Masses in the Stellar Graveyard

in Solar Masses

160
80
40
20
10
5
2
1

LIGO-Virgo Black Holes

EM Black Holes

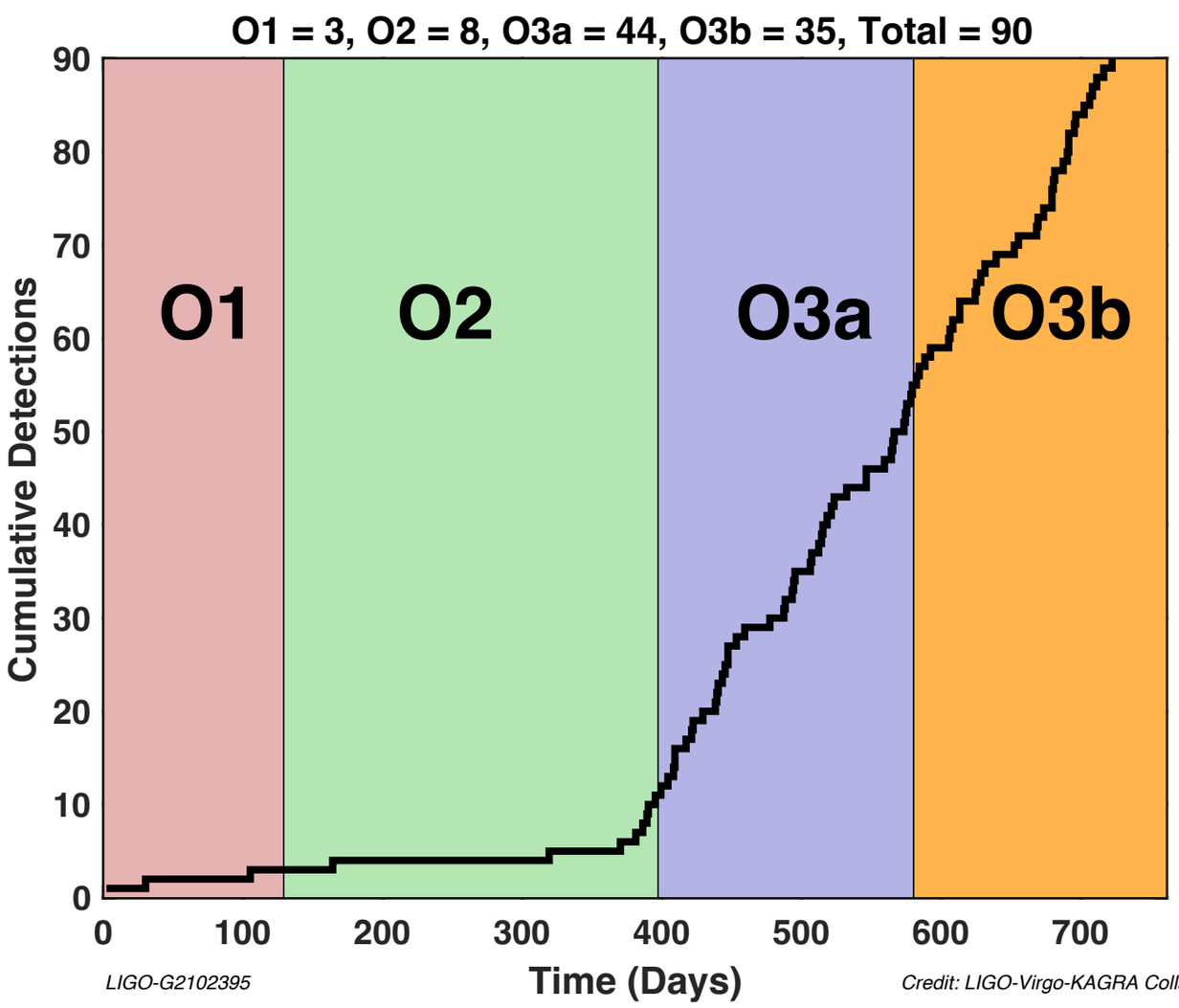
