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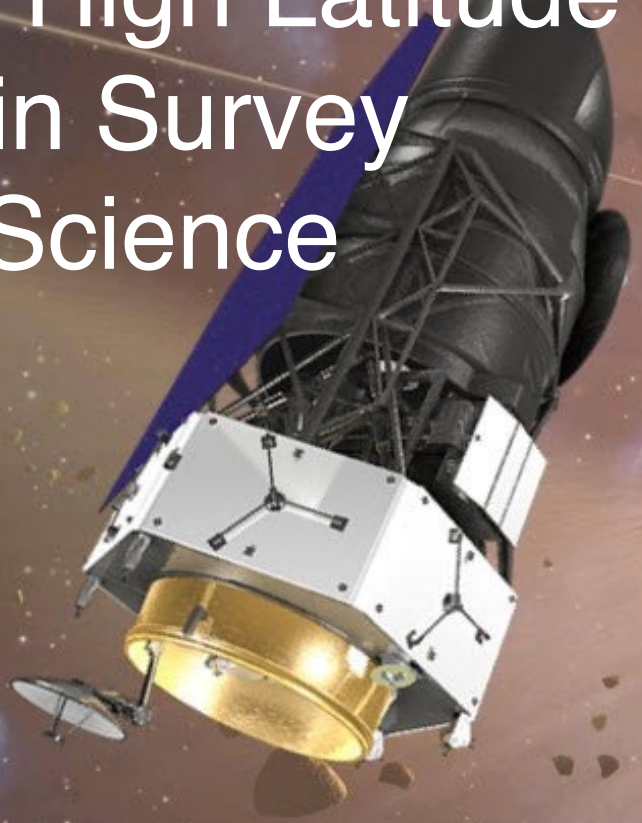
The Roman High Latitude Time Domain Survey & Kilonova Science



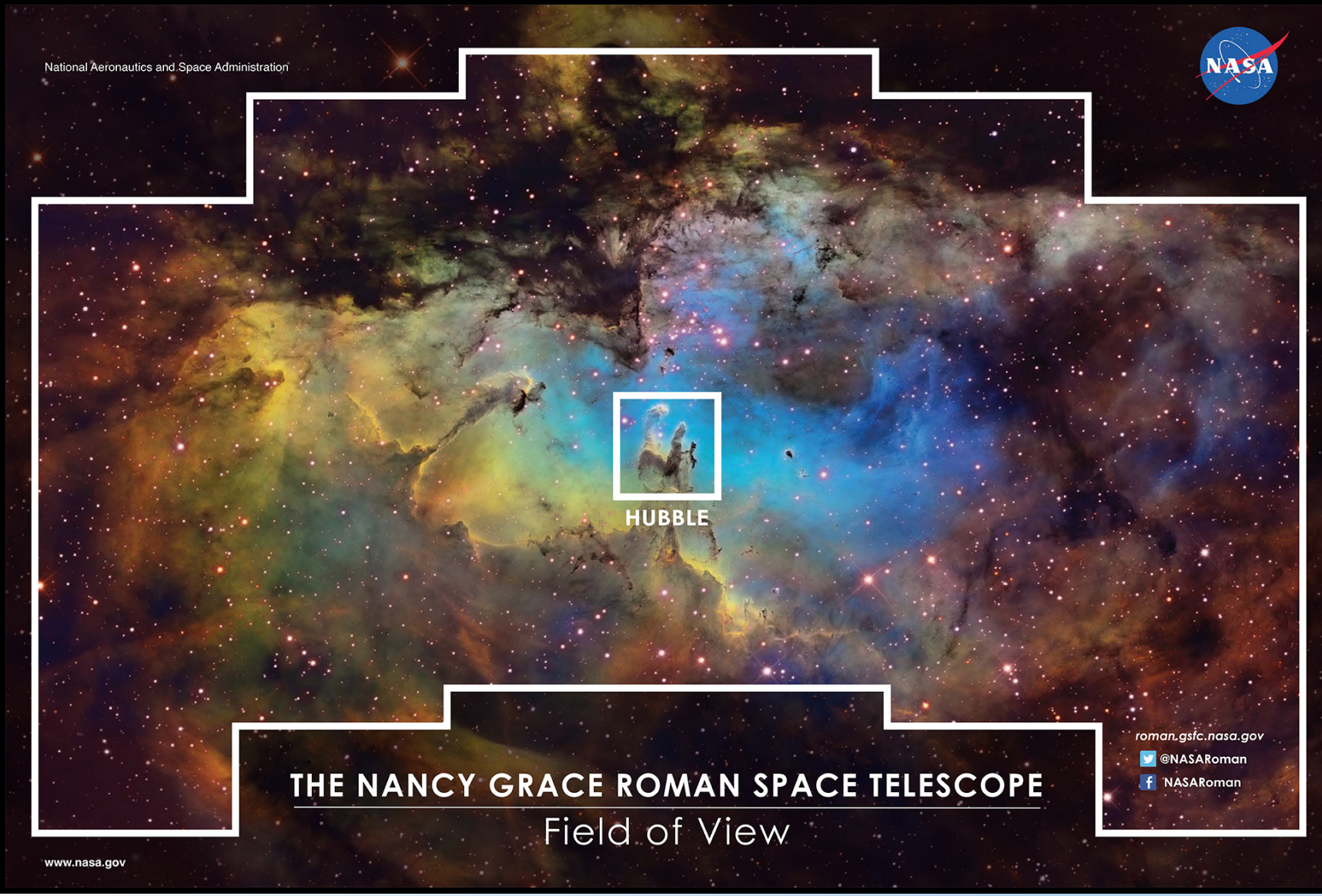
Igor Andreoni

Neil Gehrels Fellow

Rubin PCW 2023

Image credit: NASA/JPL

Nancy Grace Roman Space Telescope



Roman White Papers 2023

66 White Papers of which 20 for the High Latitude Time Domain survey

Methods: Rose+ (a, b, c), Deustua+

Subaru/CASTOR and Roman synergy: Harikane+ (a), Koyama+ Thilker+

Spectroscopy and galaxies: Rhoads+, Harikane+ (b), Fox+, Aldering+

Massive black hole binaries and AGN: Haiman+, Yamada+

Stars in the halo: Holwerda +

Distance Ladder: Kraemer+

Tidal Disruption Events: Karmen+

Supernovae: Macias+, Fox+, Moriya+, Fraser+

Kilonovae: Andreoni+, Macias+

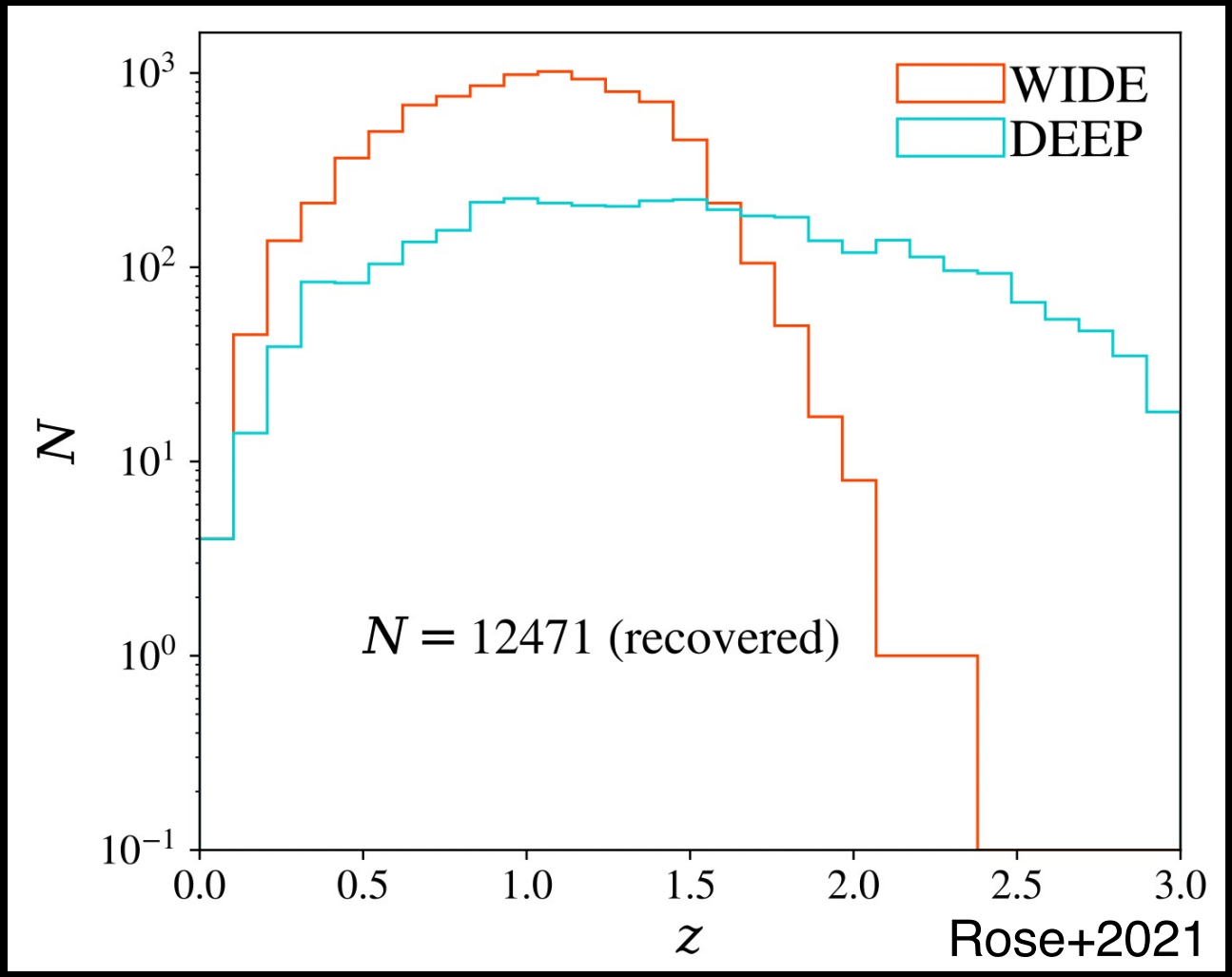
High Latitude Time Domain Survey

~Tens of sq. deg.

