LIGO and gravitational-wave Astrophysics at UO

UO-LIGO (6/2020)

- Ray Frey, Professor
- Ben Farr, Assistant Professor
- Robert Schofield, Research Professor
- Zoheyr Doctor, postdoc
- Jim Brau, Professor (ret)
- Vinny Roma, PhD June 2019 (SuperNova GW interpretation)
- Sudarshan Karki, PhD March 2019 (LIGO photon calibration)
- Paul Schale, PhD June 2019 (GWs from magnetars)
- Jordan Palamos, PhD expected August 2020 (GW-GRB)
- Philippe Nguyen, 4th-year grad student
- Kara Merfeld, 3rd-year grad student
- Bruce Edelman, 3rd year grad student
- JD Merritt, 2nd year grad student
- Adrian Helmling-Cornell, 2nd year grad student
- Matthew Ball, 2nd year grad student
- Sangeet Paul, Gino Carrillo, 1st year grad students

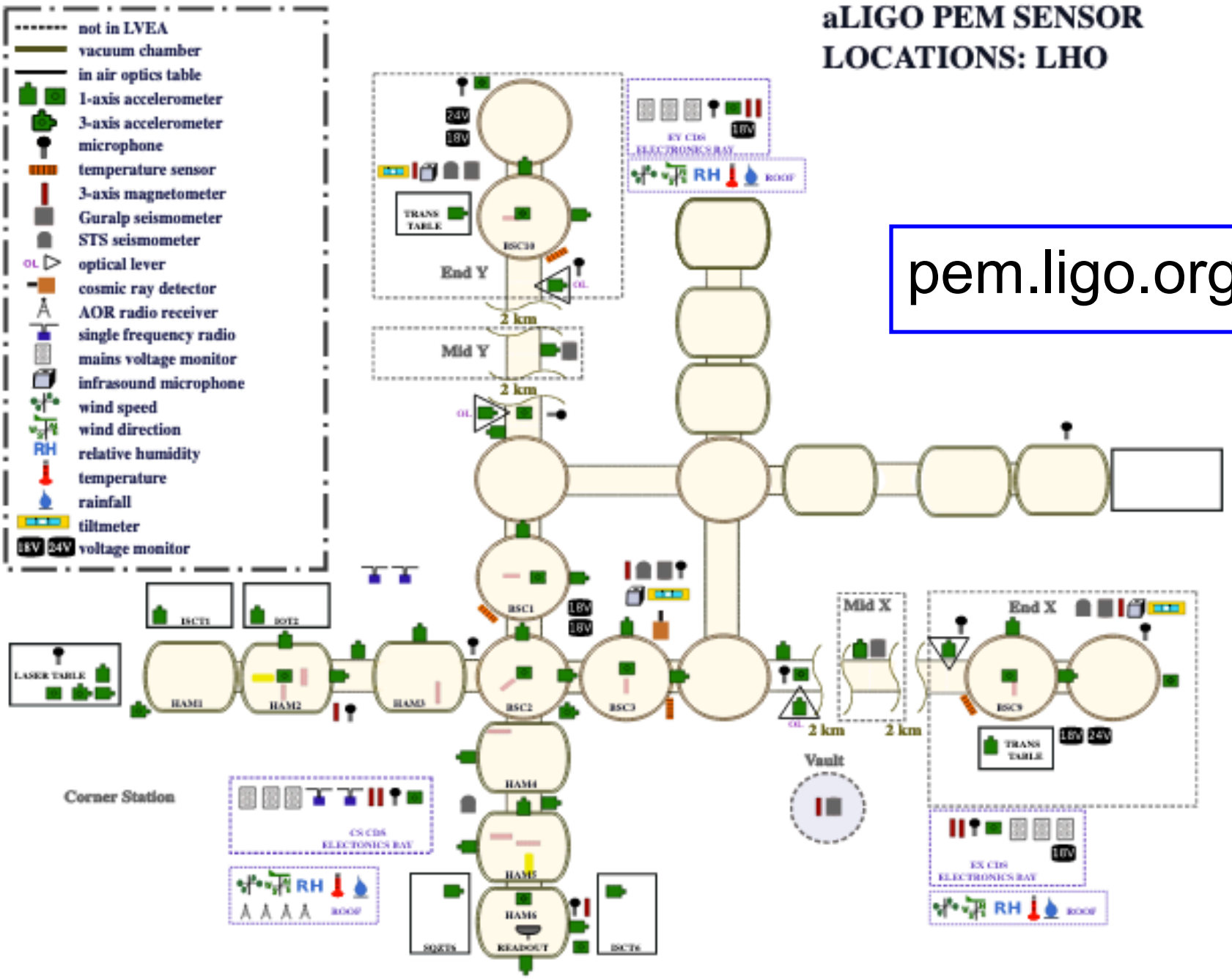
