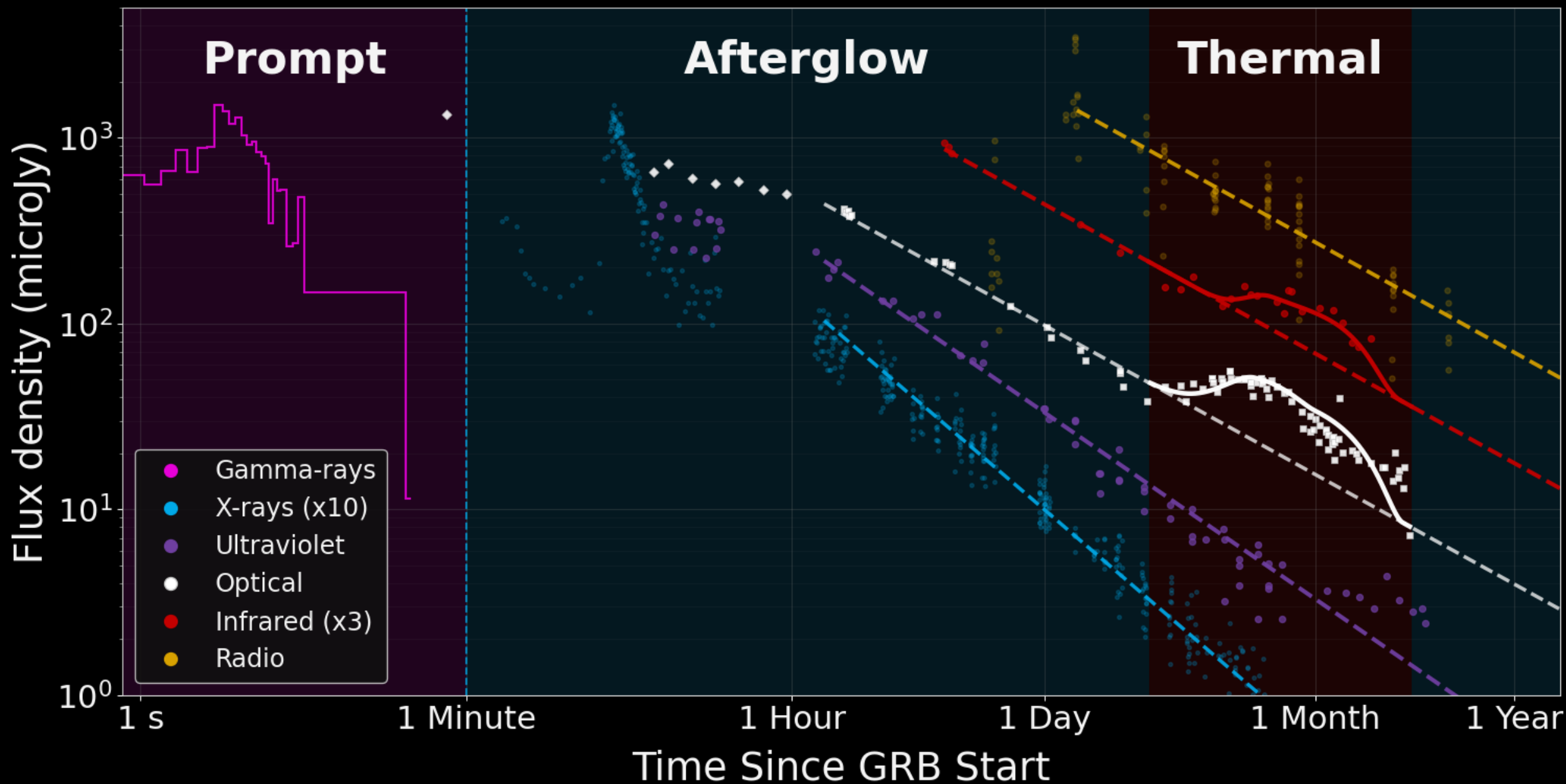


The Future of Gamma-Ray Burst Science

Eric Burns

The Three Phases of Gamma-Ray Bursts



GRB 161219B / SN 2016jca data: Swift Burst Analyser BAT observed flux density; X-rays plotted x10 from Swift/XRT 0.3-10 keV and Chandra/CSC 2.1 ACIS-S 0.5-7 keV flux; infrared plotted x3; Swift/UVOT, optical/NIR, VLA, and ALMA photometry from Laskar et al. 2018 ApJ; optical/NIR compilation includes Cano et al. 2017 A&A.

