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mm-wave transients with SPT-3G

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Based on https://arxiv.org/abs/2103.06166

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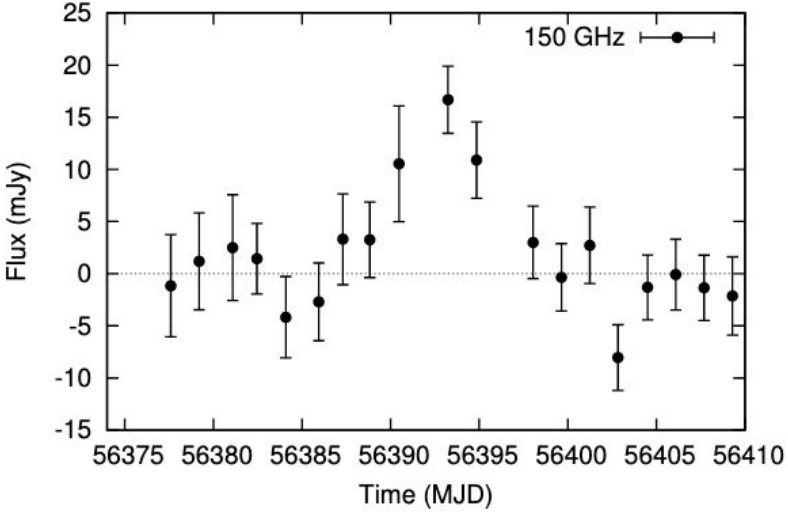
Previous Generation: pathfinder survey

SPTPol 100d field

2012-2013 winter



36 hour cadence

One candidate event at 6 sigma

Strong polarization signal

Remains unidentified

Figure from N. Whitehorn *et al* 2016 *ApJ* **830** 143

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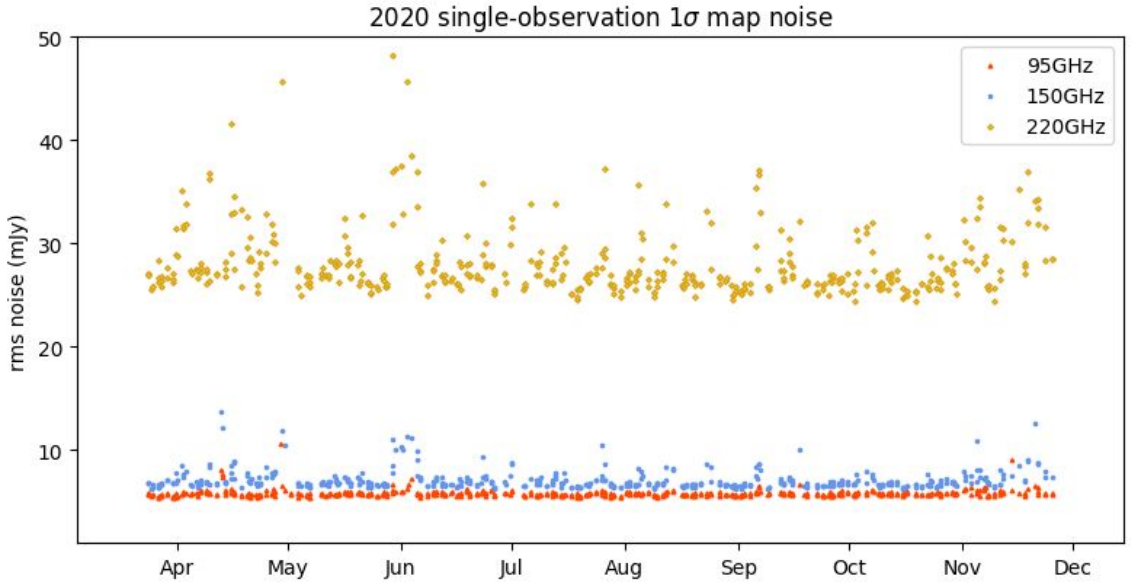
SPT-3G Search: Data

