

Fast astrophysical multi-messenger/ wavelength strategies

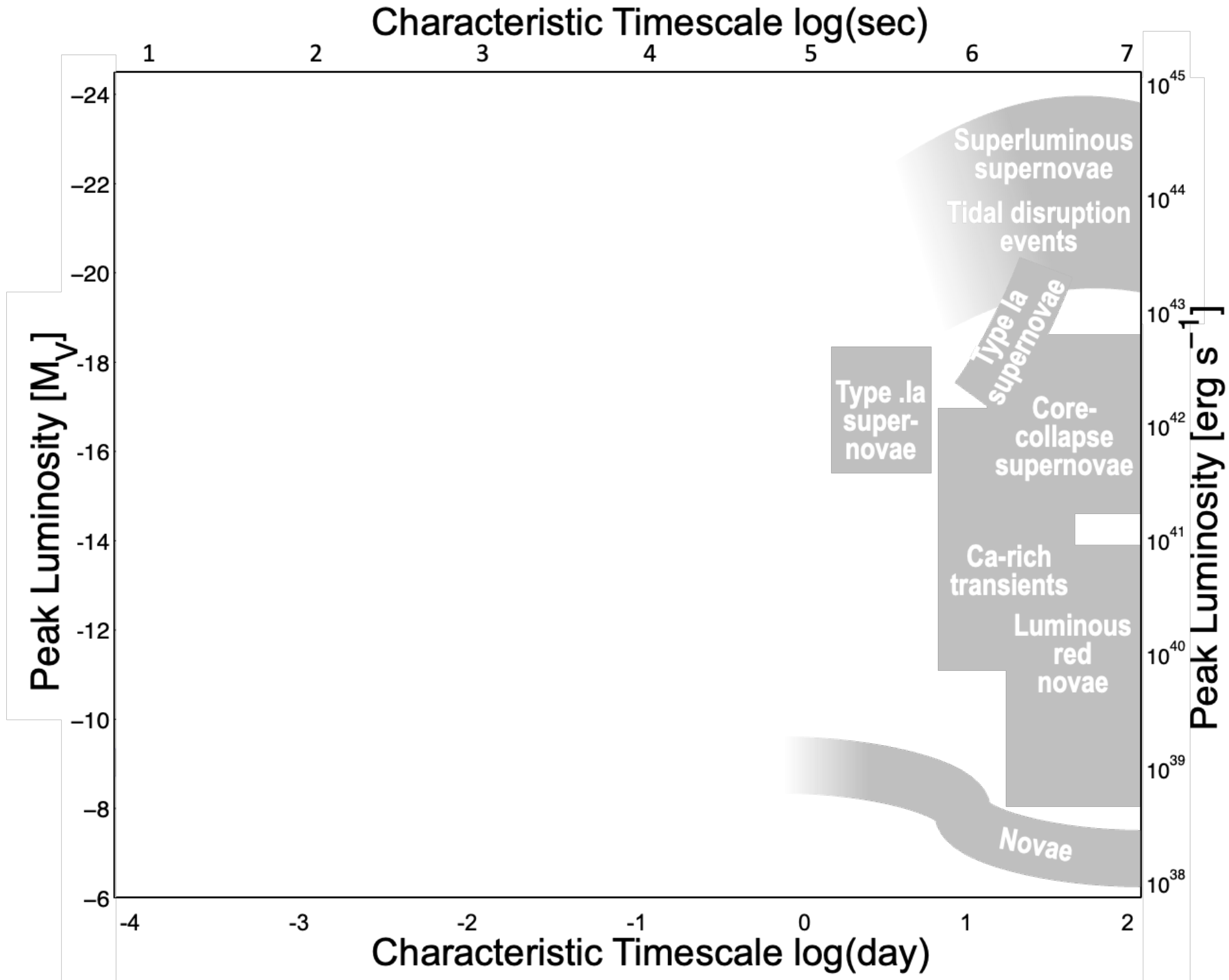


Anais Möller



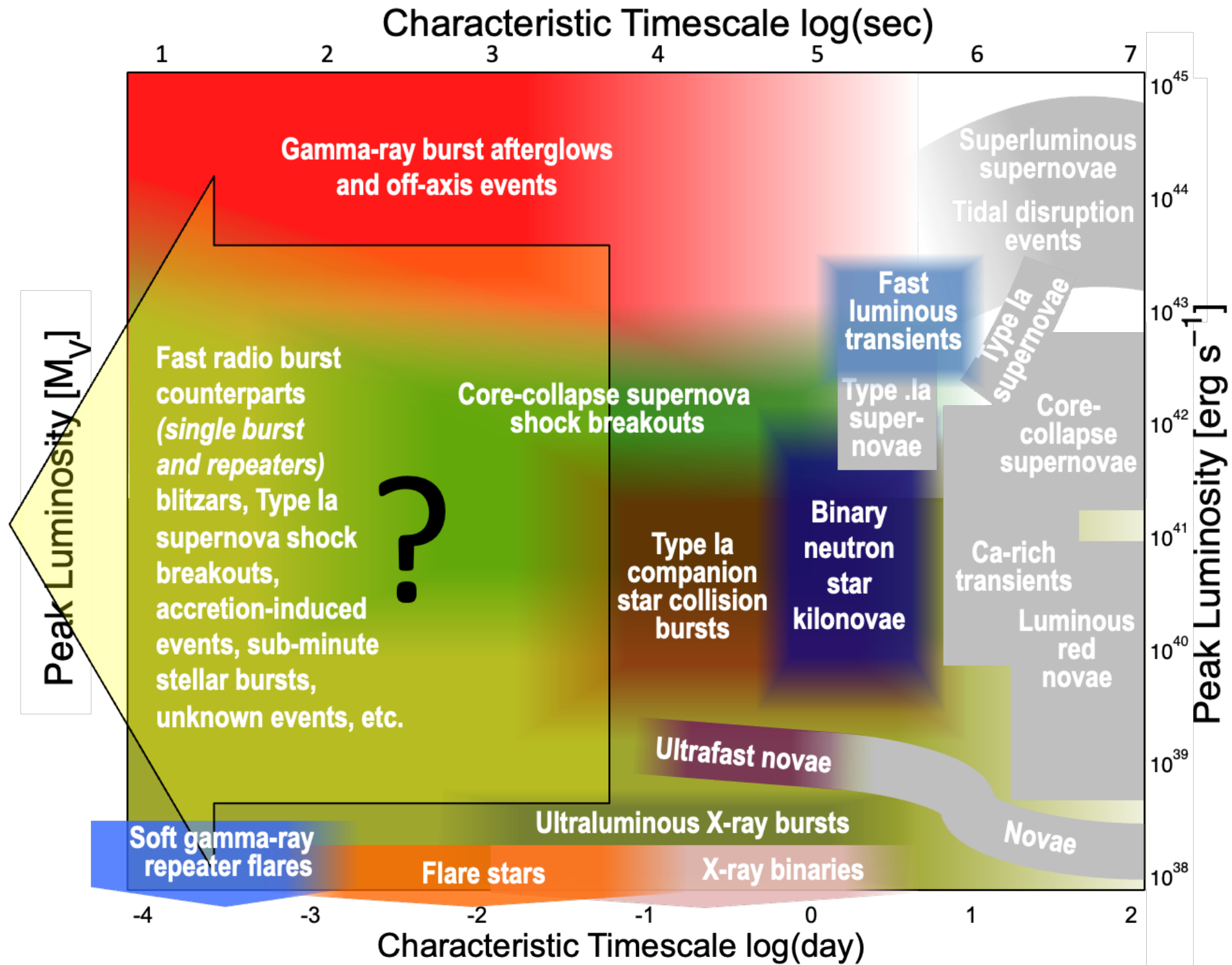