It will be defined by a Community process

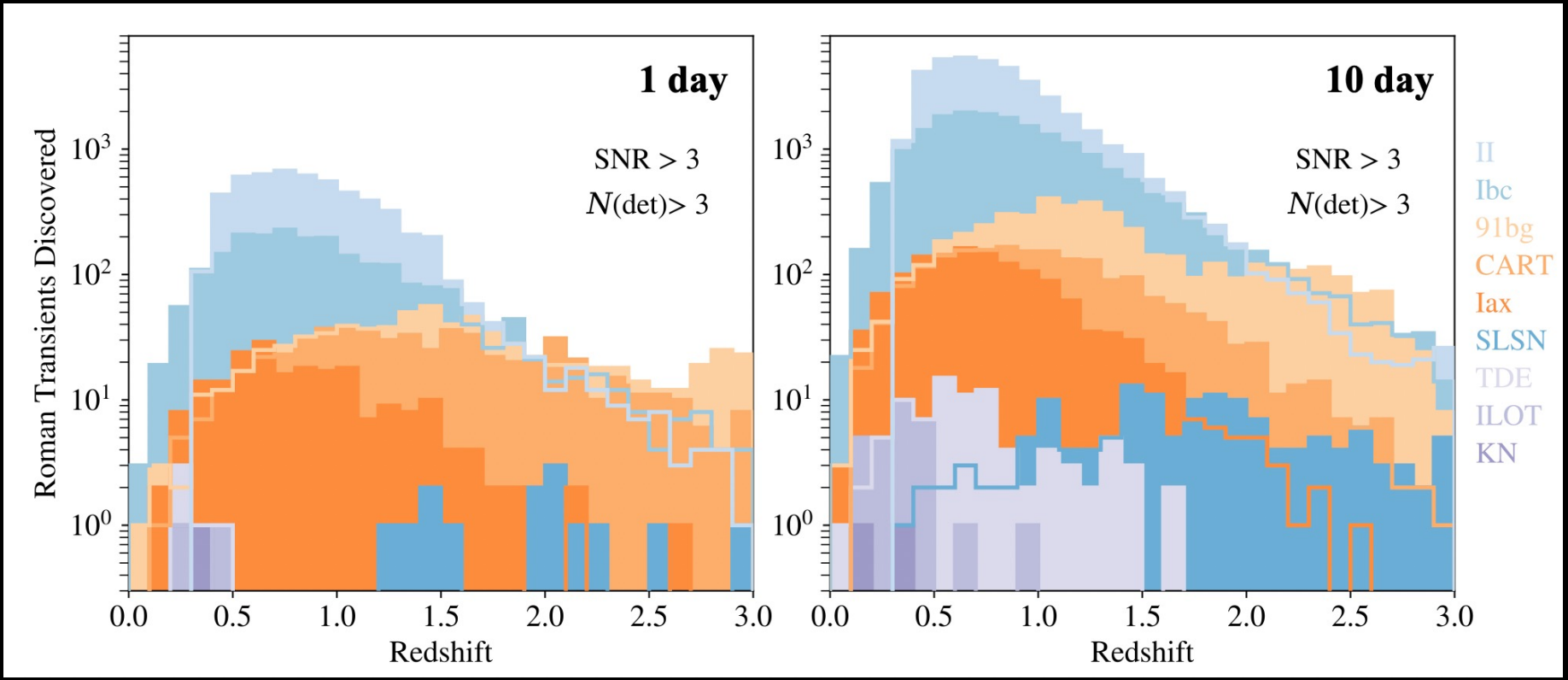
Baseline survey for SN Ia (Rose+2021):
6 months of aggregate telescope time, spread over a 2 year period, with 25% duty cycle during that period, 20 deg^2 footprint (wide), 5-day cadence

Supernova detection (Ia + core-collapse)



See also, e.g., Spergel+2015, Foley+2018, Hounsell+2018

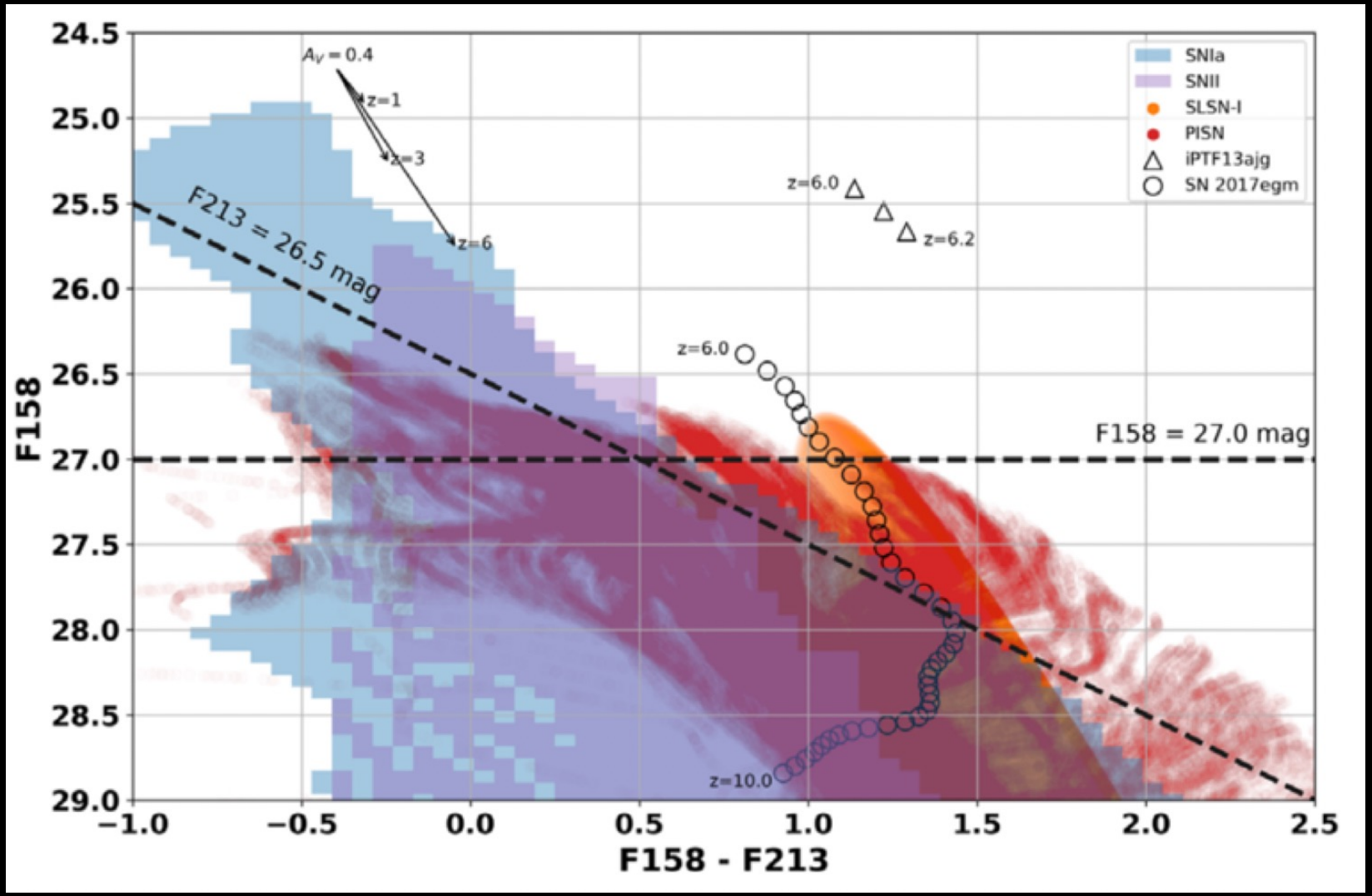
Transient detection (not Type Ia)



…will we be able to classify these transients?