- 1500 square degree field
- 3500 hours of data taken from March - November 2020



450 observations over 250 days

Median noise levels

95GHz: 5.8 mJy
150GHz: 6.8 mJy
220GHz: 27.0 mJy

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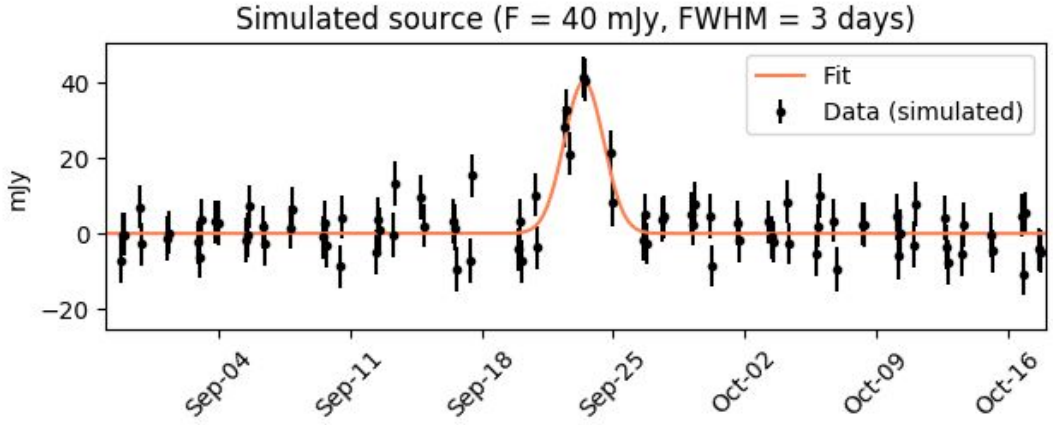
SPT-3G Search: Method

- Difference maps: (single observation) - (2019 coadd)
- Gets rid of all static backgrounds (CMB, clusters, static point sources, etc)
- Leaves: noise realisation, variable AGN (mask), **transients**
- Fit 4 parameter gaussian flare model (S_{90}, S_{150}, t_0, w) with ML



Test Statistic = likelihood ratio

$$\mathrm{TS} \equiv \frac{\ln\mathcal{L}(\hat{S}_{90}, \hat{S}_{150}, \hat{t}_0, \hat{w})}{\ln\mathcal{L}(0)}$$

of $\sigma \sim \sqrt{\mathrm{TS}}$

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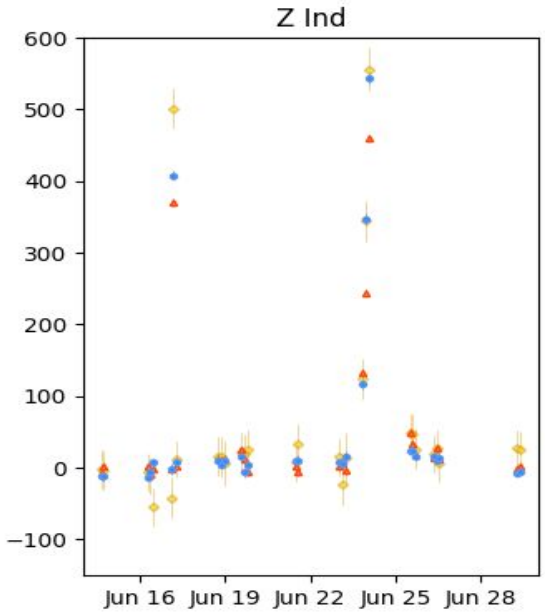
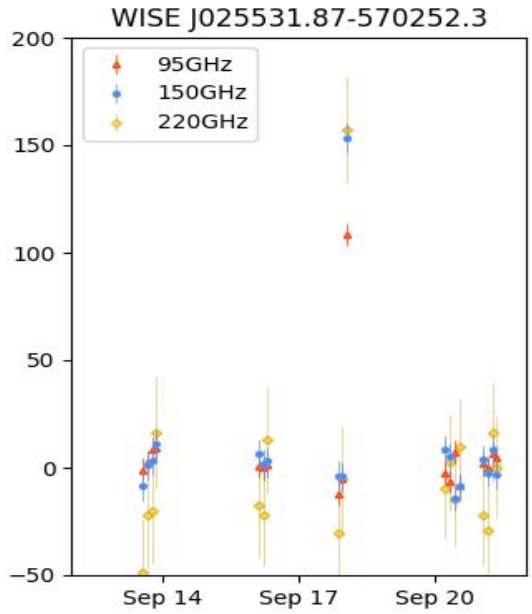
SPT3G: First Results