Fast astrophysical transients

Optical



Fast astrophysical transients

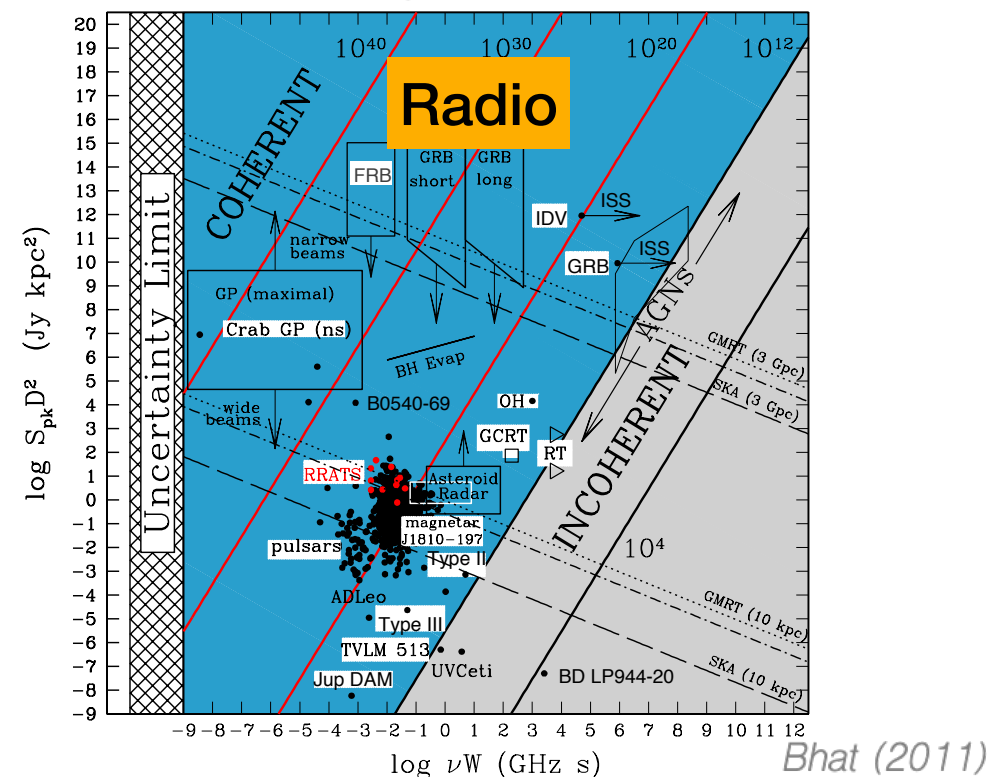
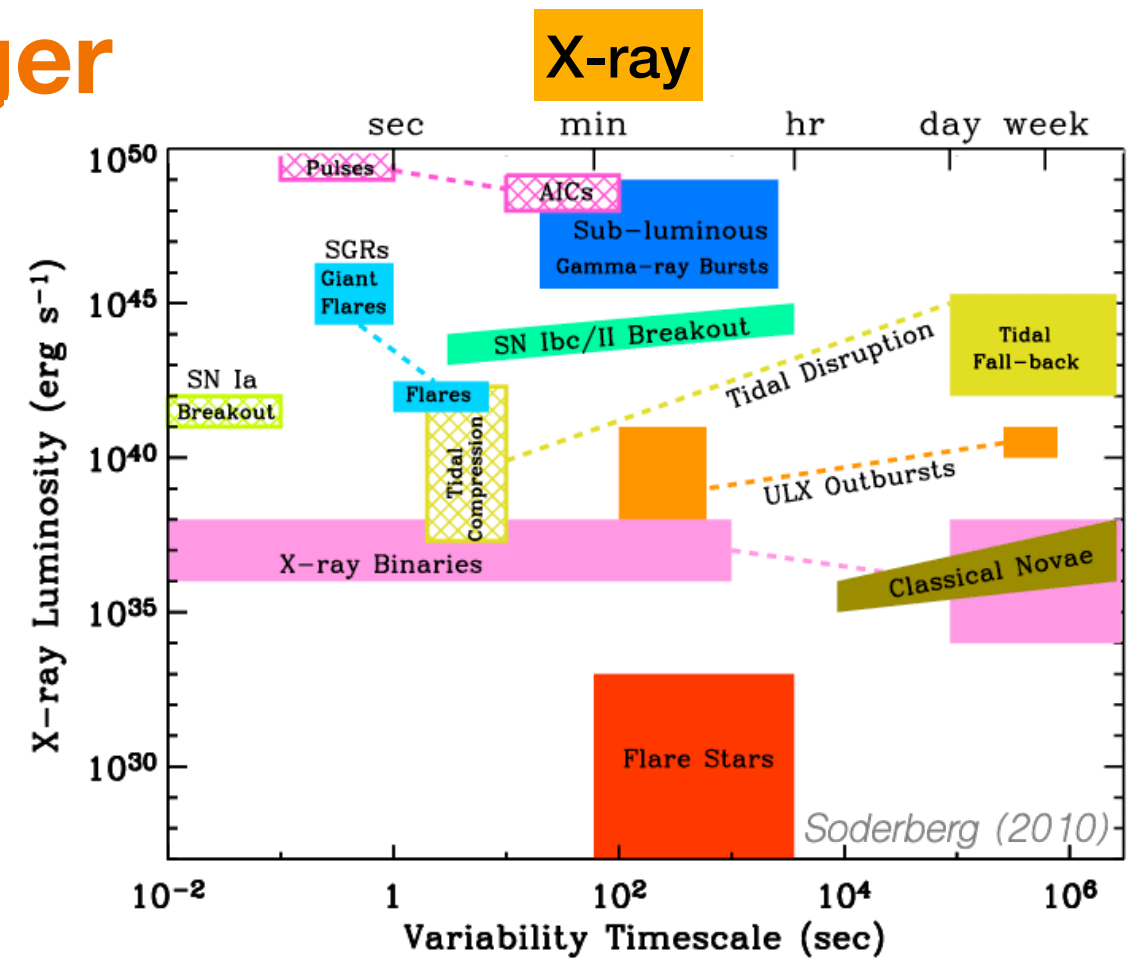
Optical



