Fermi Gamma-ray Space Telescope

Pipelines for Gravitational Waves followup

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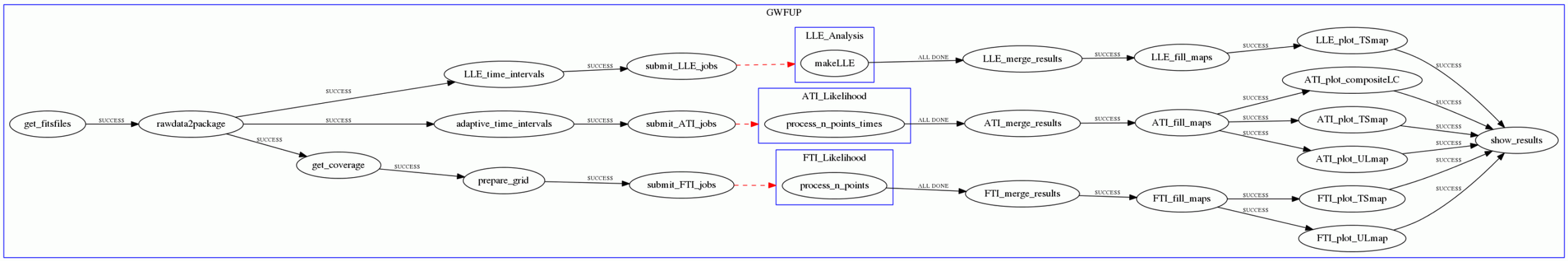
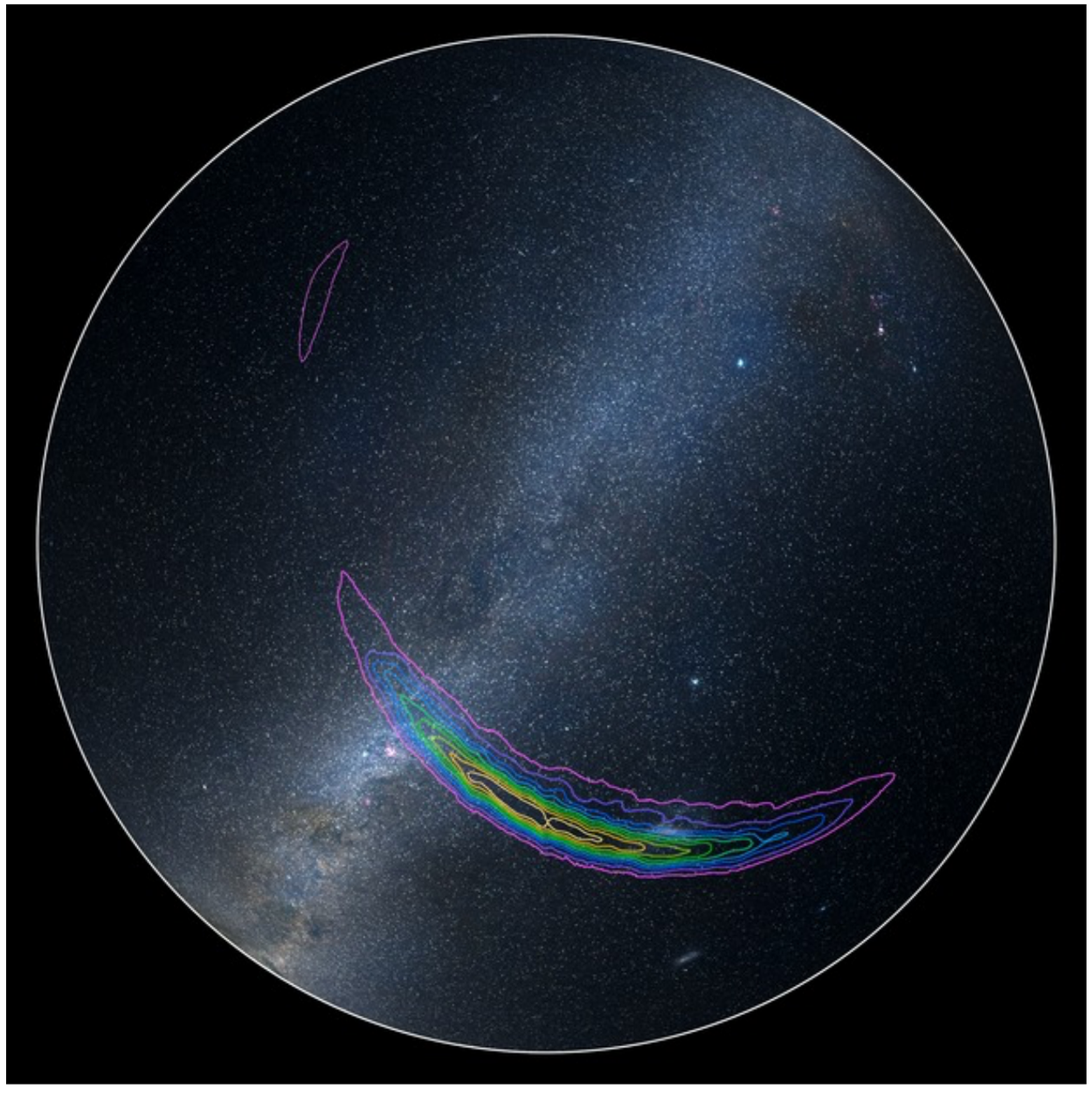
GWFUP pipeline