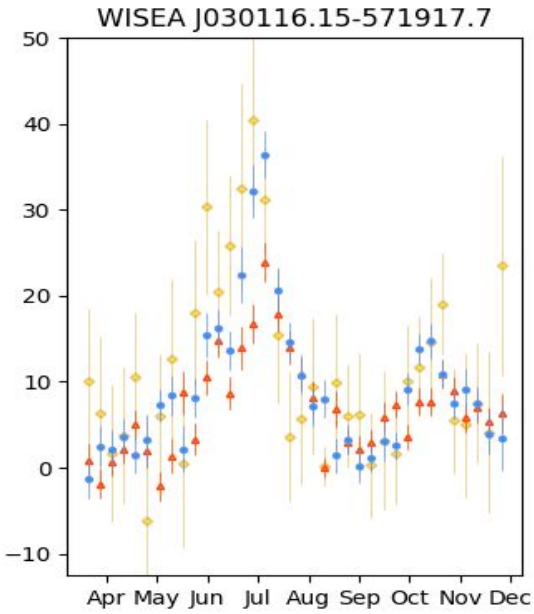
First results from 2020 dataset! 10 sources with at least one event > 10 σ (TS > 100)



Rotationally variable & X-Ray emitting star



M Dwarf



Galaxy (not ours)

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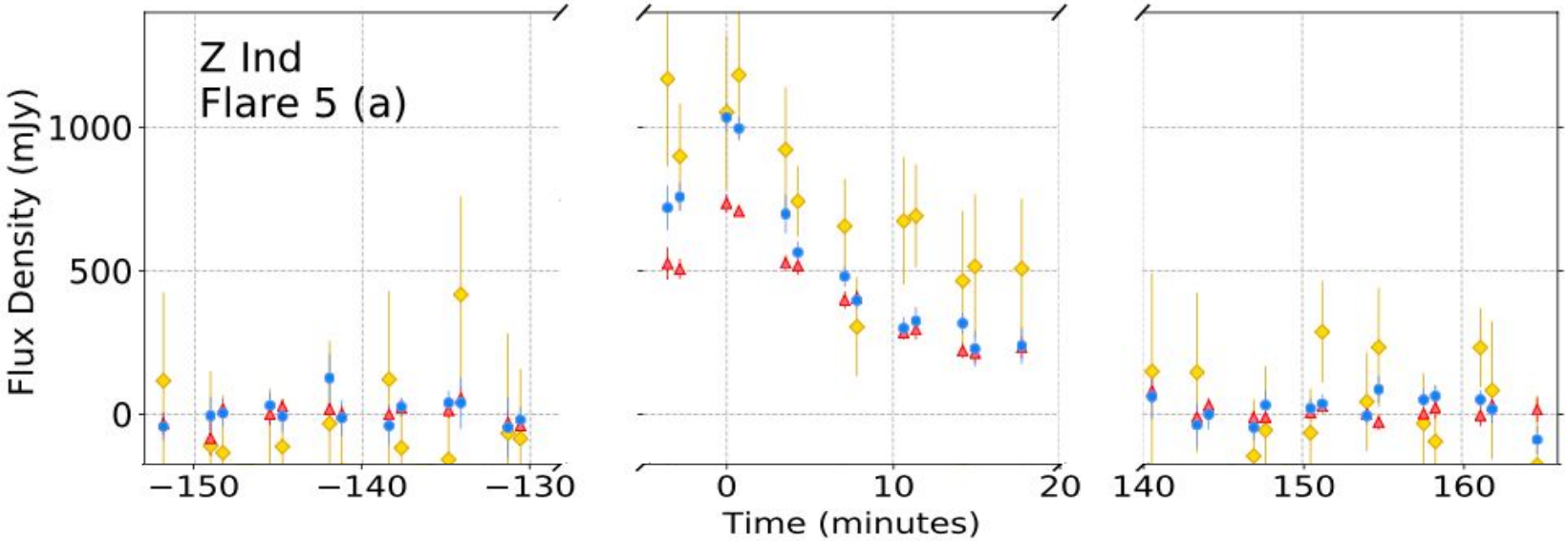
SPT-3G First Results: Stellar Flares

