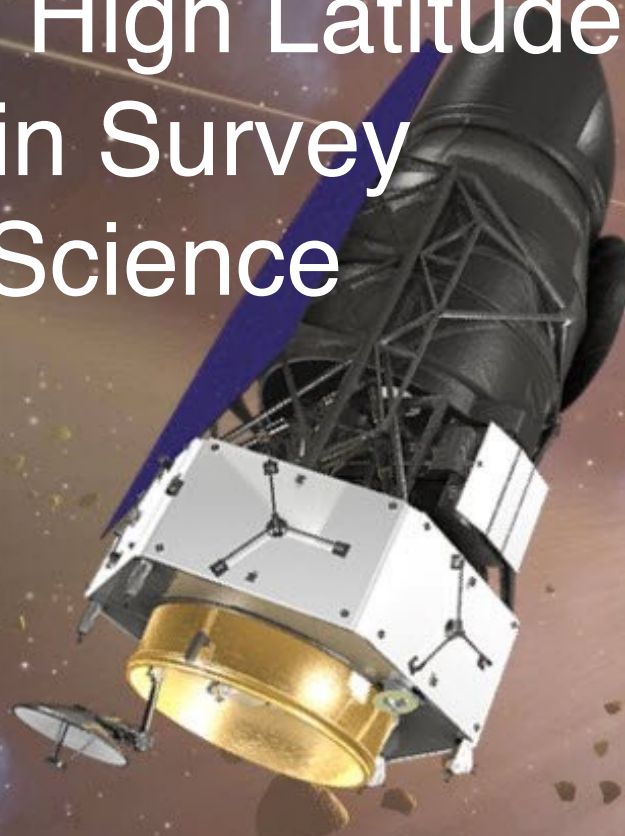


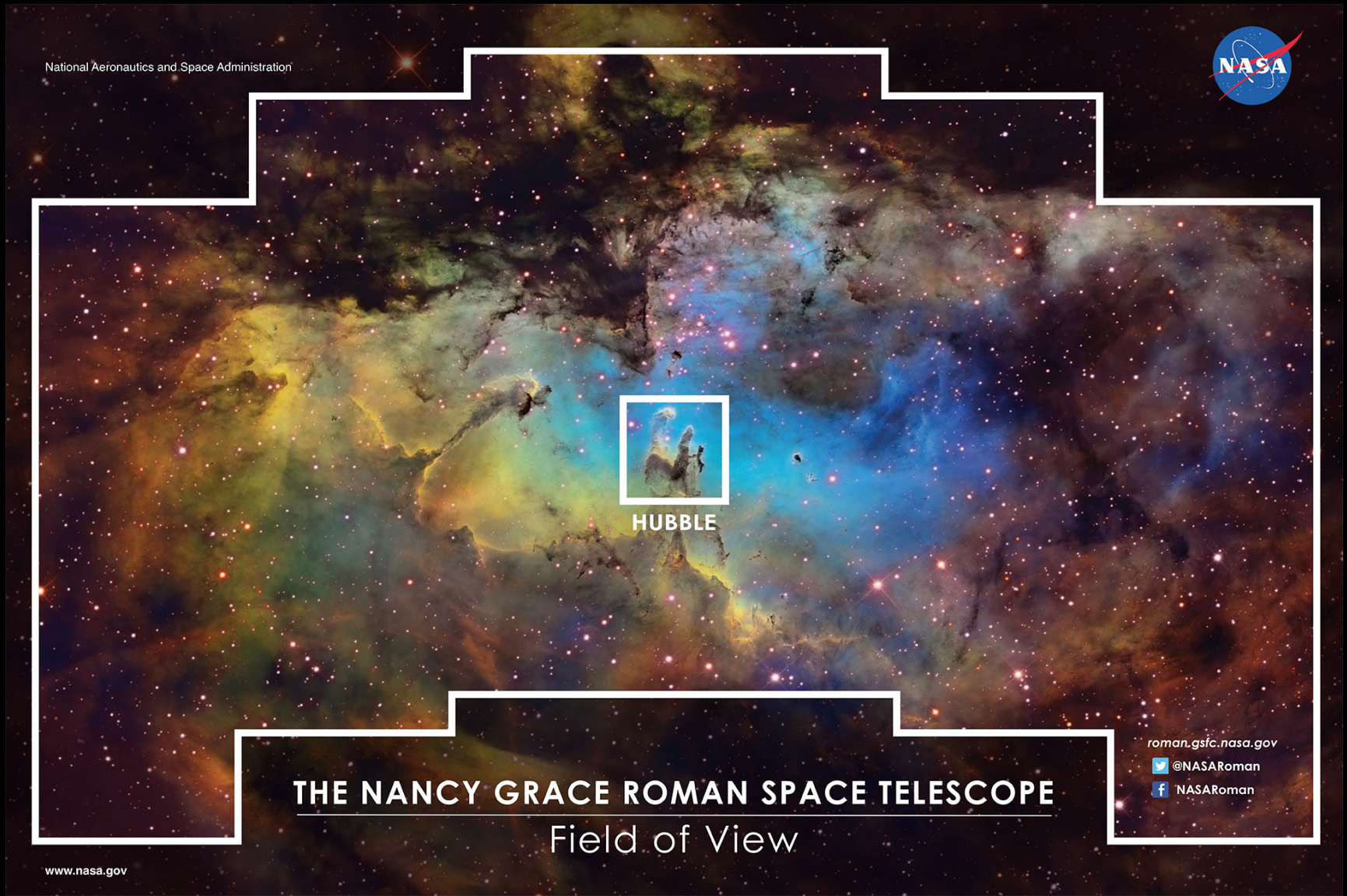
The Roman High Latitude Time Domain Survey & Kilonova Science



Igor Andreoni
Neil Gehrels Fellow

Rubin PCW 2023

Nancy Grace Roman Space Telescope



August 10, 2023



JSI



Igor Andreoni

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+

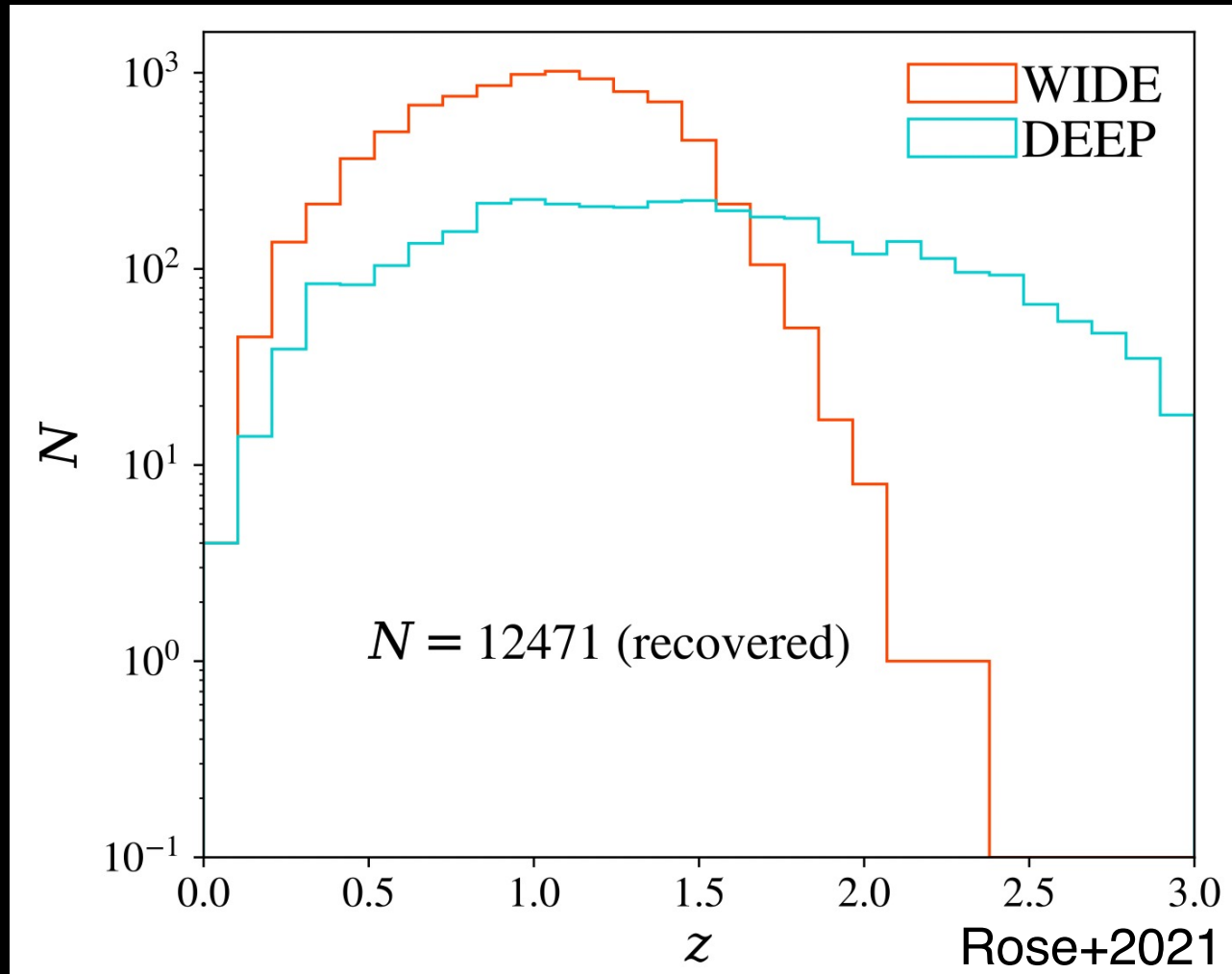
High Latitude Time Domain Survey

~Tens of sq. deg.