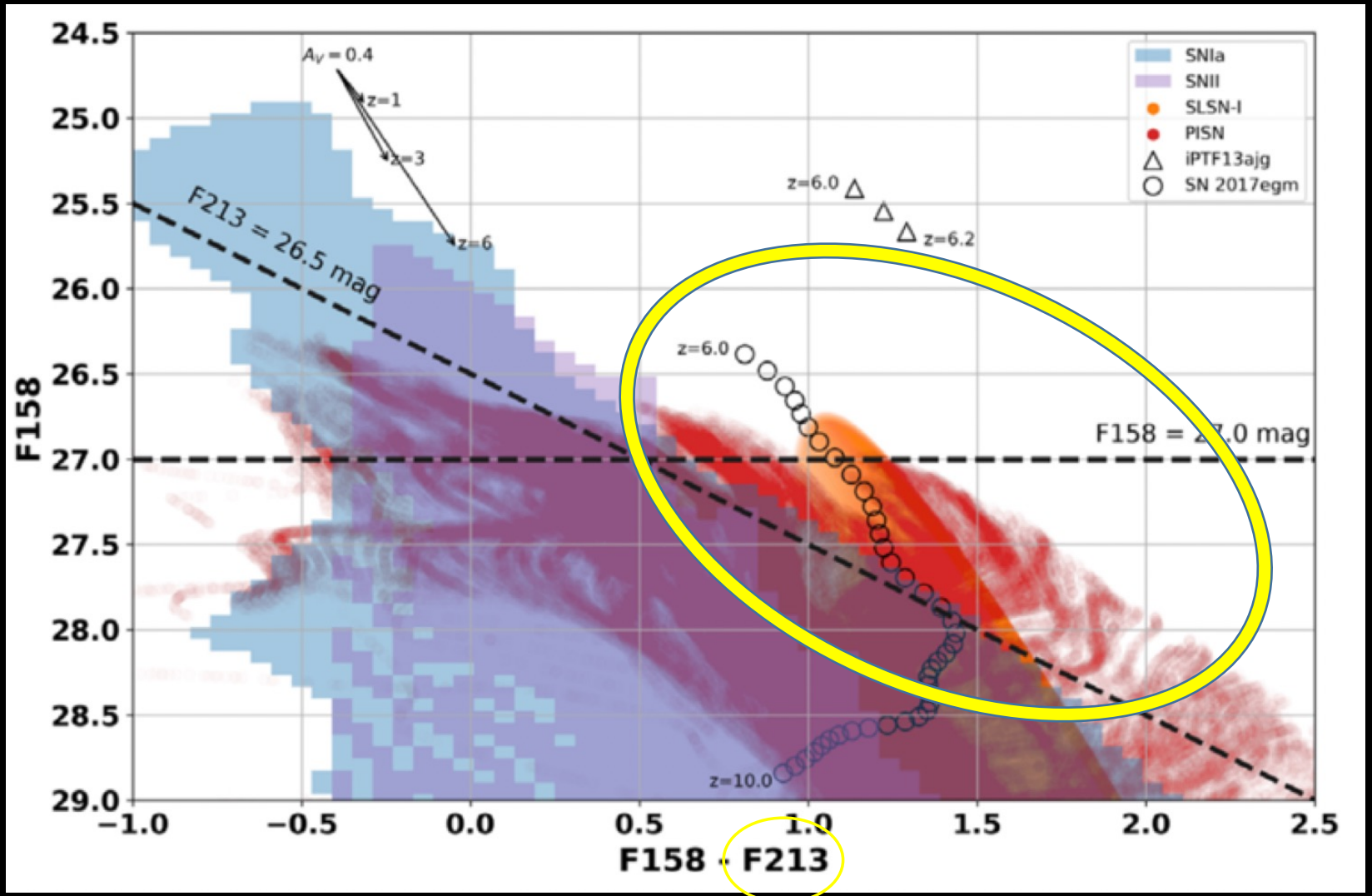
Macias+ WP 2023

Rare supernovae at high *z*



Moriya+ WP 2023

Rare supernovae at high *z*

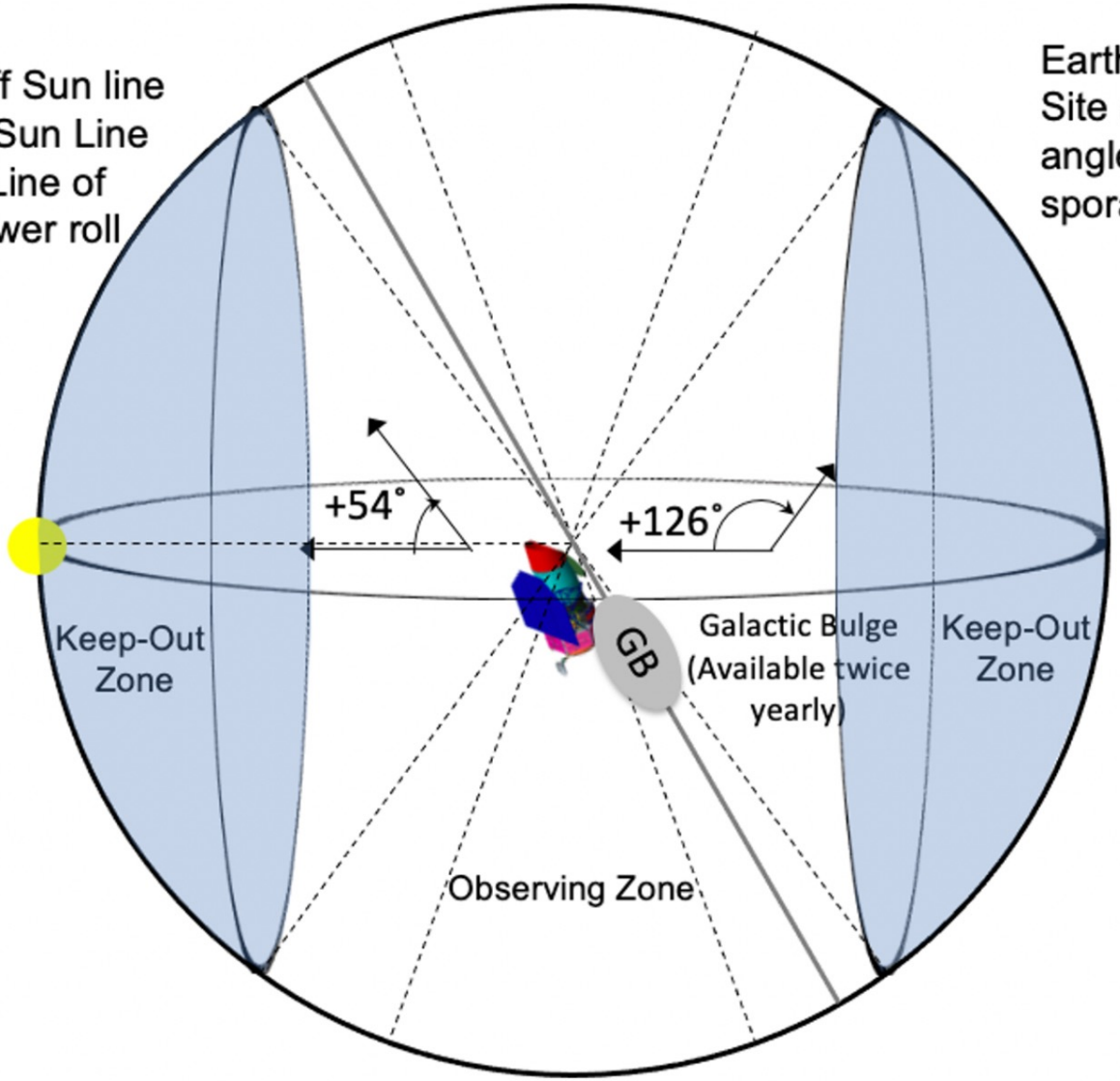


Moriya+ WP 2023

Roman Field of Regard

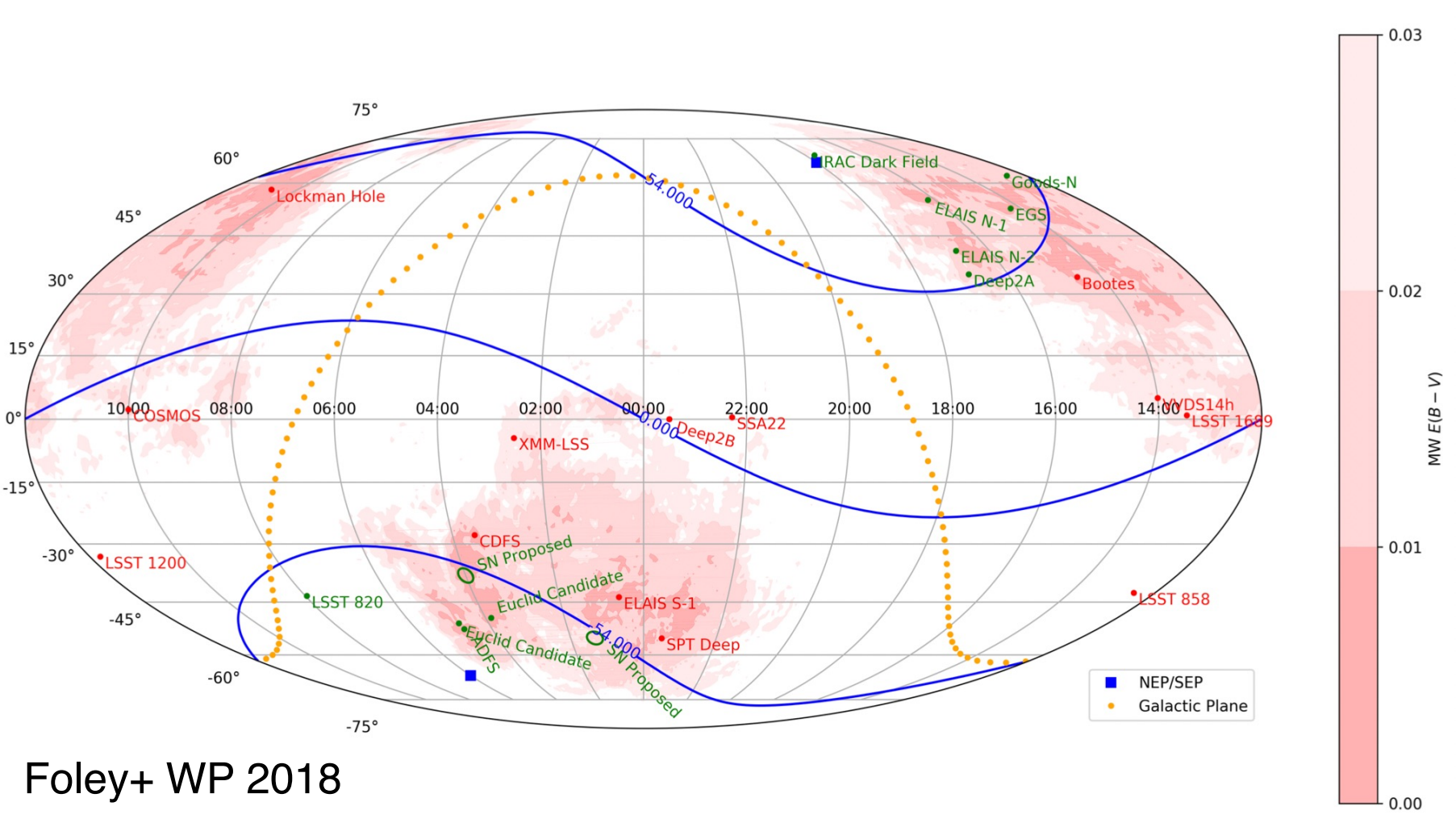
Observing Zone:

- 54˚-126˚ Pitch off Sun line
- 360˚ Yaw about Sun Line
- ±15˚ Roll about Line of Sight off max power roll angle



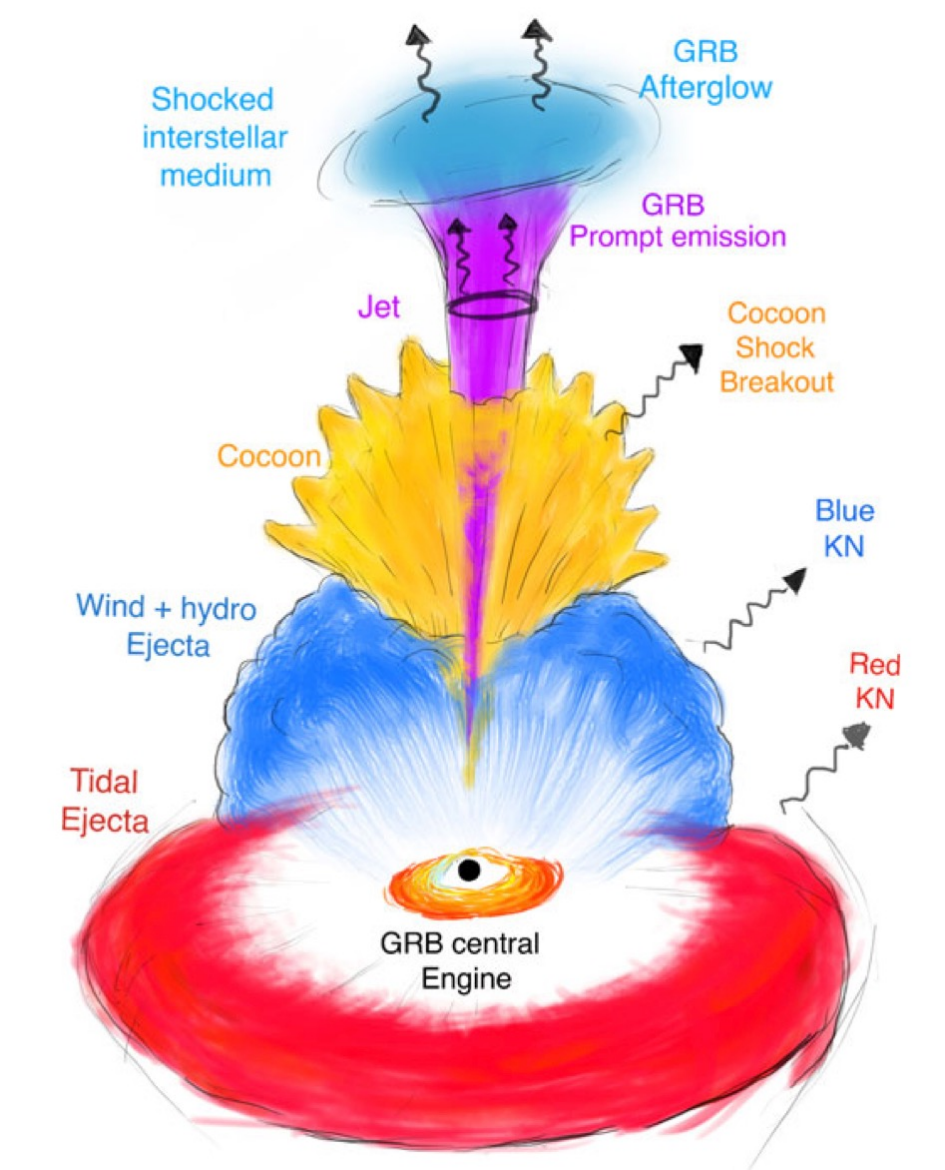
Earth/Moon Line of Site avoidance angles are a minor sporadic constraint

High Latitude Time Domain Survey: Where to observe?



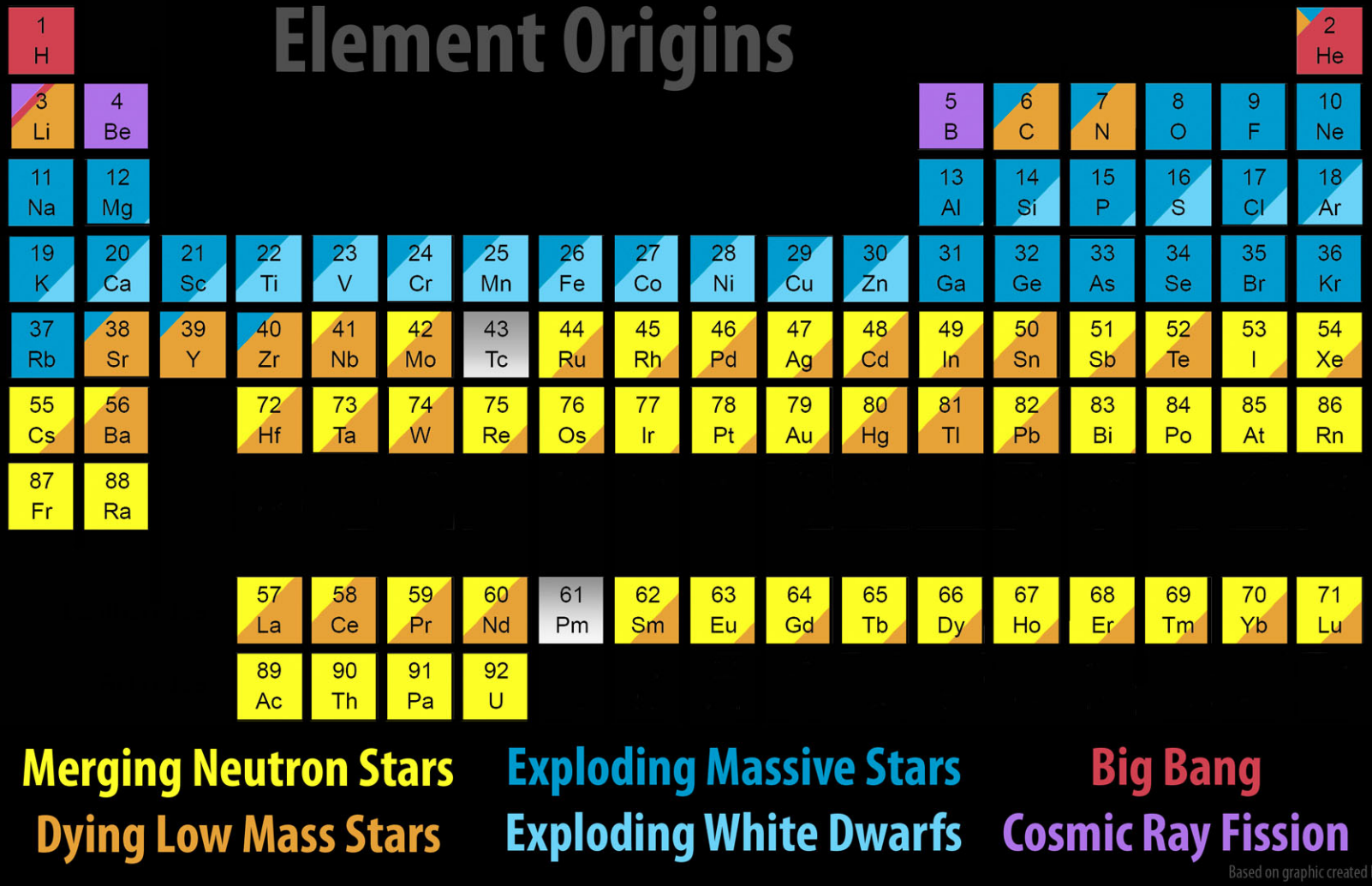
Foley+ WP 2018

Kilonovae



Ascenzi+21
(KN = kilonova)

