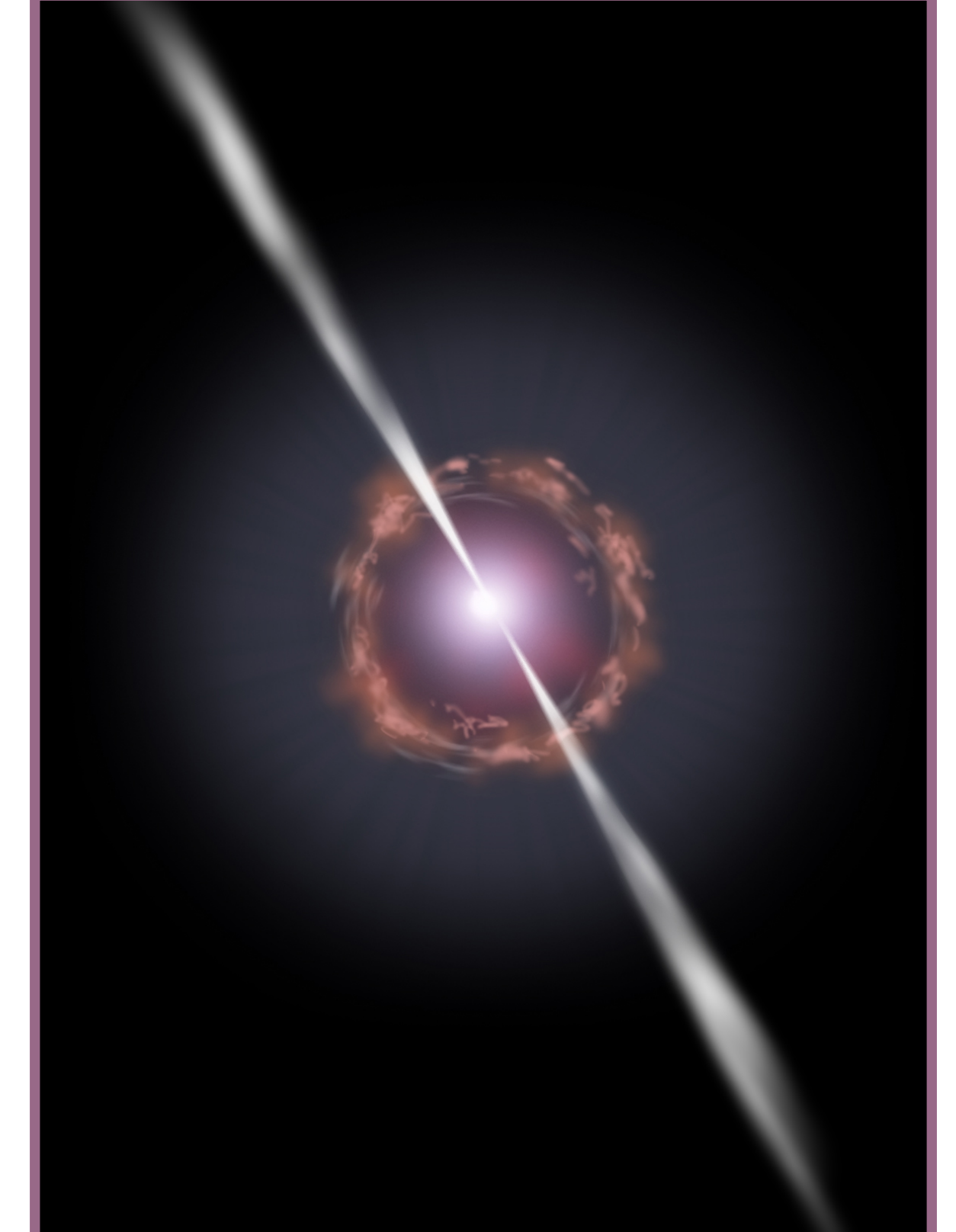


Small subset of the

Sources & Transients AWG: [^]Transient Science

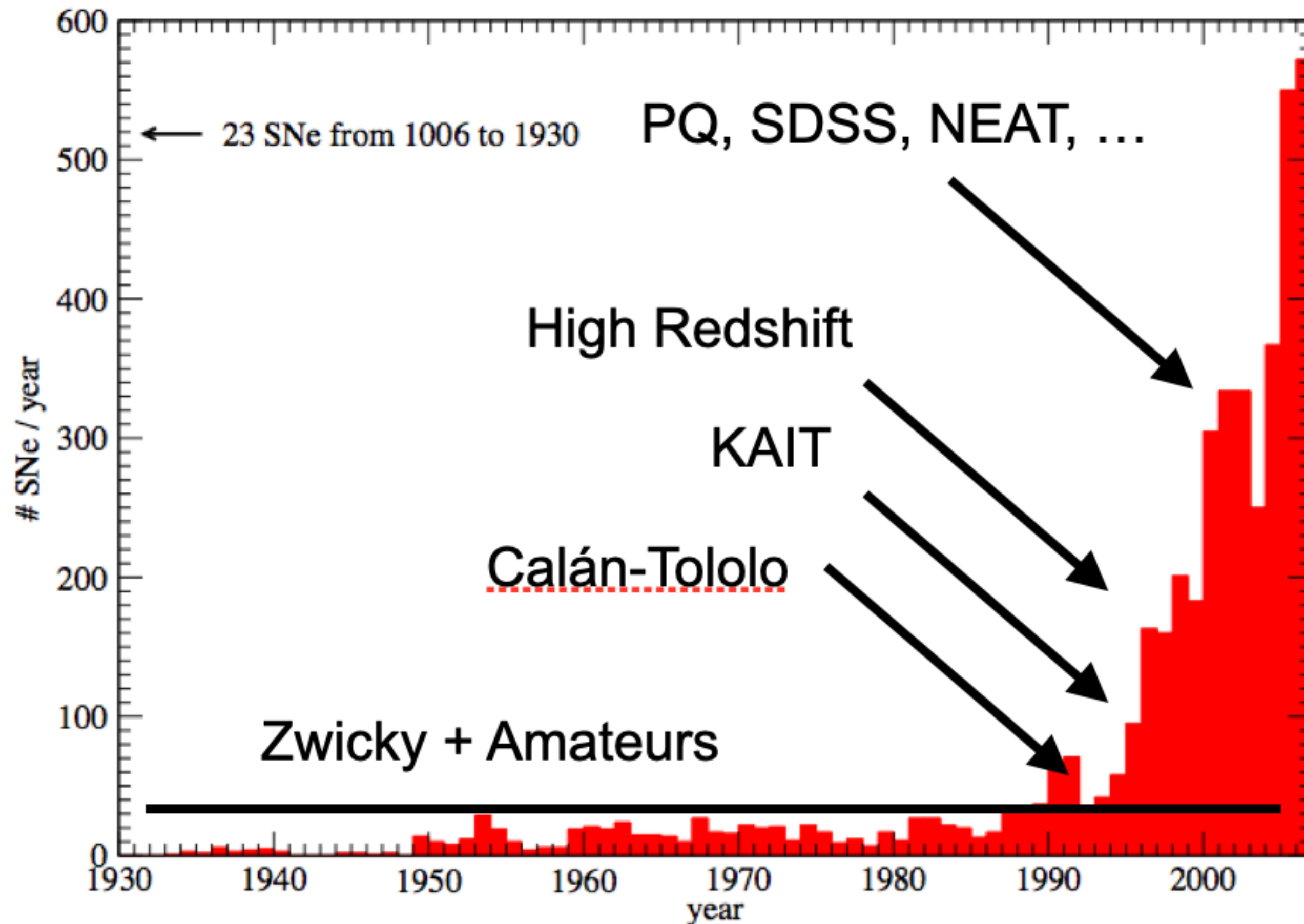


Anna Y. Q. Ho (Assistant Professor, Cornell)
On behalf of the sources & transients WG

Overview

- Co-conveners: Joaquin Vieira (UIUC) & Tom Maccarone (TTU)
- Science driver: transient and variable sources
- Biweekly telecon series
- Currently preparing for the science book
- Wide range of astrophysics: variable (e.g., AGN), Galactic (stellar flares), transient (GRBs, TDEs, SNe), solar system (asteroids, planets)