It will be defined by a Community process

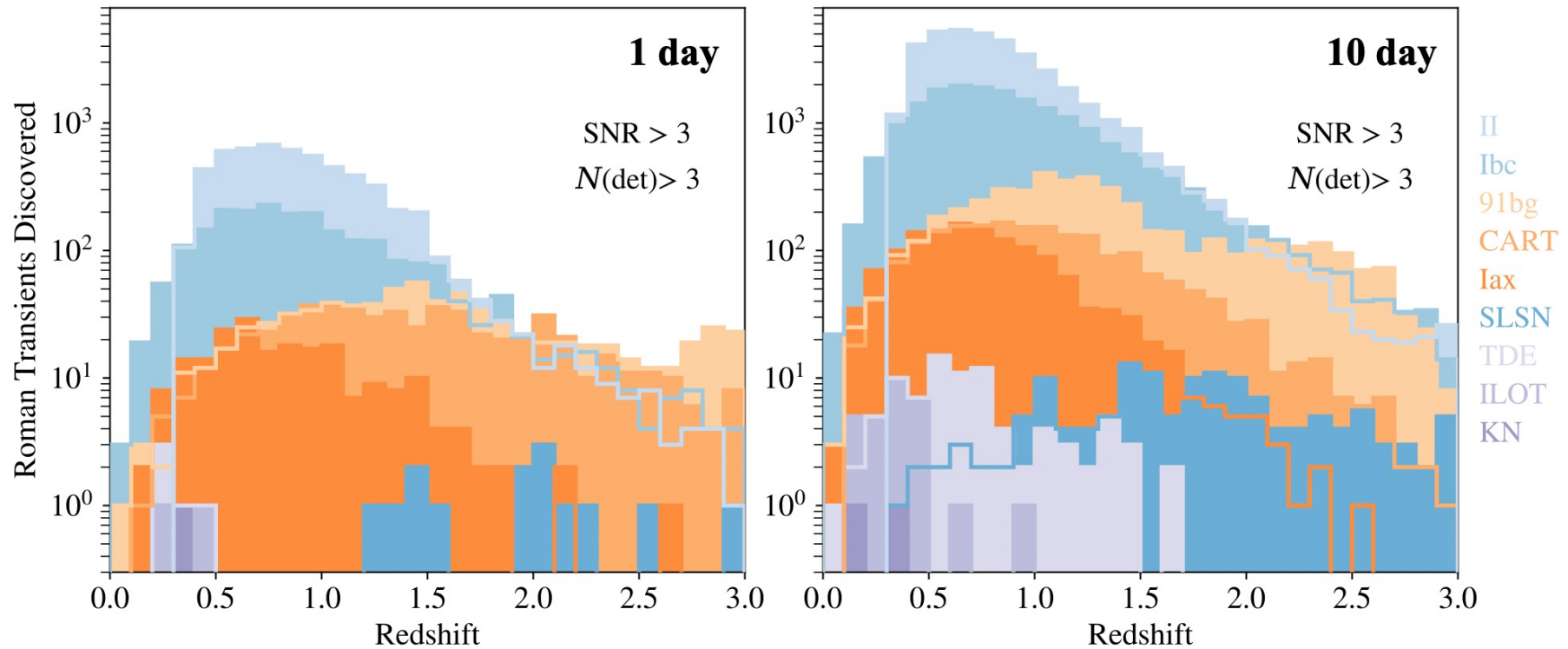
Baseline survey for SN Ia (Rose+2021):
6 months of aggregate telescope time, spread over
a 2 year period, with 25% duty cycle during that
period, 20 deg² footprint (wide), 5-day cadence