- **Add automatic followup with LTF - easy to do**
  - **Send an e-mail to LTF to start the analysis.**
- **Add a “pgwave” branch - quick and dirty - (Sara C., Gino)**
  - **Produce a LAT count map from the LIGO probability map on 10 ks (TBD).**
  - **Detect sources with pgwave (fast)**
  - **Some plots will be added to the results**
  - **Followup analysis with LTF (see above)**
- **Calculate probability maps:**
  - **from TS to something meaningful!**

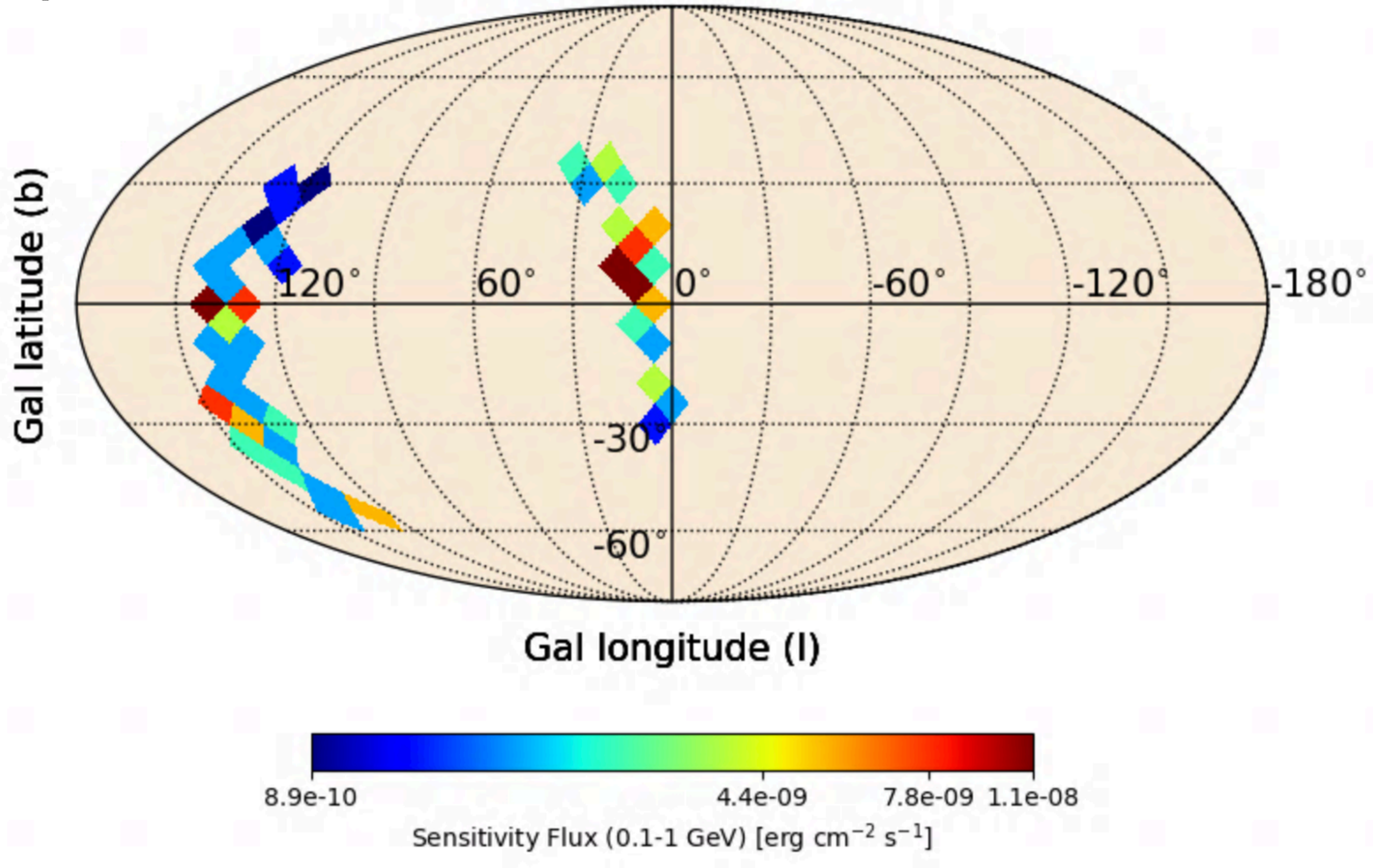
Probability maps



- **Work started by Lorenzo, Rupal and Milos**
  - **From the TS map, we could create probability maps depending on the number of pixel we search (effect trial factors)**
    - **Calibrating the p-value distribution**