Context: TDA landscape



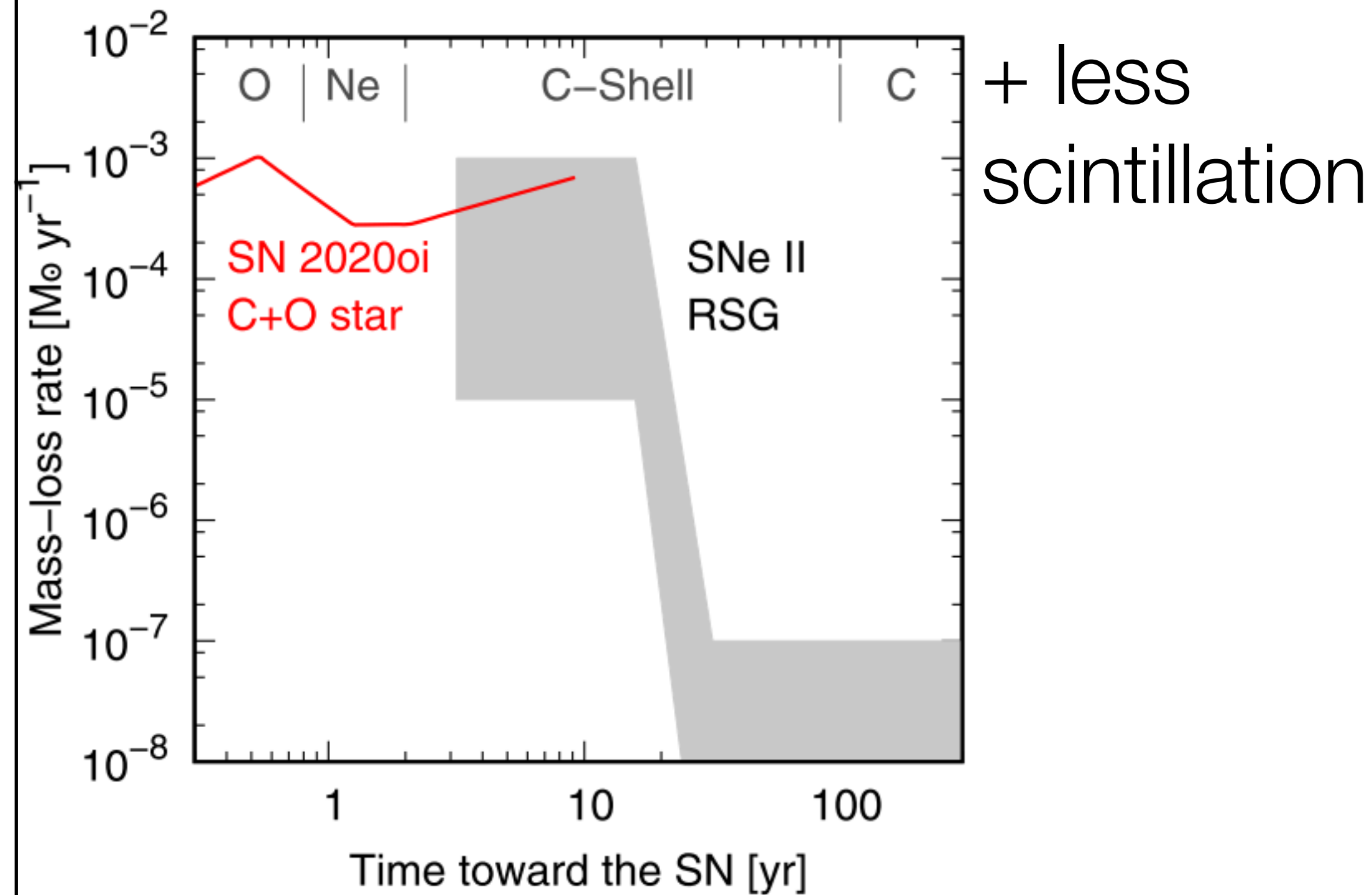
- Every second: 1 SN in the universe
- Every night: optical surveys map sky $>1x$, discover 48-72 hr old explosion
- Every year: *thousands* of transients discovered *and* spec. classified
- Big surprises (e.g., $\sim 10\%$ massive stars explode in dense CSM at <100 AU)
- This decade: large-scale time domain surveys at other wavelengths (X-ray, UV, IR, cm radio)

Why the mm band?