$3.2M_\odot$

EM Neutron Stars

LIGO-Virgo Neutron Stars

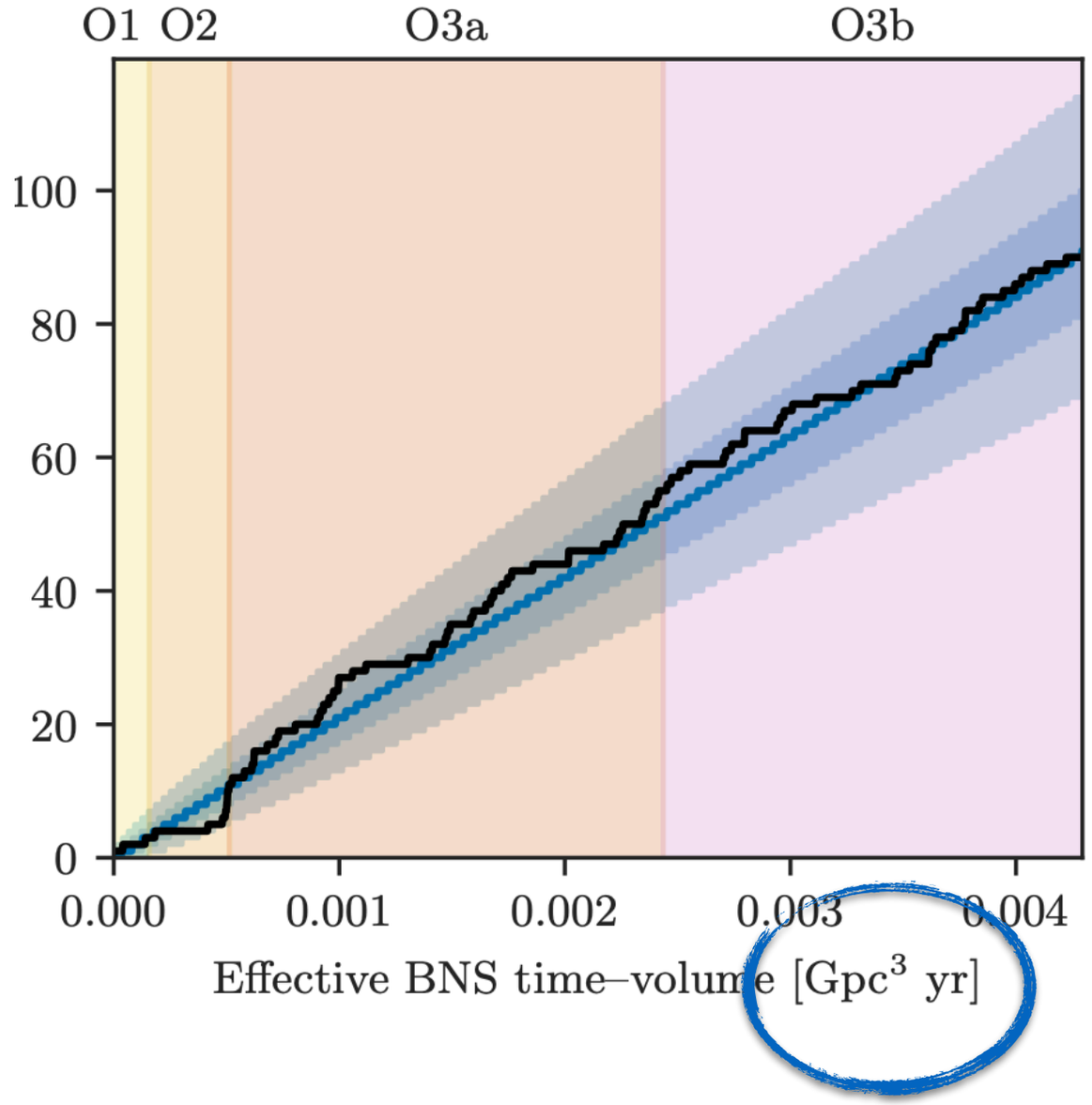
LIGO-Virgo | Frank Elavsky, Aaron Geller | Northwestern

