Search for SVOM counterparts on multi-wavelength triggers

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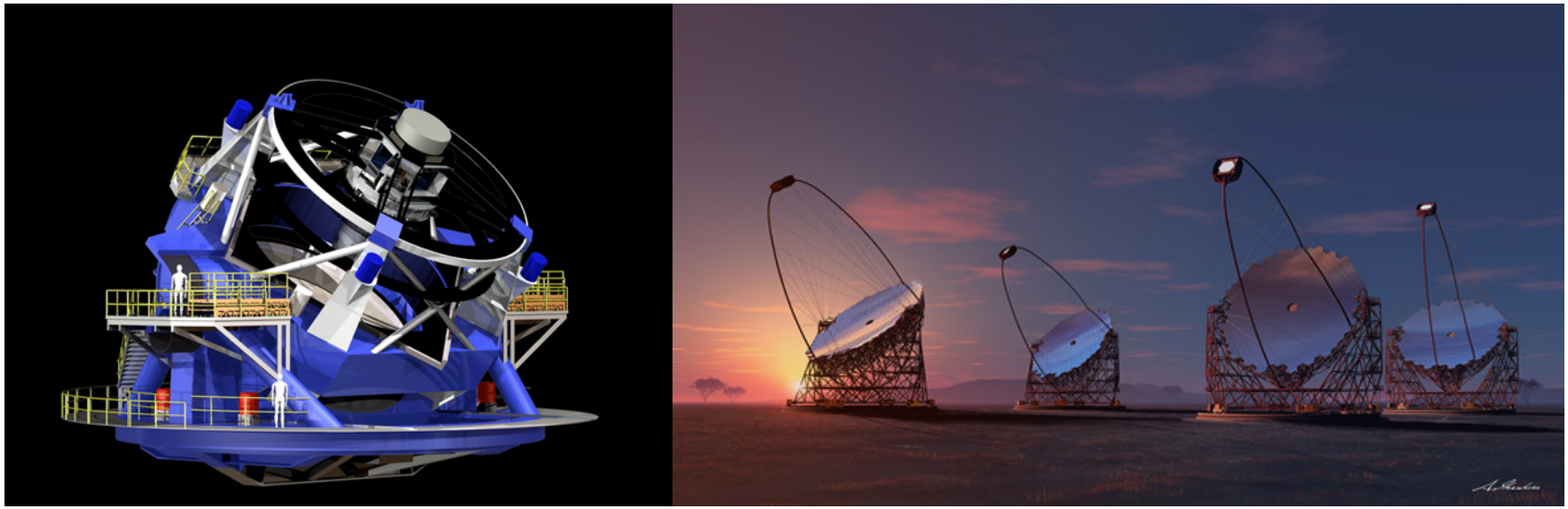
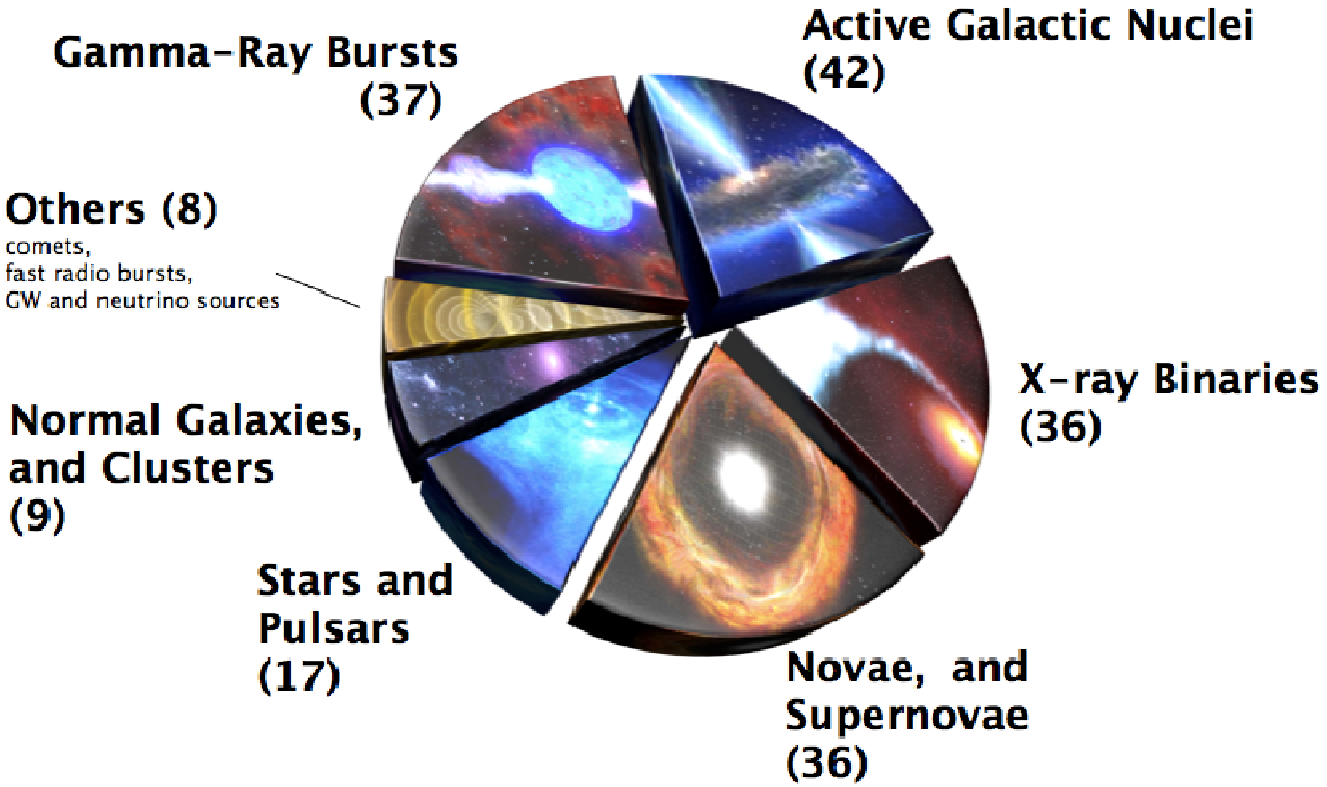
Time-domain era

The next decade is an era when time domain astronomy will truly come of age in terms of multi-wavelength, wide-field sky coverage from the radio to the gamma-ray band plus multi-messenger information.



The large data stream will provide a challenging scientific opportunity for SVOM which will have the on-board capability to obtain multi-wavelength follow-up observations.

