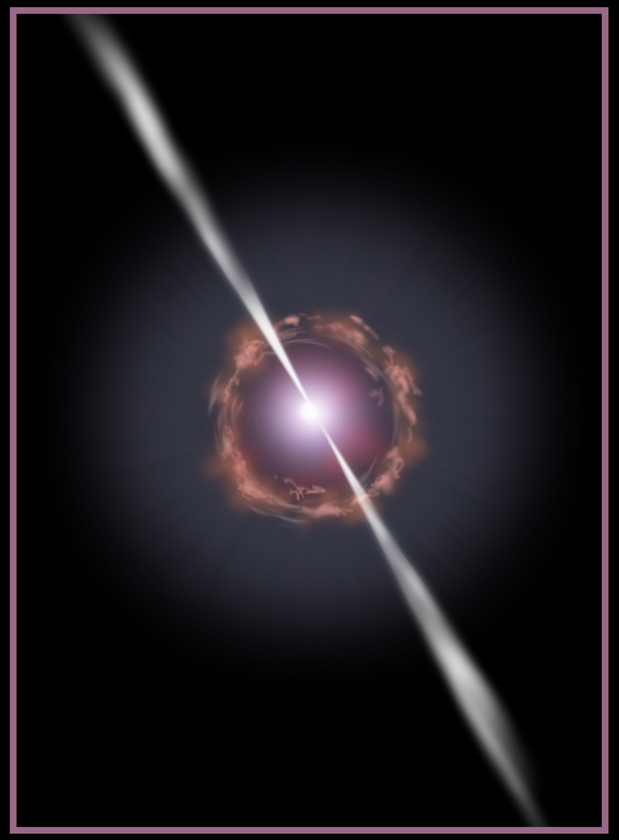
The Dynamic Sky With CMB-S4





Anna Y. Q. Ho (Miller Fellow, UC Berkeley)
with Joaquin Vieira and the sources & transients working group

The Sources & Transients Working Group

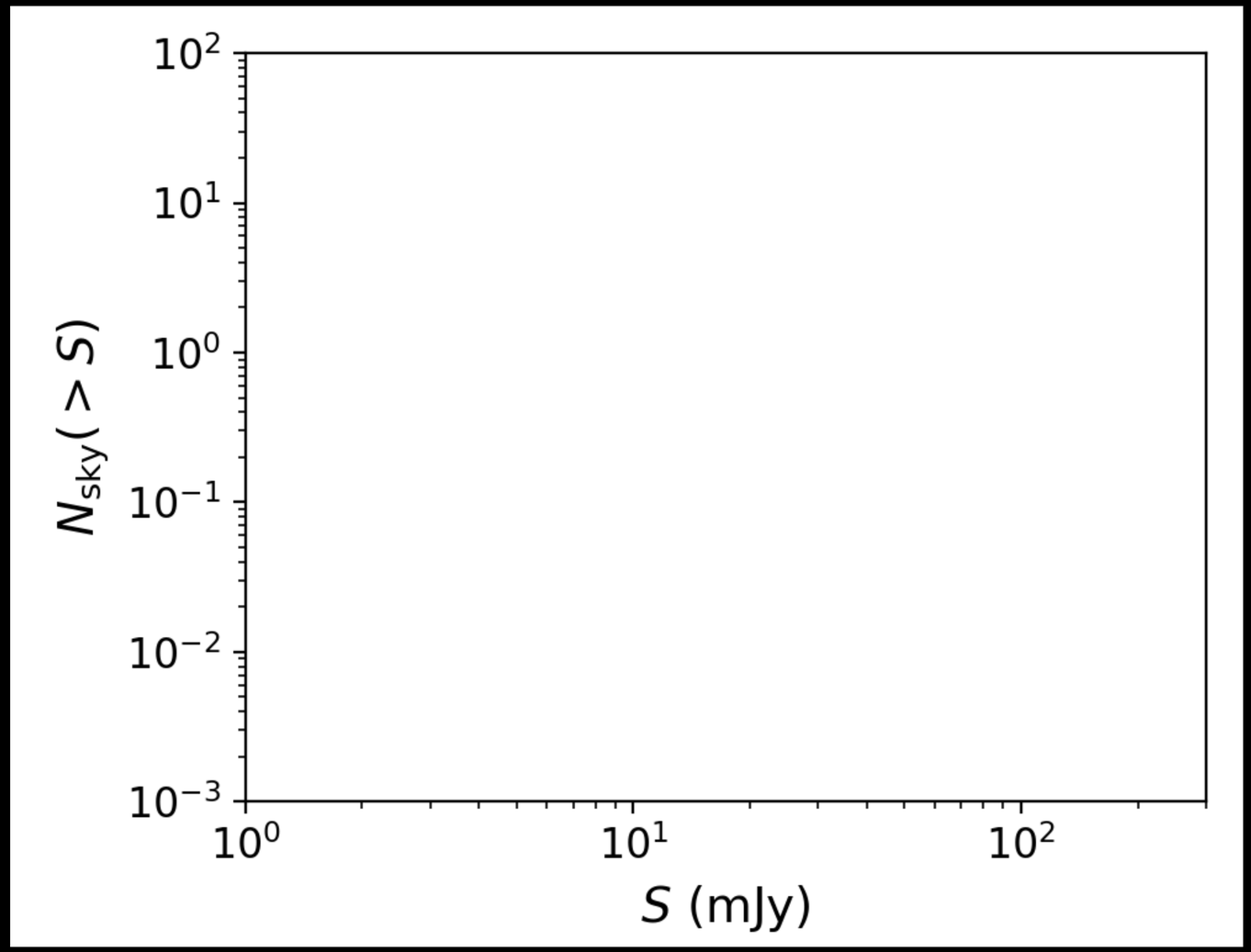
- Co-conveners: Joaquin Vieira (UIUC) & Anna Ho (UCB)
- Reorganization: clusters now its own group
- Science driver: transient and variable sources
- Wide range of science: variable (e.g., AGN), Galactic (stellar flares), transient (GRBs, TDEs, SNe), solar system (asteroids, planets)