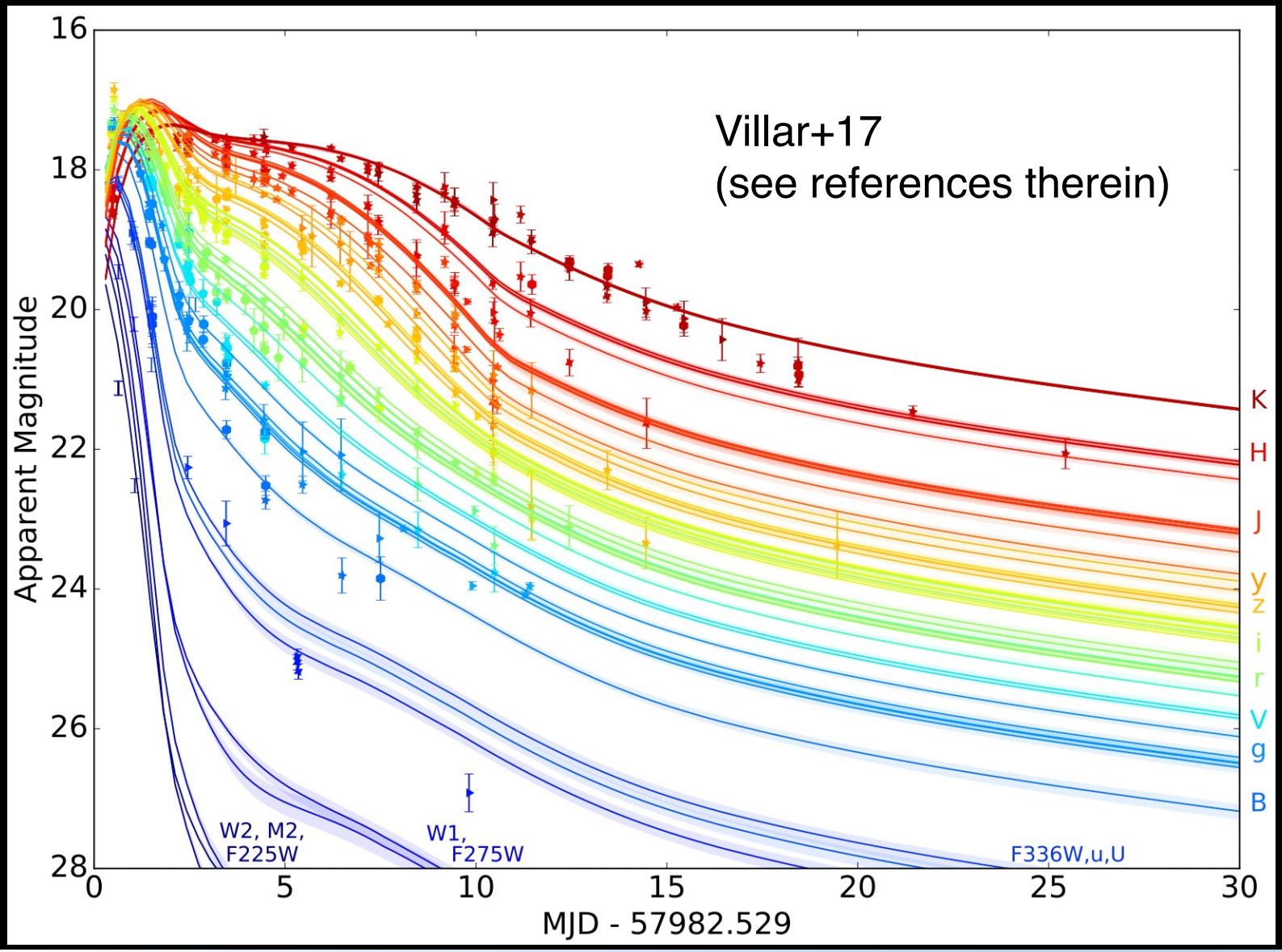
Heavy “r-process” elements



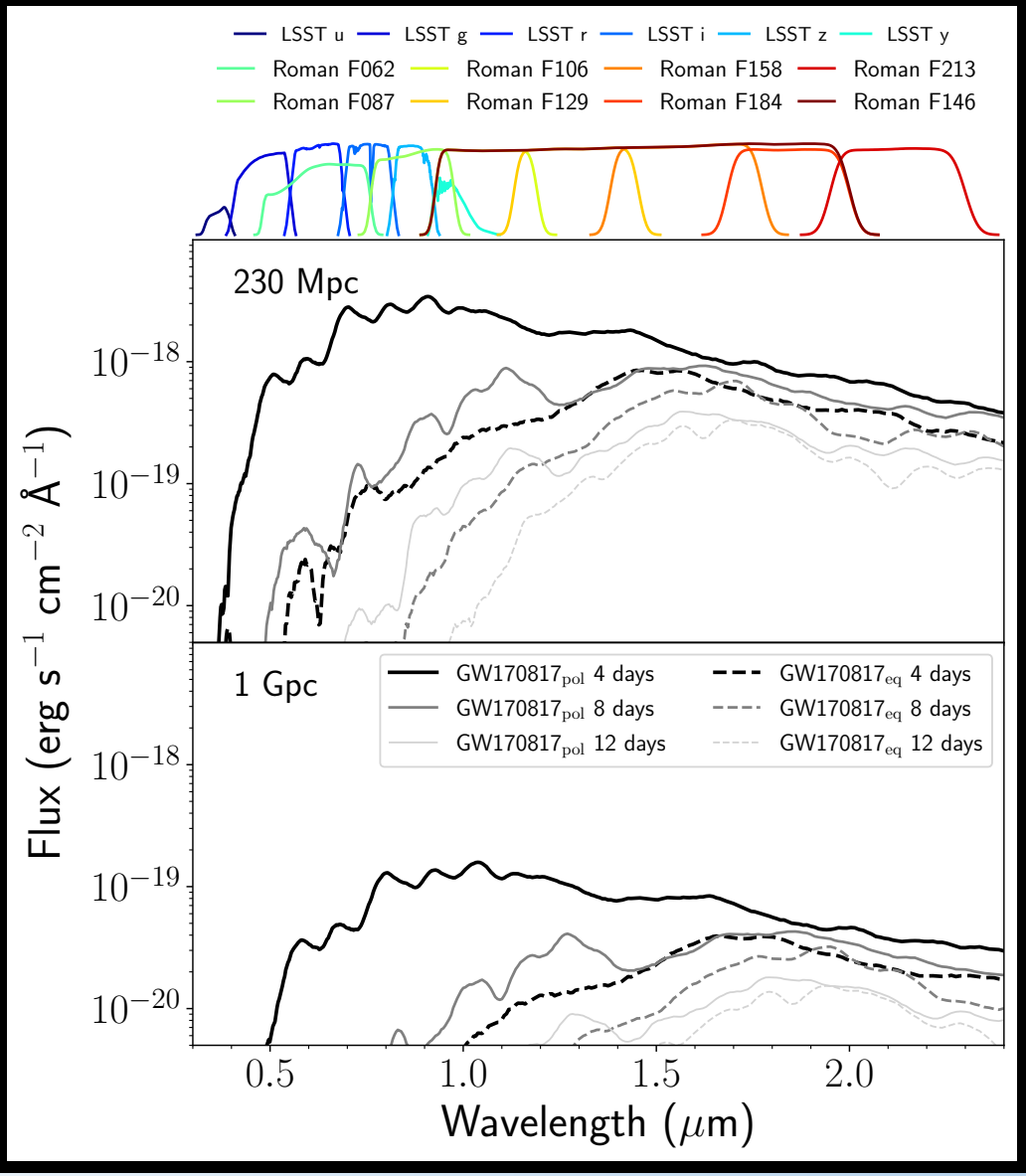
See e.g. Lattimer & Schramm (1974)