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

August 10, 2023

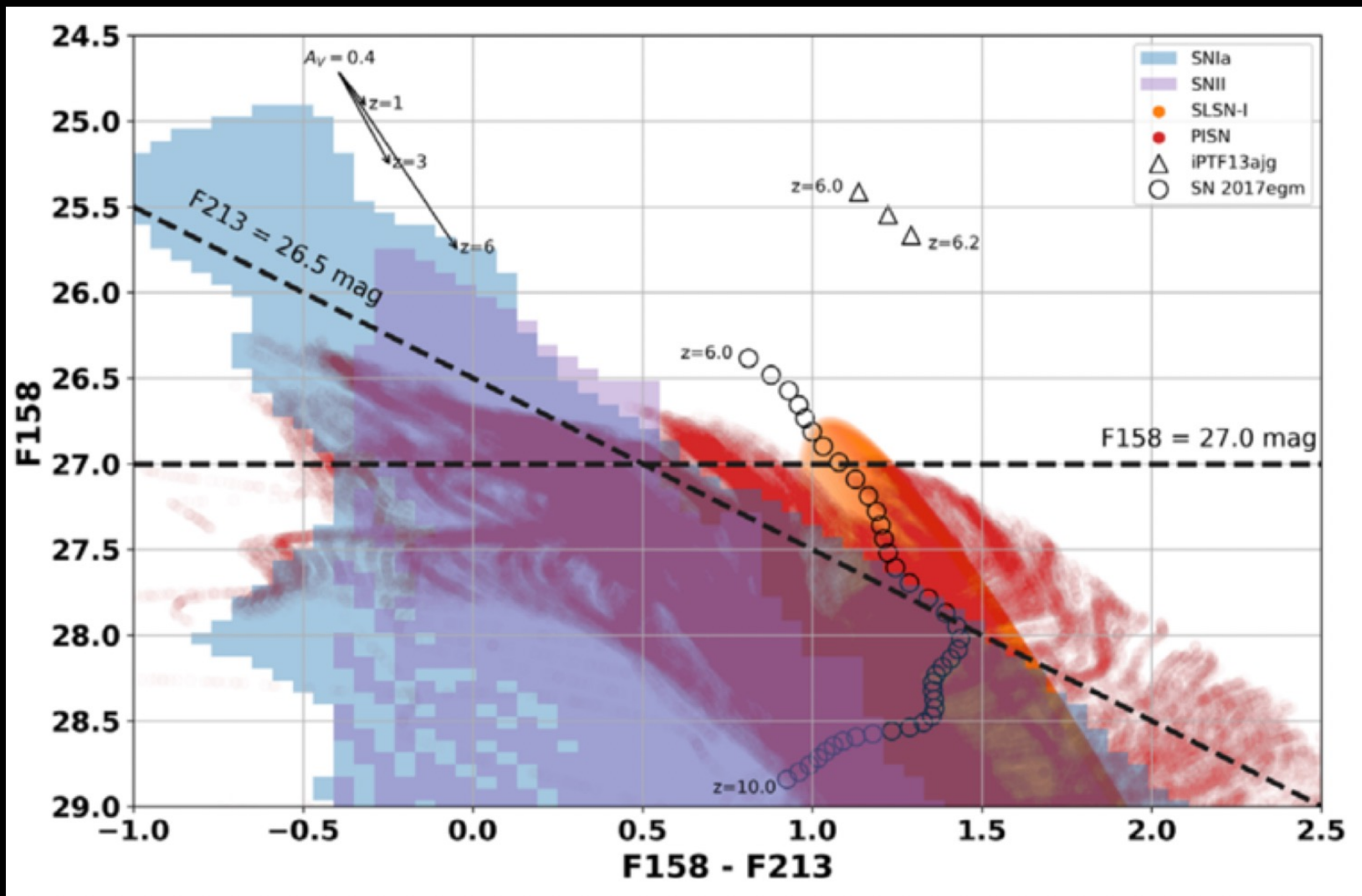


JSI



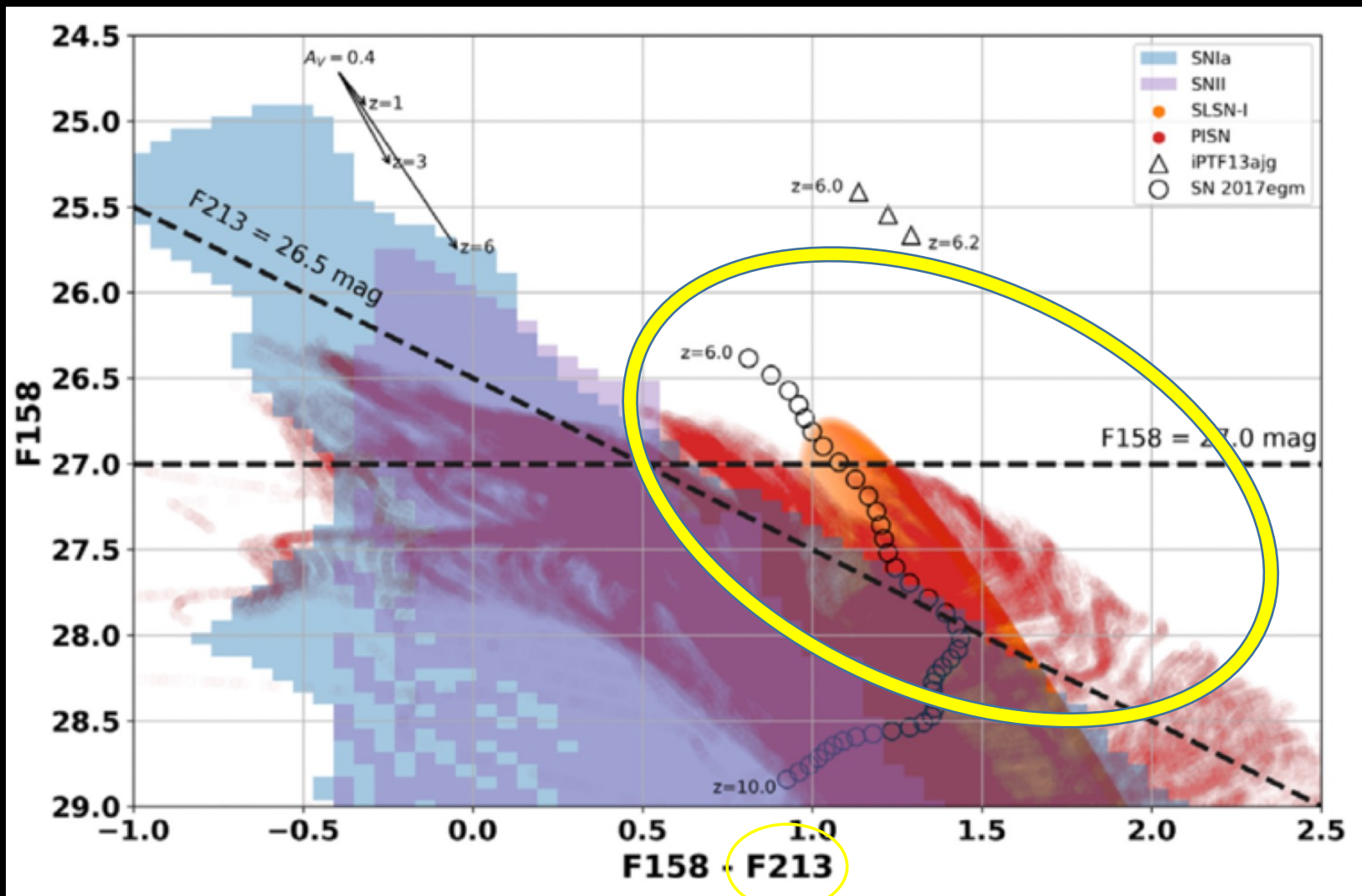
Igor Andreoni

Rare supernovae at high z



Moriya+ WP 2023

Rare supernovae at high z



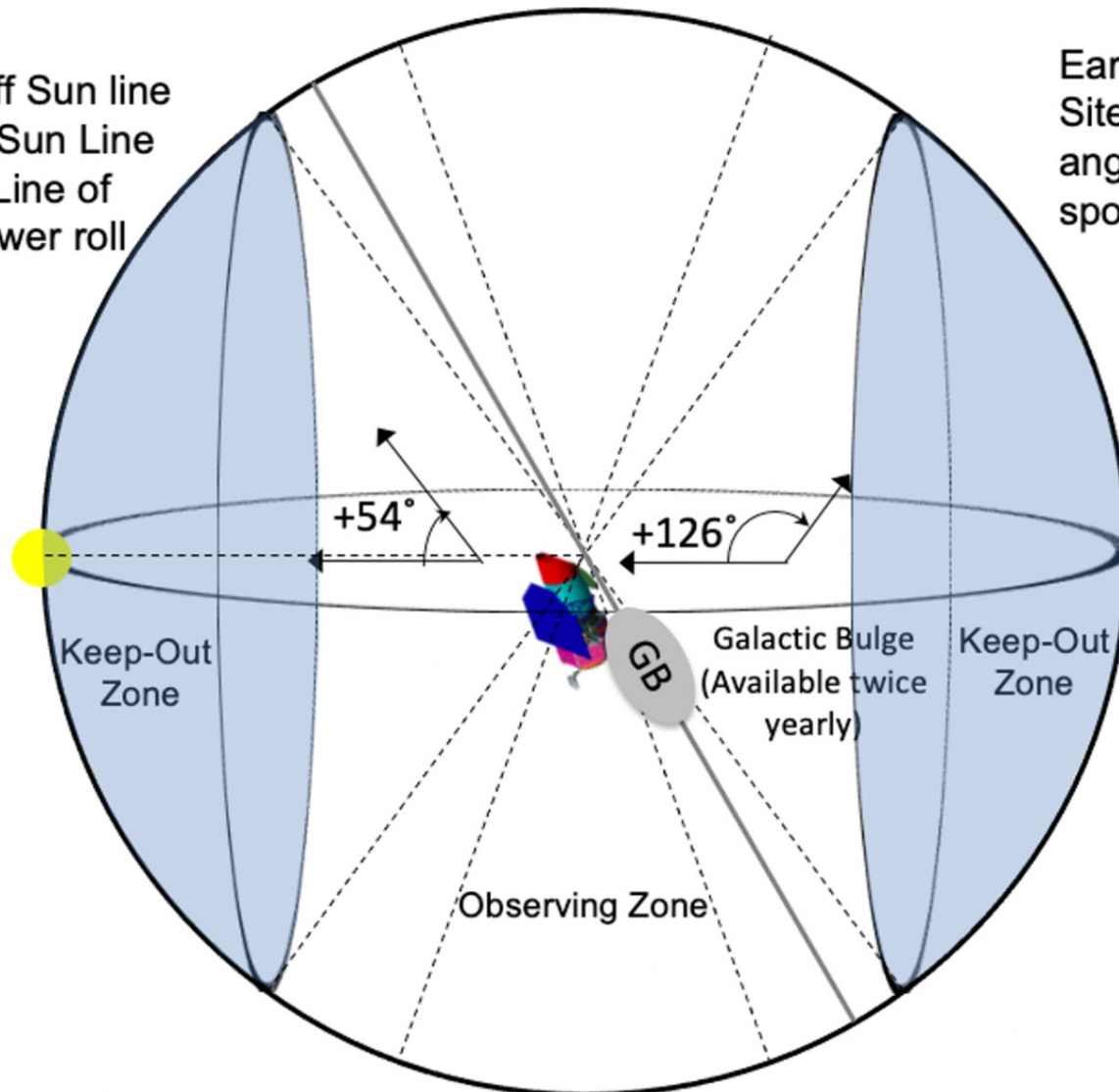
Moriya+ WP 2023

Roman Field of Regard

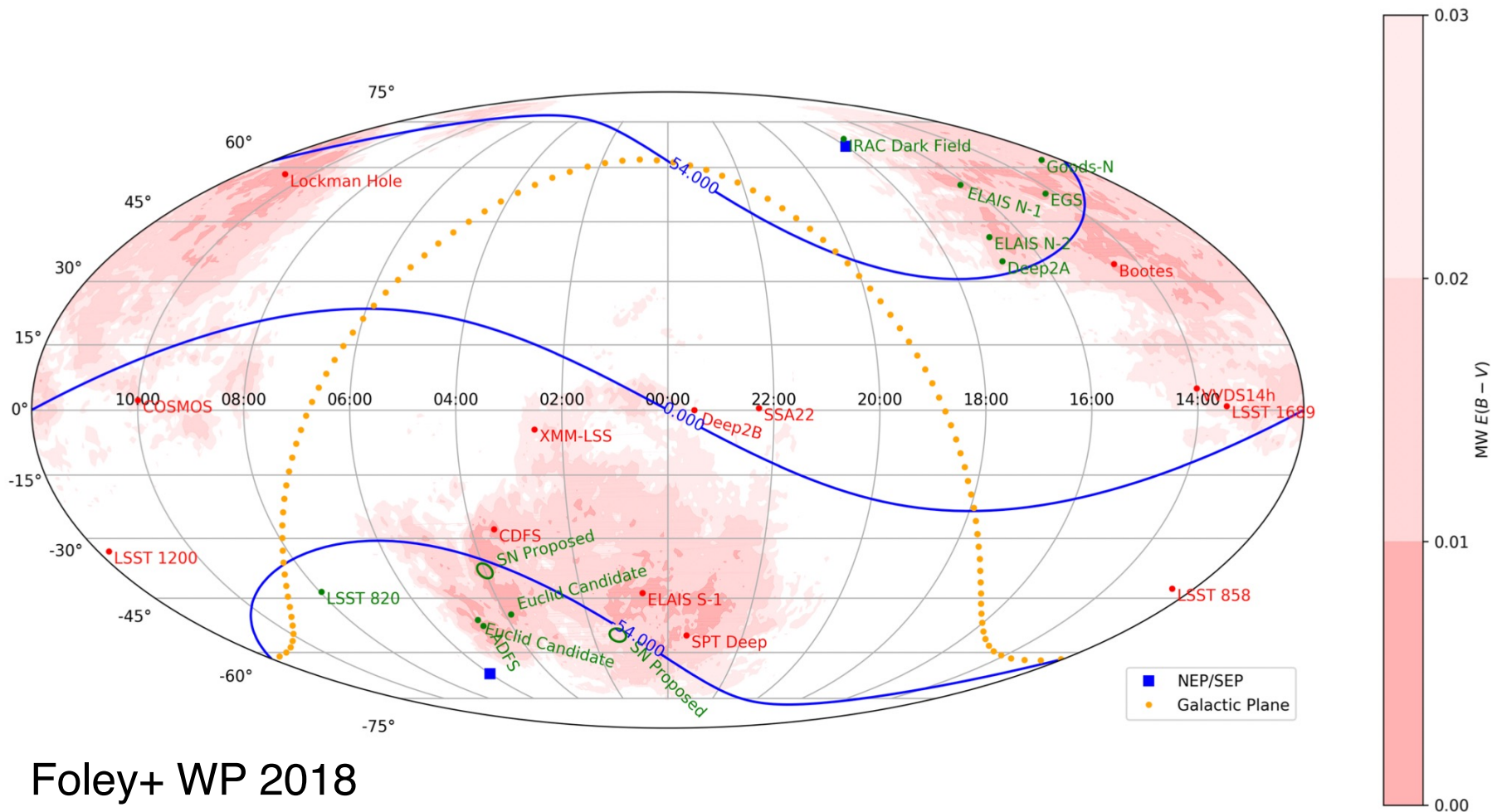
Observing Zone:

- 54° - 126° Pitch off Sun line
- 360° Yaw about Sun Line
- $\pm 15^{\circ}$ Roll about Line of Sight off max power roll angle

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

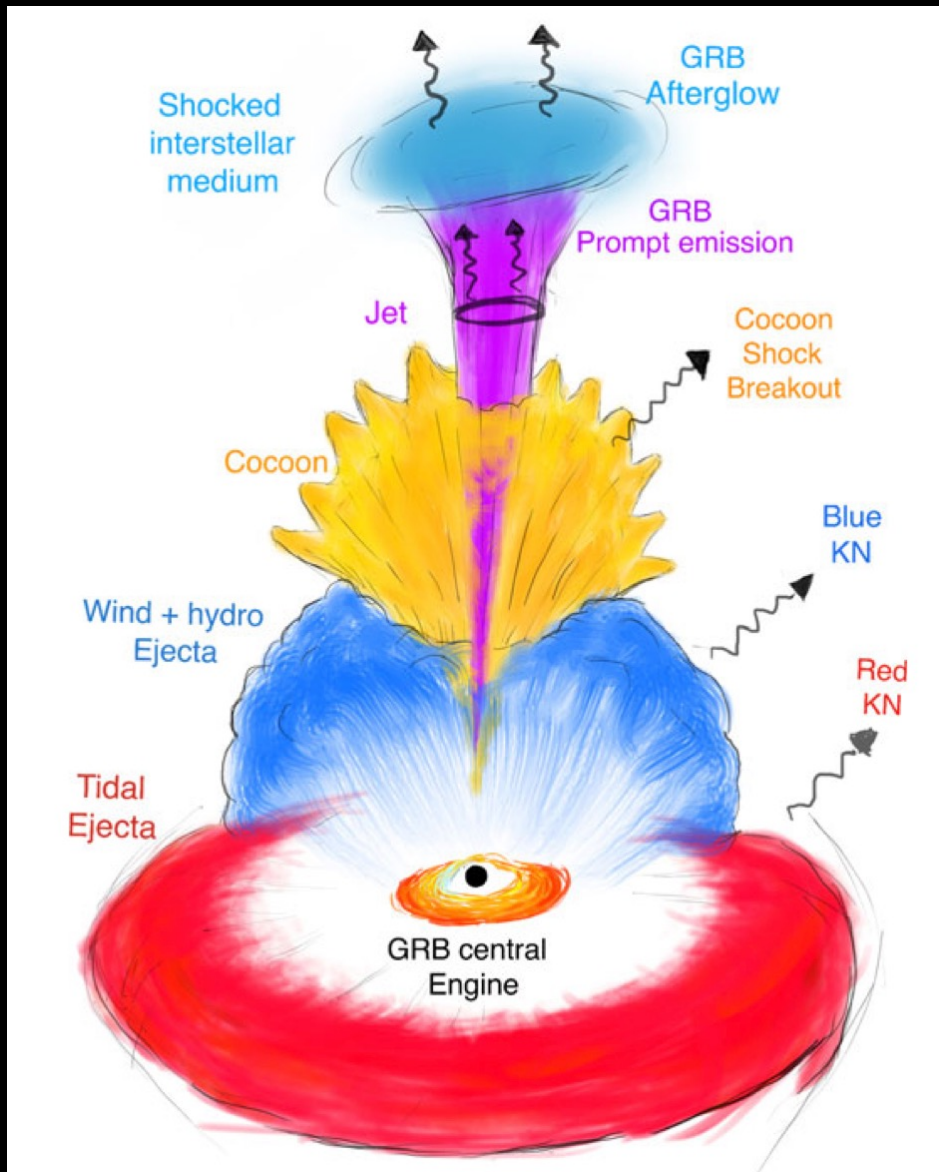


High Latitude Time Domain Survey: Where to observe?



Foley+ WP 2018

Kilonovae