Accelerating growth



LIGO-G2102395

Credit: LIGO-Virgo-KAGRA Collaborations

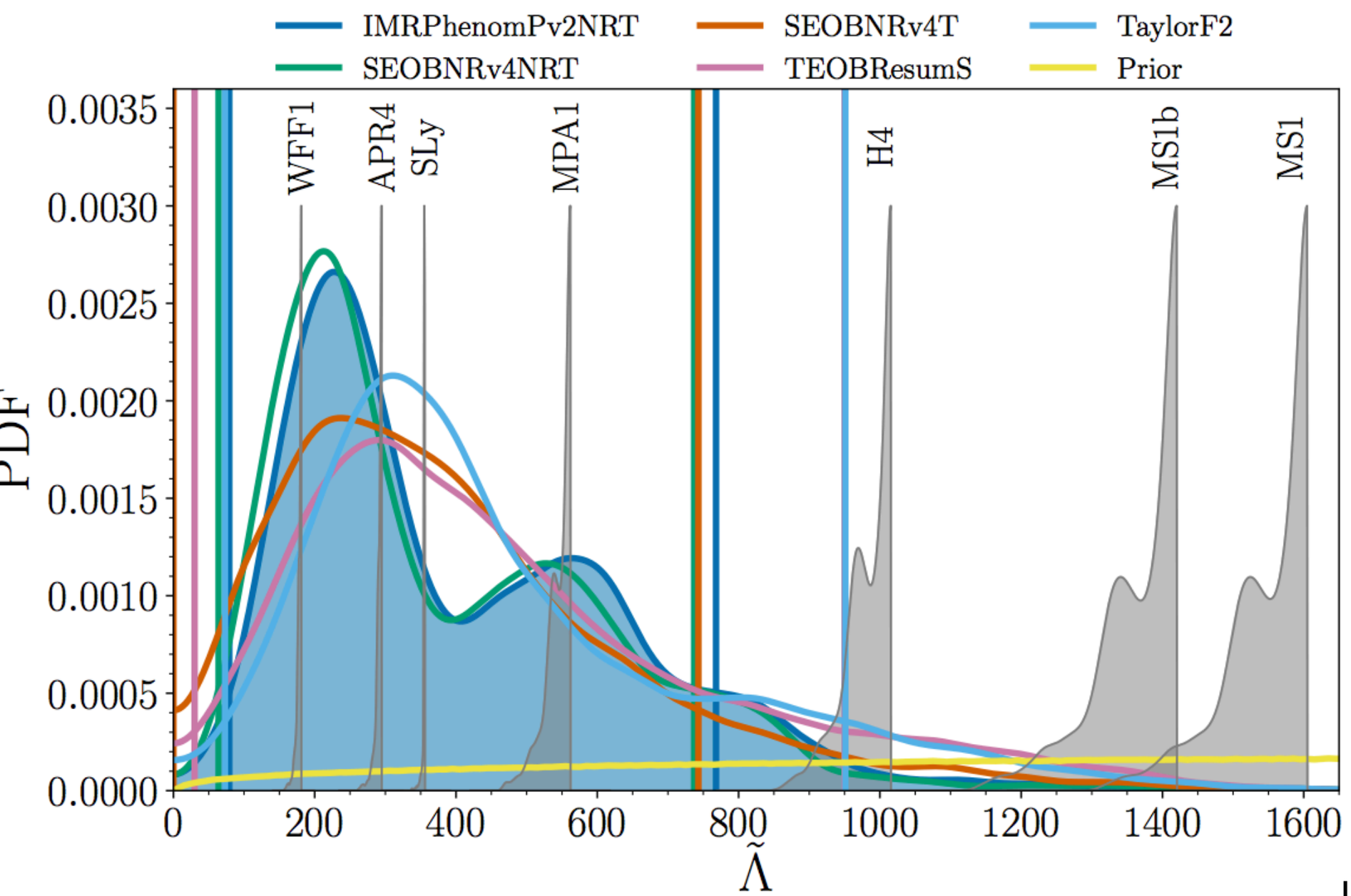


$$\text{Sensitivity} \sim \frac{1}{r}$$

$$\text{\# of detections} \sim r^3$$

LVC (arxiv:2111.03606)