Cycle 12 Swift GI Proposals



Plus 34 proposals for joint observations: NRAO, Chandra, XMM-Newton, Integral

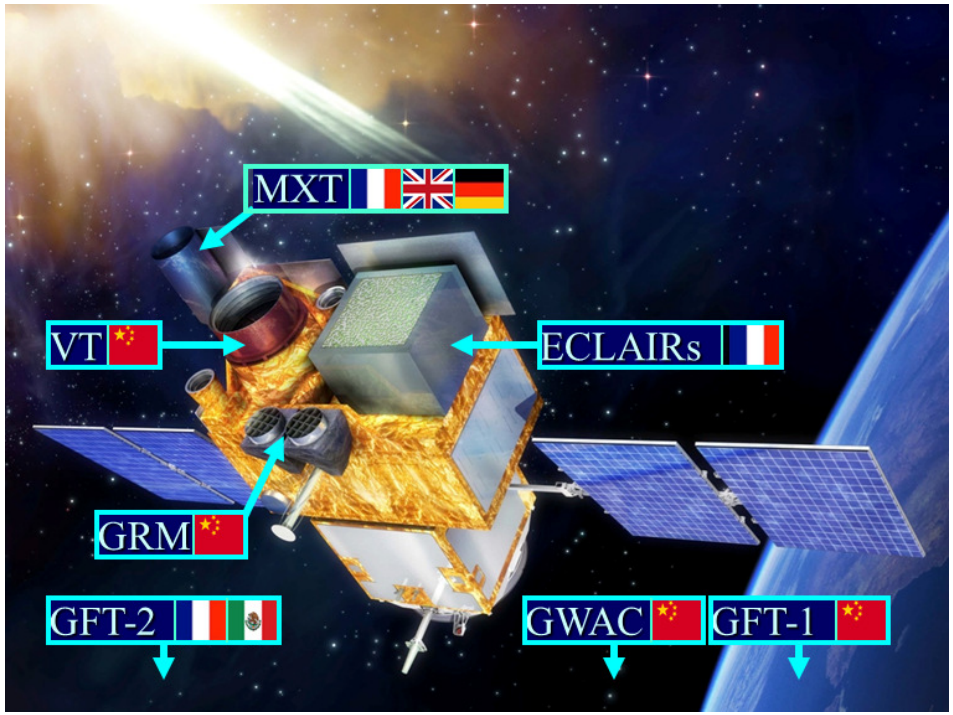
Very diverse topics, most of which are multi-wavelength

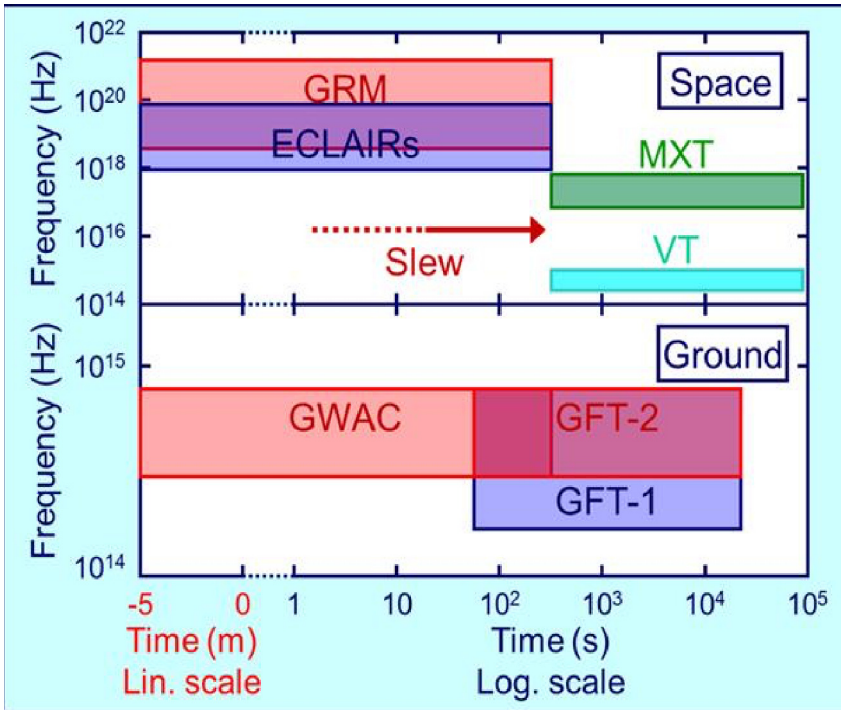
Role(s) of SVOM

Many transient/variable targets will be available for SVOM that require multi-wavelength follow-up. SVOM has multiple potential roles:

1. Follow-up triggers from other facilities, including multi-messenger facilities and any candidate counterparts found by other electromagnetic facilities
2. Trigger multi-wavelength follow-up of SVOM triggers, including faint sources found in ground analysis which did not result in an on-board trigger
3. Monitor sources likely to undergo a transient
4. Survey classes of transients to provide population information

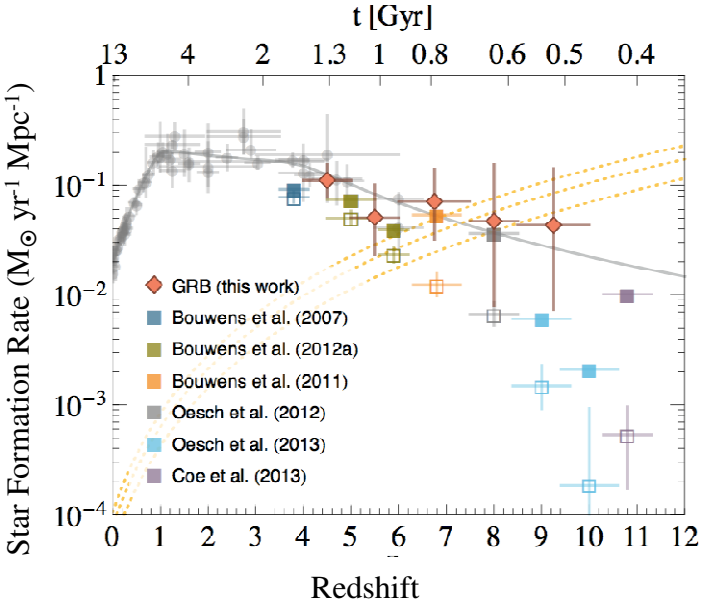
SVOM project capability





Bias to anti-Sun direction makes ground follow-up easier for SVOM triggers.
SVOM ground facilities will provide some redshift indication.