Local Cosmic Disasters: Collapsars, Magnetar Giant Flares, Binary Neutron Star Mergers, Helium Star Mergers, Accretion Induced Collapse of a White Dwarf, Tidal Disruption Events, Neutron Star – Black Hole Mergers, Neutron Star – White Dwarf Mergers, Superluminous Supernovae

Collapsar



Magnetar Giant Flare



Binary Neutron Star Merger



Helium Star Merger



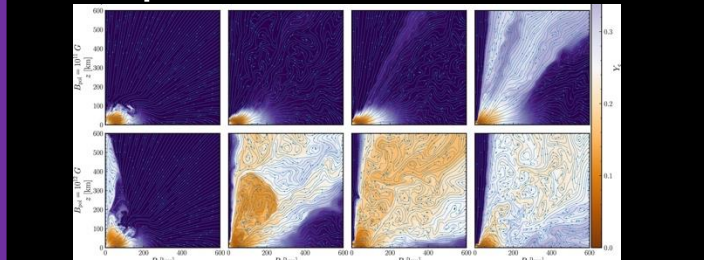
Tidal Disruption Event



Neutron Star – Black Hole Merger



Accretion Induced Collapse of a White Dwarf



Neutron Star – White Dwarf Merger

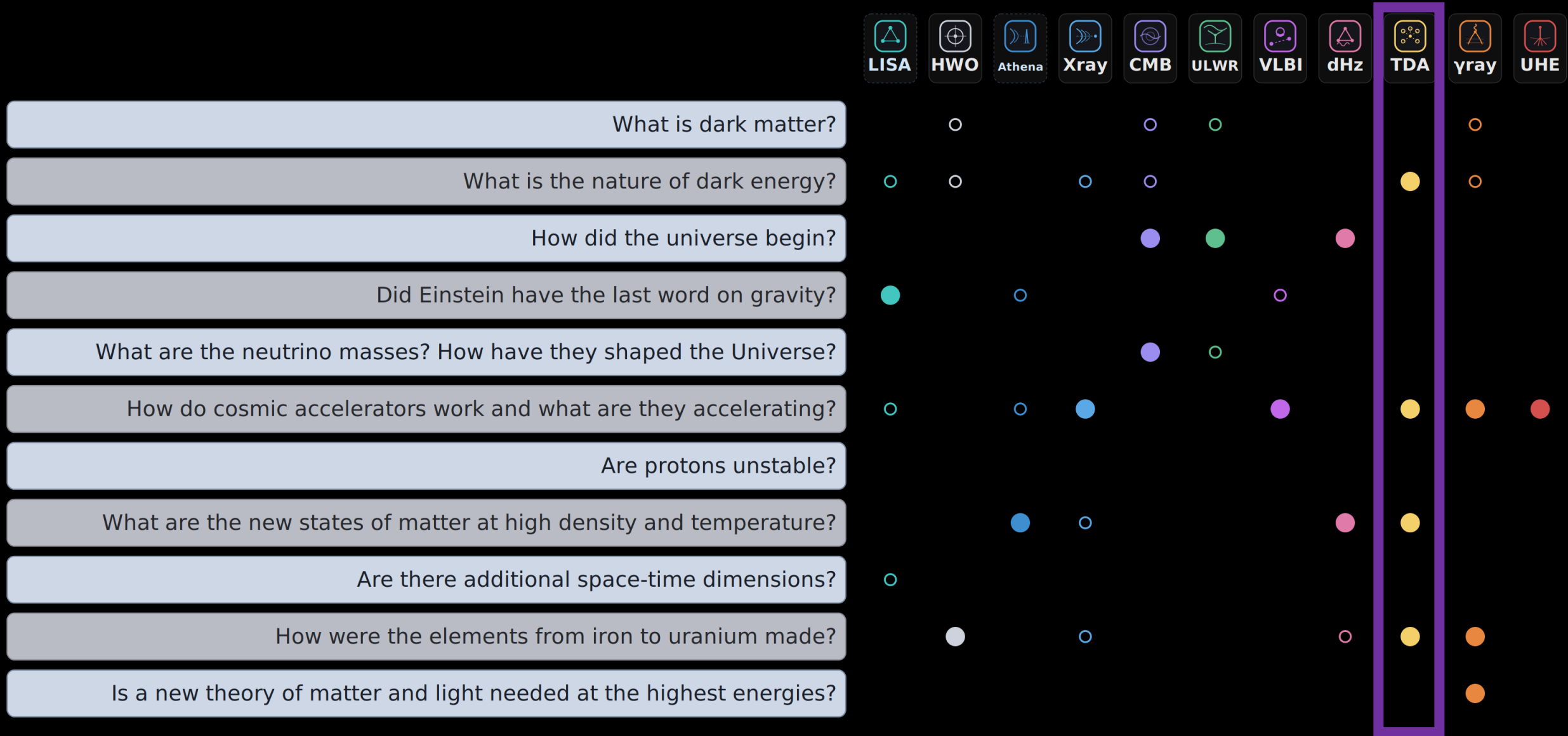


Superluminous Supernovae



Connecting Quarks with the Cosmos: Eleven Science Questions for the New Century
National Research Council, 2003 — A Quarter-Century Update for Astro2030 Planning