Credit: Jennifer Johnson

Kilonovae - GW170817

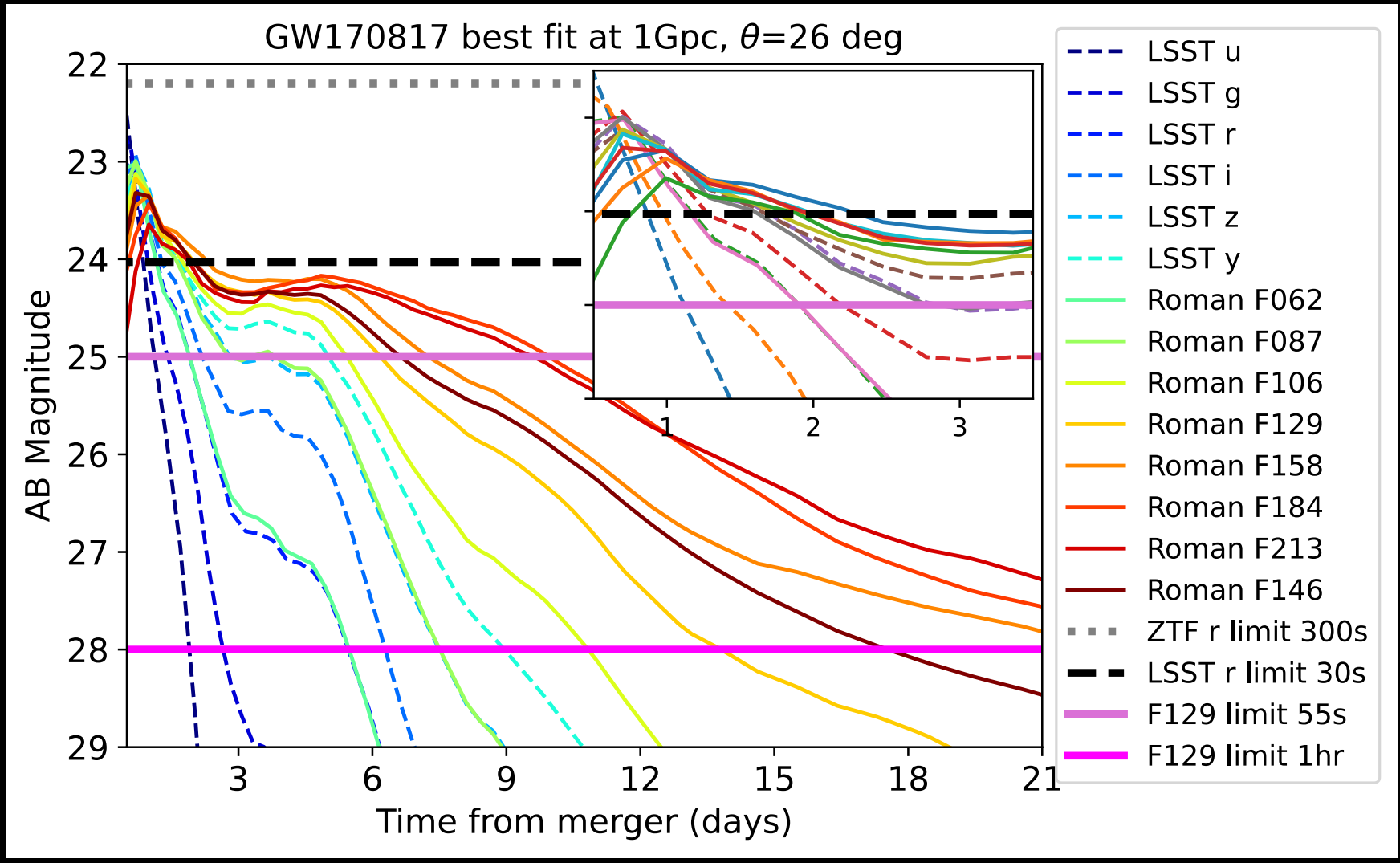


Rubin & Roman kilonova observations



I.A.+2023,
arXiv:2307.09511

Rubin & Roman kilonova observations



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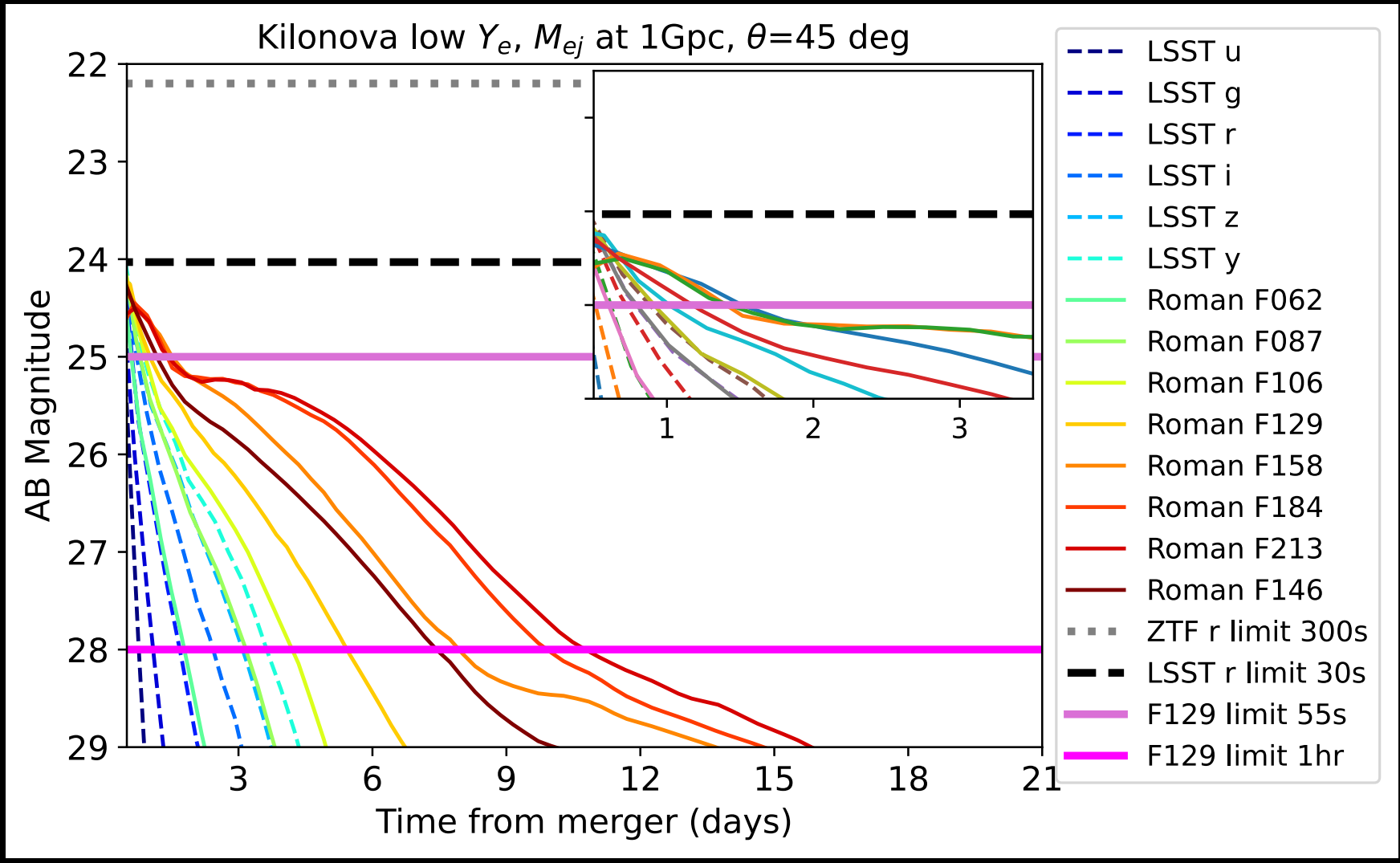
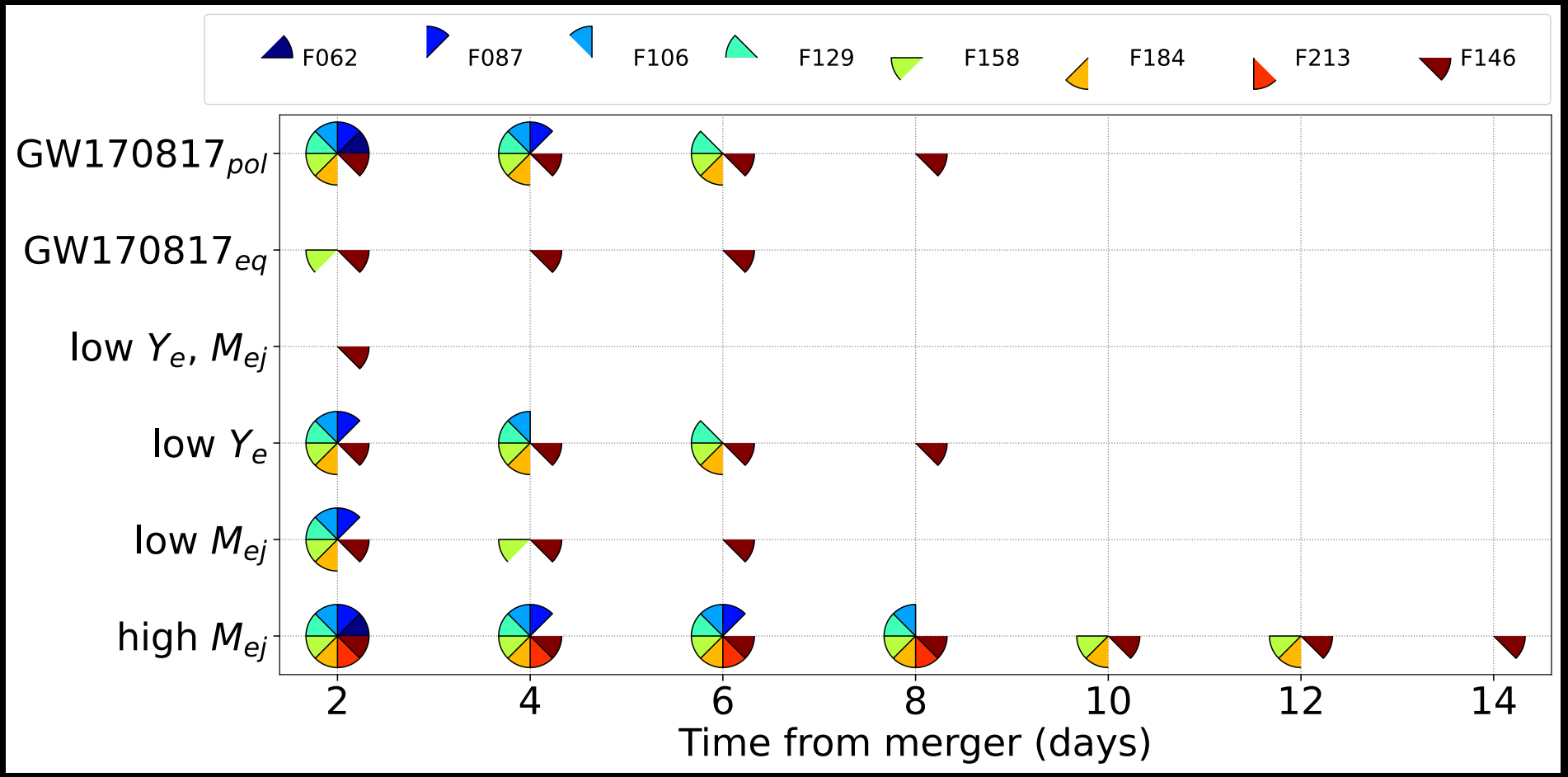
Rubin & Roman kilonova observations