High-z GRBs

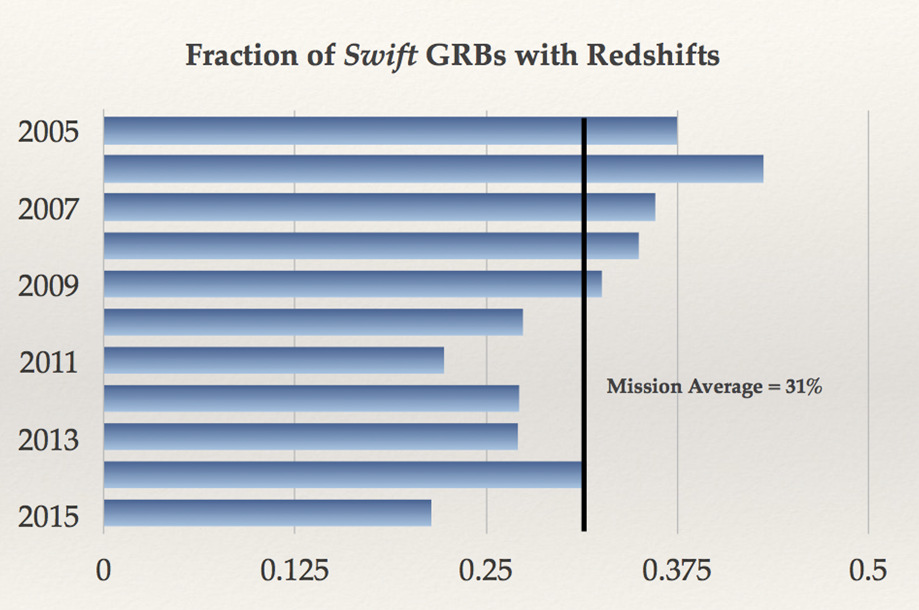


- GRBs are most luminous objects in universe
- Good positions enable ground spectroscopy
- Unique probes of SFR, re-ionization and cosmic chemical evolution

Kistler+ '13, Trenti+ '14, Kistler+ '09
Horiuchi & Beacom '10, Robertson & Ellis '11

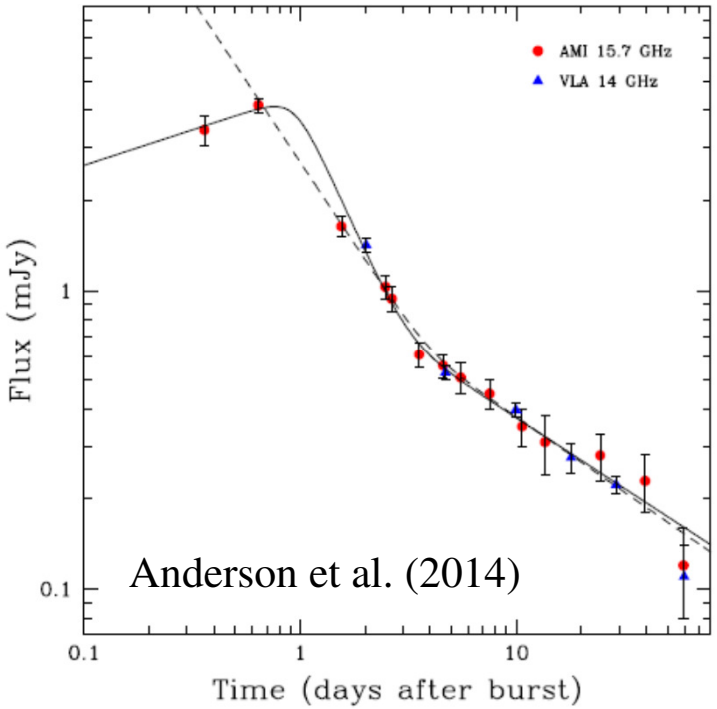
How to get the required imaging and spectra?

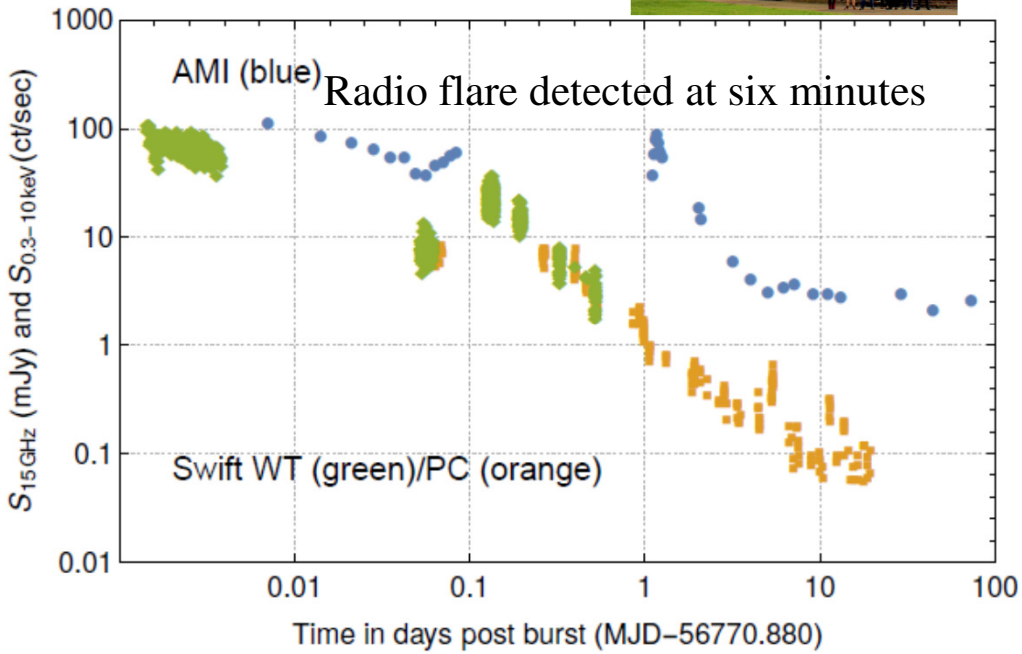
<=4m size telescopes harder to fund



Cenko

Swift + AMI(15 GHz)