Outline

1. Results from Stage 3 (SPT & ACT)
2. CMB-S4 capabilities
3. Science topics
4. Schedule for the parallel session

Areal density vs. flux density diagram for mm transients (150 GHz)

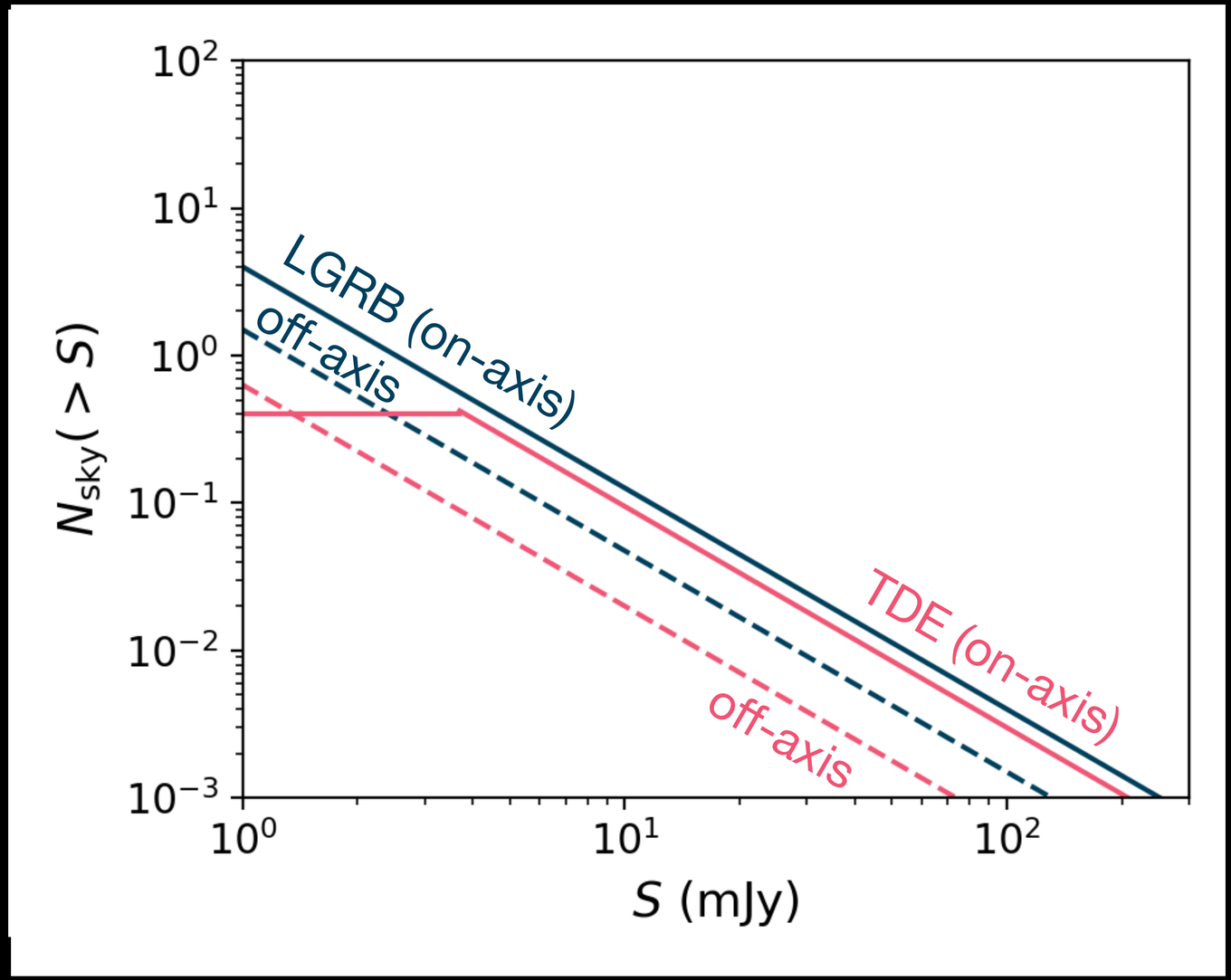
Number of sources in the sky brighter than the threshold



Flux Density (Sensitivity)

