Joint GW-GRB Localizations with Fermi GBM

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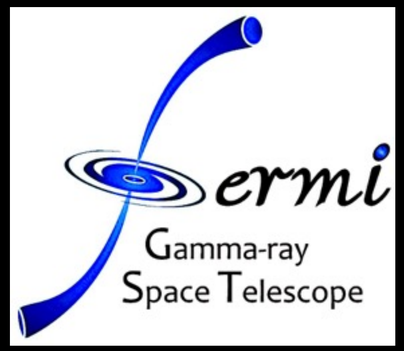
On behalf of the *Fermi* GBM Team
& LVC Collaborators



The Fermi Gamma-ray Burst Monitor

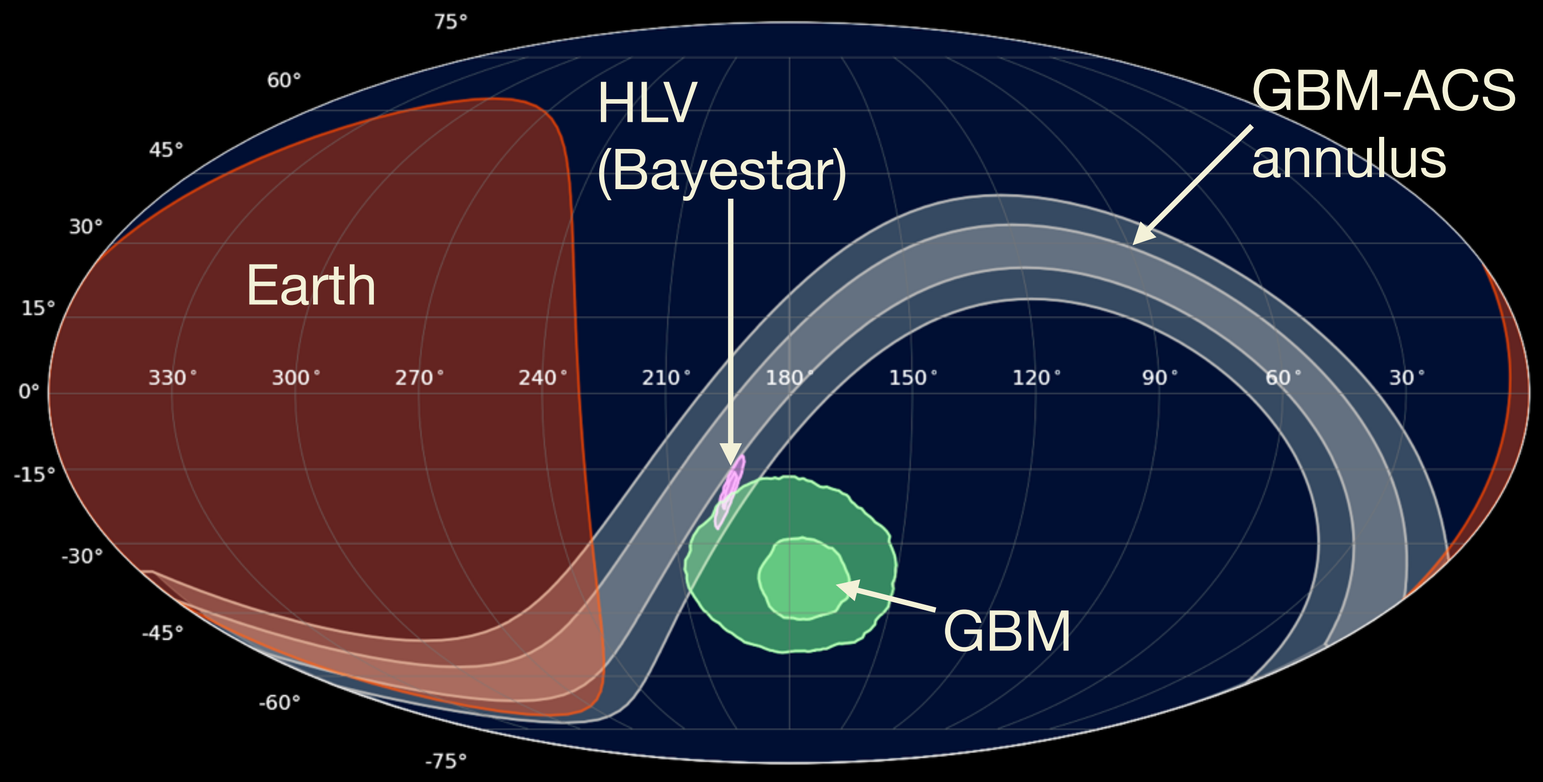
- Trigger on many different sources: GRBs, Solar Flares, SGRs, X-ray Binaries
  - ~2300 GRBs (~40 triggered short GRBs/year)
- Triggers are classified and communicated to the ground/public within seconds
- GRBs are localized within seconds—10 minutes
- Sub-threshold searches for signals below triggering threshold (latency ~2–5 hours):
  - Un-targeted blind search for short GRBs sends out GCN notices*
  - Targeted follow-up search of known multi-messenger events

