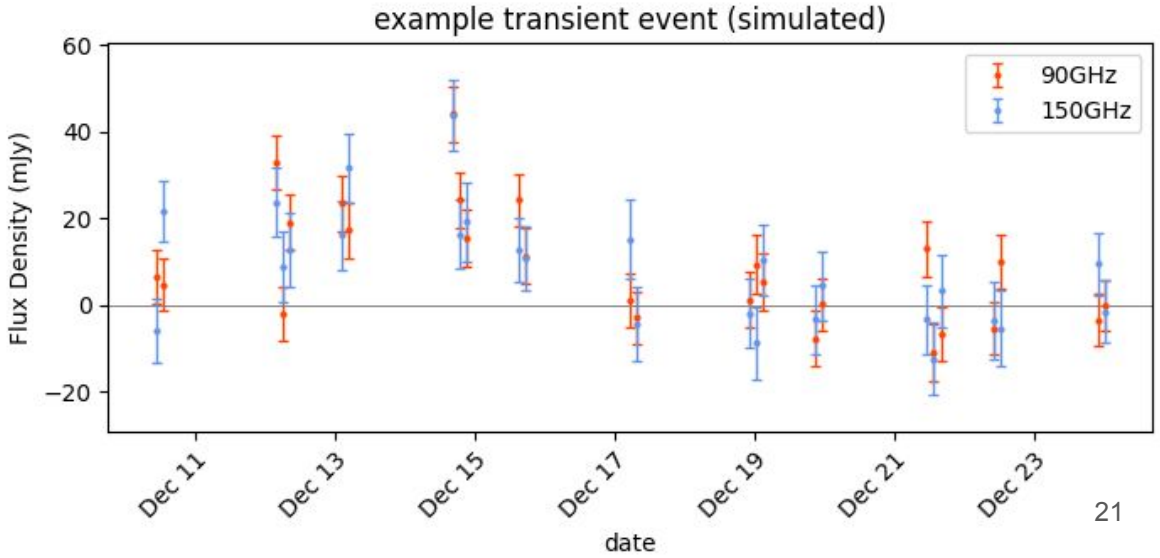
- 4x more data
- Better filtering and better understanding of noise and systematics
  - => increase data volume AND search down to 6.5 sigma (down from 10)
- Fit more lightcurve profiles
- Mask all AGN and other sources > 5 mJy (2.5% of survey area)
- Cut on > 10 day emission

Search algorithm

1) Filter maps, subtract a 3-year average, estimate noise
2) Select all > 3 sigma pixels and construct 12 day lightcurves
3) Fit a lightcurve profile and calculate the Test Statistic (likelihood ratio)



7-day image stack of SPT-3G filtered maps



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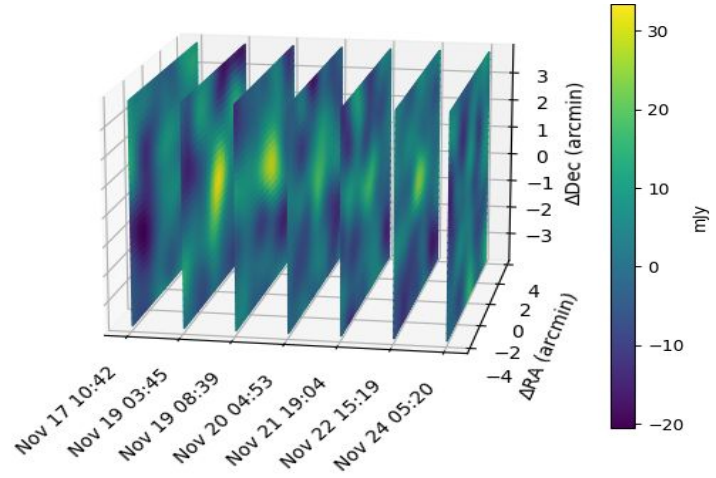

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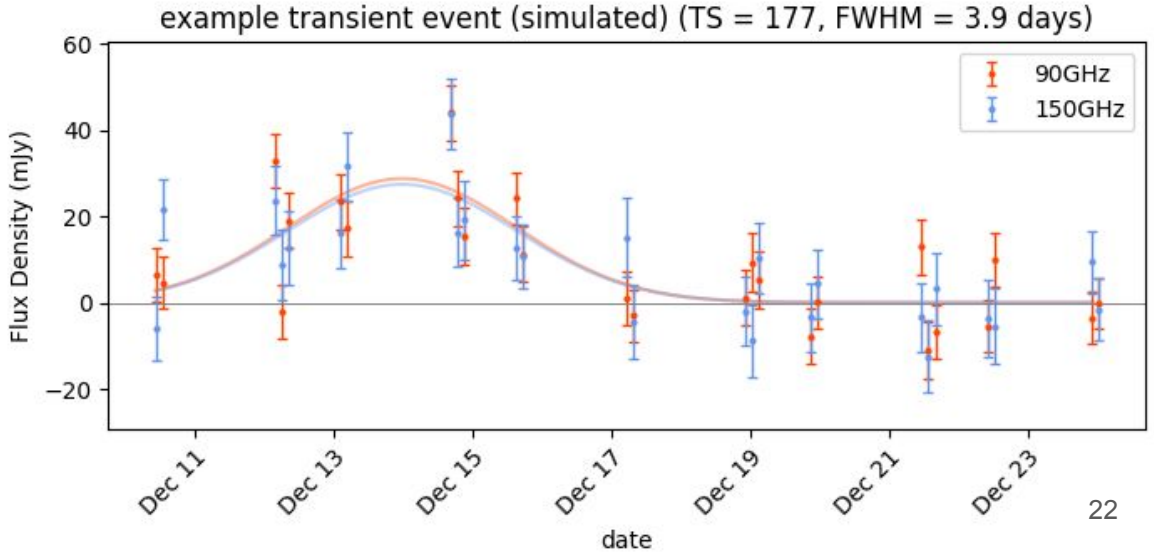

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See Chris Tandoi’s talk later today!

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- Plan for the future – CMB-S4