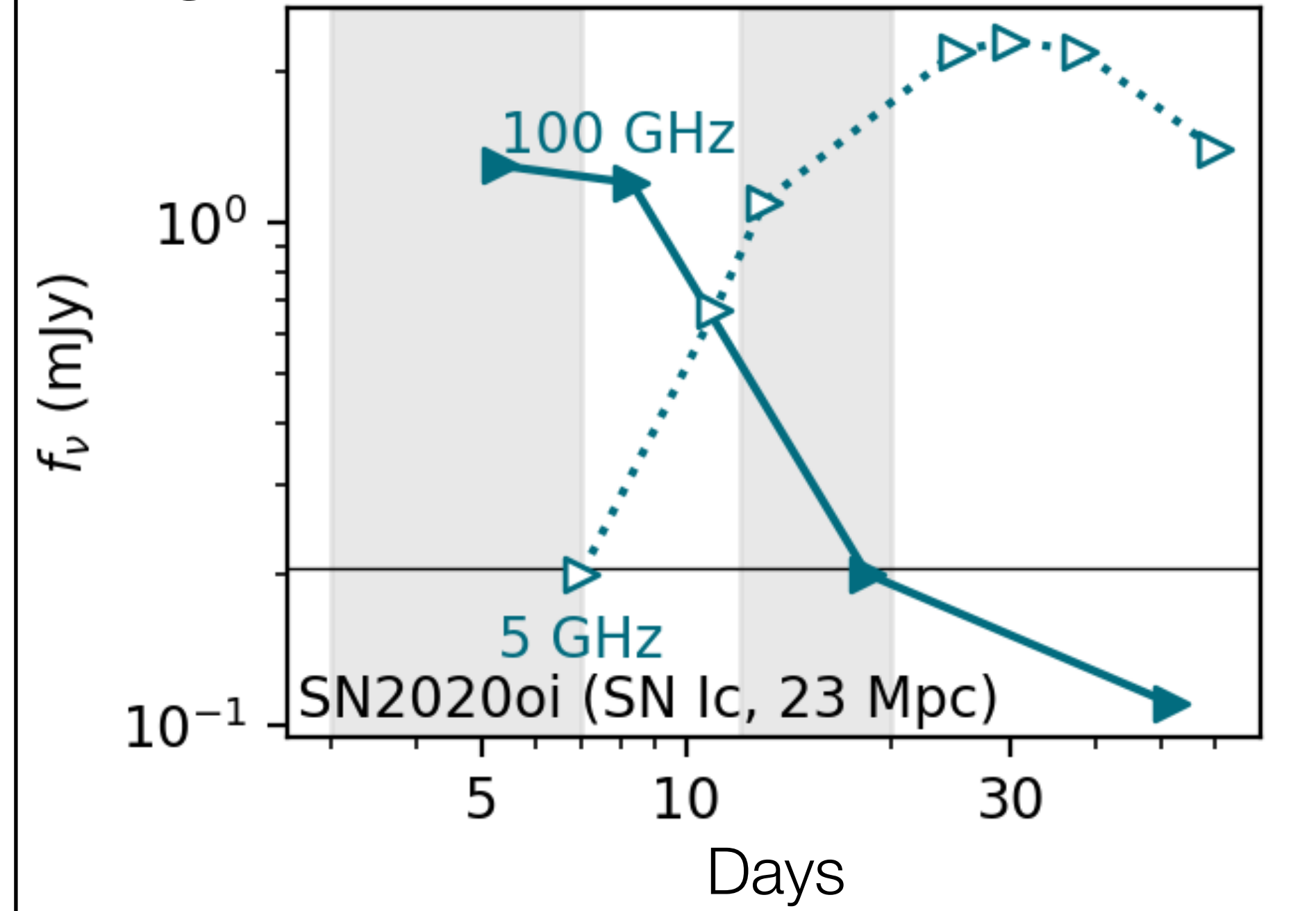
Basic feature of energetic transients: radio (cm-mm) emission...decades-long cm history

Emission: synchrotron, free-free

Modeling: velocity, *density*, energy



High densities: cm absorbed



Distinct components: reverse shock, relativistic Maxwellian electrons, ...

Example #1: Long-duration gamma-ray bursts (GRBs)

Major open questions

- Rate (nucleosynthesis, explosion mechanism)

CMB-S4: find without GRB trigger

- Off-axis events
- New classes

- Launch/powering mechanism

CMB-S4: reverse shock

- Fast: e.g. for GRB161219B, ALMA observations at 1.4 & 3.4 days still had significant RS contribution