*https://gcn.gsfc.nasa.gov/fermi_gbm_subthreshold.html

Example: Initial GBM Localization for GRB 170817A

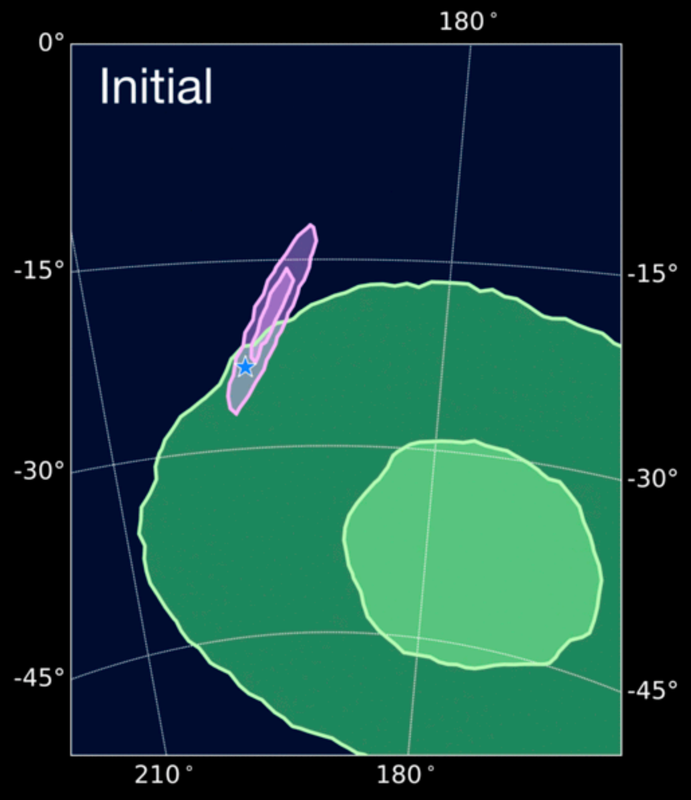
Typical weak triggered short GRB