Fast astrophysical transients

Multi-wavelength & messenger

- Occur in one, multiple, or all wavelength regimes
- Some include high-energy particles and gravitational waves
- Timescales may not overlap between different wavelengths/messenger



Strategies

ToO-like

Survey-
coincidence

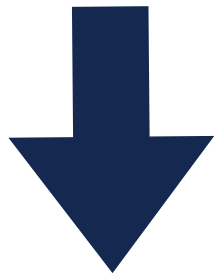
Simultaneous
observations

Strategies **ToO-like**

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Localised

GRB



Get spectra/
photometry

Strategies **ToO-like**

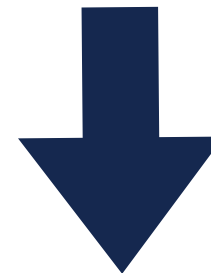
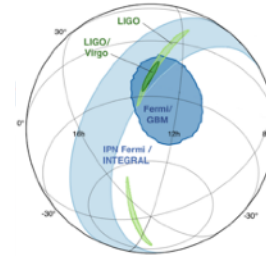
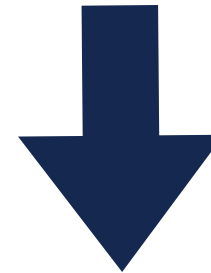
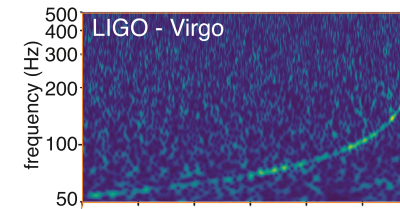
Localised

GRB



Get spectra/
photometry

Footprint



Find transients
Counterpart?

GW170817 Abbott+ 2017, Andreoni+ 2017

FRB170827 Farah et al. 2018, FRB180301 Price et al. 2018

Strategies

Survey-
coincidence

More at Thursday's seminar!

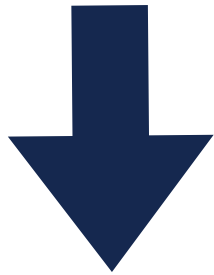
Strategies

Survey-coincidence

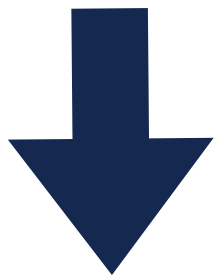
More at Thursday's seminar!

Footprint

SVOM/Fermi/Swift



Optical transients



Follow-up

Möller et al. 2021

Work by D. Turpin, J. Peloton +

Strategies

Survey-coincidence

More at Thursday's seminar!

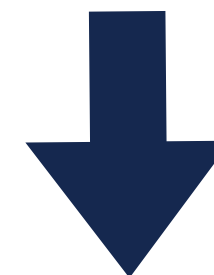
Orphans

Optical transients



Is it a kilonova?

Biswas et al. 2022



- Low S/N GW?
- No GW
- Follow-up

EXPECTED NUMBER OF KNe FOUND IN EACH SAMPLE.

Survey	# KNe ^a	Survey Years	KN Redshift Range
SDSS	0.13	2	0.02 – 0.05
SNLS	0.11	4	0.05 – 0.20
PS1	0.22	4	0.03 – 0.11
DES	0.26	5	0.05 – 0.20
ASAS-SN	< 0.001	3	—
SMT	0.001	5	0.01 – 0.01
ATLAS	8.3	5	0.01 – 0.03
ZTF	10.6	5	0.01 – 0.04
LSST WFD	69	10	0.02 – 0.25
LSST DDF	5.5	10	0.05 – 0.25
WFIRST	16.0	2	0.1 – 0.8