Tides in neutron stars: low mass GW170817

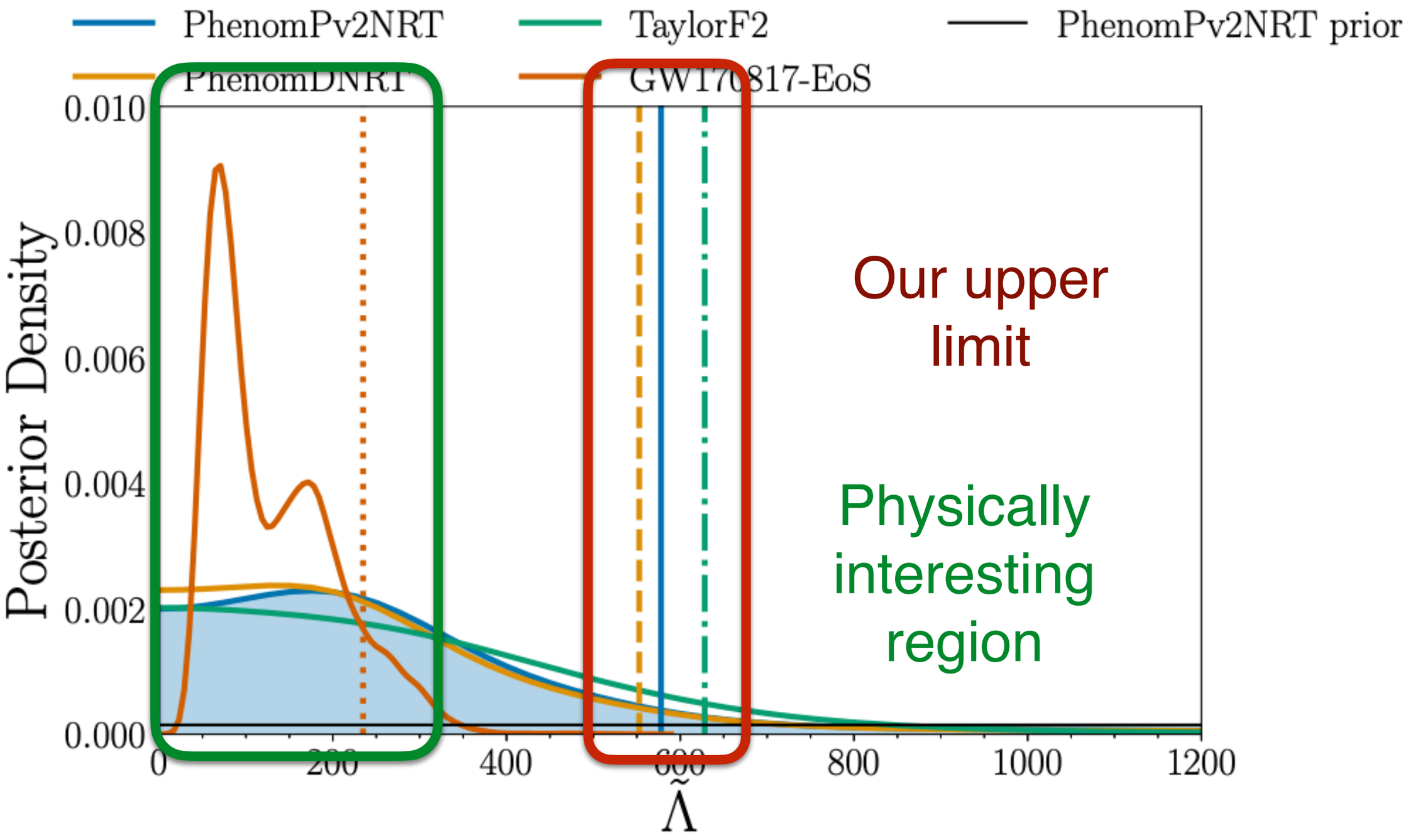


LVC (arxiv:1811.12907)

PE: Veitch+ (arxiv:1409.7215)

Waveforms:
Dietrich+ (arxiv:1804.02235),
Nagar+ (arxiv:1806.01772),
Hinderer+ (arxiv:1602.00599)