HLV, GBM initial, GBM-INTEGRAL SPI/ACS timing annulus

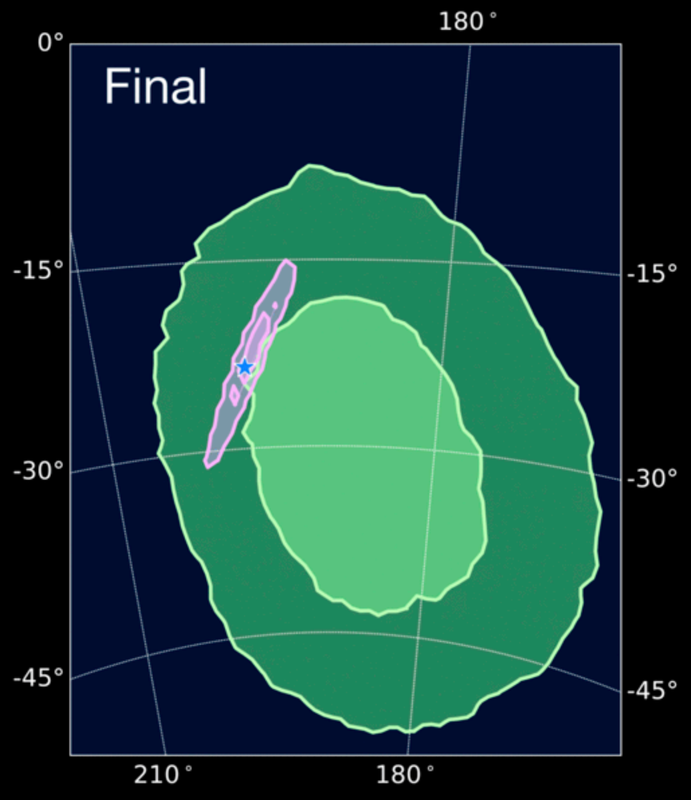


Updated Localizations

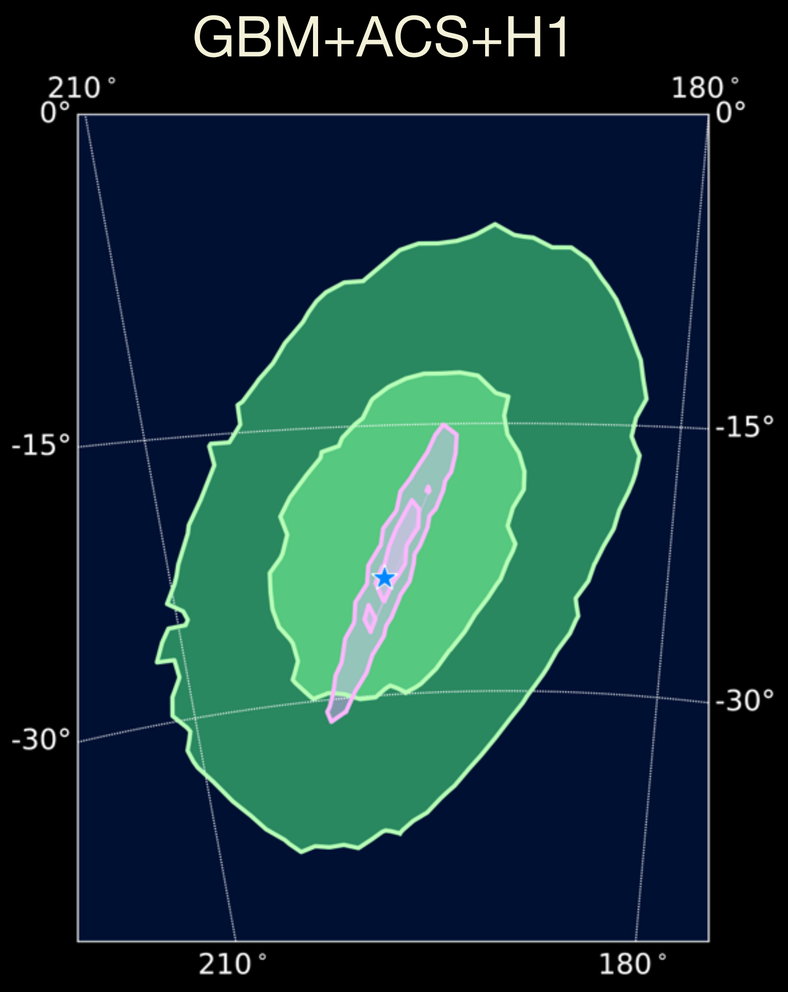