LIGO

UO-LIGO

What UO Does - I

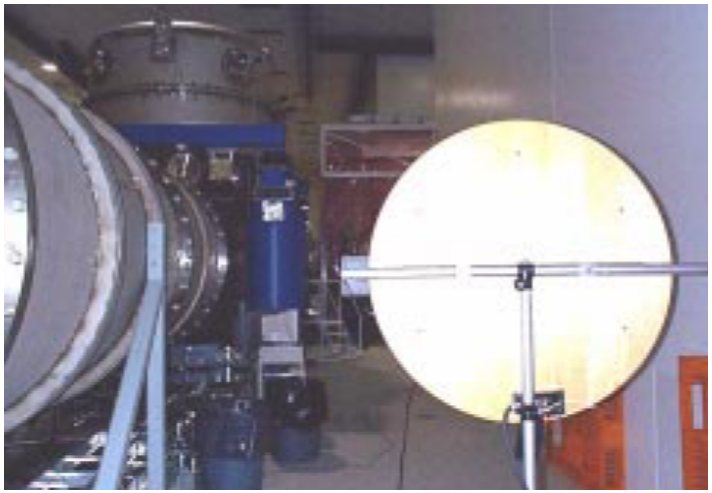
- The non-GW environment – are the candidate GW signals astrophysical?
  - In charge of the LIGO PEM system (Schofield)
  - Environmental injections to determine coupling to DARM (Schofield, Nguyen, Merfeld, Ball, Helmling-Cornell)
  - Analyze GW candidates to determine environmental contamination; vetting (Schofield, Nguyen)
    - Talk at GWANW-19 by Philippe Nguyen
  - A typical starting point for new UO students
- Commissioning, noise hunting and mitigation (Schofield, et al)
  - Read the aLogs to get a sense of this…
- Calibration
  - Led the O2 photon calibration effort at LHO (Karki)
  - Requirements for CBC parameter estimation (Farr)
  - O4 ?