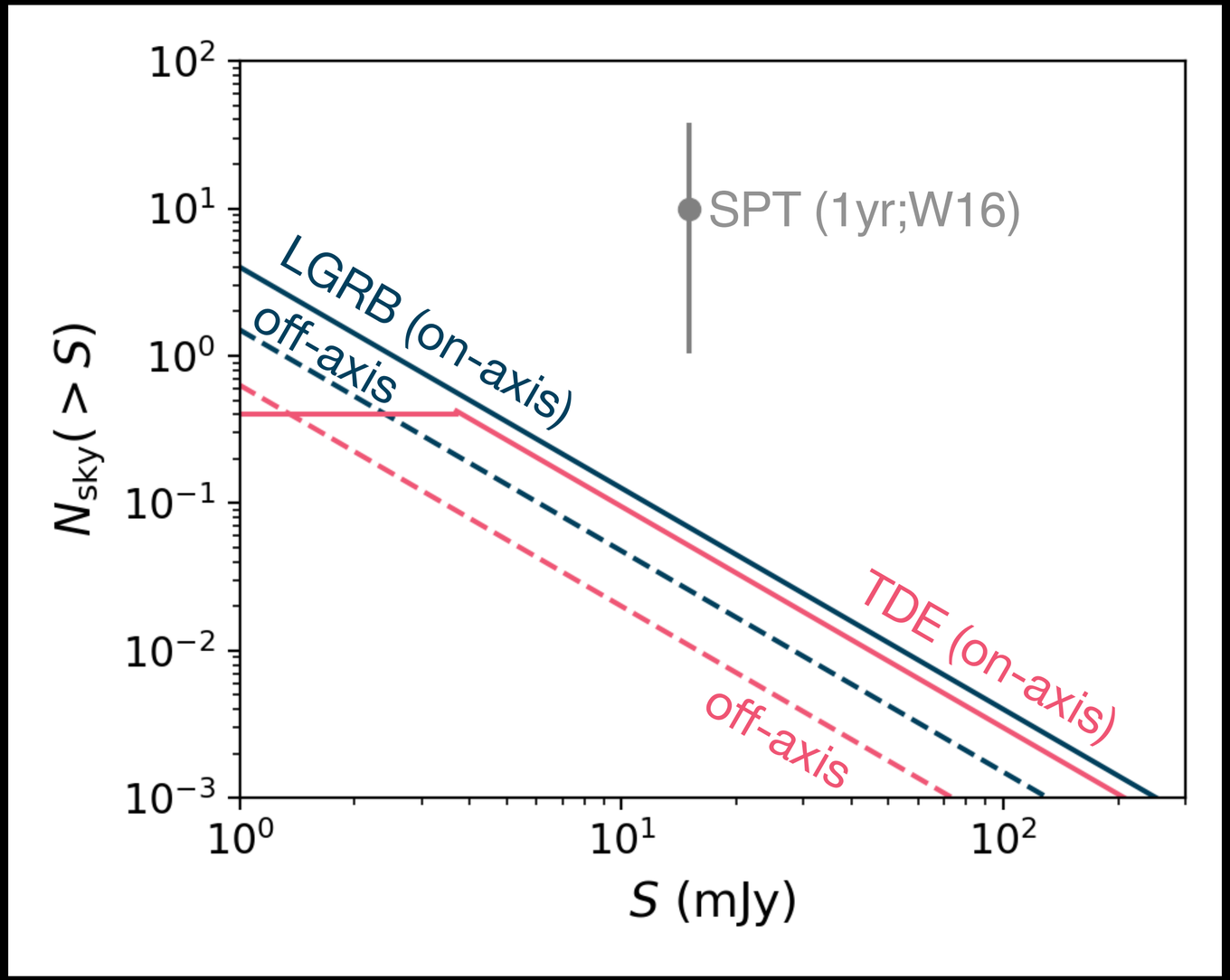
Areal density vs. flux density diagram for mm transients (150 GHz)

Predictions from Metzger et al. (2015)
(Caveat: large uncertainties)



Transient searches at millimeter wavelengths

SPT (Whitehorn+16):
100 deg² for ~1 yr
1 extragalactic transient



(~15 mJy (6σ) for ~1 week)

Transient searches at millimeter wavelengths

SPT (Whitehorn+16):
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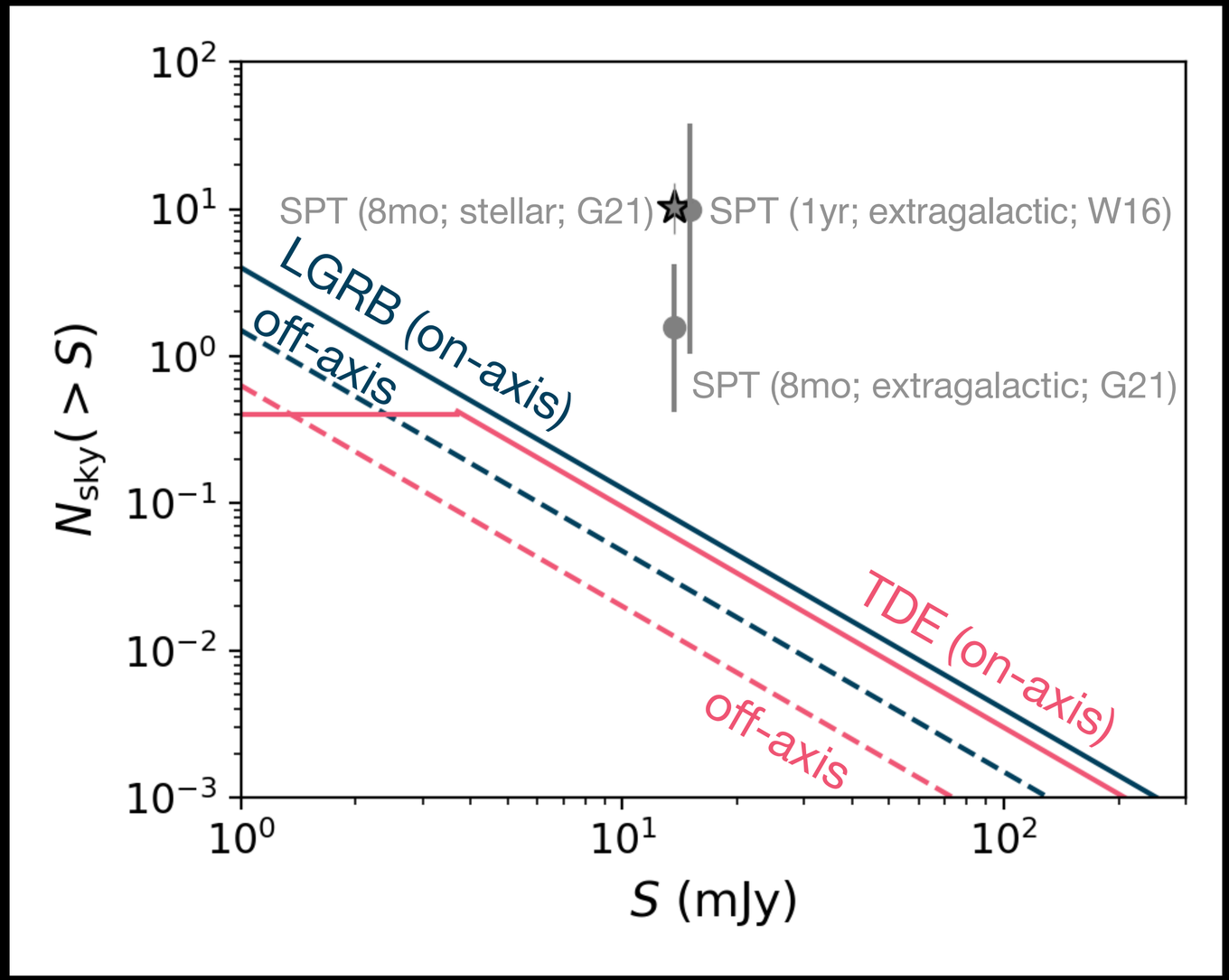
1 extragalactic transient