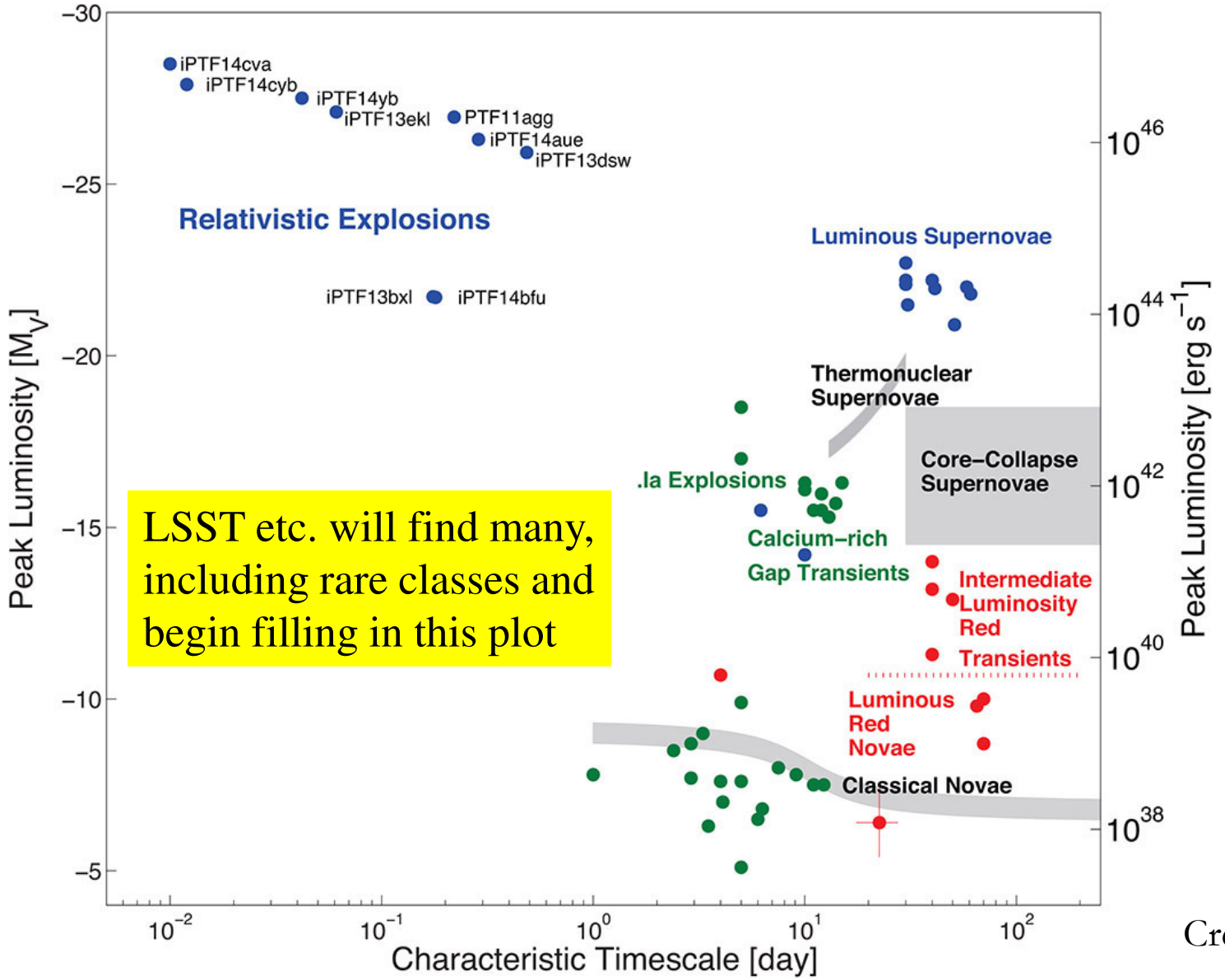


Fender et al. (2015)

Use Large (Ryle) and small (SZ) arrays – started 2012
Early time detection (reverse shock) in GRB
Very fast radio transient from nearby flare star
Very early time radio detection of V404 Cyg 2015
Unbiased catalogue of GRB radio emission

World's only robotic radio telescope array 4pisky.org

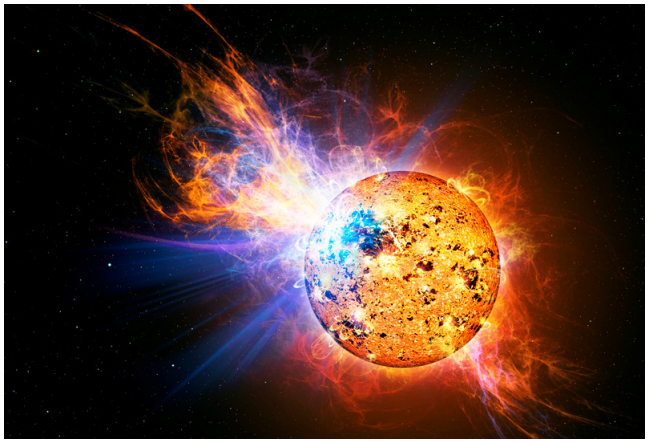
Optical Transients



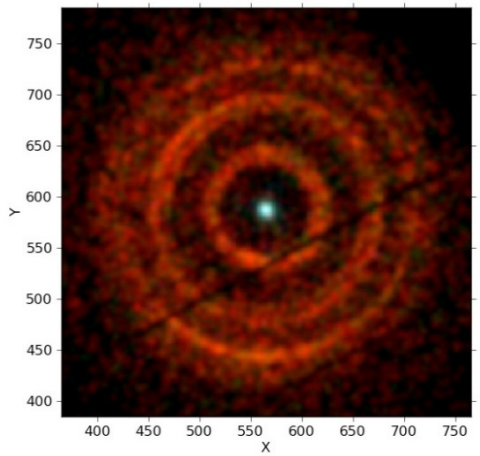
LSST etc. will find many, including rare classes and begin filling in this plot