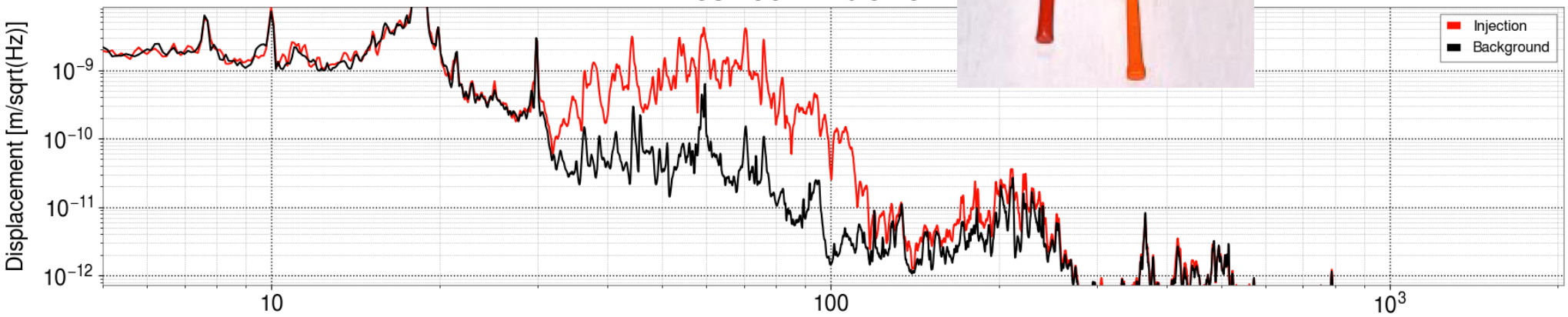
Keeping the non-GW environment in check

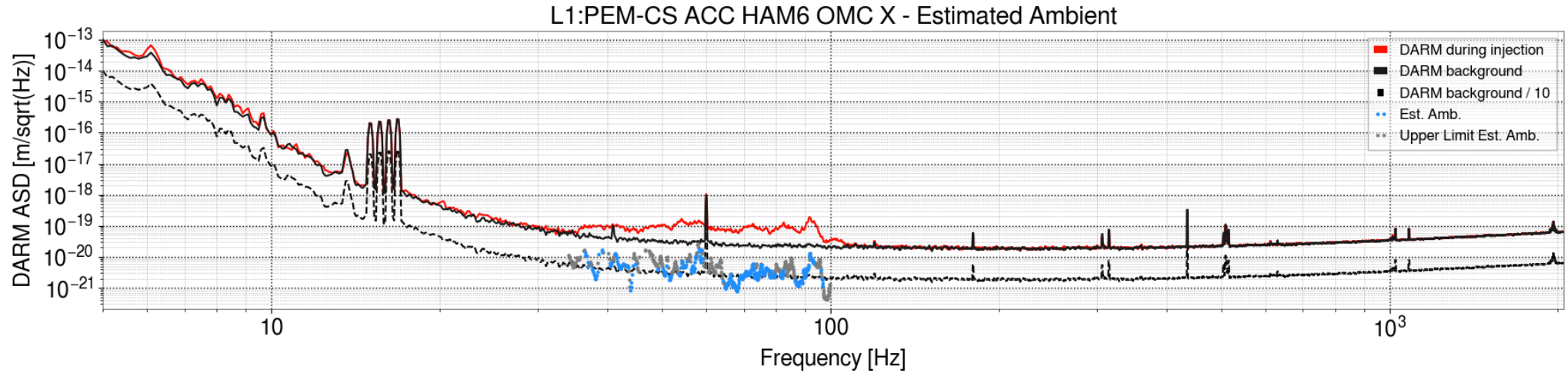


pem.ligo.org

Determining GW-environment couplings





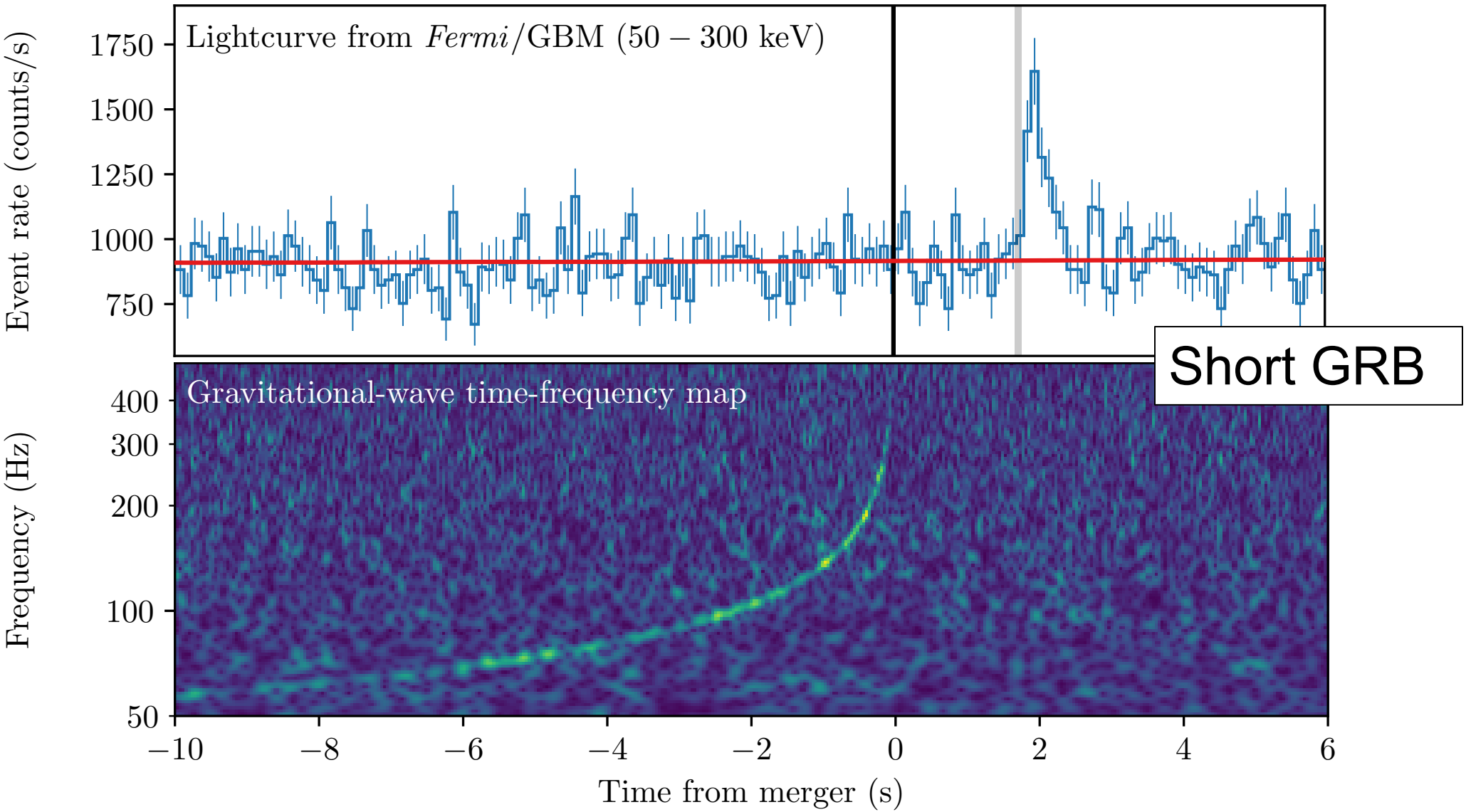


What UO Does - II

- GWs associated with GRBs
  - Led the initial LVC searches
  - GRB/GW170817 : co-led the paper
  - Co-led the O2 GRB/GW LVC analysis and paper (Palamos)
  - Ongoing O3 involvement (Palamos, Nguyen, Merfeld)
- GWs associated with FRBs/magnetars (Merfeld)
  - Galactic magnetar+FRB April 2020 (SGR 1935+2134)
- Interest by Helmling-Cornell and Ball in GW Burst searches for high-mass binary black hole systems
- Astrophysics of compact binaries (Farr, Doctor, Edelman, Merritt)
  - Will let Ben Farr and Zoheyr Doctor provide their own summaries ;)

- Farr: co-chair LVC CBC group 2018-2020
- Frey: co-chair LVC Burst group 2018-2022

August 17, 2017: LIGO+Fermi



Short GRB

Astrophys. J. Lett. **848**, L13 (2017)

$\Delta t = 1.74 \pm 0.05$ s

Speed of gravity

$$\Delta t = 1.74 \pm 0.05\,\mathrm{s} = \Delta t_{\mathrm{astro}} + \frac{D}{c^2}(c_g - c)$$