SPT (Guns+21):
1500 deg^2 for ~8 months
15 transients, 2 extragalactic
Alert stream now online



Transient searches at millimeter wavelengths

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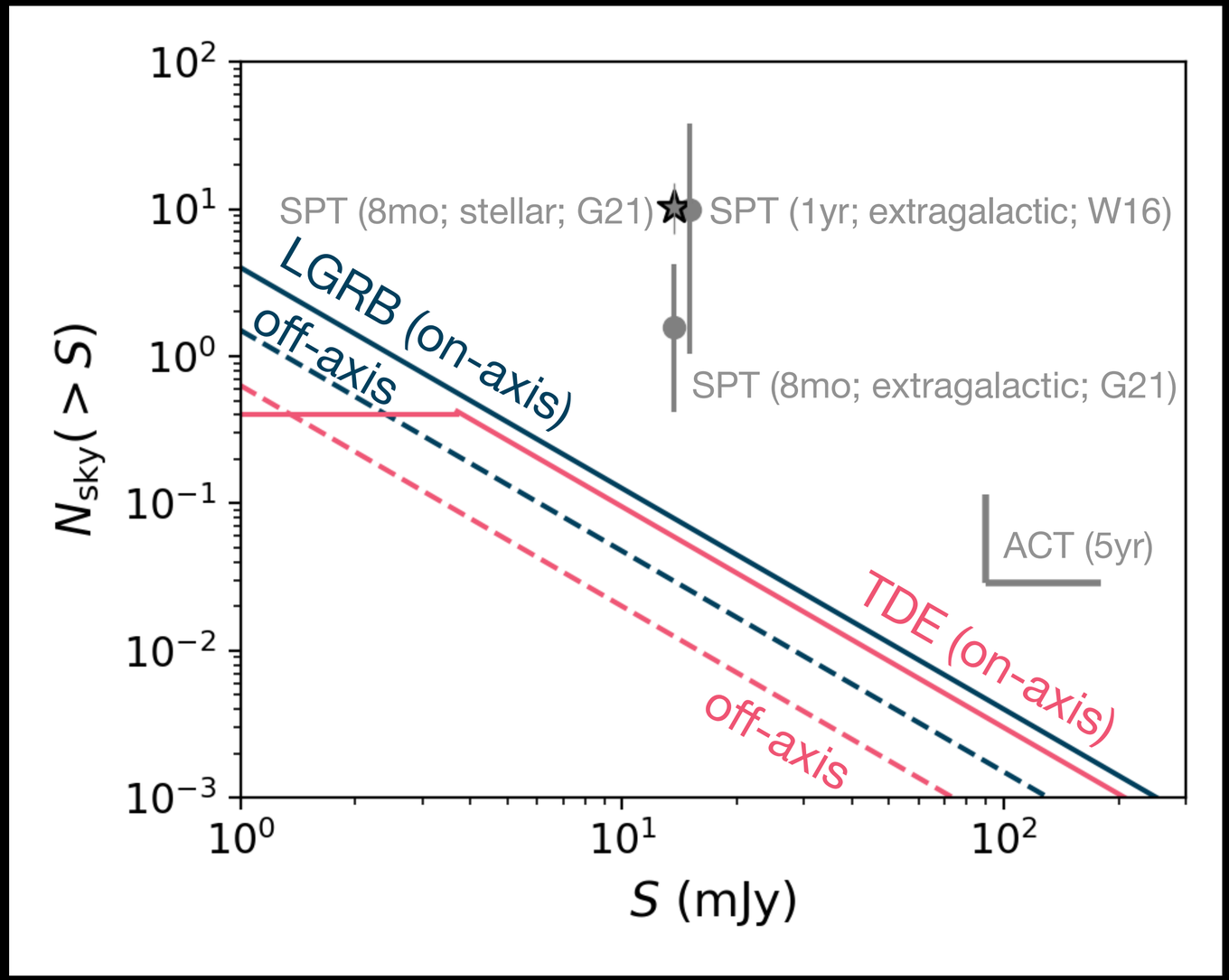
ACT (Naess+21):
40% sky weekly since 2016
3 stellar flares so far