Ascenzi+21
(KN = kilonova)

Heavy “r-process” elements

Element Origins

Element Origins

1 H																	2 He		
3 Li	4 Be													5 B	6 C	7 N	8 O	9 F	10 Ne
11 Na	12 Mg													13 Al	14 Si	15 P	16 S	17 Cl	18 Ar
19 K	20 Ca	21 Sc	22 Ti	23 V	24 Cr	25 Mn	26 Fe	27 Co	28 Ni	29 Cu	30 Zn	31 Ga	32 Ge	33 As	34 Se	35 Br	36 Kr		
37 Rb	38 Sr	39 Y	40 Zr	41 Nb	42 Mo	43 Tc	44 Ru	45 Rh	46 Pd	47 Ag	48 Cd	49 In	50 Sn	51 Sb	52 Te	53 I	54 Xe		
55 Cs	56 Ba			72 Hf	73 Ta	74 W	75 Re	76 Os	77 Ir	78 Pt	79 Au	80 Hg	81 Tl	82 Pb	83 Bi	84 Po	85 At	86 Rn	
87 Fr	88 Ra																		
		57 La	58 Ce	59 Pr	60 Nd	61 Pm	62 Sm	63 Eu	64 Gd	65 Tb	66 Dy	67 Ho	68 Er	69 Tm	70 Yb	71 Lu			
		89 Ac	90 Th	91 Pa	92 U														