National Research Council, 2003 — A Quarter-Century Update for Astro2030 Planning



Duration: Short (<2 s), Ultralong (>1 hour), Long (otherwise)



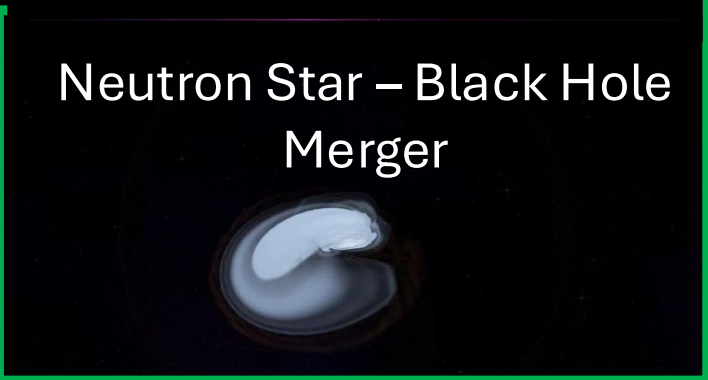
Helium Star Merger



Tidal Disruption Event

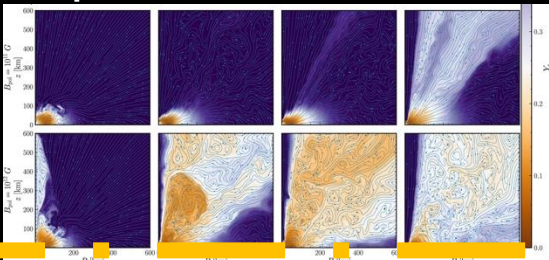


Binary Neutron Star
Merger



Neutron Star – Black Hole
Merger

Accretion Induced
Collapse of a White Dwarf



Neutron Star – White Dwarf
Merger



Superluminous Supernovae

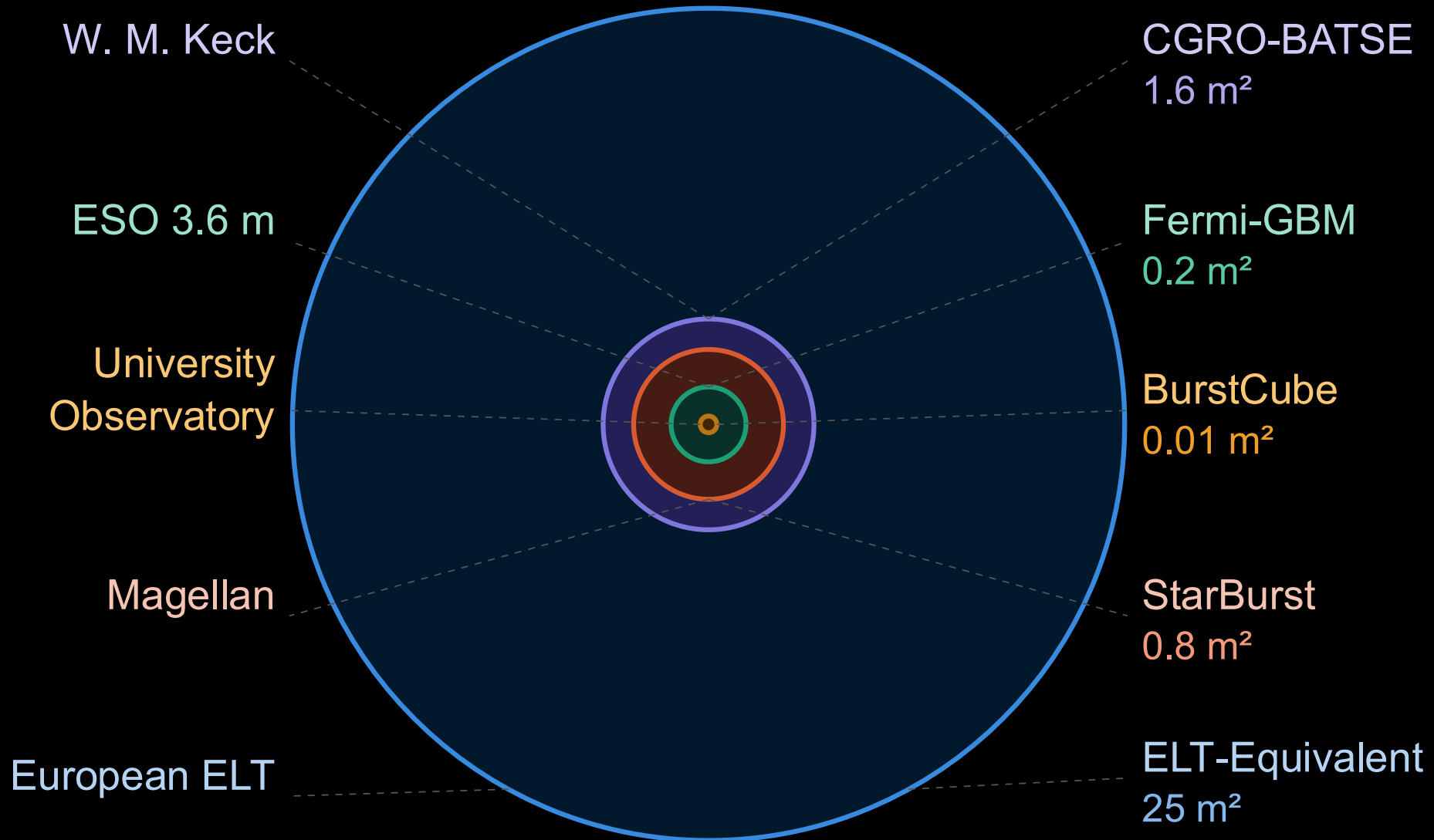


Gamma-Ray Transient Network Science Analysis Group



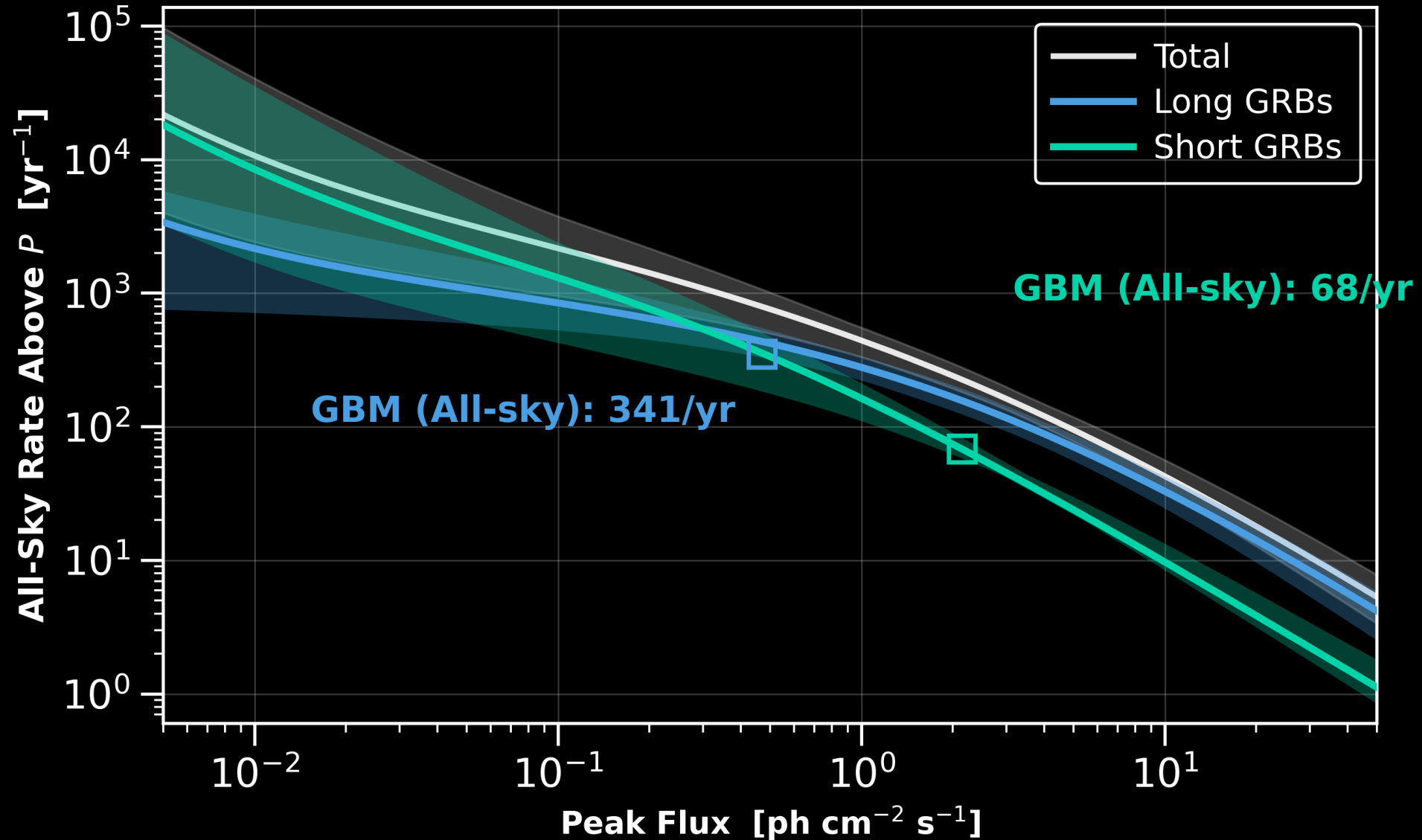
- ~60 page report on science, requirements, and action items
 - Short GRBs from mergers, magnetar giant flares, long GRBs from mergers and ultra-long GRBs are key events to focus on
- **Science outlined as a function of instrument capability 10 different metrics**
- Has become more important with the eminent end of Swift
- Overview for future GRB-focused high-energy monitors:
 - **True all-sky coverage, ~100% livetime, ~week contiguous intervals**
 - **Ideal localization precision <10 arcminutes**
 - **Ideal alert latency measured <10s of seconds**
 - **Sensitivity**