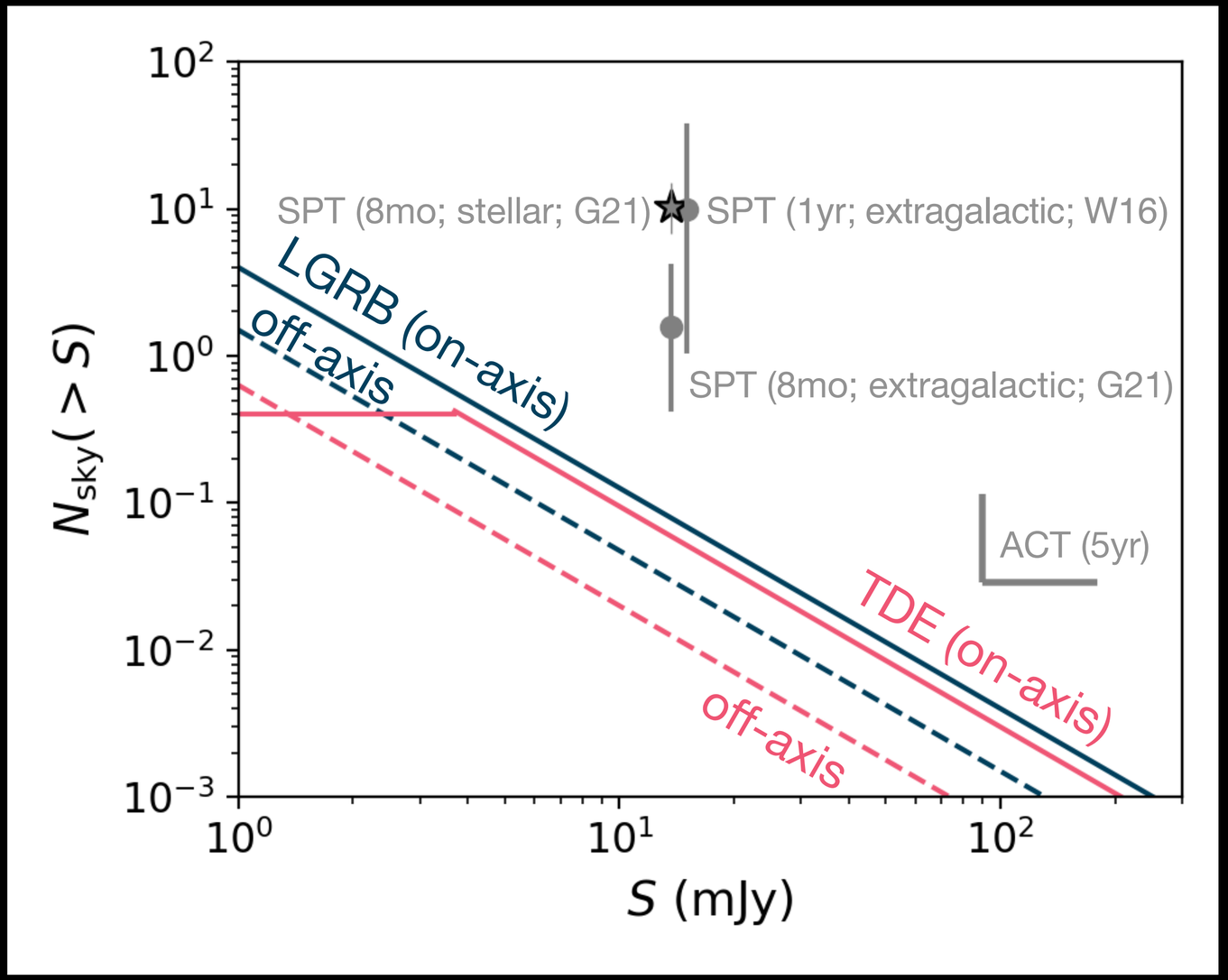
~90 mJy (6σ)

Transient searches at millimeter wavelengths

Takeaways:

- Systematic searches let us construct a logN-logS diagram & measure rates

- Many stellar flares (see parallel session)