Standard GBM
Human-in-the-Loop

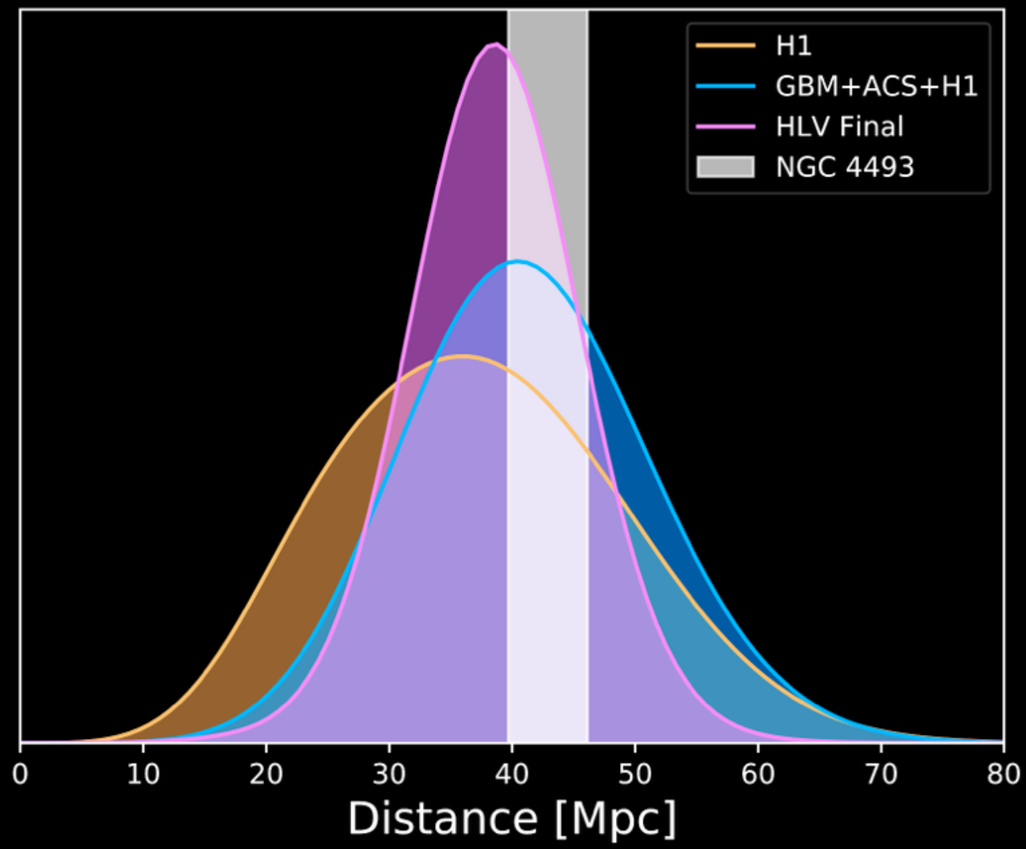


Sub-threshold
Targeted Search



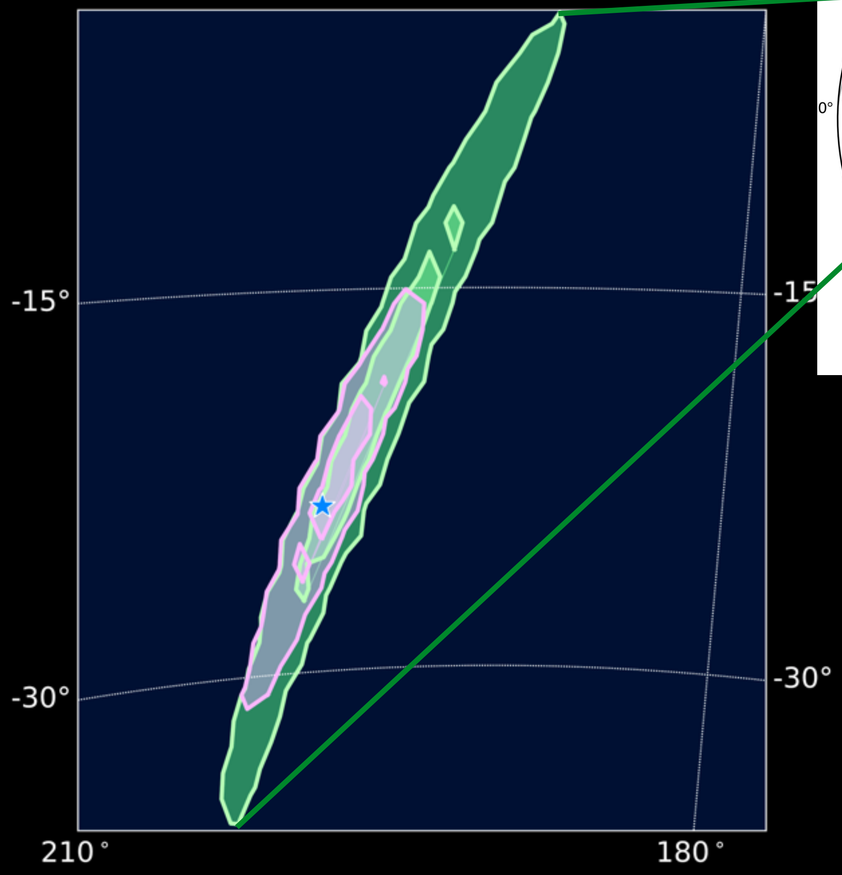
If We Combine Localizations….