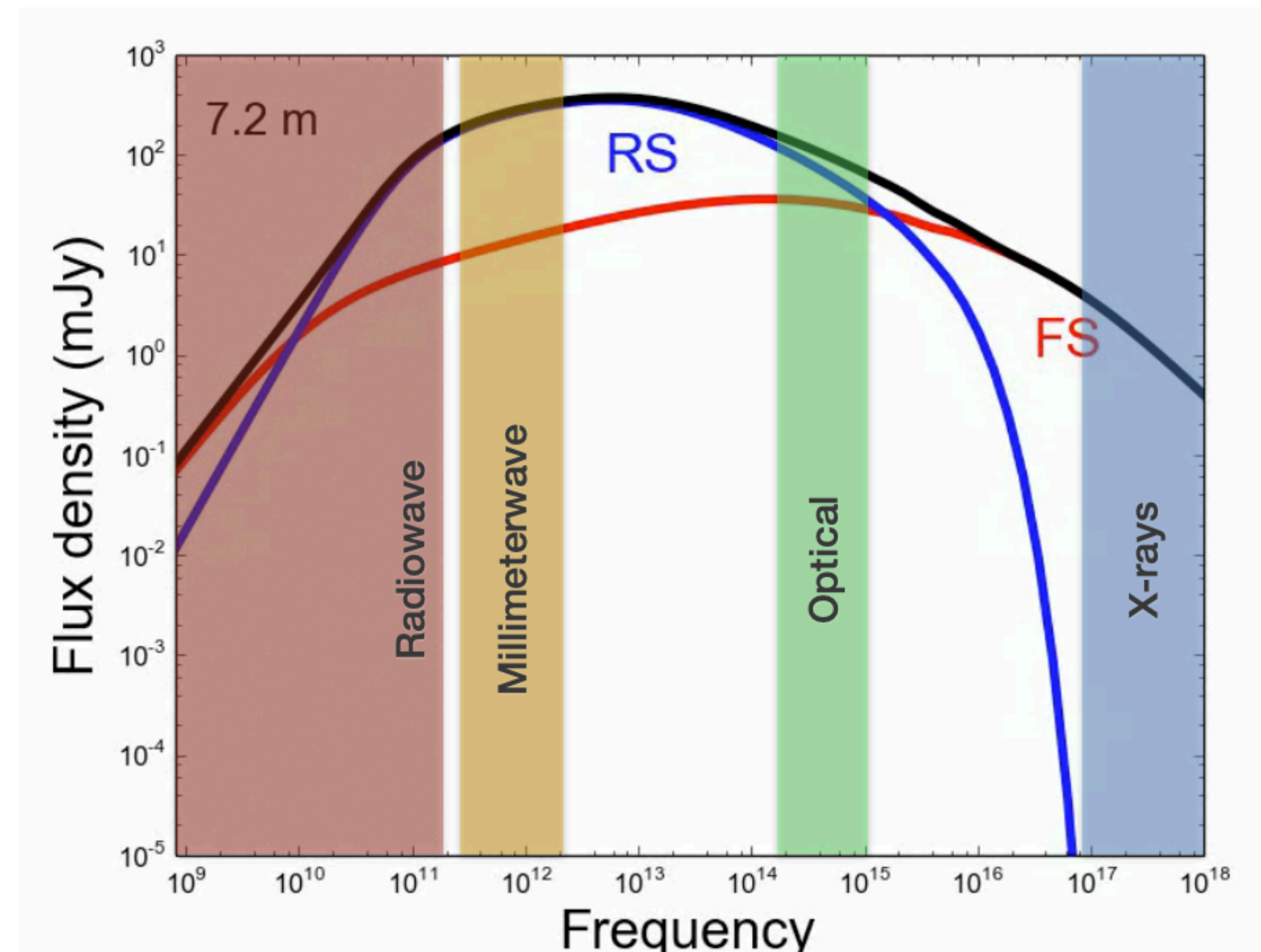
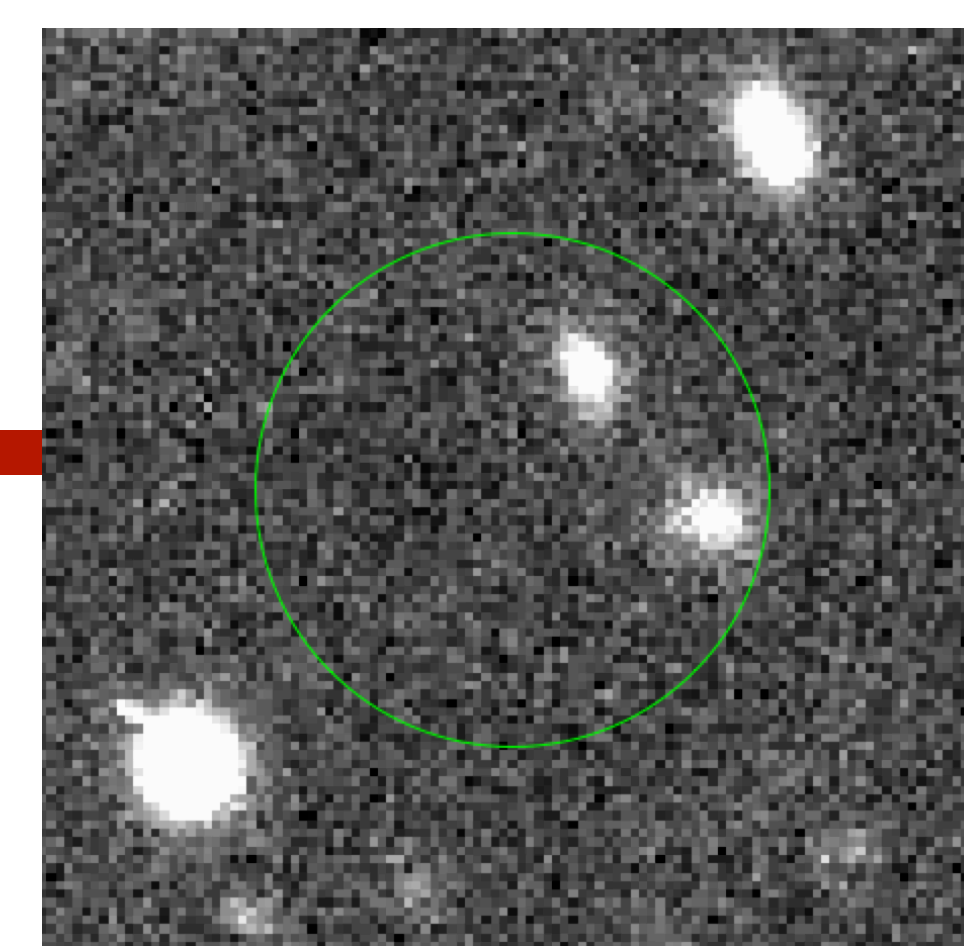