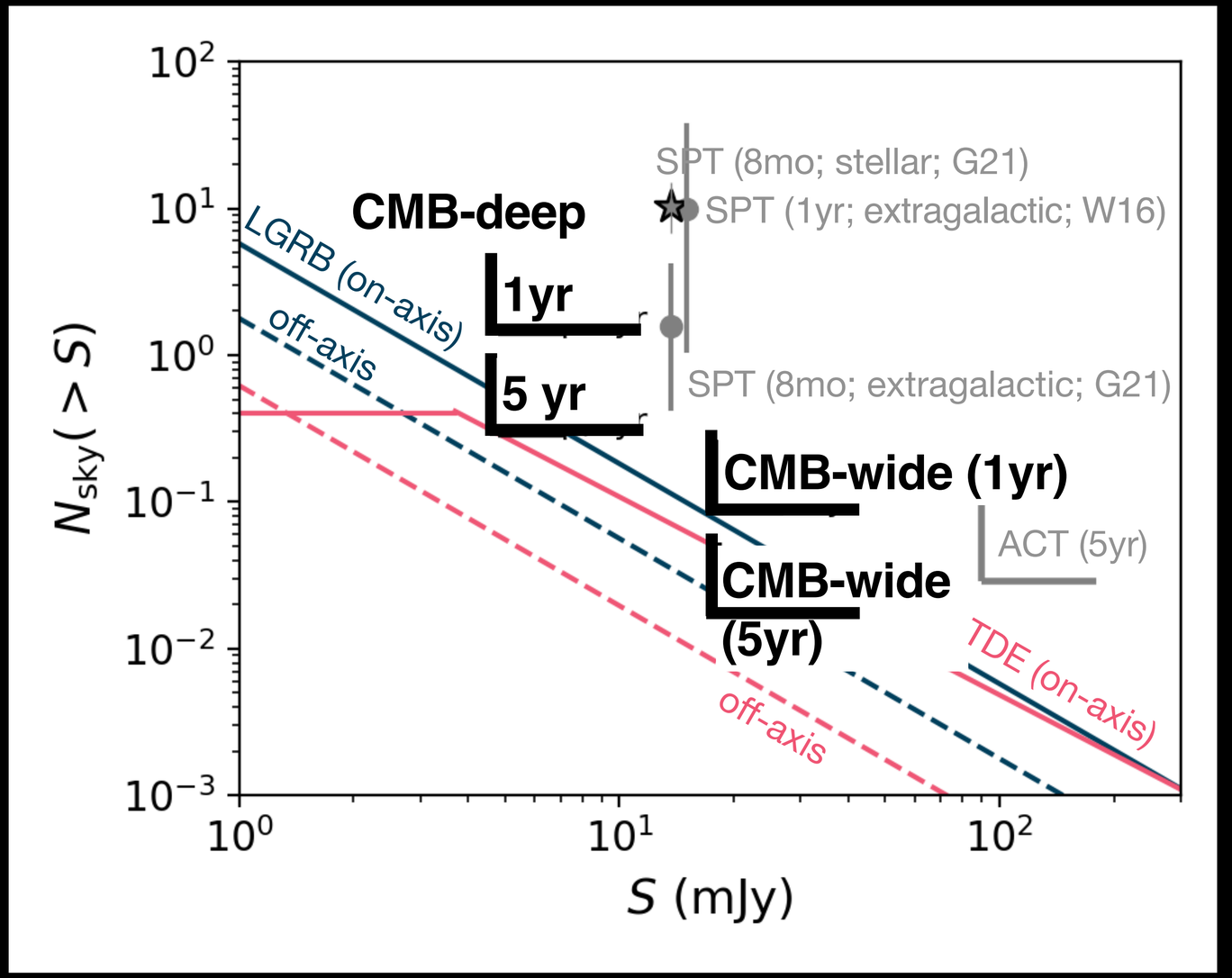


CMB-S4 capabilities

More sensitive + wider area

Wide survey (Chile):
half-sky at ~daily cadence
~18 mJy (6σ) in 1 week

3% sky: deep survey (Pole)
~5 mJy (6σ) in 1 week



Relativistic explosions: long-duration gamma-ray bursts (GRBs)

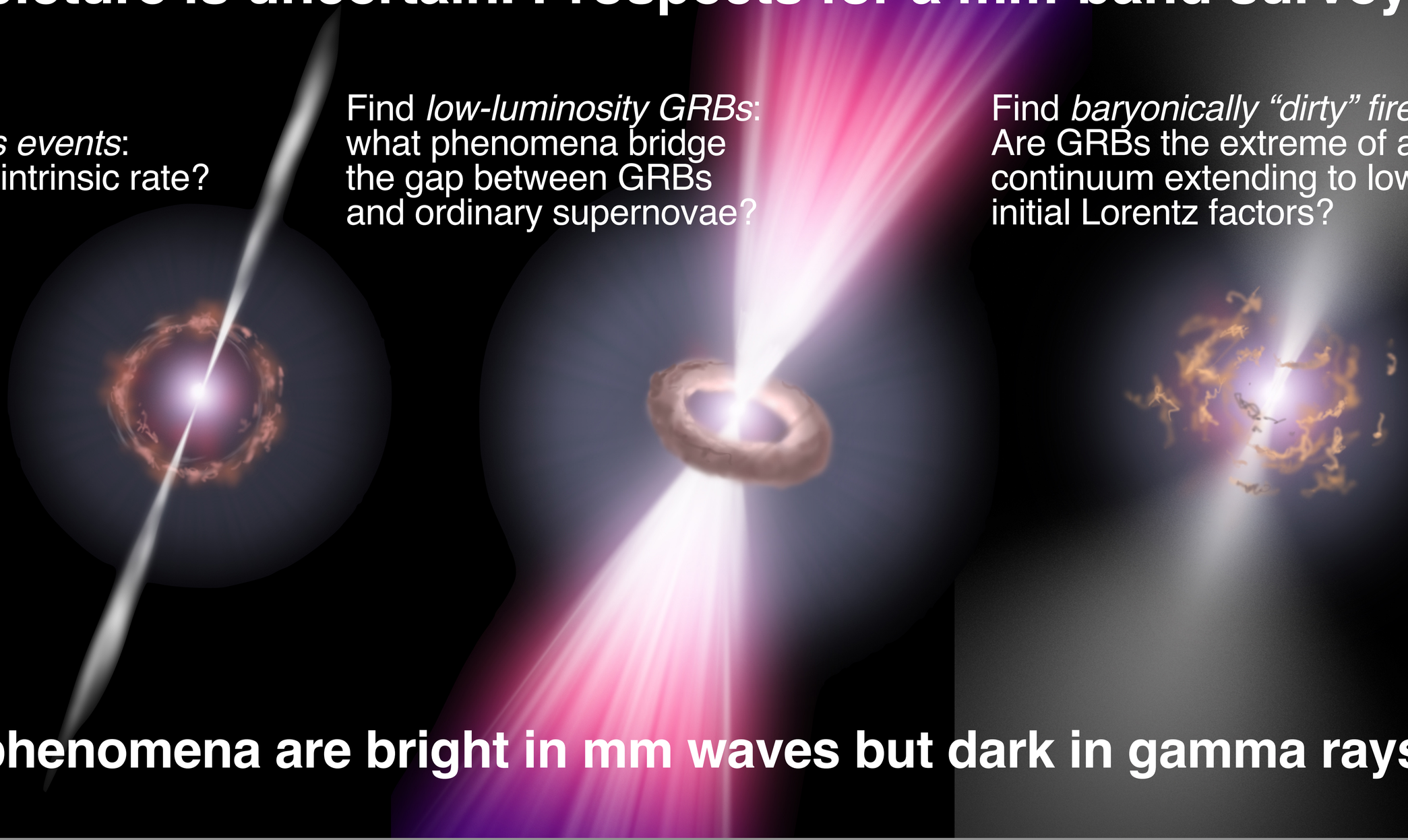
NASA's Goddard Space Flight Center

Basic picture is uncertain. Prospects for a mm-band survey:

Find *off-axis events*:
What is the intrinsic rate?

Find *low-luminosity GRBs*:
what phenomena bridge
the gap between GRBs
and ordinary supernovae?