Merging Neutron Stars
Dying Low Mass Stars

Exploding Massive Stars
Exploding White Dwarfs

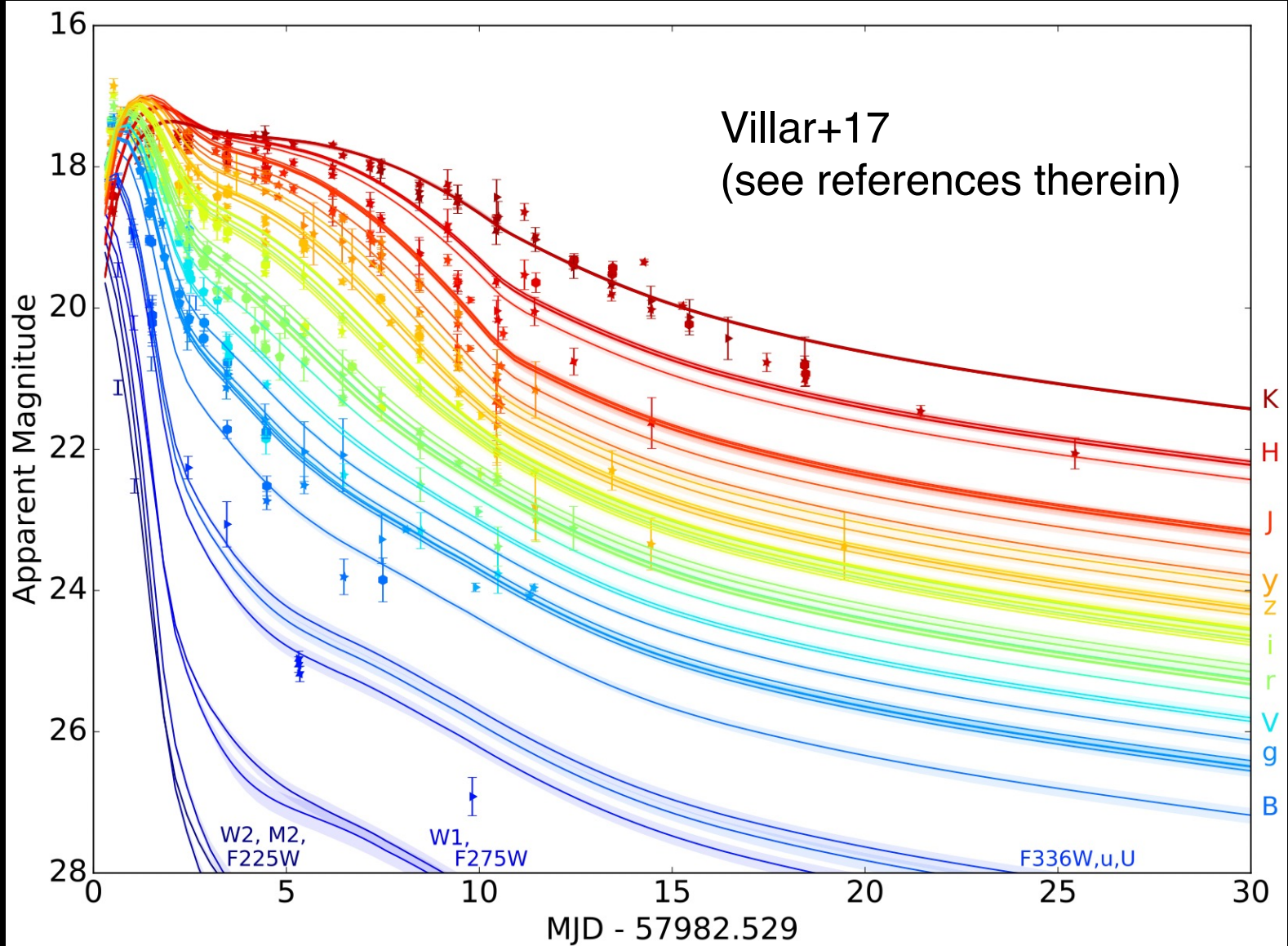
Big Bang
Cosmic Ray Fission

Based on graphic created by Jennifer Johnson

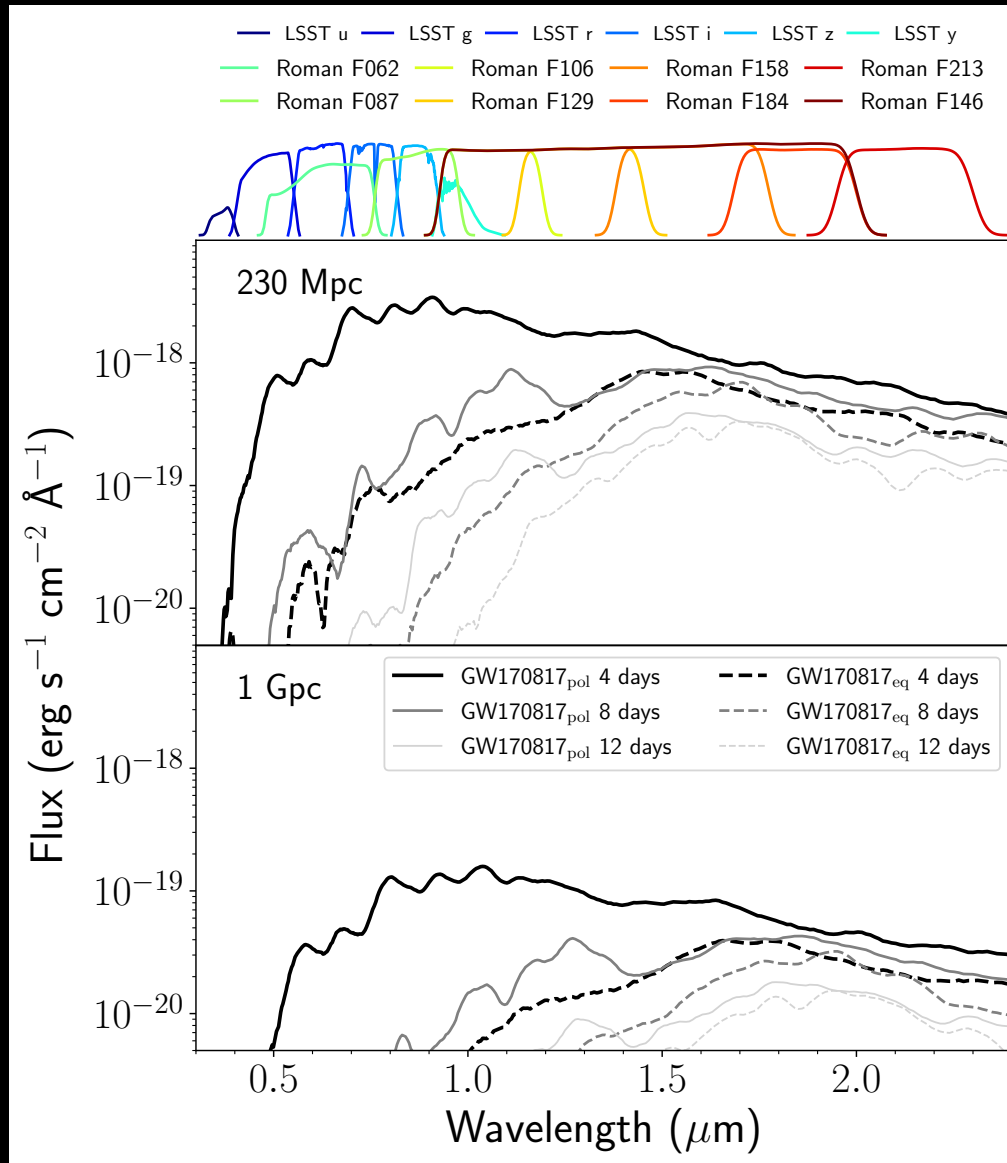
See e.g. Lattimer & Schramm (1974)