Instrument Sensitivity

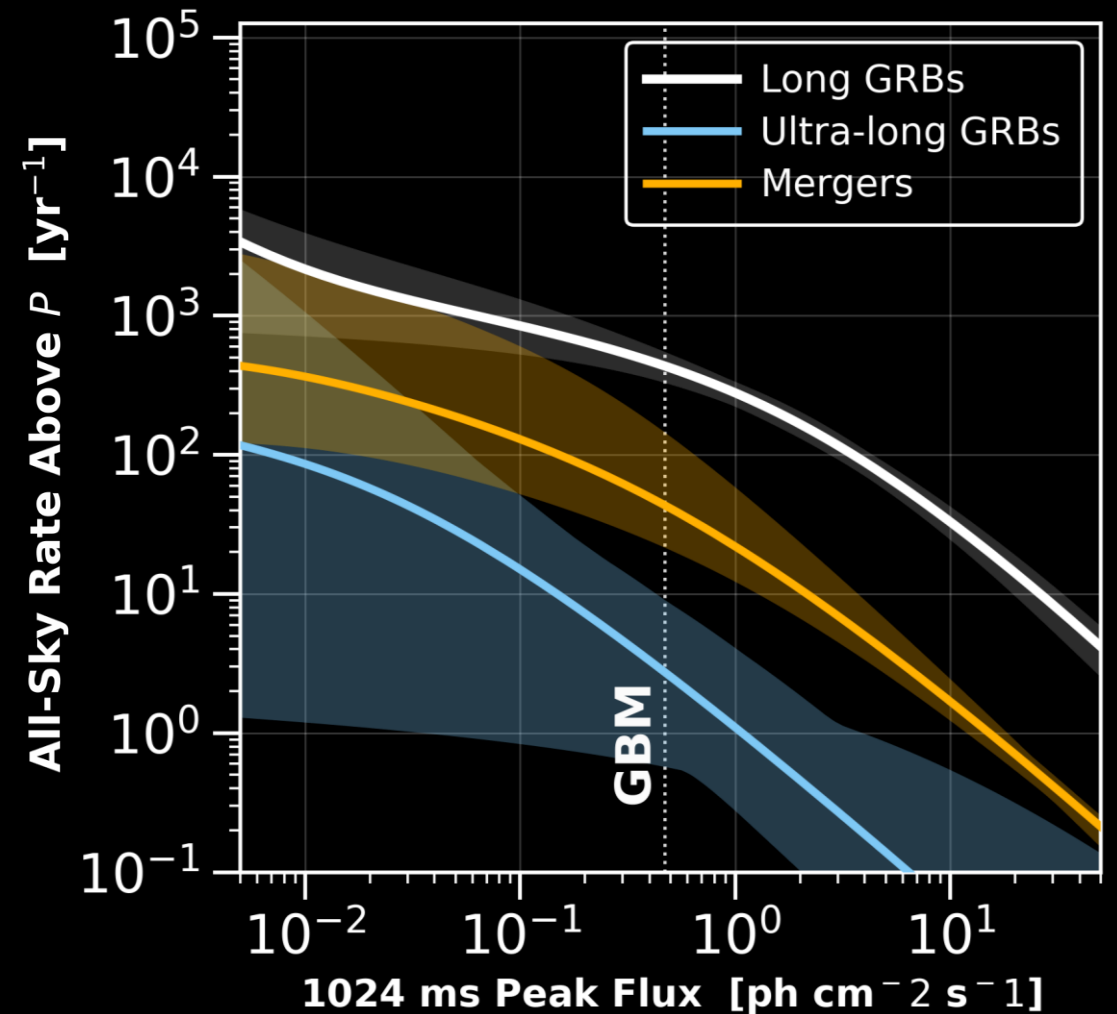