I.A.+2023, arXiv:2307.09511

Kilonova detection in the HLTD survey

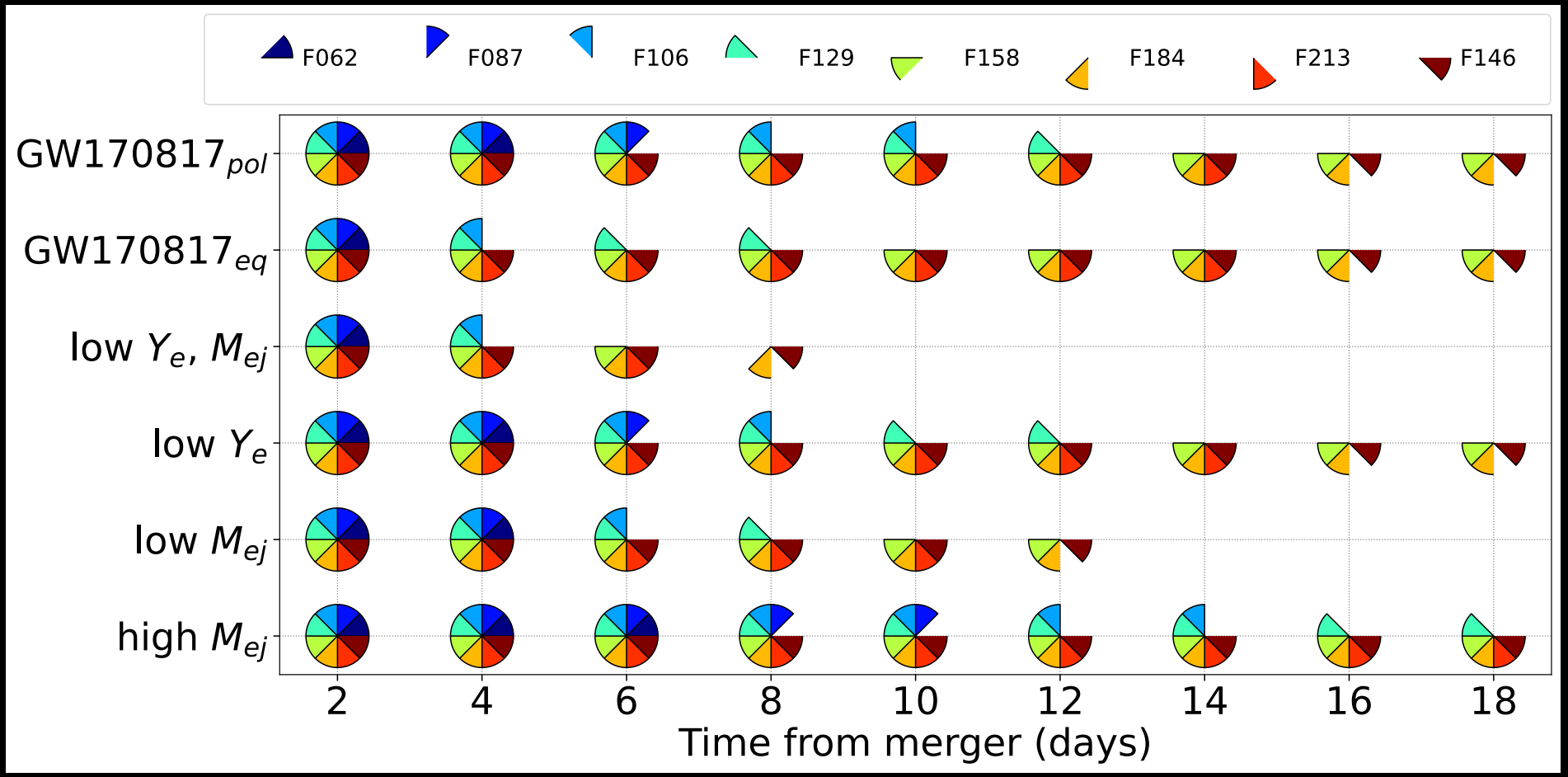
55s, z=0.2 ($D_{comoving}$ = 850 Mpc)



I.A.+2023, arXiv:2307.09511

Kilonova detection in the HLTD survey

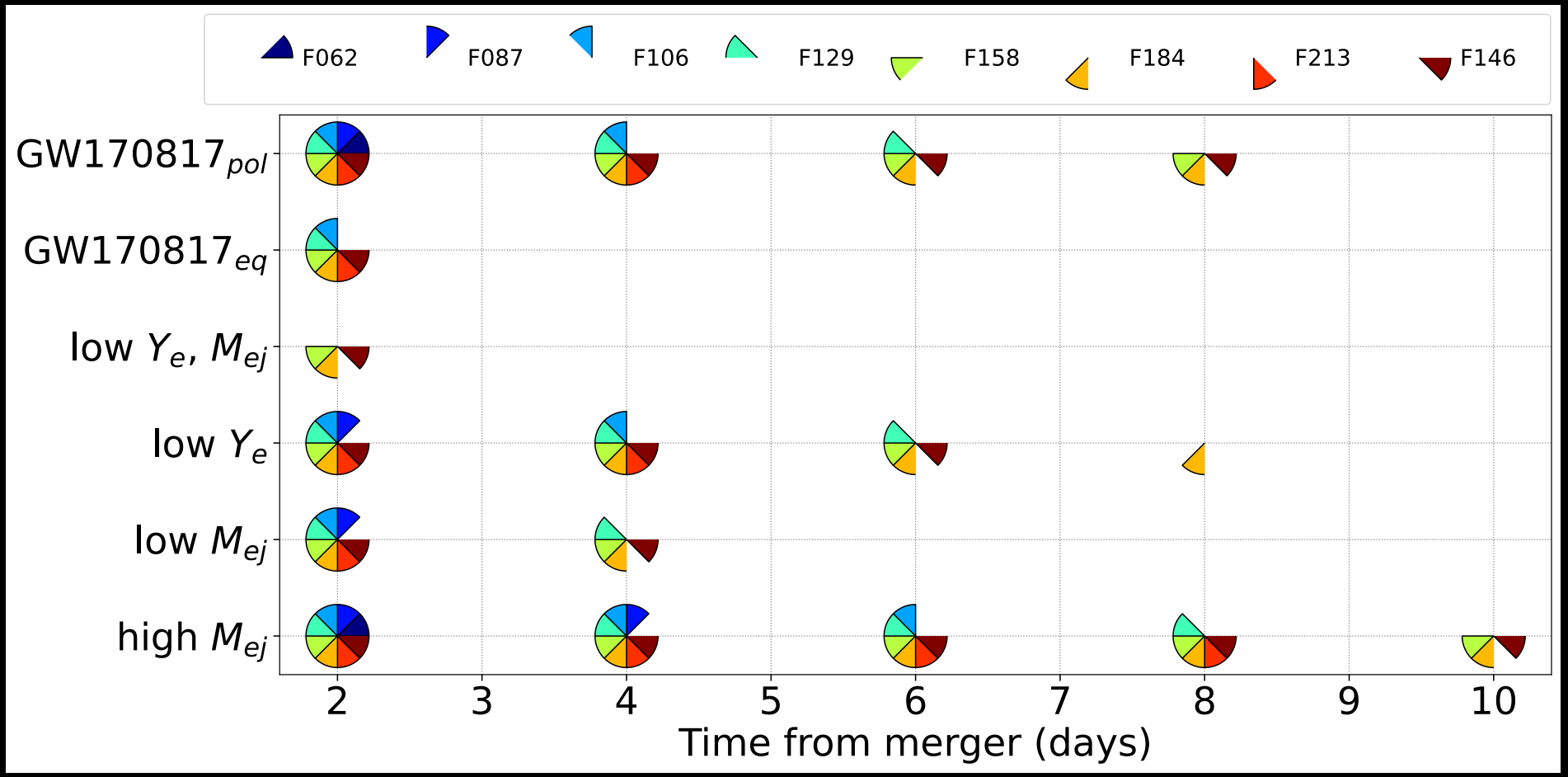
1hr, z=0.2 ($D_{comoving}$ = 850 Mpc)