- **8 flaring stars**, some with multiple events (13 total flares)
- Brightest is more than **2 Jansky** , briefest is less than 20 minutes long.
- 2 hour subfield observation → 10-12 raster scans across a source



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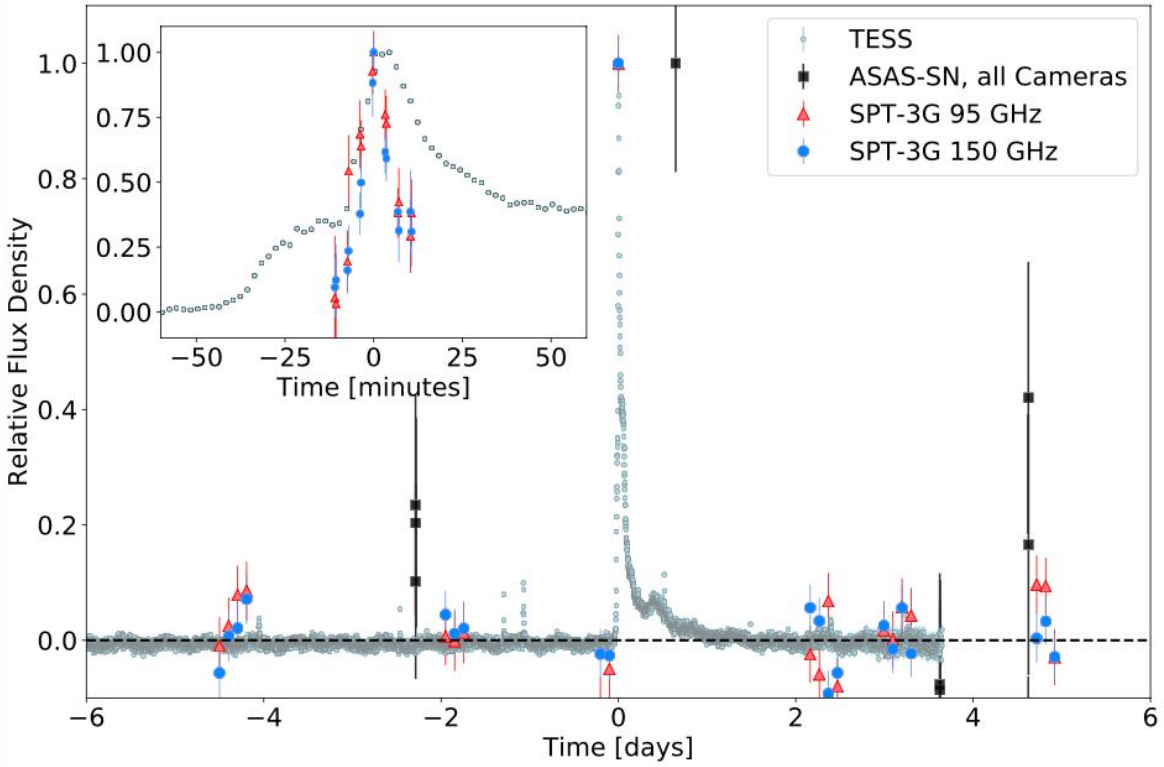
SPT-3G First Results: Stellar Flares

Multiwavelength public data:

Simultaneous coverage in ASAS-SN and TESS shows bright 24-hour optical event.