Credit: PTF

Galactic transients

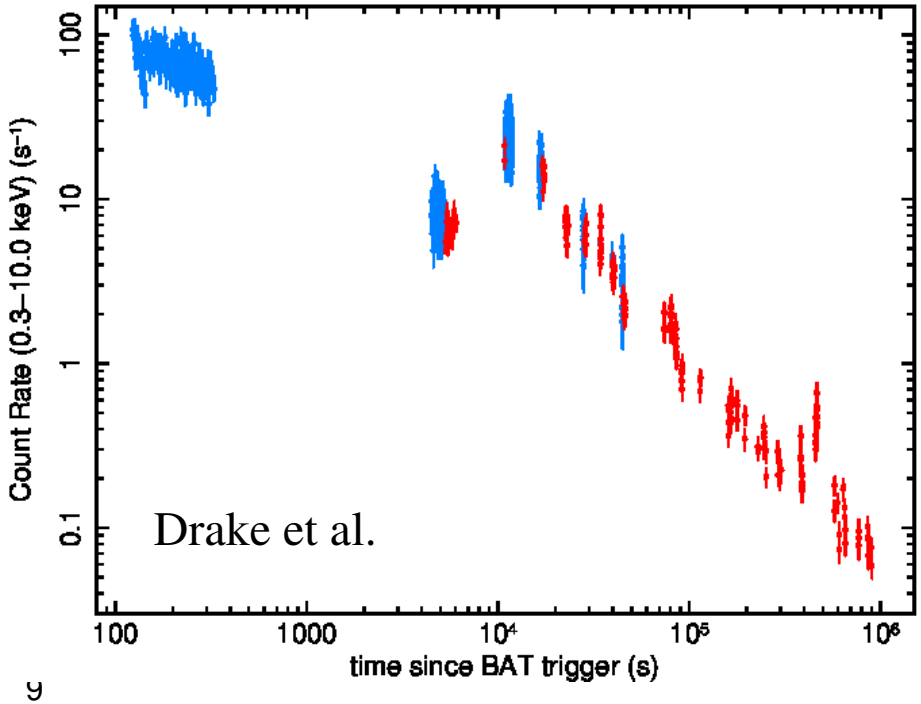


Flare Star DG CVn

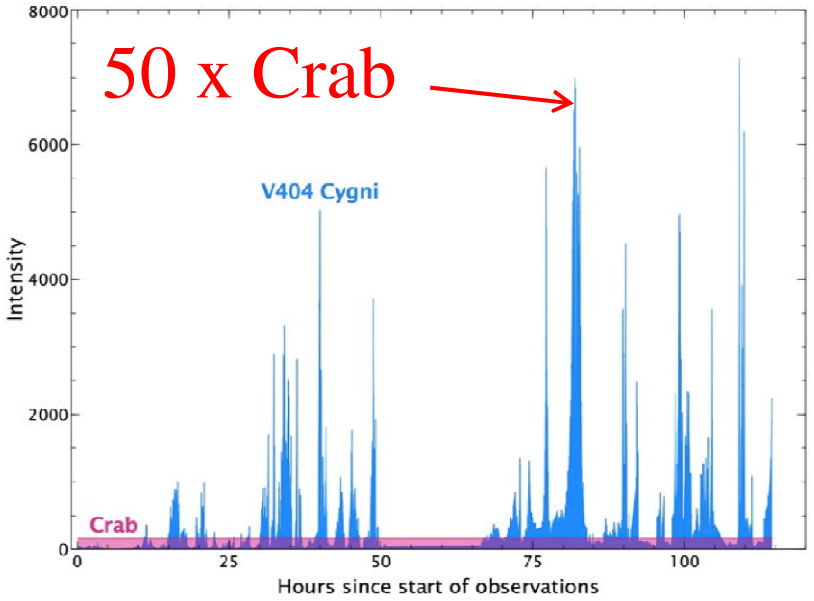


Beardmore

X-ray nova V404 Cyg

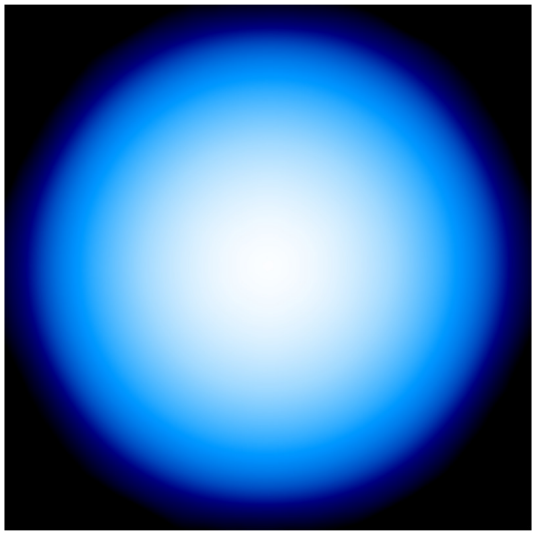


Drake et al.



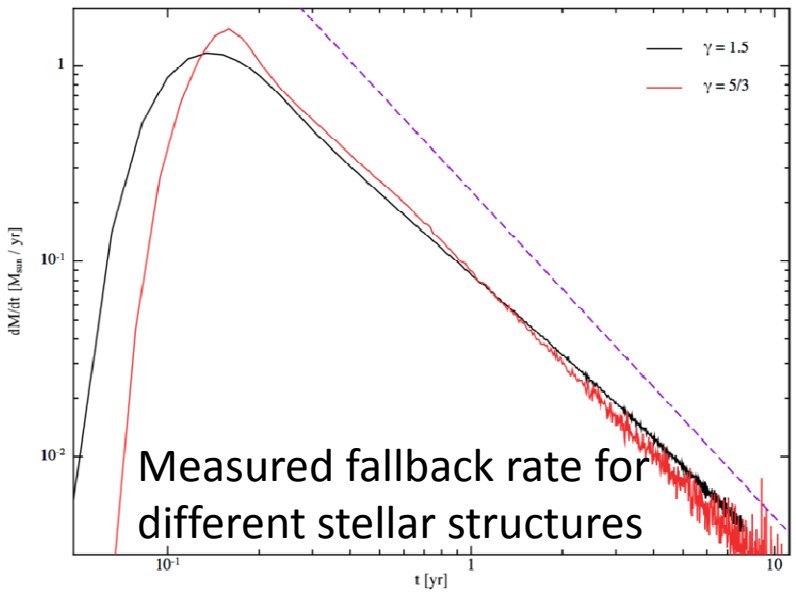
Kuulkers & Rodriguez

Tidal disruption events



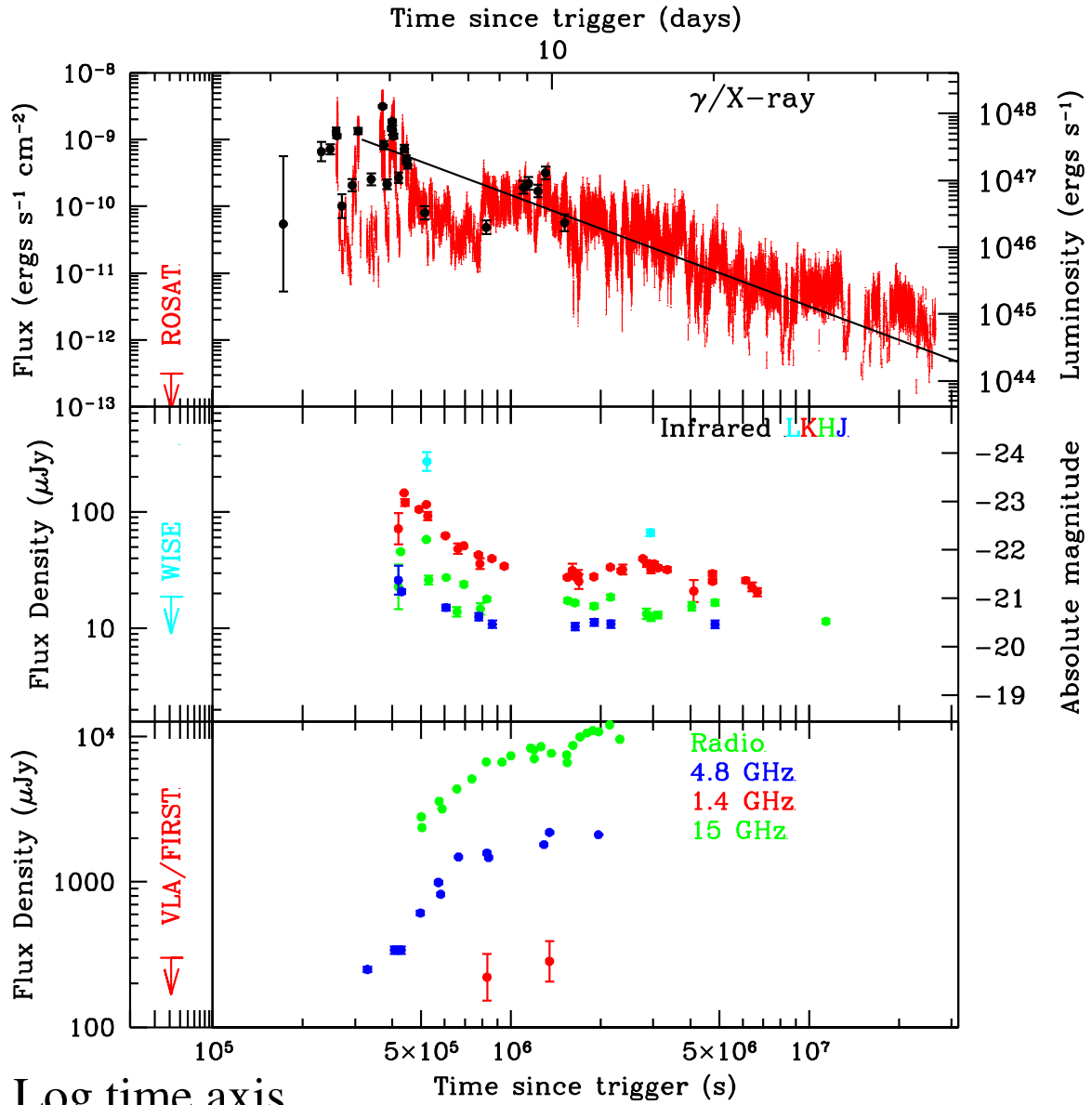
Supermassive black hole destroys a star – result need not be simple…