Credit: Jennifer Johnson

Kilonovae - GW170817

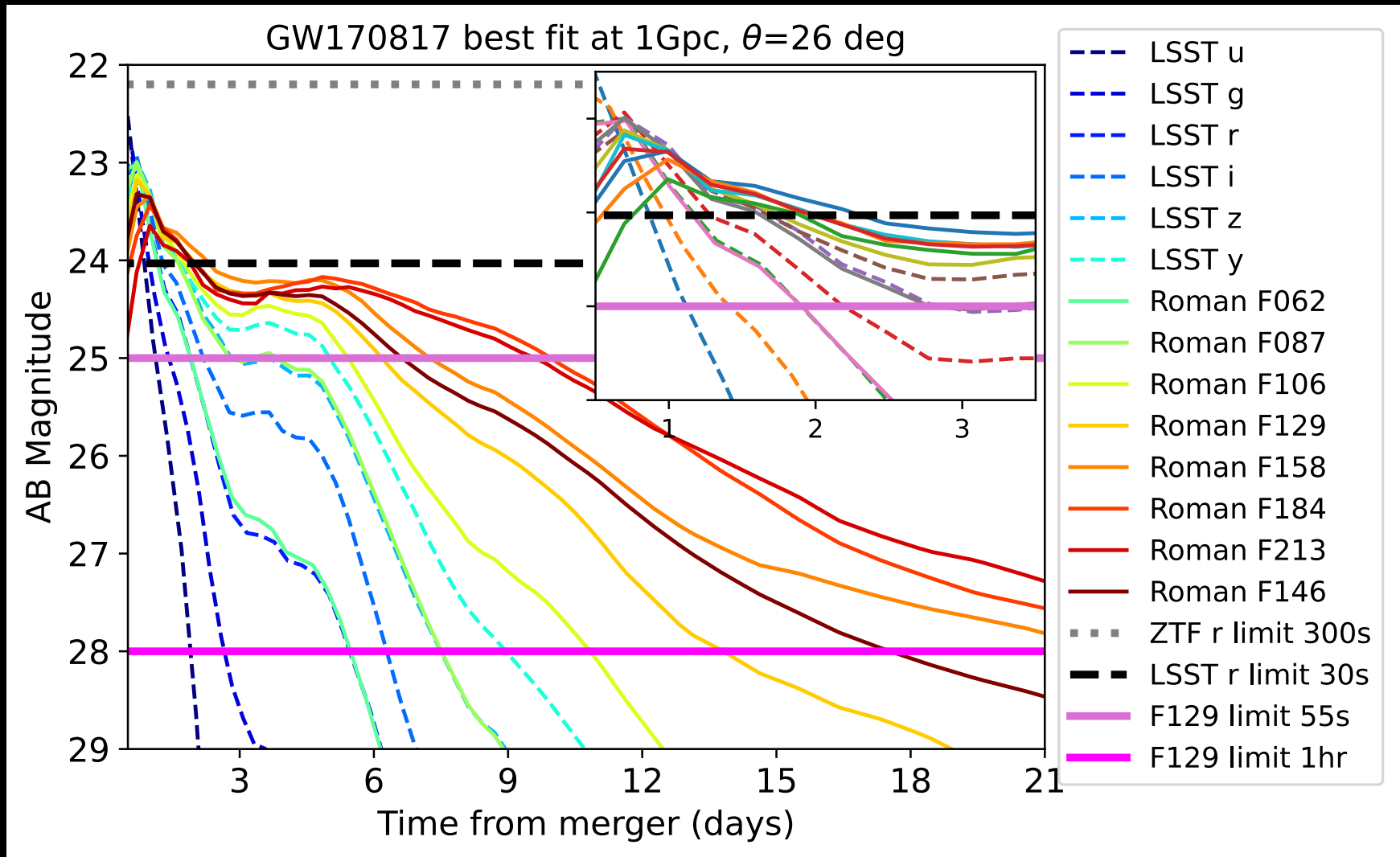


Rubin & Roman kilonova observations



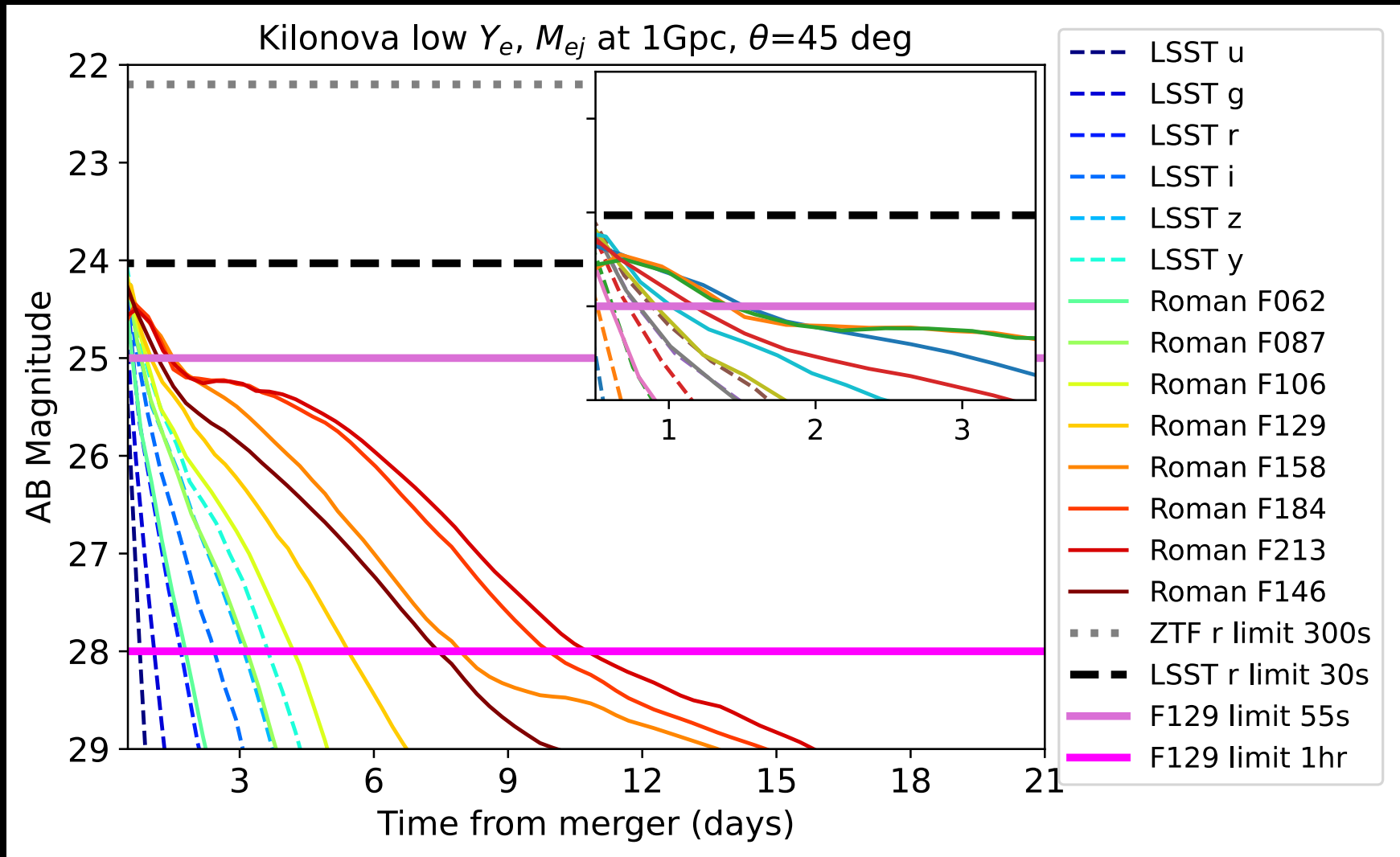
I.A.+2023,
arXiv:2307.09511

Rubin & Roman kilonova observations



I.A.+2023, arXiv:2307.09511

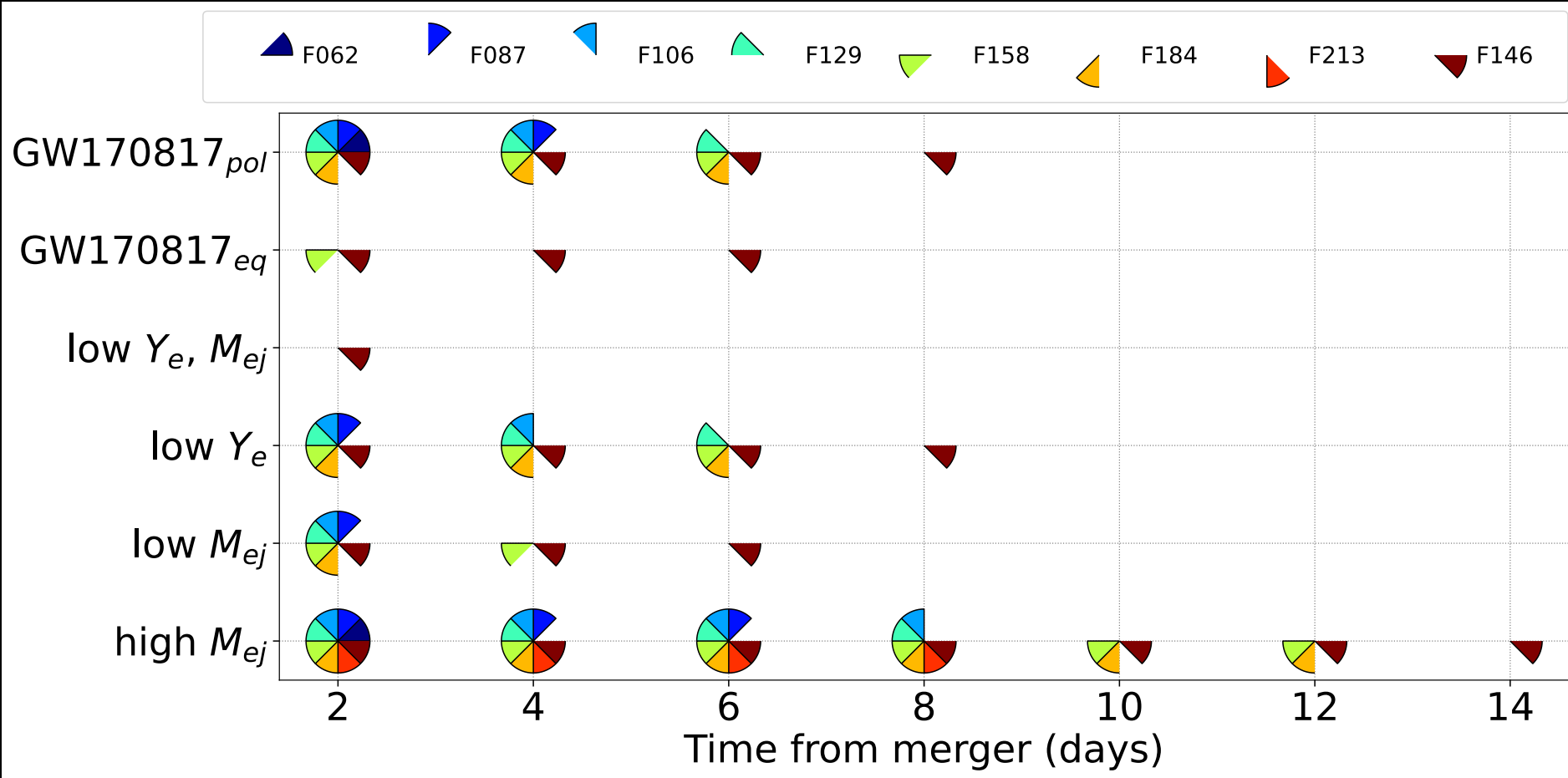
Rubin & Roman kilonova observations