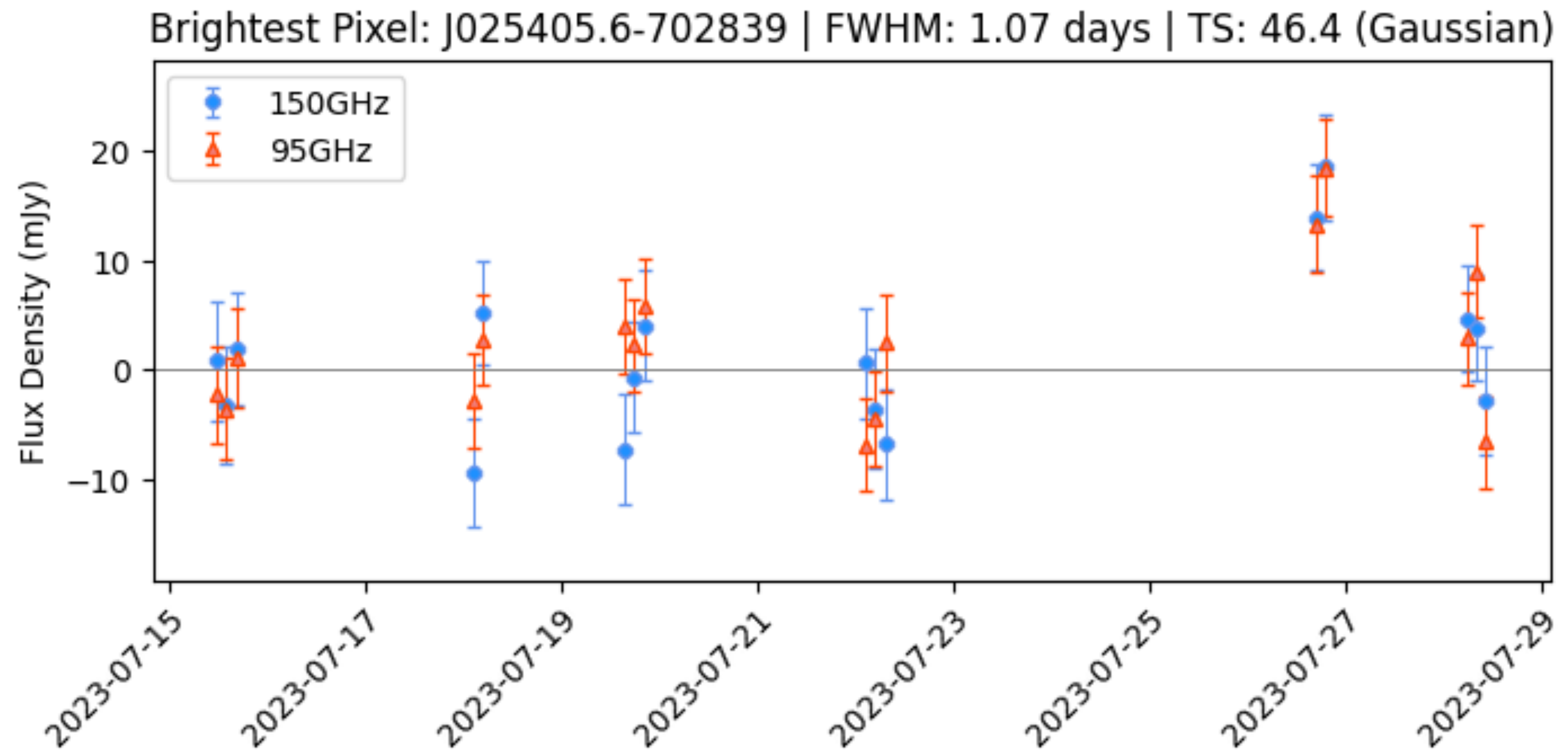
Figure from Tanmoy Laskar

Proof of concept from SPT



26 July 2023: SPT detection
31 July: GCN alert
2 Aug: ALMA DDT subm. (PI Ho)
5 Aug: DDT accepted
9 Aug: Observed (20 μ Jy RMS)
No detection (dt=14d)