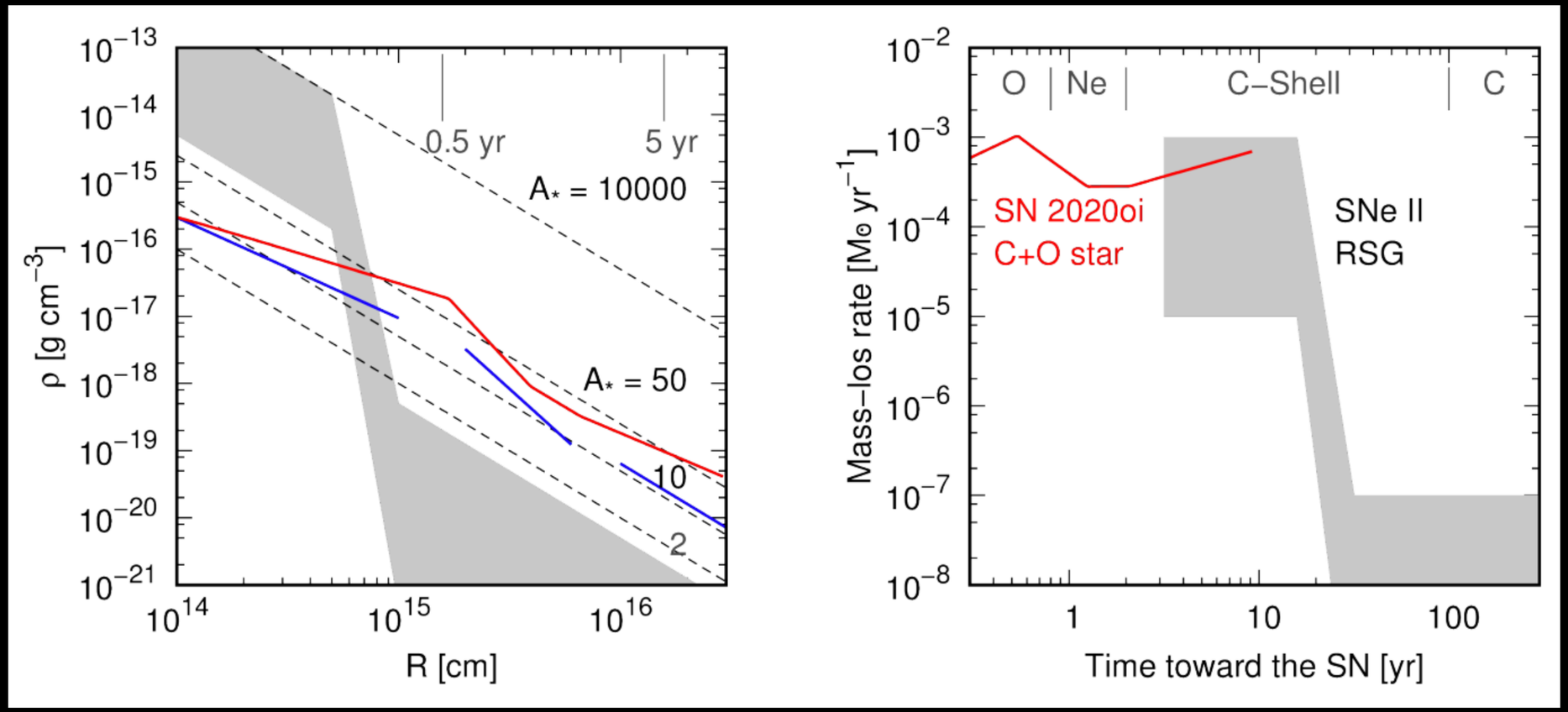
Find *baryonically "dirty" fireballs:*
Are GRBs the extreme of a
continuum extending to lower
initial Lorentz factors?



These phenomena are bright in mm waves but dark in gamma rays

Stellar astrophysics: the final years in the lives of massive stars

Instabilities -> star ejects matter -> dense material surrounding star at the time of explosion -> luminous mm emission



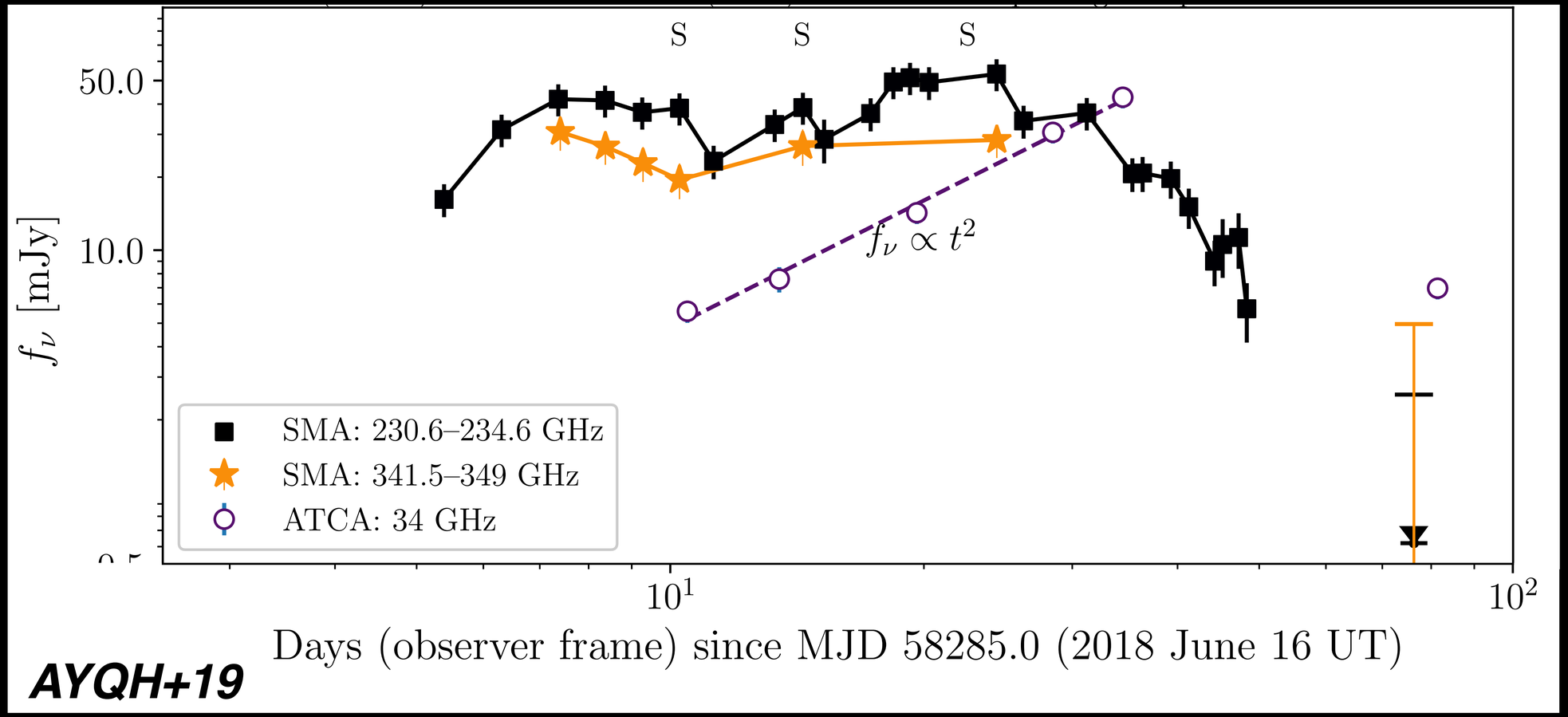
ALMA observations of SN2020oi (Maeda+2021)