I.A.+2023, arXiv:2307.09511

Kilonova detection in the HLTD survey

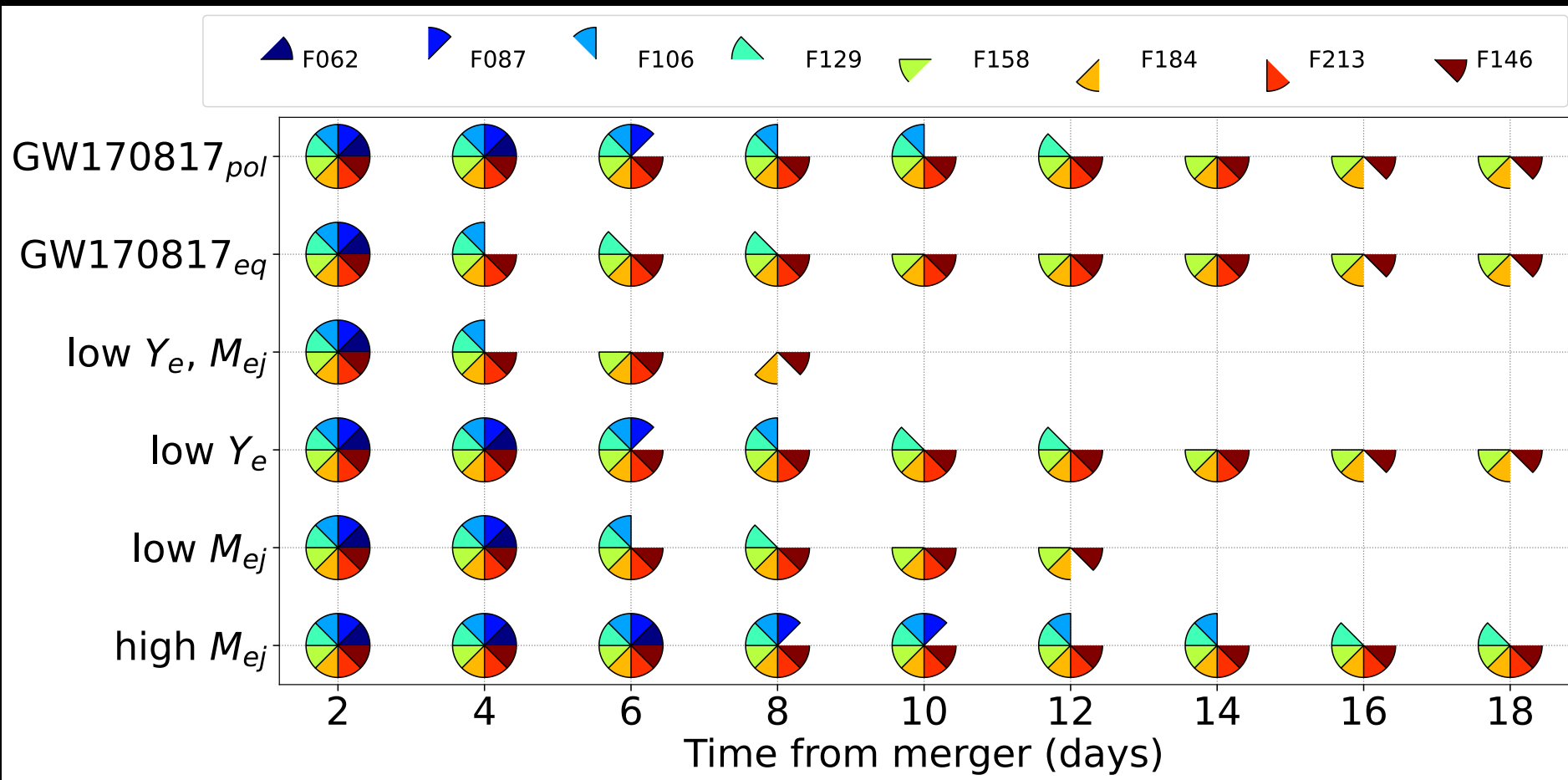
55s, $z=0.2$ ($D_{\text{comoving}} = 850$ Mpc)



I.A.+2023, arXiv:2307.09511

Kilonova detection in the HLTD survey

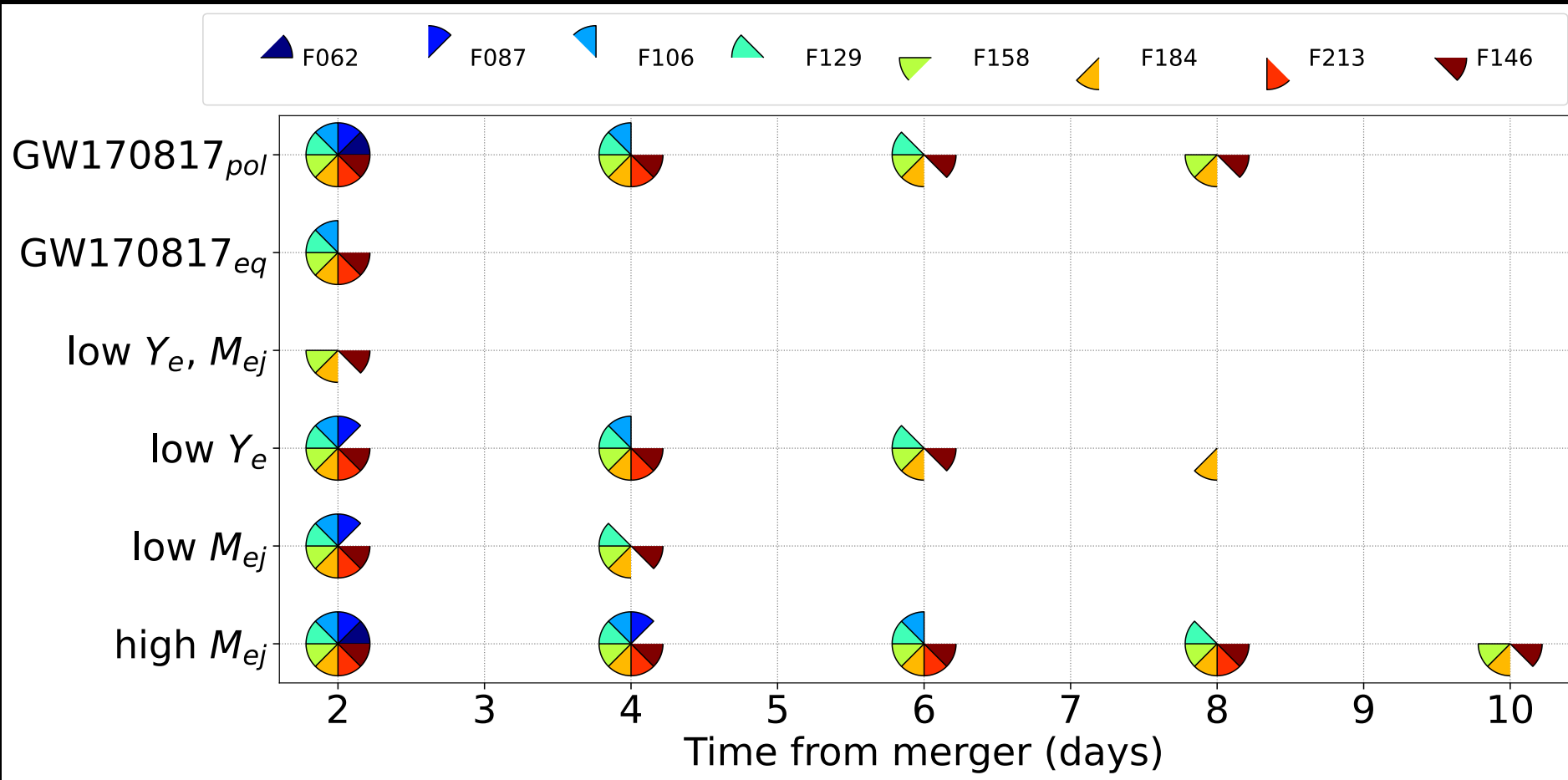
1hr, $z=0.2$ ($D_{\text{comoving}} = 850$ Mpc)