**Disclaimer: with 2017 data, observing strategy, etc
Scolnic+ 2017*

GRANDMA+ Fink 2022

Strategies

Simultaneous observations

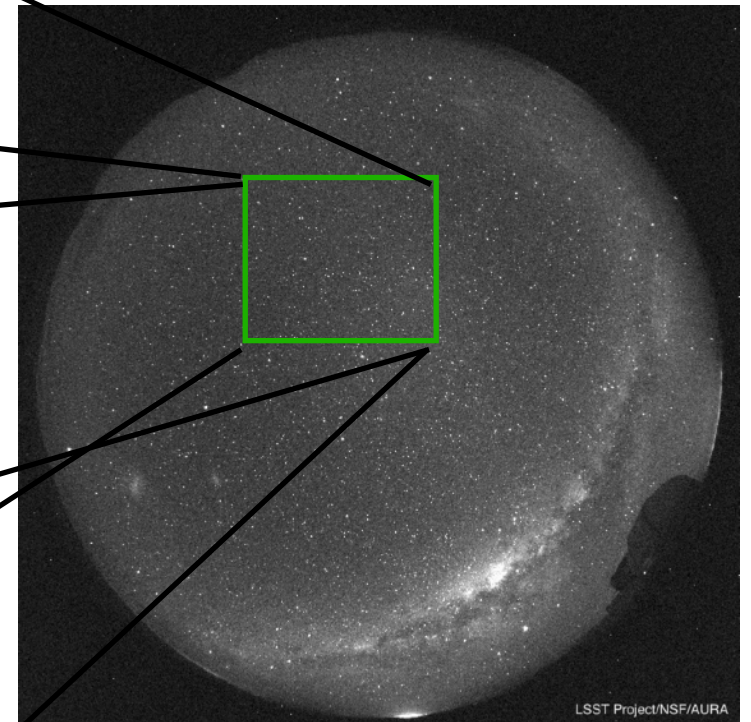
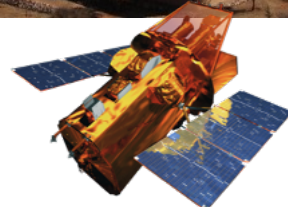
Optical