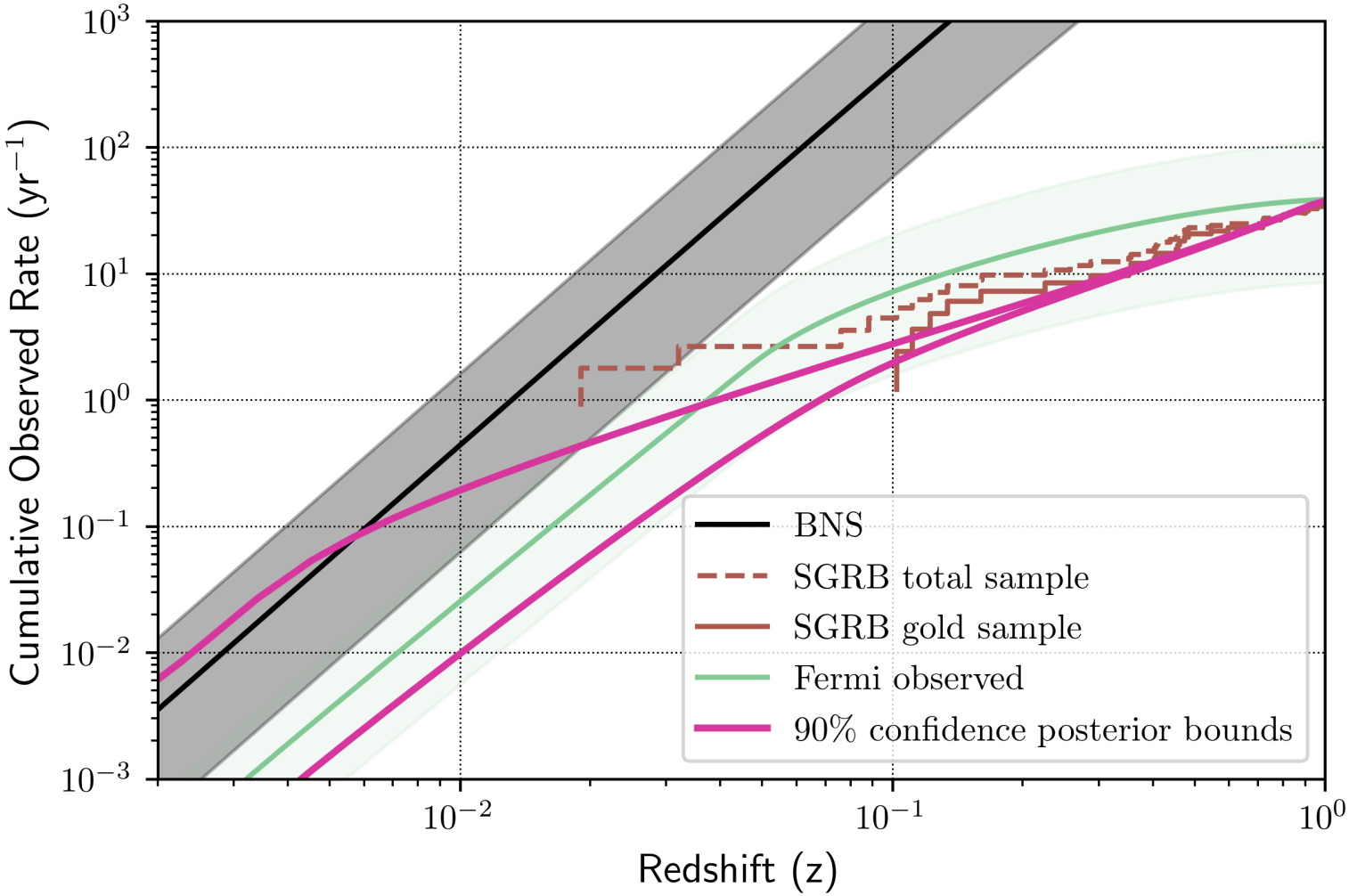
- Δt_astro ~2 s is very reasonable
  - Our prior based on astrophysics of SGRBs was Δt = [0,4] s
  - jet with γ ~ 50 is delayed by ~2 s (relative to v=c) at a photospheric radius of ~30 AU
- Limits: (1) Let Δt_astro = 0; (2) Let Δt_astro = 10 s:

$$-3 \times 10^{-15} < \frac{c_g - c}{c} < 7 \times 10^{-16}$$

  - Future measurements at different distances can improve this
- Also from GW170817/GRB 170817A:
  - Kilonova observation – r-process nucleosynthesis
  - First H0 measurement with GWs

O2 GRB paper

- LVC paper: ApJ vol. 886 pg. 75 (2019)
  - No additional detections, besides GW170817/GRB 170817A
  - Analysis and PWT co-led by Jordan Palamos



Magnetars and FRBs

- Most recent LVC GW+magnetar searches from Oregon group (Quitzow-James and Schale)
- O3 FRB search (Merfeld) – CHIME !
- FRB progenitor(s) uncertain – treat similarly to GRB search
- April 28: galactic FRB (first!) associated with known magnetar 1935+2154