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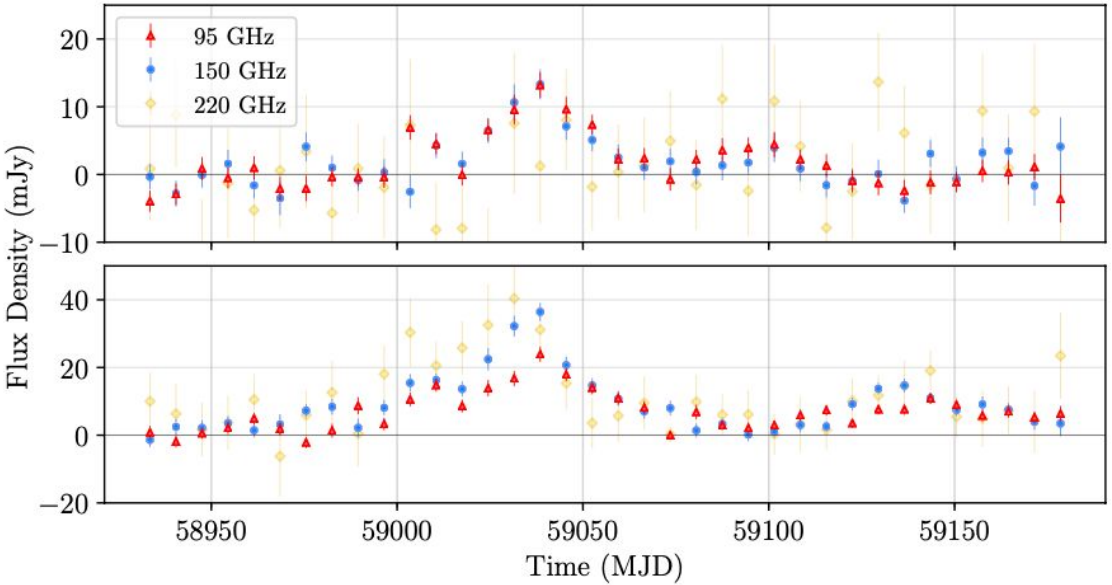
SPT-3G First Results: Extragalactic



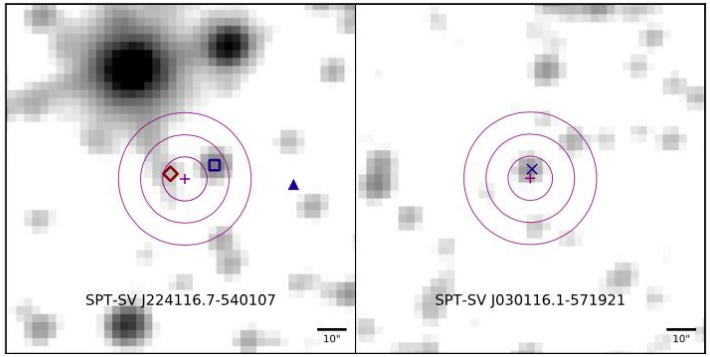


Figure 6. Localization of the long-duration events for sources 9 (left) and 10 (right) using grayscale images from unWISE 3.4 μm W1 (Lang 2014) in log stretch. The *purple cross and contours* show the SPT-3G best-fit position

2 events, with factors of 4 and 15 increase in flux compared to 2019 average (<5 mJy for both).

Super variable AGN, something else? One is also an X-Ray source.

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SPT3G Online Alert System

- Time from observation to transient results is already < 24 hours, aiming to decrease even further.
- All processing and analysis is fully automated.
- Online alert system running since October, produced 2 signals in the paper.
- 2021 Winter observing starts in 2 weeks.
- First SPT-3G transient ATel in … ?

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Outlook for 2021 - 2023

- Currently implementing automatic weather balloon avoidance with help from AMRC.
- Lowering detection threshold to 9, 8, 7, …. sigma. A 2019 - 2020 population paper should have many many more events.
- Besides ATels, need to develop more tools (lightcurve server) to enable community involvement.
- Poised for multiwavelength follow-up on 2021 transients, in radio / optical (NSF NOIRLab, external collaboration with DES) / UV & X-Ray (SWIFT)

Thanks for listening!