Tides in neutron stars: high mass GW190425

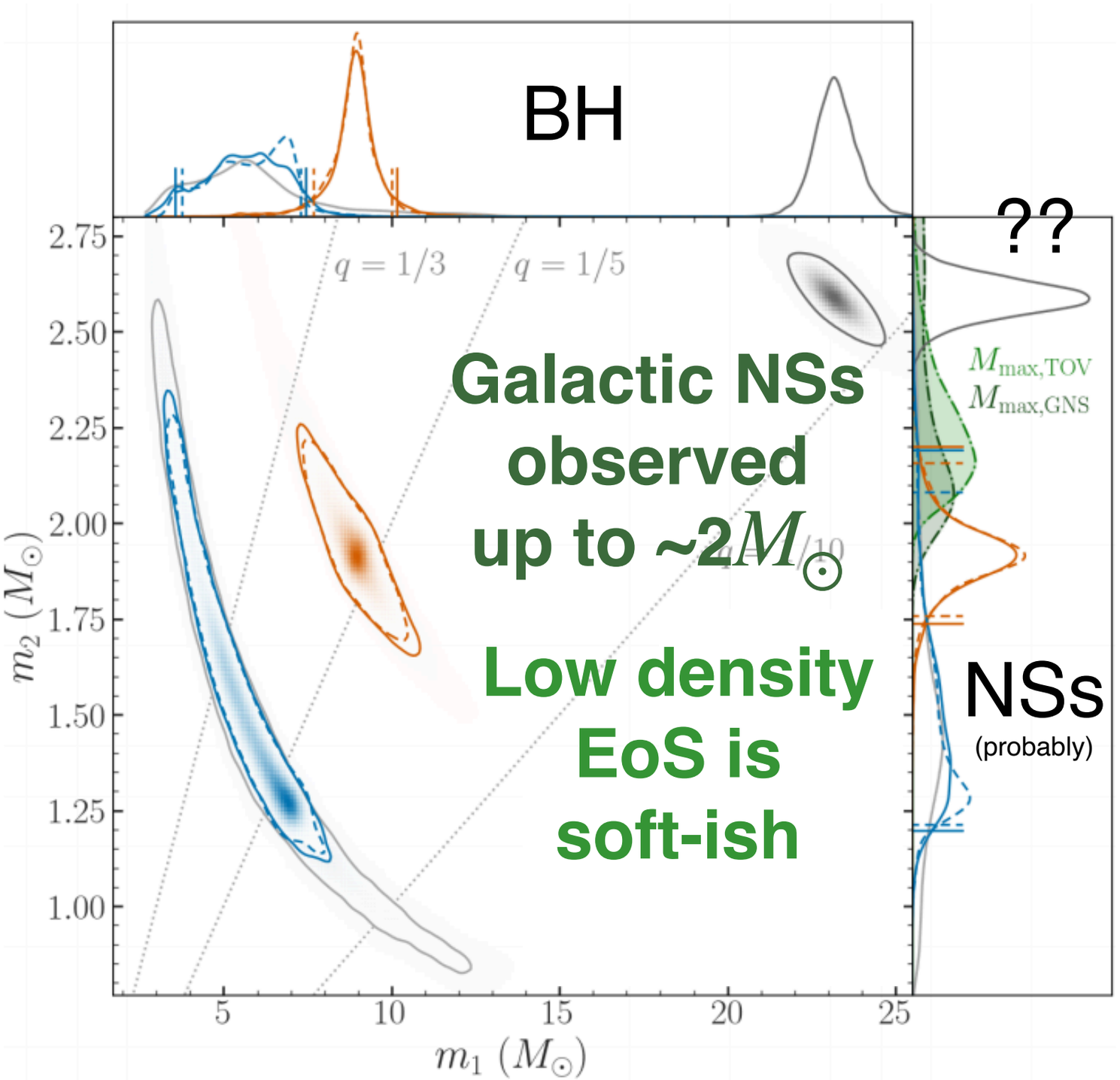


LVC (arxiv:2001.01761)

PE: Veitch+ (arxiv:1409.7215)

Waveform: Dietrich+ (arxiv:1804.02235)

Observations



No tidal signature in any event, need external input?