**Need faster follow-up for
localization (which enables
other follow up)**

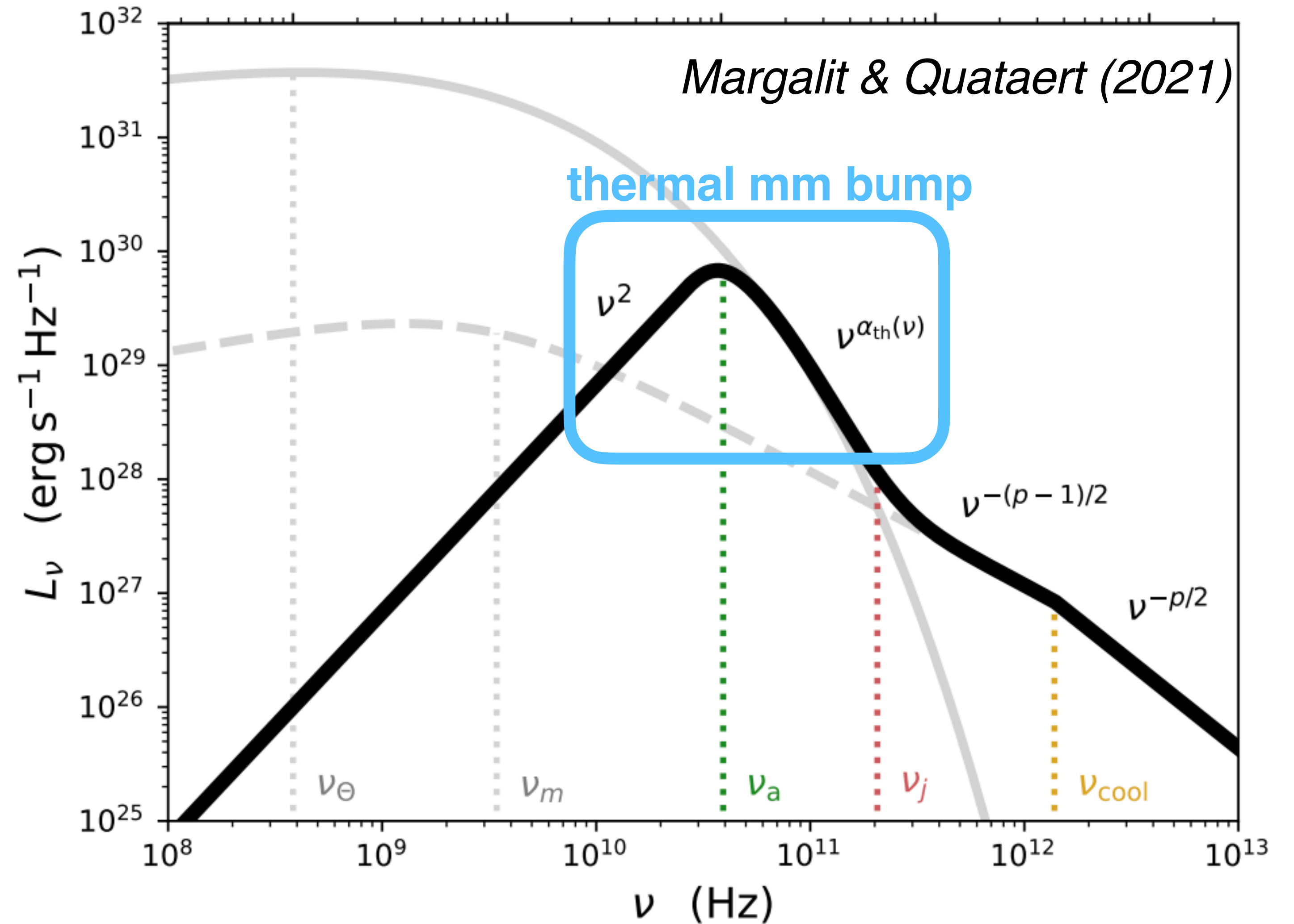