I.A.+2023, arXiv:2307.09511

Kilonova detection in the HLTD survey

1hr, $z \sim 0.9$ ($D_{\text{comoving}} = 3 \text{ Gpc}$)

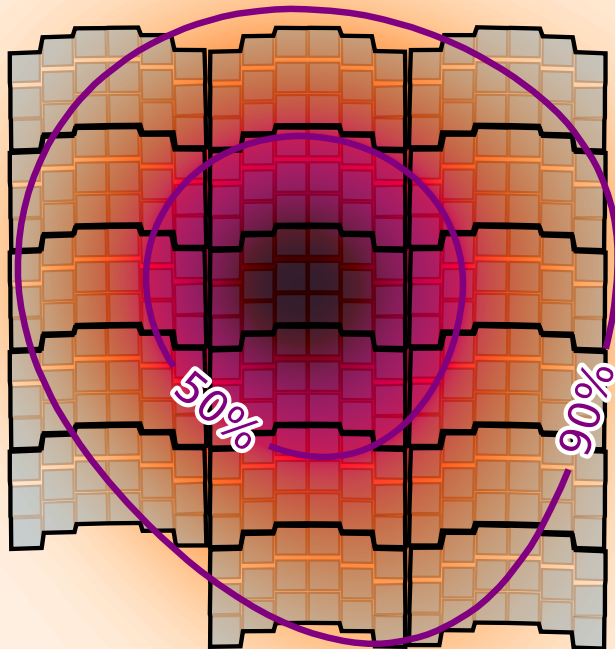


I.A.+2023, arXiv:2307.09511

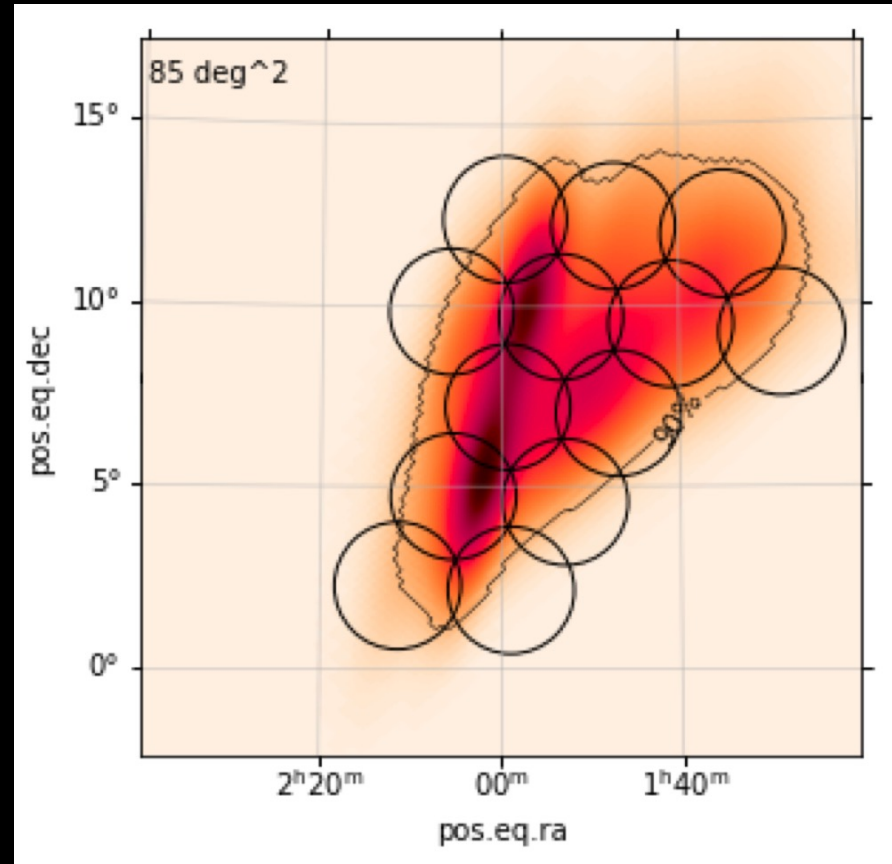
Beyond the HLTD survey: Target of Opportunity

Roman

50% area = 1.38 deg^2
90% area = 5.06 deg^2
17 fields



Rubin

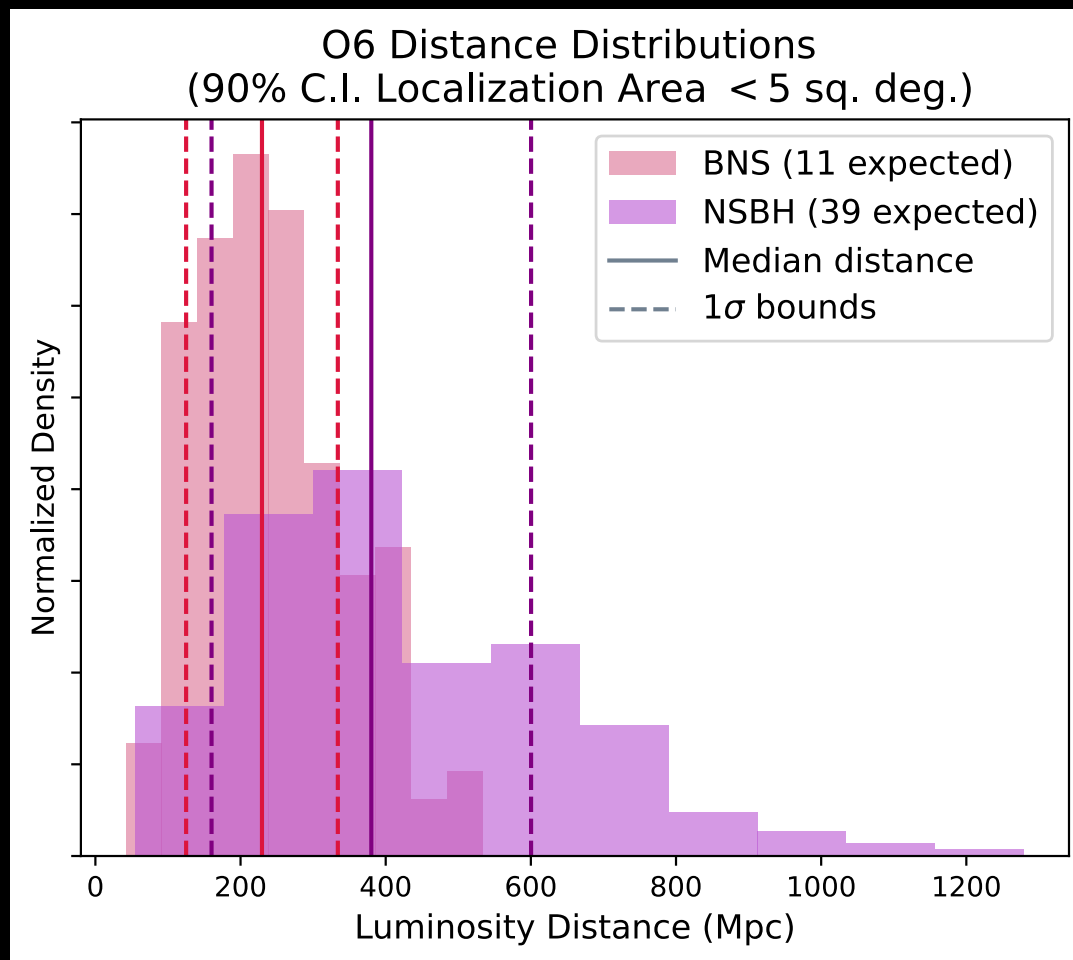


I.A.+2023, figure by Leo Singer

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 deg²** footprint and **1hr** exposures, **~ 1–8** kilonovae similar to GW170817 can be found yearly

1–6 ToO observations of well localized ($A < 10 \text{ deg}^2$) 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)