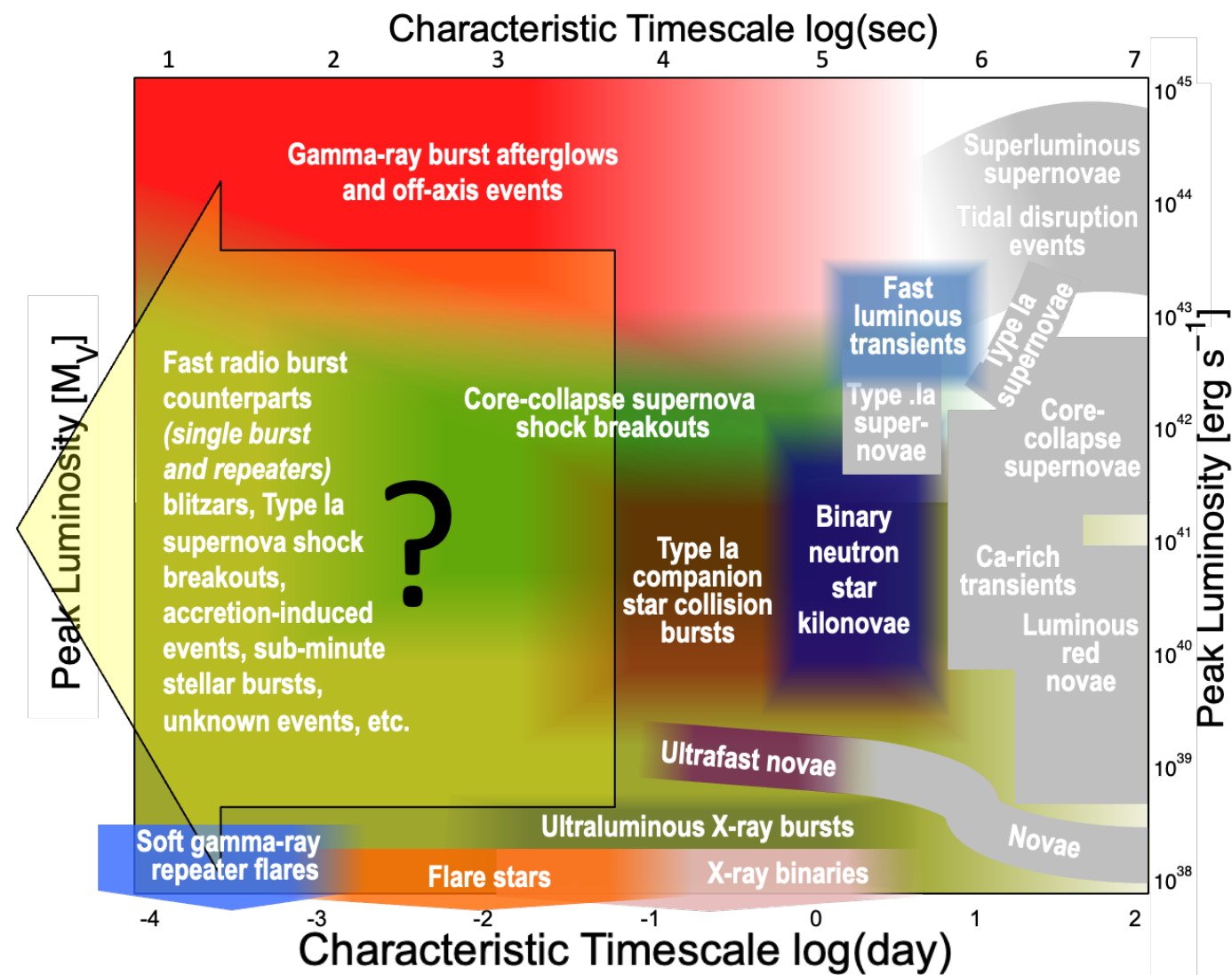
Radio



High-energy

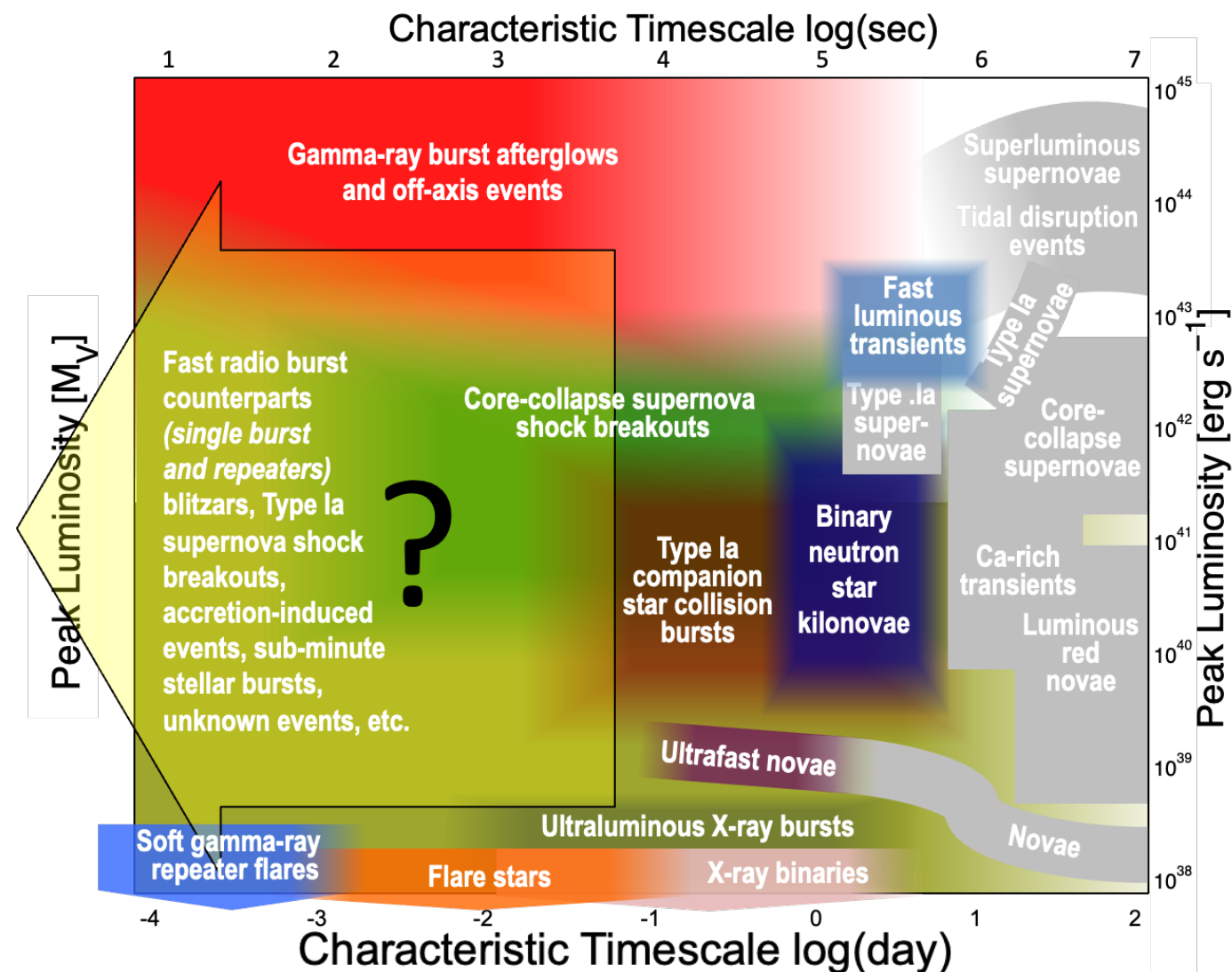


Deeper Wider Faster



Deeper Wider Faster

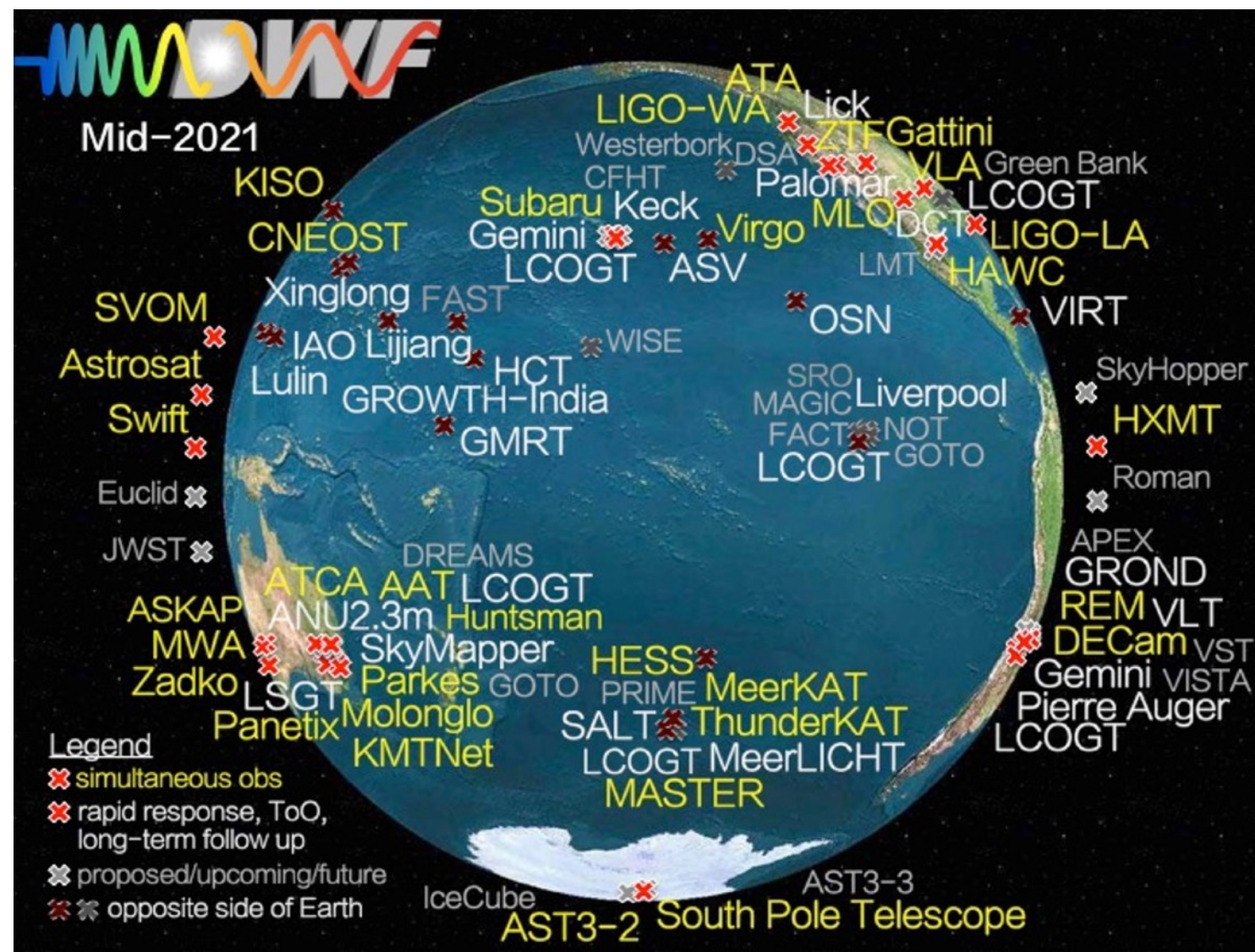
- Fast exposures (= shallow)
- Simultaneous all-wavelength observations
- Process events fast to trigger follow up
- Rapid-response spectroscopy and imaging