Example #2: Particle acceleration in shocks

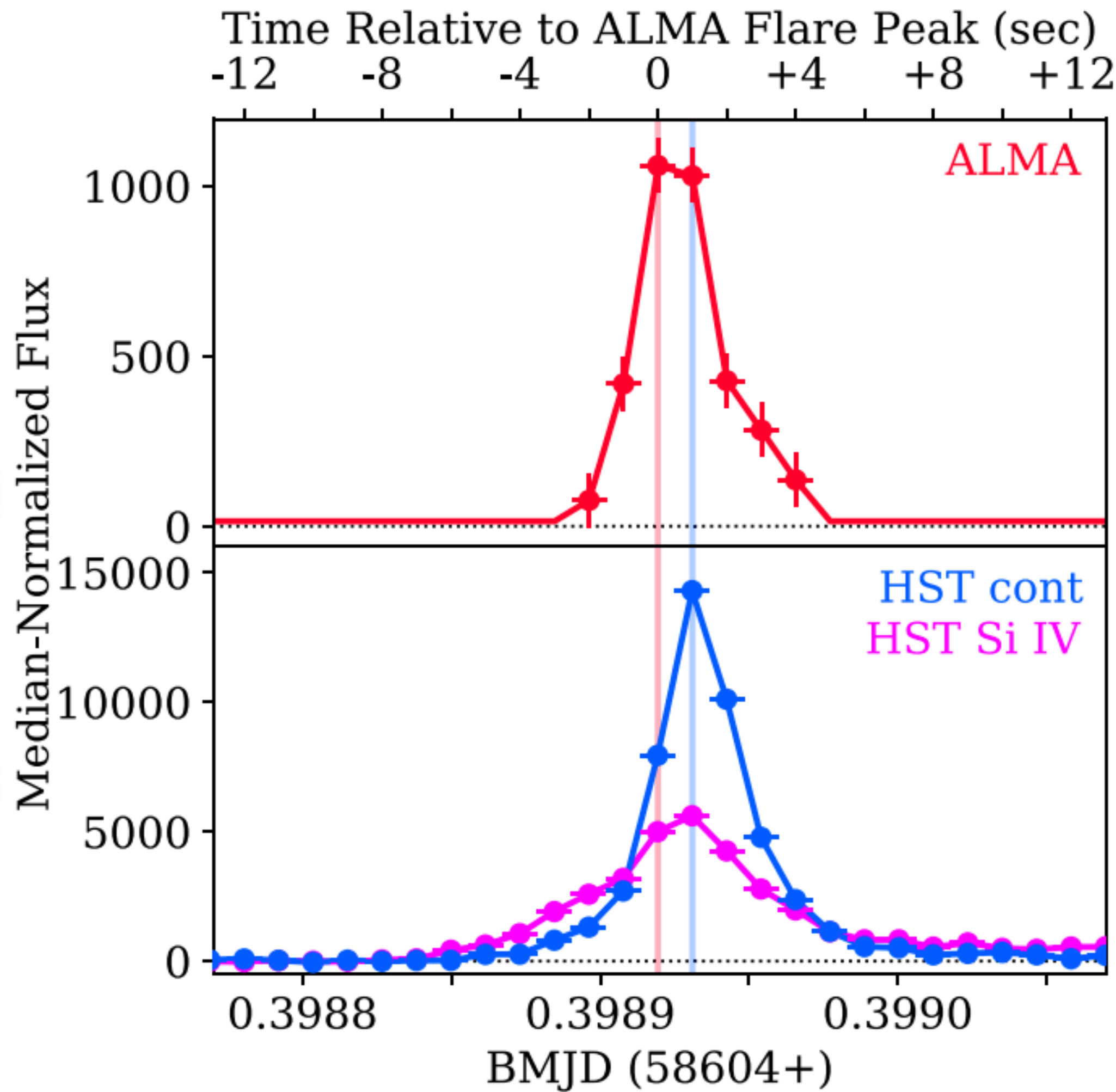
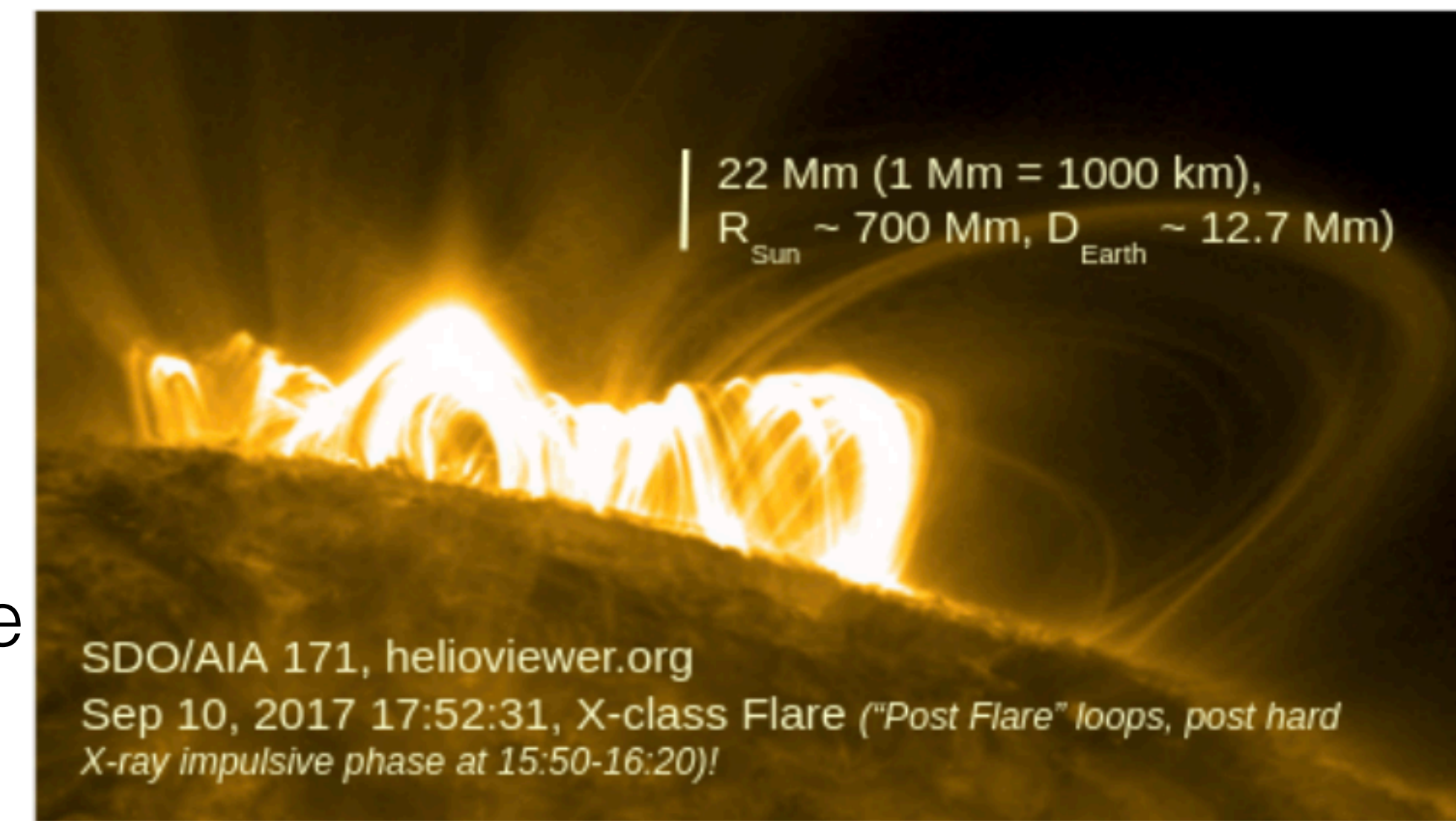
Margalit & Quataert (2021):