Coughlin, Nixon et al.



Measured fallback rate for different stellar structures

Swift J164449.3+573451



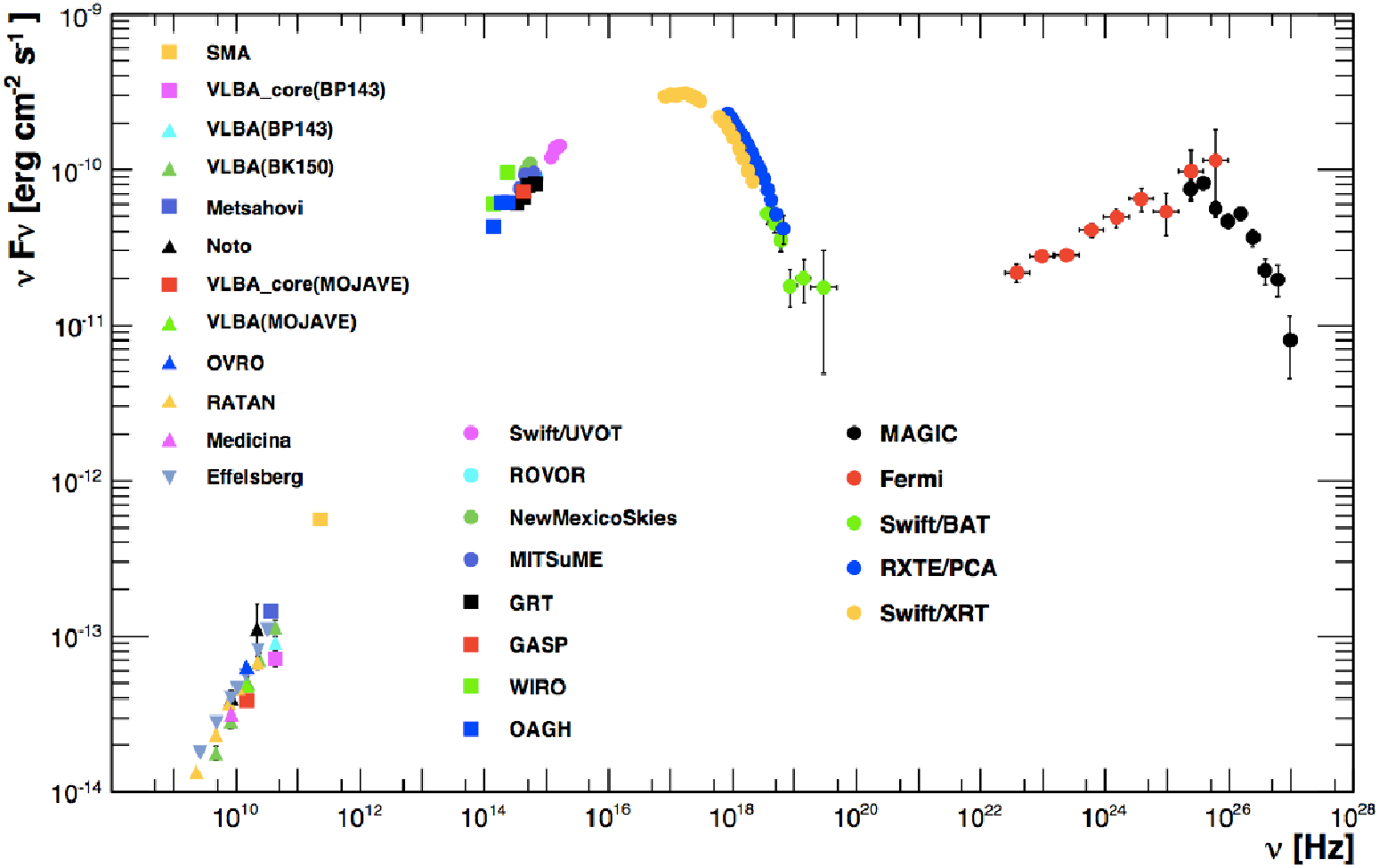
Log time axis

Large amplitude rise from quiescence.
Multiple BAT triggers.
$L_x \sim 10^{47}$ erg s^{-1} for ~2 weeks
Continued variability – particularly "dips"

Peak luminosity ~1000 x Eddington for likely BH mass → superluminal jet
Radio data support presence of rel. jet (Zauderer et al. 2011)