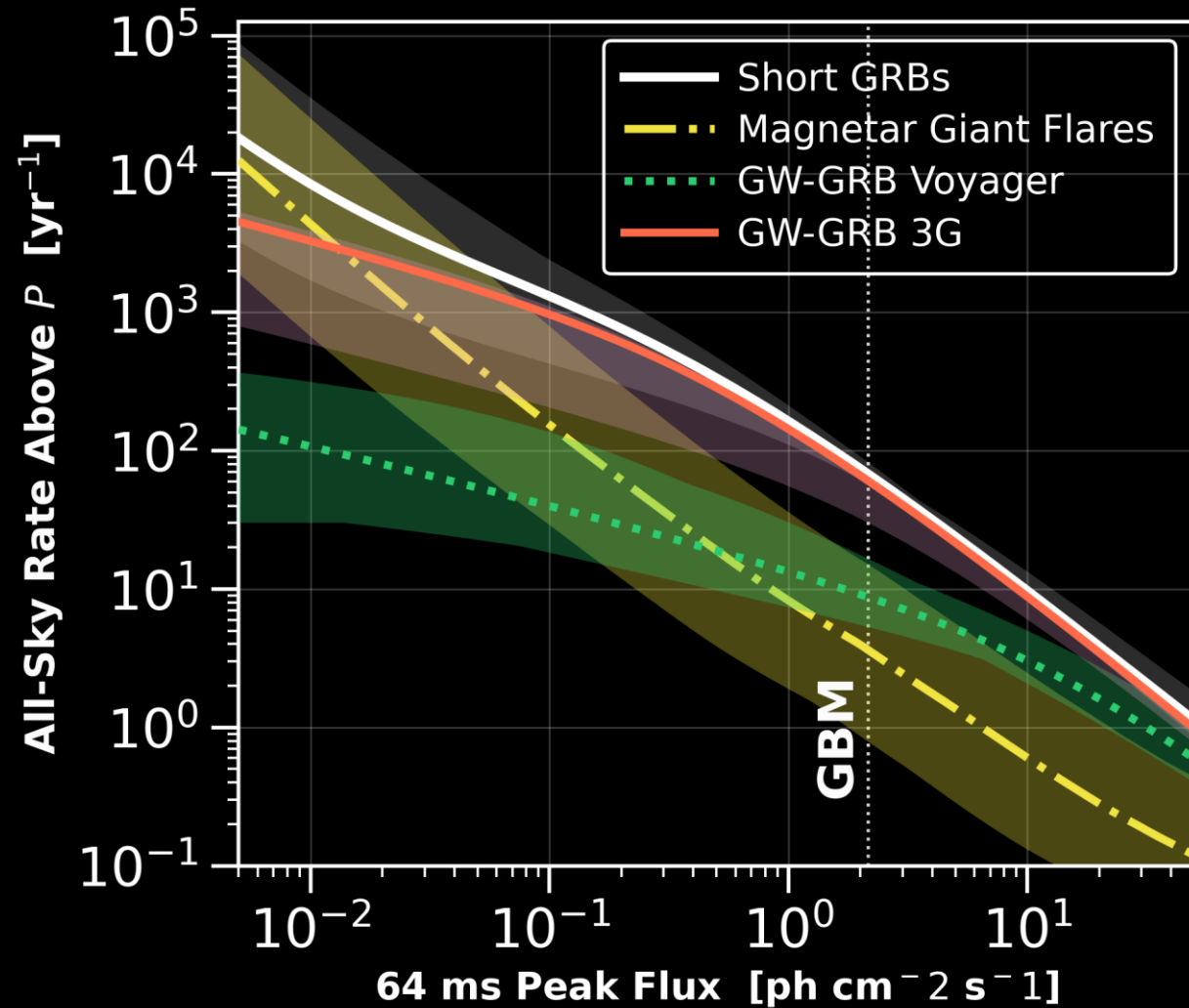