- Events with high shock speeds ($v > 0.1c$)
- Observed at mm/sub-mm wavelengths

Key: very high-frequency (>300 GHz) observations



Example #3: Stellar Flares



Magnetic energy release in atmosphere

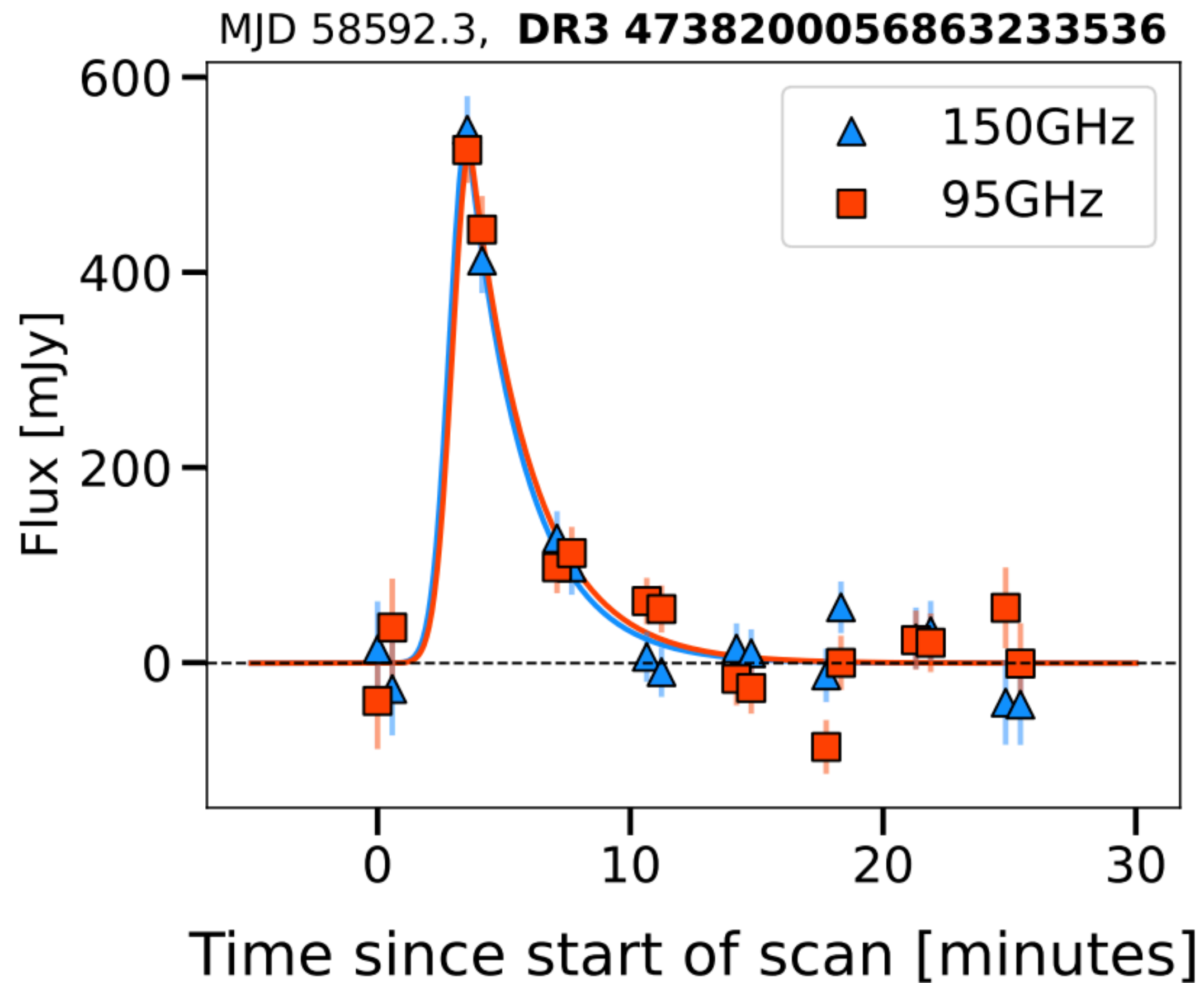
Resurgence with Kepler, TESS

Science questions (Kowalski 2024):

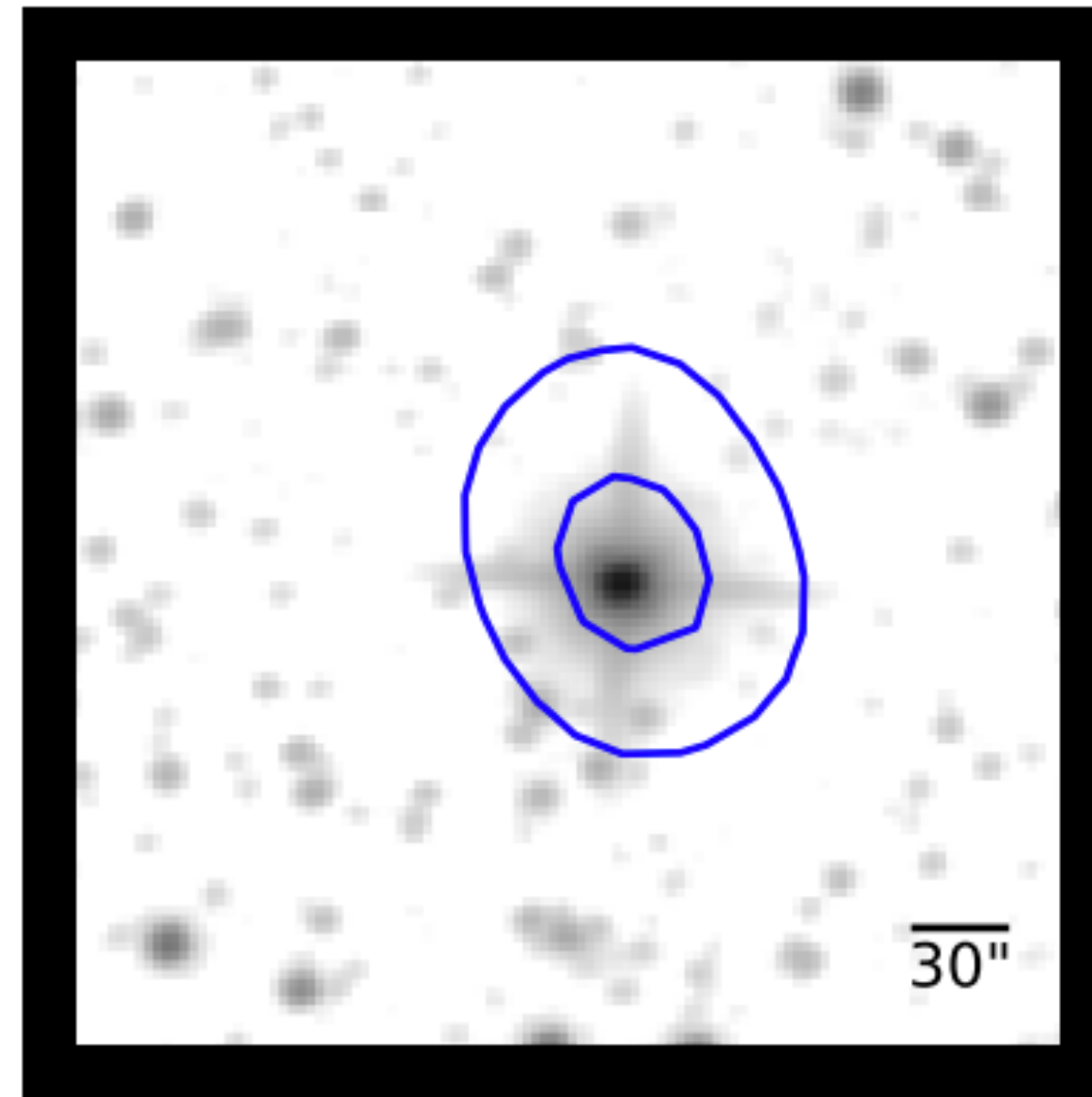
- Exoplanet habitability & photochemistry
- Connect flare energy (esp. \gg solar) to magnetic fields, particle acceleration, footprint, energy transport
- Rate of superflares across stellar age/type
- Model for long (mins to hours) flares
- Emission: how/when nonthermal particles are accelerated

Fig. from MacGregor et al. 2021;
 for review see Kowalski 2024

Proof of concept from SPT and ACT



Tandoi et al. 2024



- 10^2 detected
- Duration minutes to hours
- < 1 kpc

Naess et al. 2021, Guns et al. 2021,
Li et al. 2023, Tandoi et al. 2024

Anna Y. Q. Ho (Asst. Prof., Cornell)

Key for CMB-S4: fast timescales, multi-frequency, all sky

How to Get Involved

- Meeting: Alternating Thursdays, 10am PT / noon Central / 1pm ET
- Minutes
- Mailing list: sources@cmb-s4.org
- Talk to Joaquin (jvieira@illinois.edu) and/or Tom (thomas.Maccarone@ttu.edu)