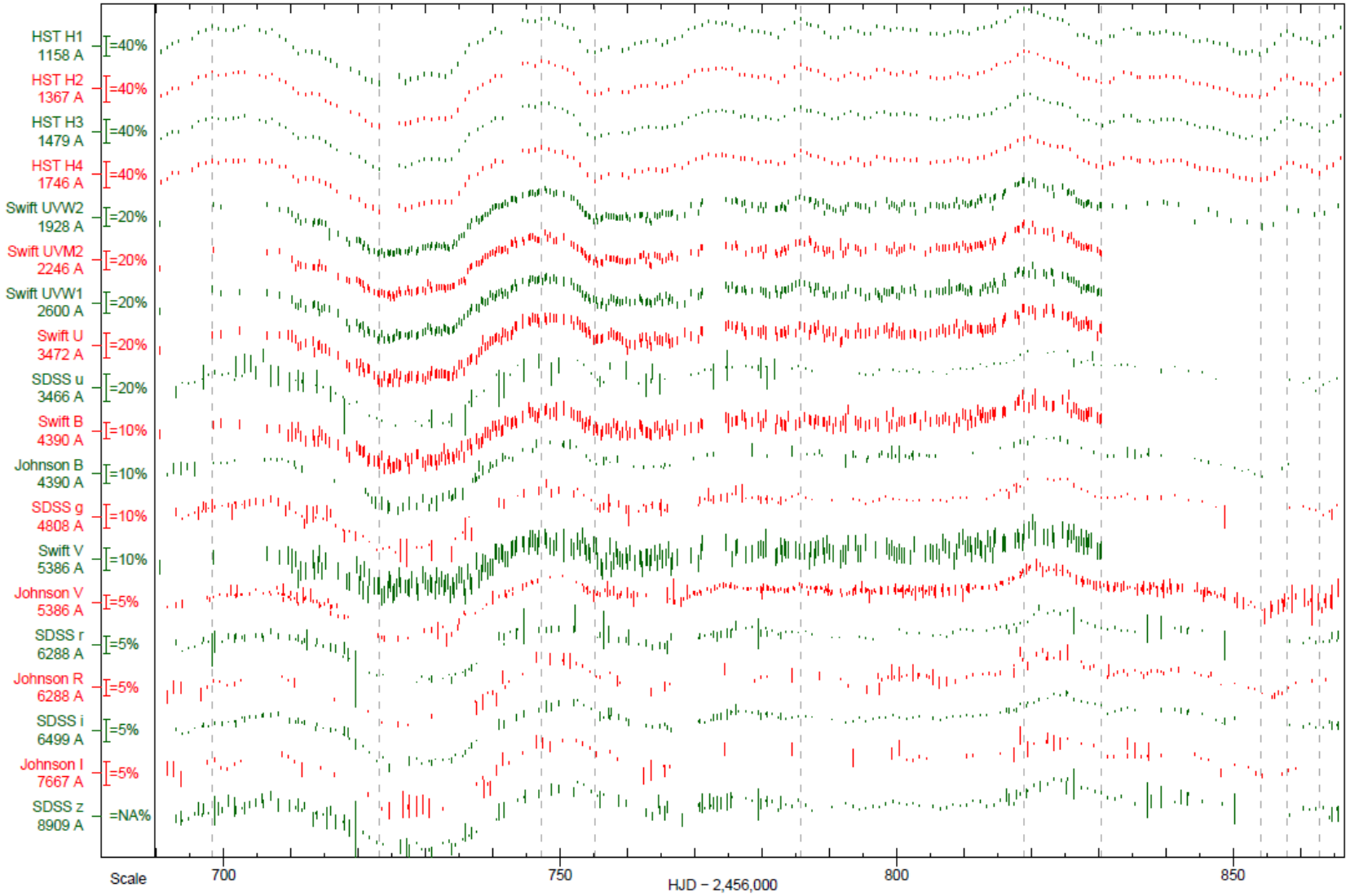
Levan et al. 2011; Burrows et a. 2011; Berger et al. 2012

Blazar SED



Optical and X-ray data can constrain synchrotron versus synchrotron-self-Compton emission. AGN undergoing state change of particular interest.

NGC 5548 – fast monitoring



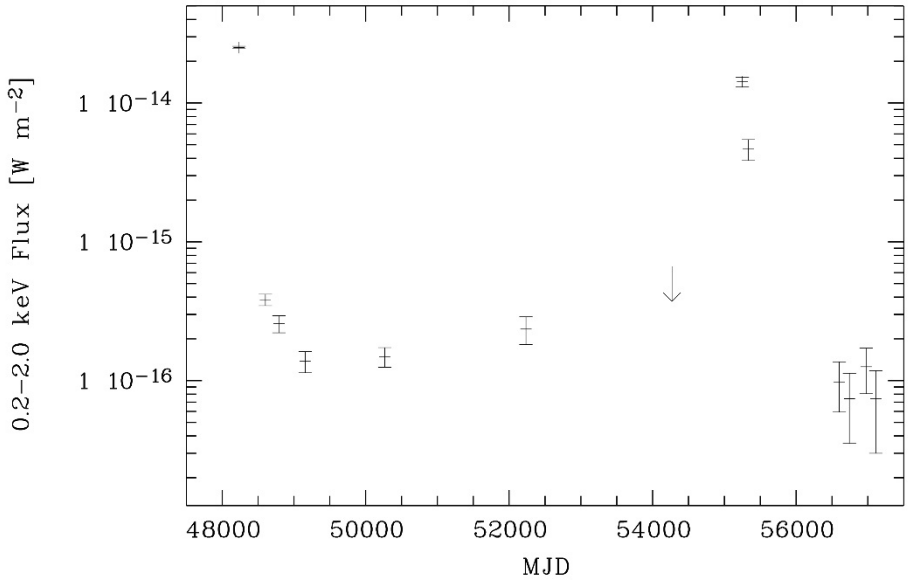
Dense sampling for reverberation mapping (disk) and BLR studies

Swift contributed 0.2Msec to this single project

Edelson

IC3599 – slow monitoring

- Very bright AGN during the RASS, then declined by x100
- Swift observations in 2010 revealed a new outburst
- TDE or something else?
- Multi-wavelength data can help distinguish



1990 2015

The unknown

The most exciting SVOM discoveries will come from transients which are poorly understood and those types yet to be found.

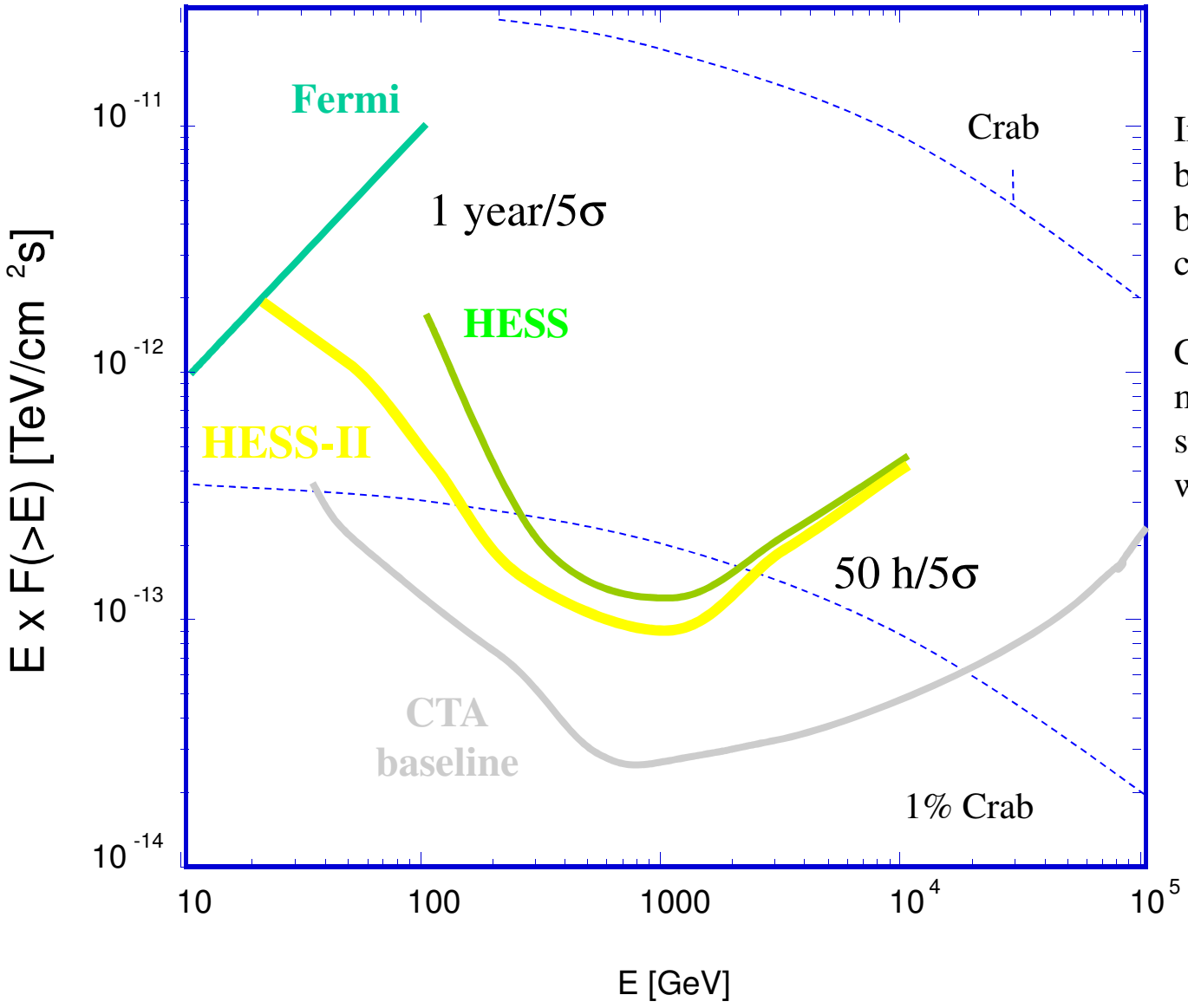
What will LSST find in the optical?