Deeper Wider Faster

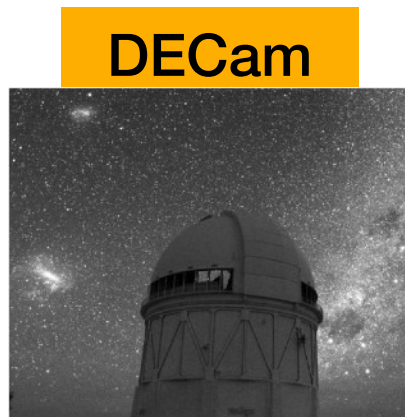
Strategy

- DECam 30s exposures in g-band ~23 mag
- Simultaneous observations for ~one week twice per year
- Follow-up + late monitoring observations



Deeper Wider Faster

Strategy

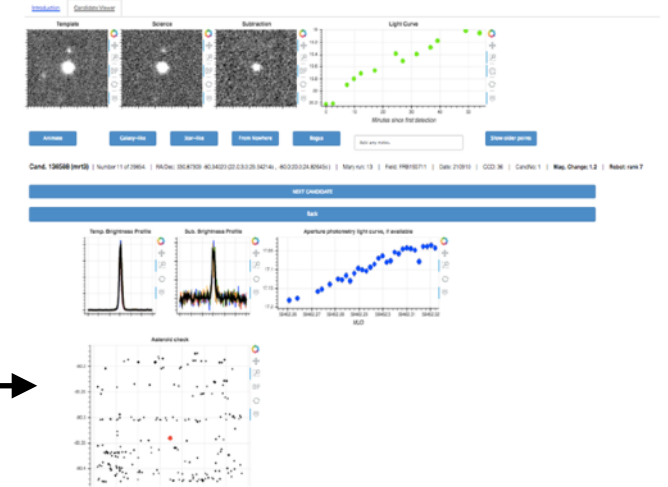


Fast compression
Transfer (~1 minute)



Fast processing

Andreoni et al. 2017



Visualisation
+
Filtering

PerSieve led by *S. Hegarty*
Cross-matching based on Fink tools *Möller et al. 2021*

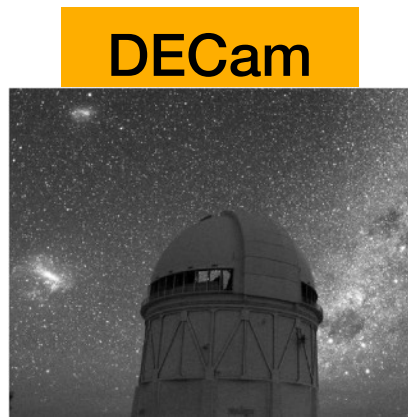
Follow-up

Including optical (VLT, Gemini, SALT), high-energy (e.g., Swift) and radio (e.g., ATCA)



Deeper Wider Faster

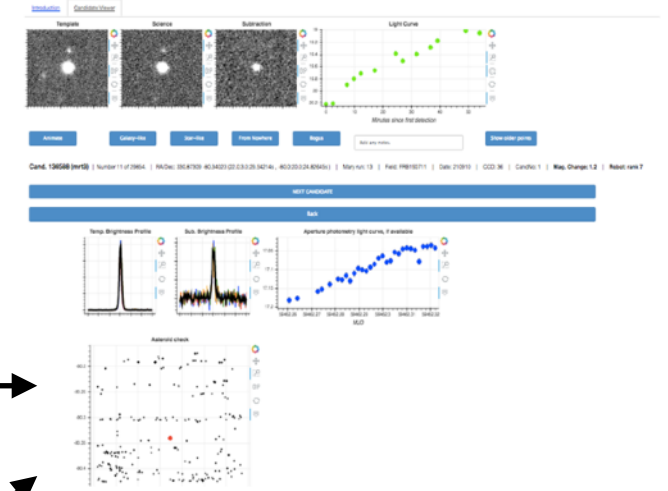
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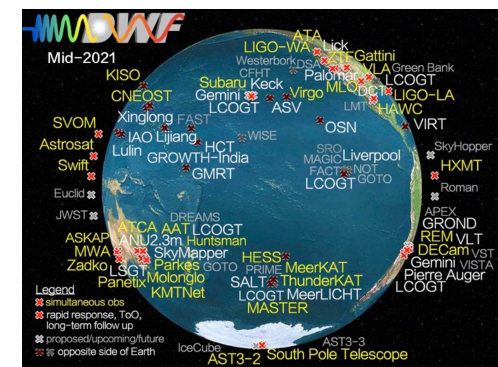
Multi-wavelength +
messenger