I.A.+2023, arXiv:2307.09511

Kilonova detection in the HLTD survey

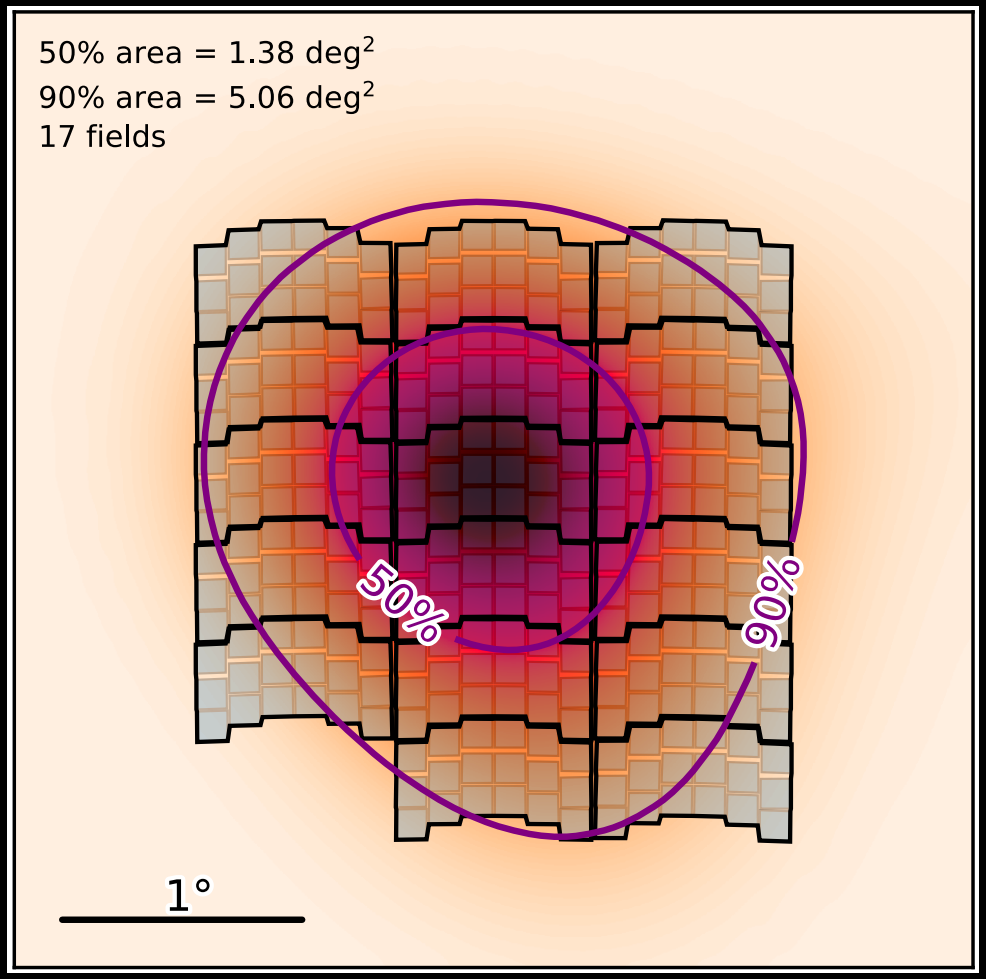
1hr, z~0.9 ($D_{comoving}$ = 3 Gpc)



I.A.+2023, arXiv:2307.09511

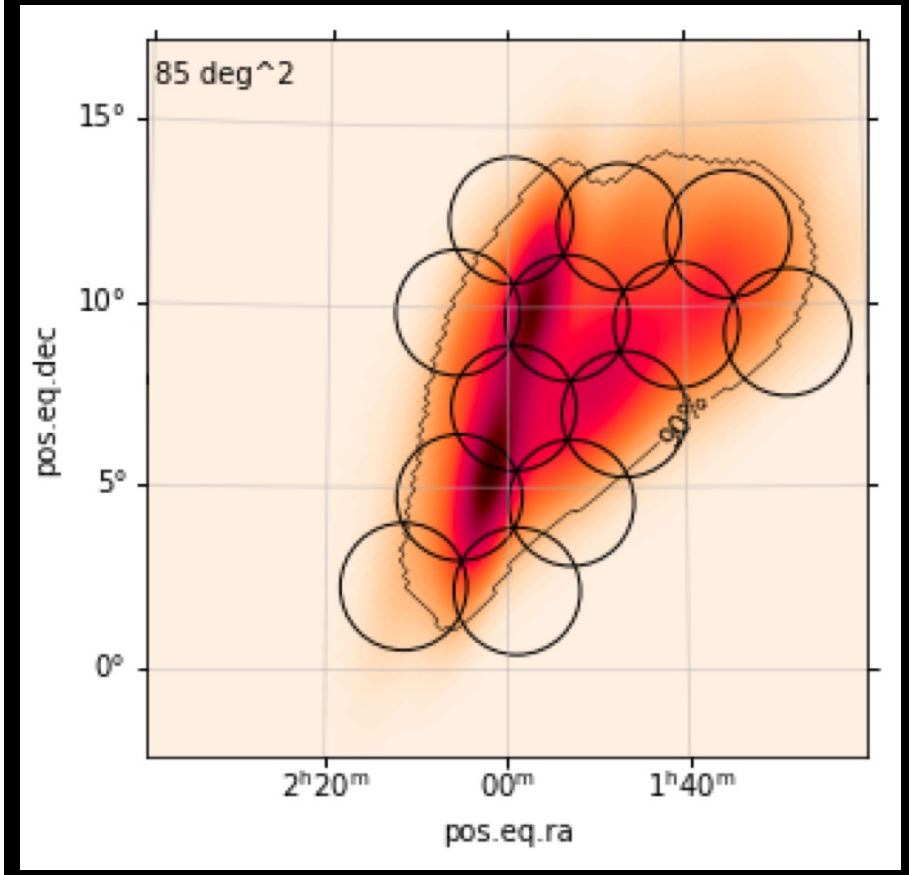
Beyond the HLTD survey: Target of Opportunity

Roman



I.A.+2023, figure by Leo Singer

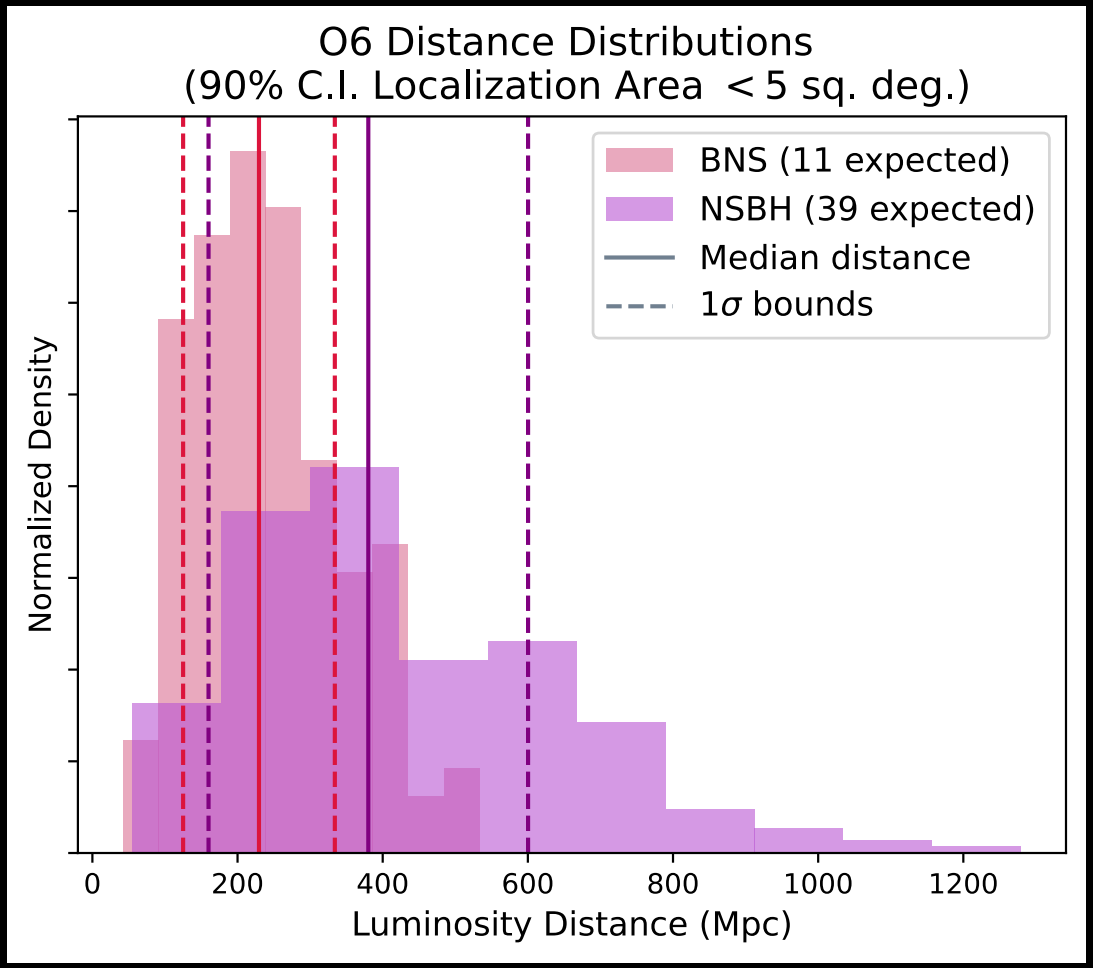
Rubin



I.A.+2022, ApJS, 260, 1, 18

Beyond the HLTD survey: Target of Opportunity

LIGO-Virgo-KAGRA detection prospects



I.A.+2023, based on the analysis by Petrov+2022

Some key findings…

With a 19 deg^2 footprint and 1hr exposures, ~ 1–8 kilonovae similar to GW170817 can be found yearly

1–6 ToO observations of well localized (A < 10 deg^2) mergers during 1.5 years of LVK O5, or ~4–21 during 1.5 years of O6

We need a cadence better than < 8 days in at least 2 filters (preferably F158 & F213)

See also Scolnic+18, Chase+22, Macias+23 WP

…and my wish list for further exploration

Synergies between Roman and Rubin in Deep Drilling Fields

Photometric classification of kilonovae and other transients in the nIR or joint optical + nIR

Deep & Wide survey with the F158 & F213 Roman filters

Possibility of faster ToOs with Roman (~ 1 week instead of 2 weeks)

Tools for survey strategy exploration (similar to MAF)