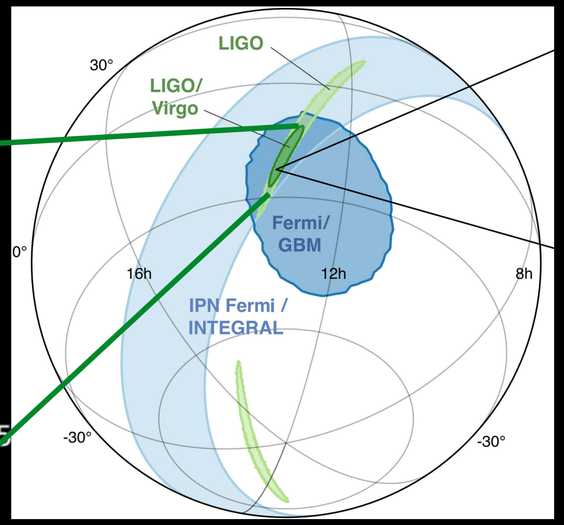


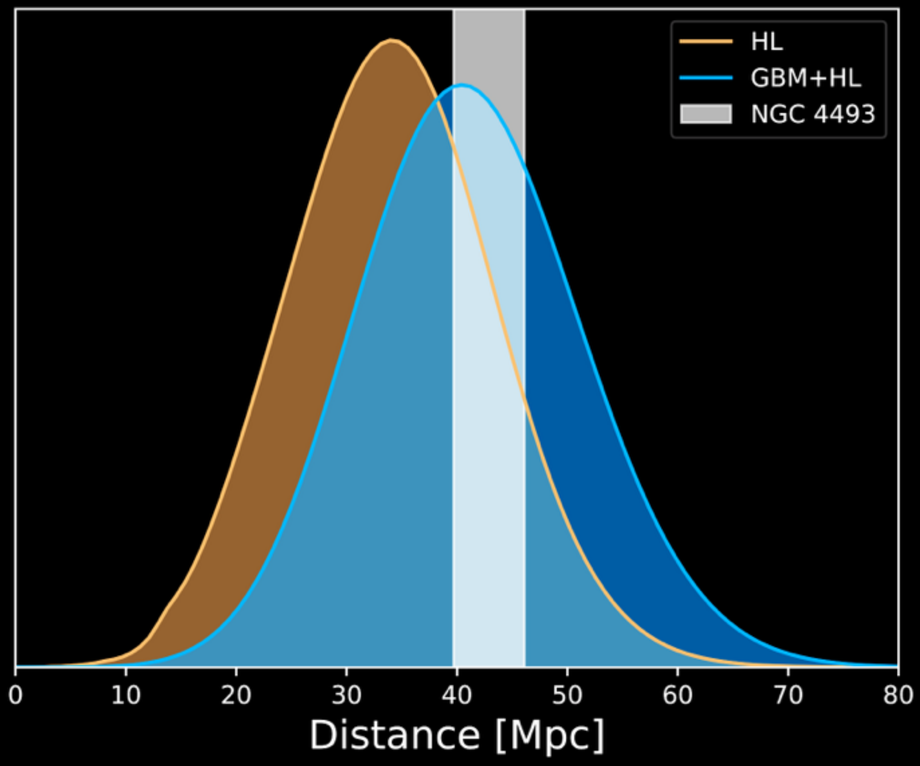


Combined Localizations, 2 GW Detectors

GBM initial+HL







Upshot and Deliverables

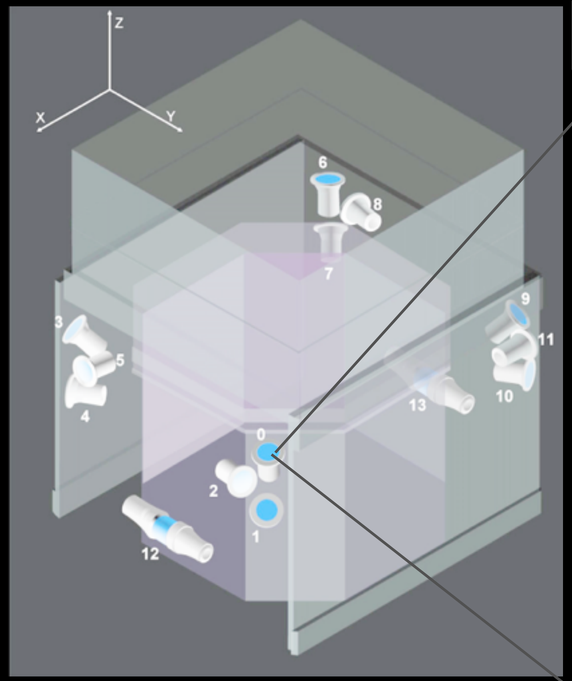
- Combining GBM w/ GBM-ACS annulus -> up to factor 2–3 localization improvement
- GBM w/ single IFO -> Actual localization on sky with distance information
- GBM w/ 2 IFOs -> factor ~3 (or more?) localization improvement

- Working on improving GBM “initial” localizations to be as accurate as the GBM “Final”
- Current known sky map latencies:
  - GBM triggers: ~10 minutes
  - LVC online trigger: ~few minutes