- Detections from other facilities
- simultaneous observing
 - GCN notices

Follow-up

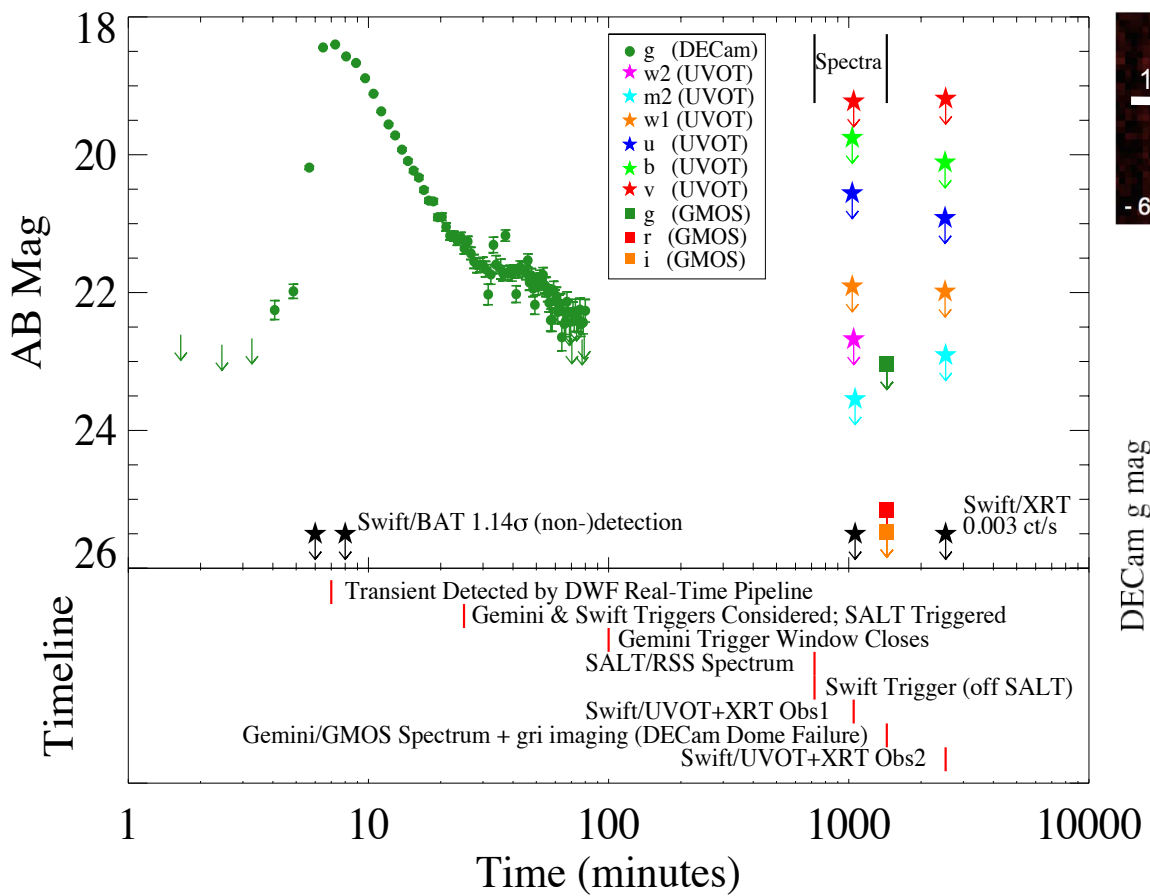
also... imaging before (shorter wavelengths arrive before for coherent bursts) and after (SN, and longer) run

Including optical (VLT, Gemini, SALT), high-energy (e.g., Swift) and radio (e.g., ATCA)



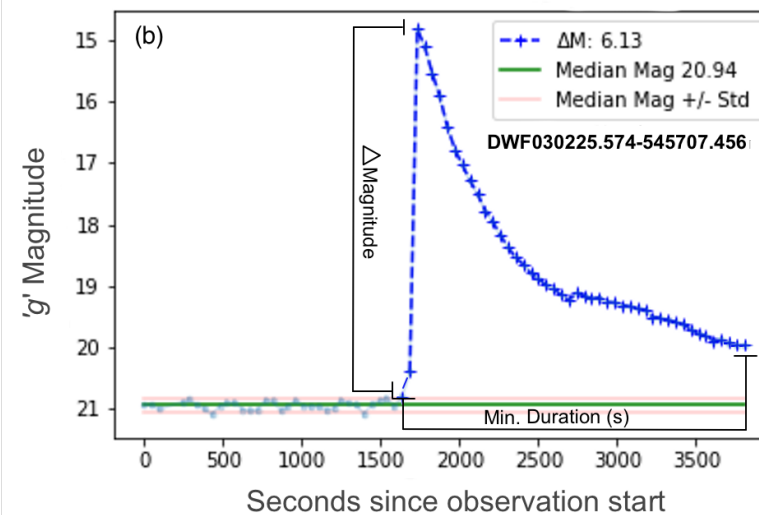
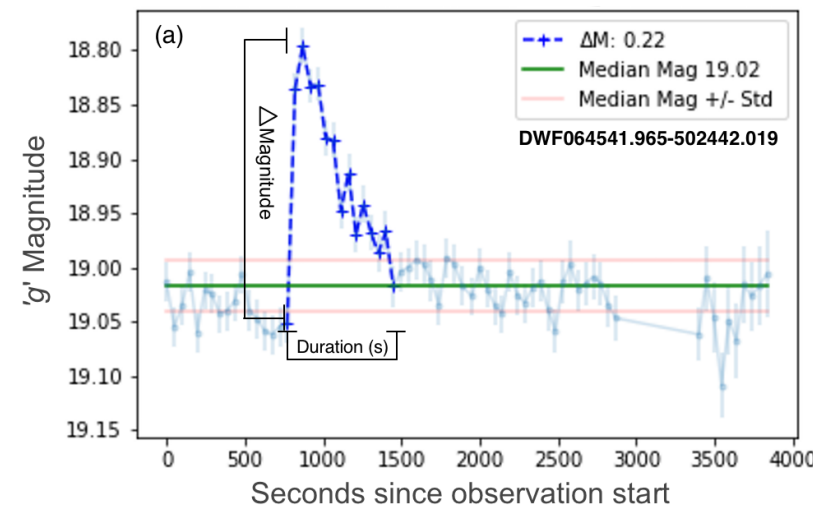
Deeper Wider Faster