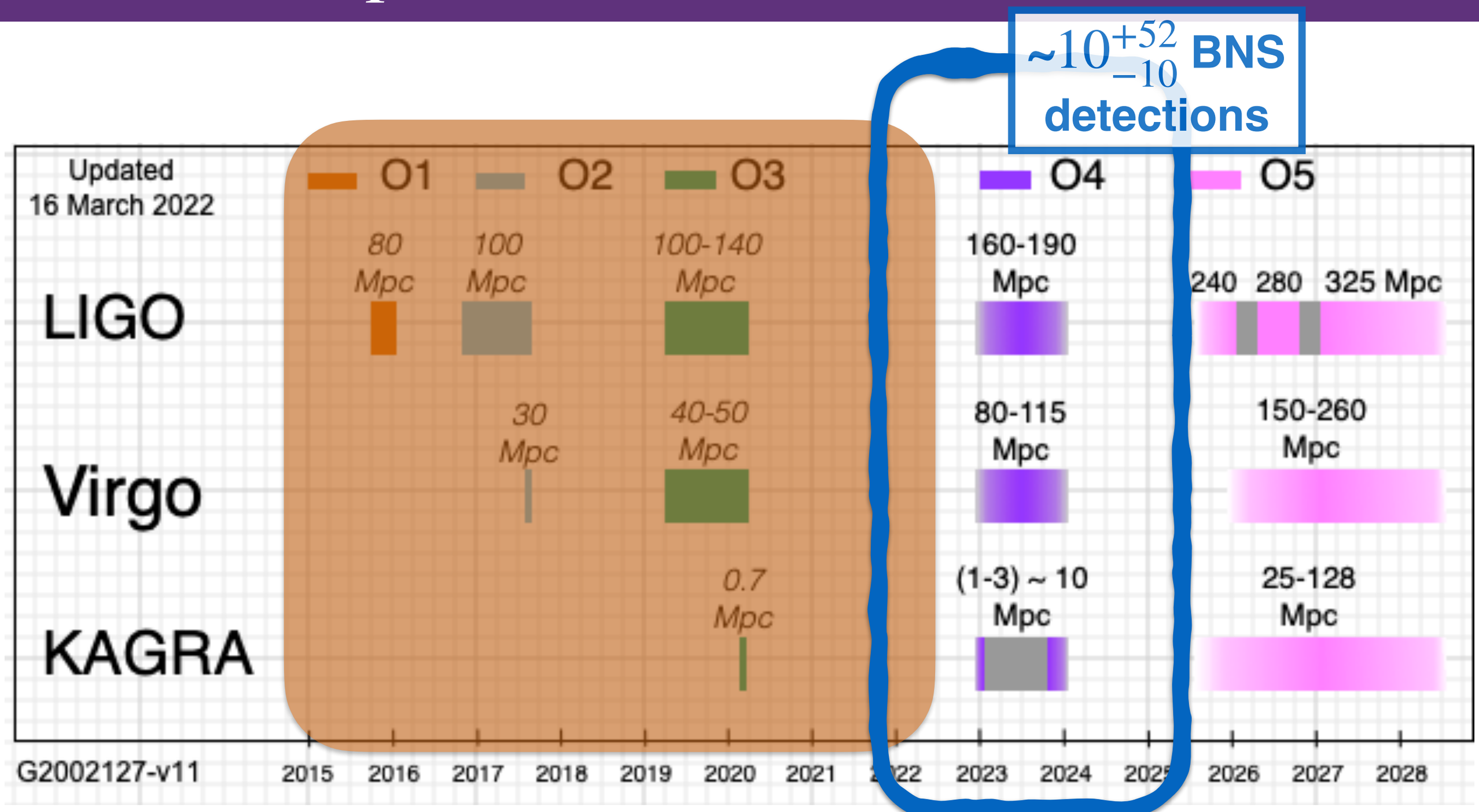
A $2.6M_\odot$ object:

- BH
- Spinning NS
- Phase transitions
- Statistical outlier
- …

LVC (arxiv:2106.15163)
LVC (arxiv:2006.12611)
PE: Veitch+ (arxiv:1409.7215), Ashton+ (1811.02042)
Waveforms: Khan+ (arxiv:1911.06050), Ossokine+ (arxiv:2004.09442), Pratten+ (2004.06503)