  - INTEGRAL SPI-ACS data downlink: ~1 hour
  - GBM sub-threshold triggers/searches: ~2–5 hours

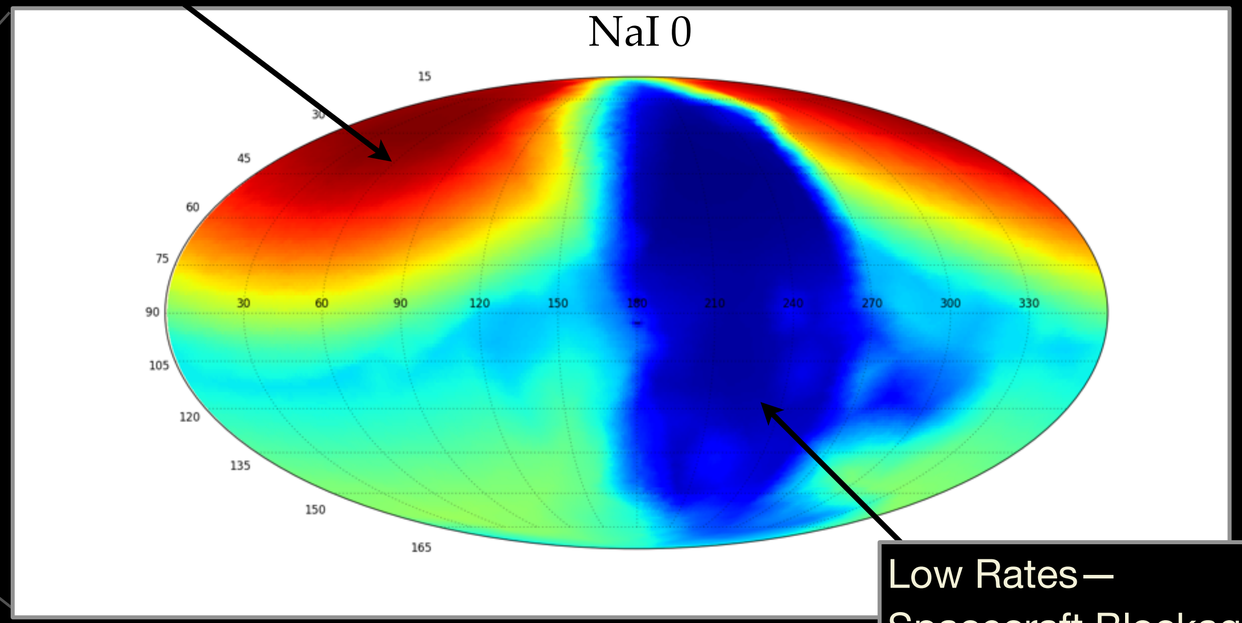
- Working on a pipeline to automatically combine and deliver the sky maps via GraceDB? VOEvents? etc.

Backup

GBM Localization Method



High Expected Rates



Low Rates—
Spacecraft Blockage

- Localization is performed by comparing the relative observed rates from the GRB in each detector to the expected rates on a 1 degree grid
- This requires an assumption of the spectrum, and the sky grid limits to a statistical minimum uncertainty of 1 degree radius (systematic uncertainty is > 1 deg).