First results



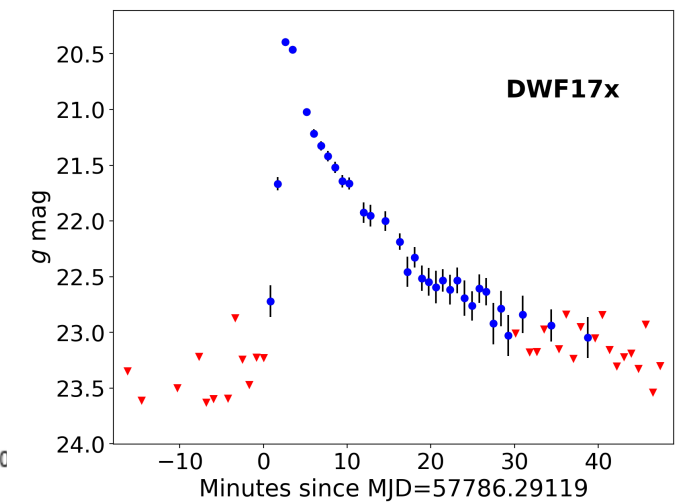
Stellar flares

Webb et al. 2020 and 2021



Extragalactic fast transients

Andreoni et al. 2020



Radio transients

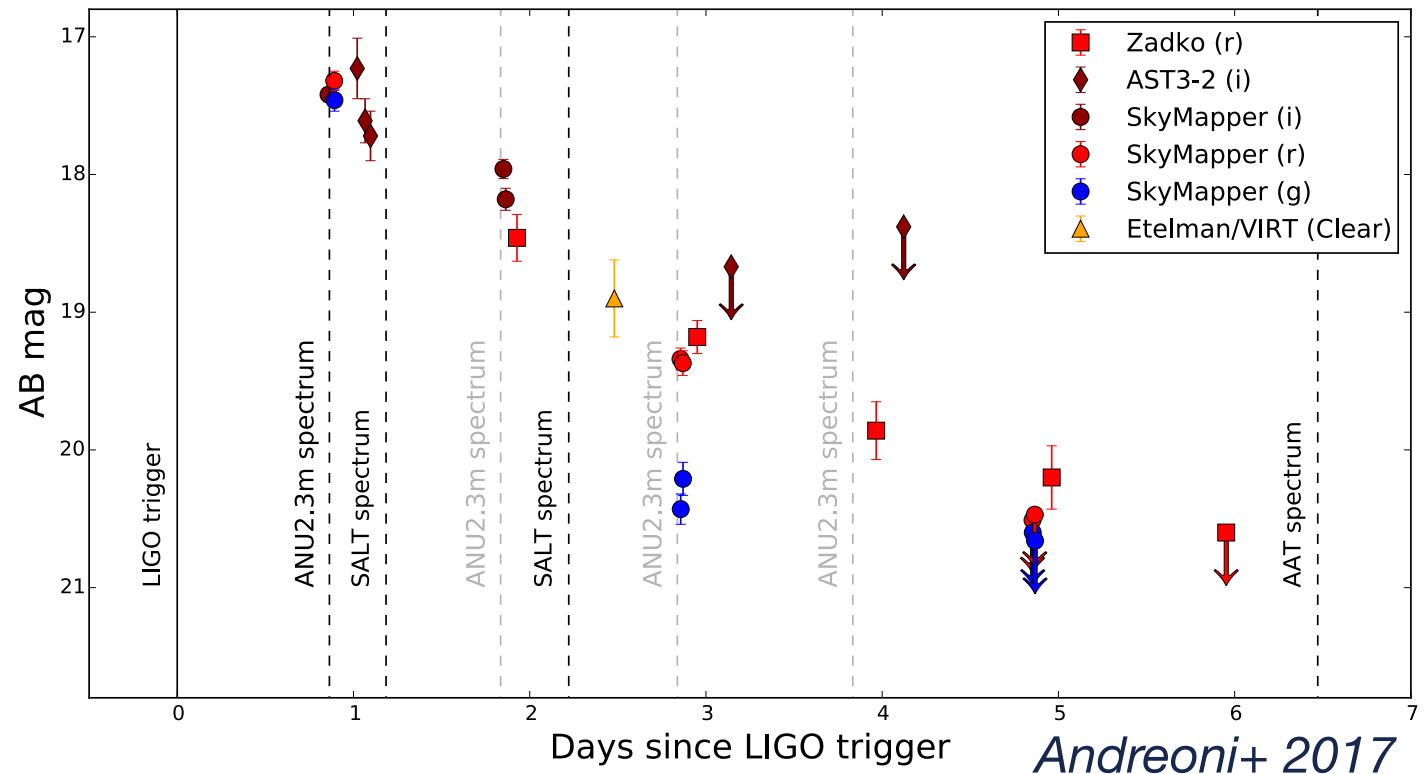
Dobie et al. submitted

Deeper Wider Faster

First results

Kilonovae

- 14 of 70 telescopes for GW170817
- Triggered and coordinated optical, infrared, radio observations



FRBs

- Early wide-field optical searches (DECam)
- Detected 2 FRBs in Sept. 2020 (*Zhang et al. in prep*)
- Mapping line-of-sight galaxies to FRBs to constrain ionised IGM

Take away

Deeper Wider Faster

Simultaneous observations allow to study a wide-variety of transients in an unexplored space

Some challenges:

- Processing is facility dependent...
- As we go fainter catalogues are less complete
- Chip gaps and other unfortunate events

Take away

Deeper Wider Faster

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Fast multi-messenger/wavelength strategies

- Strategies are highly complimentary.
- Fast triggering and coordination remains a challenge.
- A breath of science is possible!