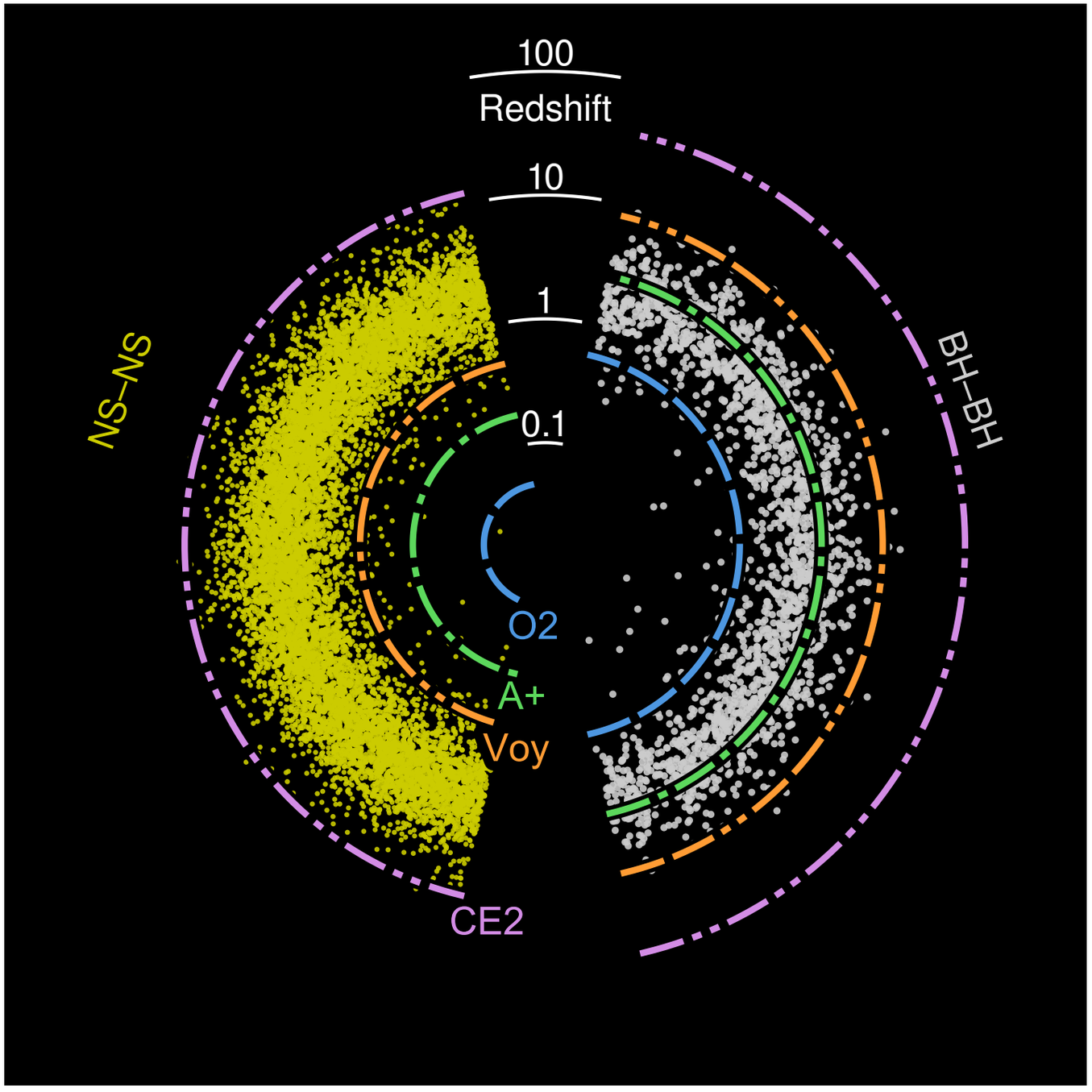
Tan+ (arxiv:2006.16296)
Essick+ (arxiv:2007.01372)
Dexheimer+ (arxiv:2007.08493)
Tews+ (arxiv:2007.06057)
Fattoyev+ (arxiv:2007.03799)

The next steps



Pulsar timing arrays (nHz; $10^9 M_\odot$)

Even further ahead



O2: 10 binary black holes, 1 binary neutron star

O5/A+: 2xLIGO

Voyager: ceiling for current sites

CE2: 3rd gen detectors, science case

LISA (mHz; $10^6 M_\odot$, WD, EMRIs,…)

Hall/Vitale/MIT