What will SKA find in the radio?

What will CTA find in the VHE?

Simultaneous multi-wavelength+multi-messenger signals?

VHE waveband Sensitivity



Improvement versus Fermi better on short timescales, but IACT ground duty cycle is much less

CTA has wider bandpass, more sensitive: experience suggests new discoveries will be made.

FRBs vs. GRBs

	GRBs	FRBs
Step one: Are they astrophysical?	1967 – 1973	2007 – 2015
Step two: Where are they (distance)?	1997 – 2004	2016 ?
Step three: What make them?	1998 – ???	???

Observationally driven
Healthy dialog between observers and theorists

Current radio limits

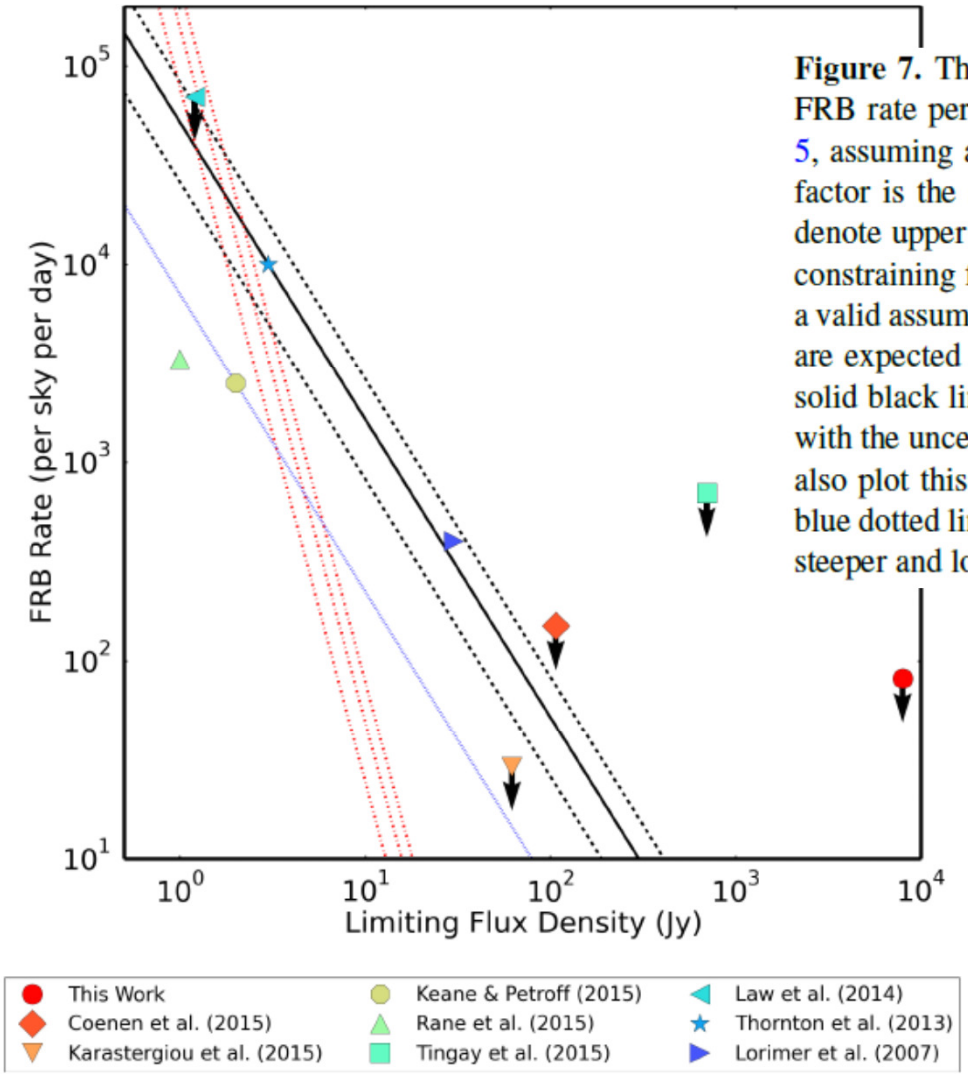


Figure 7. This plot, based on plot from Coenen et al. (2014), shows the FRB rate per sky per day as determined from the surveys given in Table 5, assuming a flat spectral slope. This plot assumes that the only limiting factor is the survey sensitivity. Symbols are as in the legend and arrows denote upper limits. Assuming a cosmological population, where the only constraining factor is the sensitivity of the survey (although note this is not a valid assumption for FRBs, see the text for further details), the data points are expected to be consistent with a straight line of slope -1.5. We plot a solid black line representing this and normalised to Thornton et al. (2013) with the uncertainties bounded by the dashed black lines. For reference, we also plot this for the lower rate given by Keane & Petroff (2015) using a blue dotted line. Finally the red dash-dotted lines represent the significantly steeper and lower rate model proposed by Macquart & Johnston (2015).

(Rowlinson et al. 2016)

Reminder: Role(s) of SVOM

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As we heard, many facilities will provide triggers/monitor the sky. The new era will require detailed planning to avoid overwhelming SVOM's observational capacity.