Extreme case: AT2018cow & analogs
(Prentice+18, Perley+19, Margutti+19, many others)

Optical transients that are much faster and more luminous than ordinary supernovae

AT2018cow (z=0.014): ~50 mJy for one month at 230 GHz (AYQH+19)

AT2020xnd (z=0.244): ~1 mJy for one month at 100 GHz (AYQH+ in prep.)

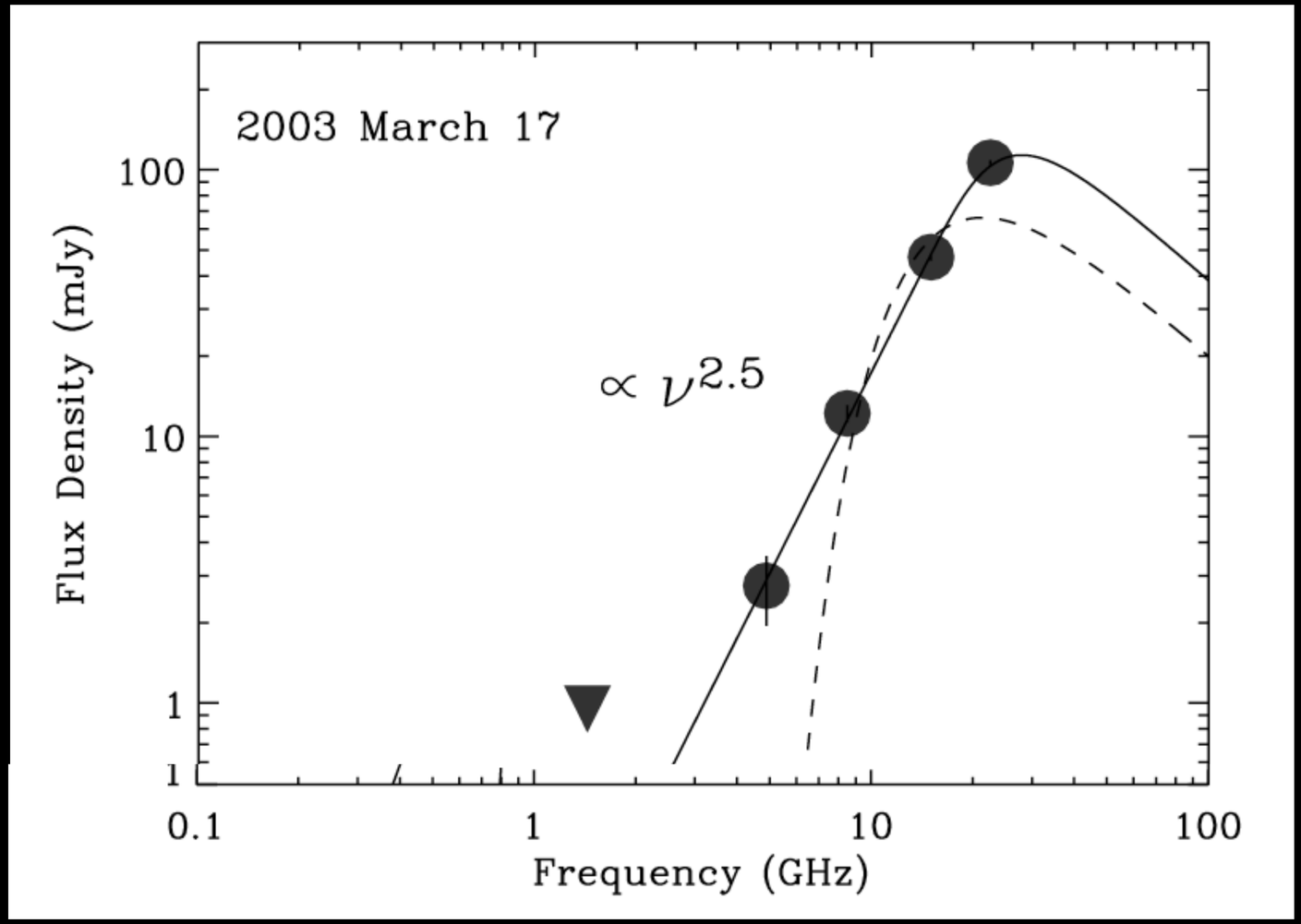


Prospects from CMB-S4

Rare (Coppejans+20,AYQH+21), so rate in CMB-S4 is < 3 per year (wide) and < 1 per year (deep)

Do other SNe exhibit similar behavior?

Cross-match with supernova surveys in the South



SN2003bg (Soderberg 2006)

Schedule

Parallel Session

1) ***GRBs*** (science driver)
   … Antonio de Ugarte Postigo
   … Tanmoy Laskar
   … Discussion
2) ***Stellar Flares*** (recent Stage 3 results)
   … Rachel Osten
   … Meredith MacGregor
   … Discussion

Plenary Summary

1) ***The radio transient sky***: Gregg Hallinan
2) ***Summary***: AYQH