Note: the effective area does not need to be done on a single spacecraft

Rates as a Function of Sensitivity

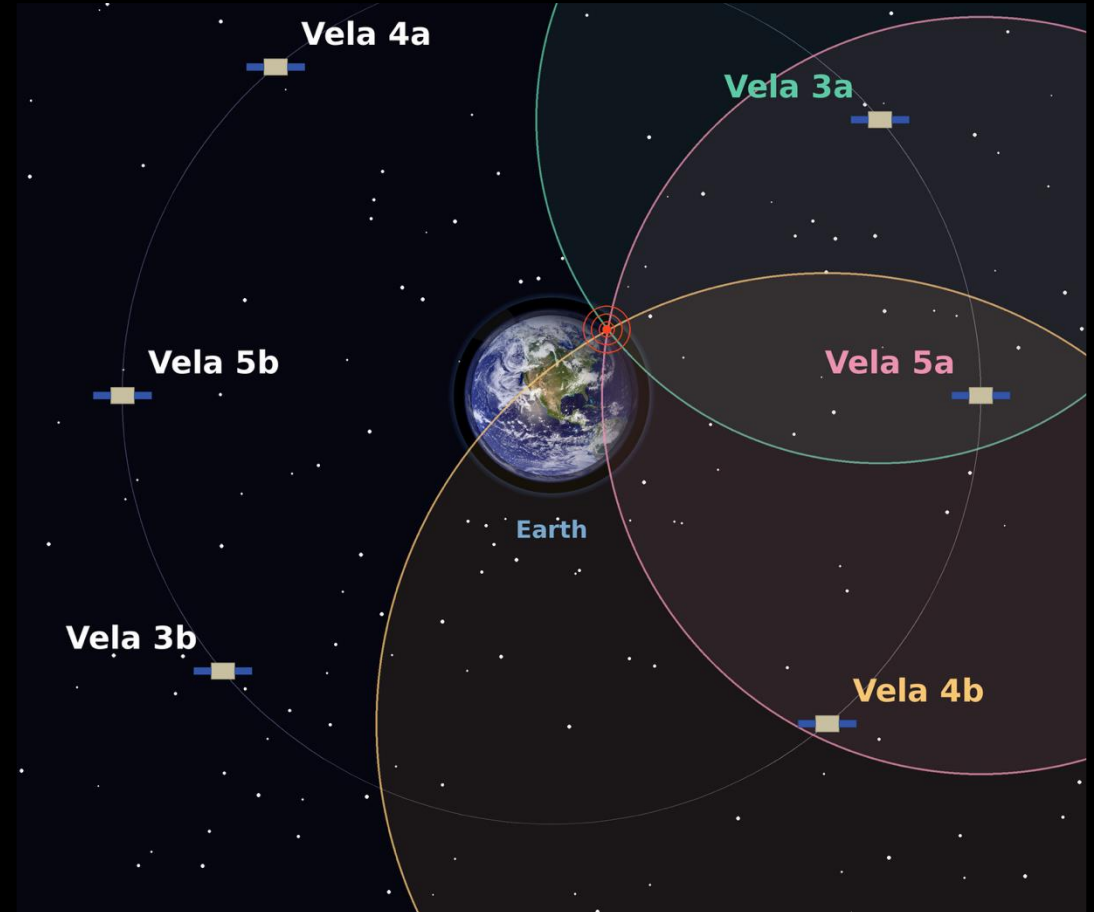


Rates as a Function of Sensitivity

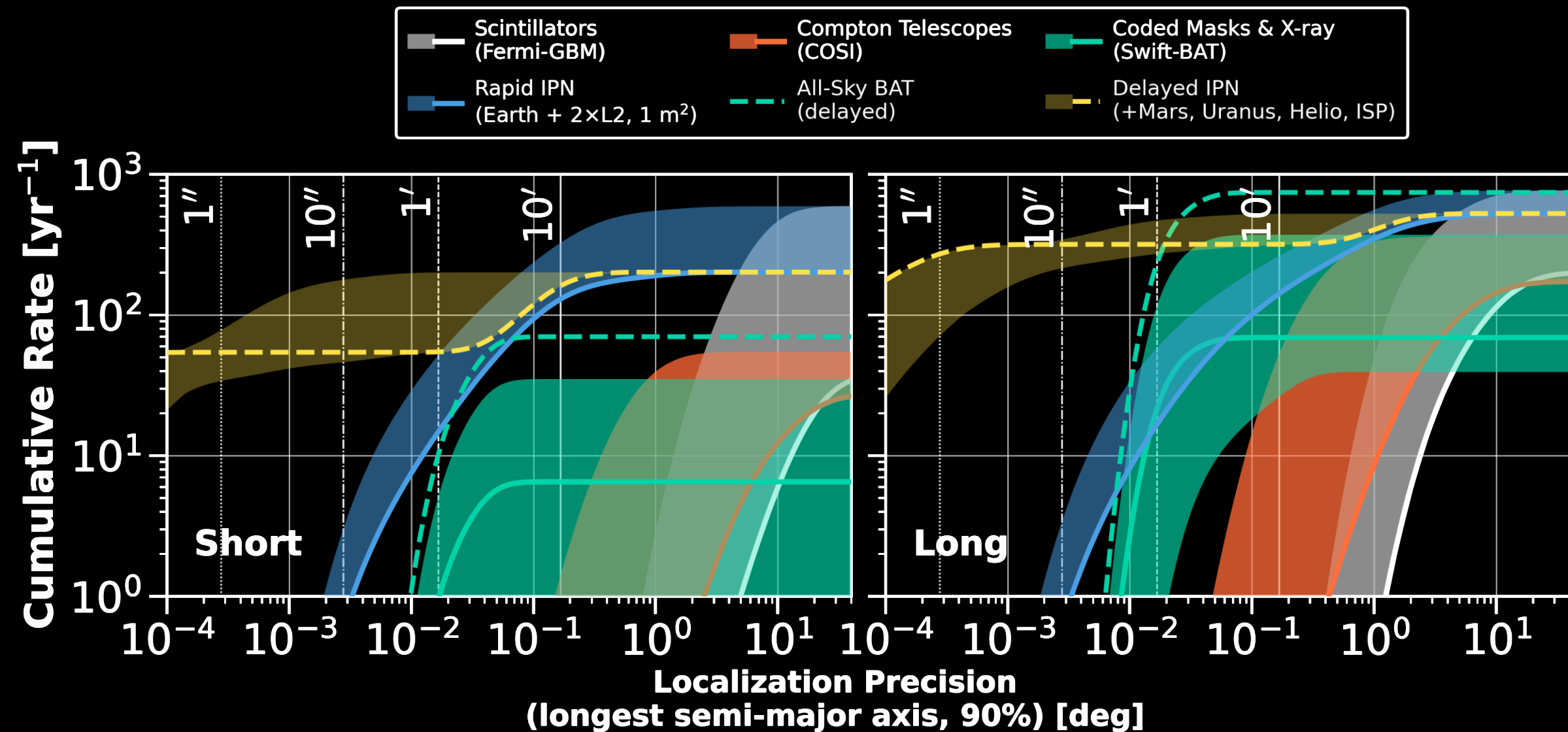


Detection and Localization Methods

- Scintillators – Fermi-GBM
 - The InterPlanetary Network
- Compton Telescopes - COSI
- Coded Masks – Swift-BAT
- Lobster Optics – Einstein Probe

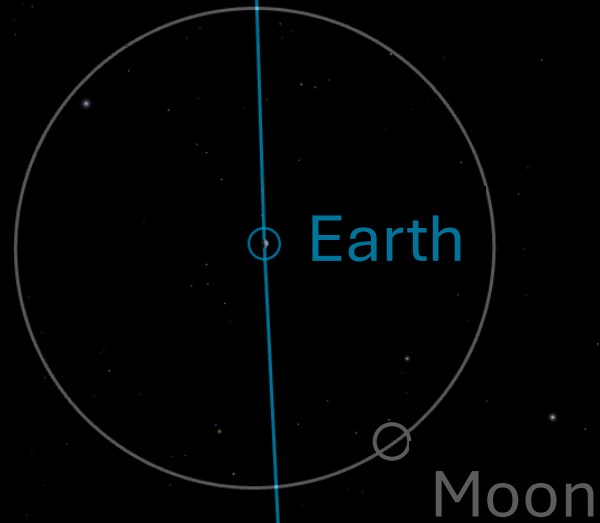


Rates as a function of Localization Precision



◊ Your L2 mission
~1 m²

◊ Wind
~0.01 m²



◊ Habitable Worlds Observatory
~1 m²

Conclusions

- Gamma-ray bursts enable numerous insights into how our universe works at a fundamental level
- The idealized detection and localization method is the InterPlanetary Network (or all-sky coverage with coded masks (\$\$))
 - We can place nodes on any distant spacecraft, with modular tradeoffs on power, data, volume, and mass.
 - An idealized network is an Earth orbiting satellite and two (phased) at L2, such as HWO and your favorite mission
 - If we place detectors on the most distant satellites, we can do science without rapid follow-up
 - But the IPN will integrate all relevant instruments!