  - **"The more you look, the less you find" effect!**
    - **Using the LIGO probability map as prior, we can set up a searching strategy to decrease the number of trials, limiting the region only to hot spots.**

Estimating the sensitivity

- **Fix the threshold probability (5 sigma): estimate the flux such that we detect a source 50% of the time, for a given Ts_eff=30 (see Lorenzo's talk)**
- **This is the flux upper limit (as opposed to upper bound) which is an estimation of the sensitivity to transient sources (as opposed to the estimation of the flux of a source compatible with the observation).**

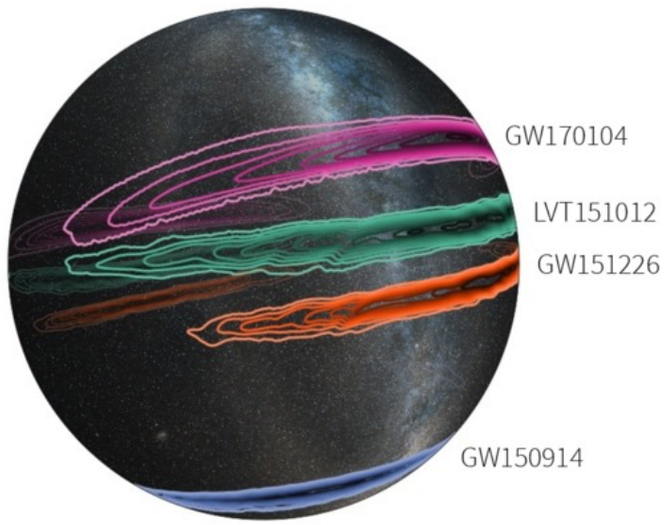


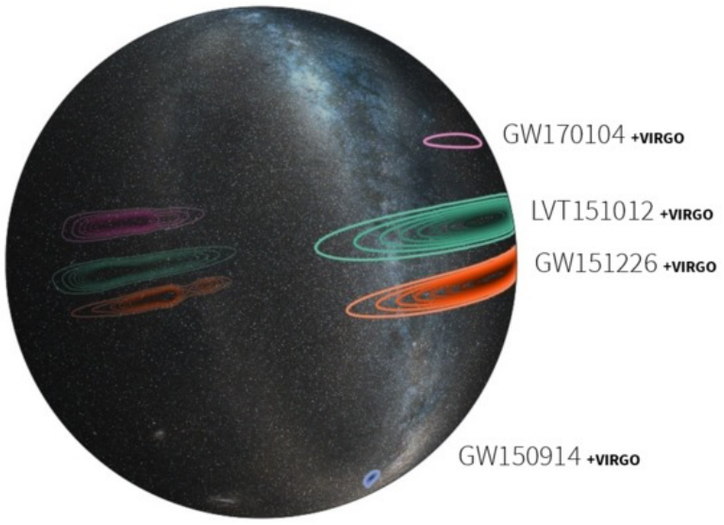
Infrastructures (database, web interface)

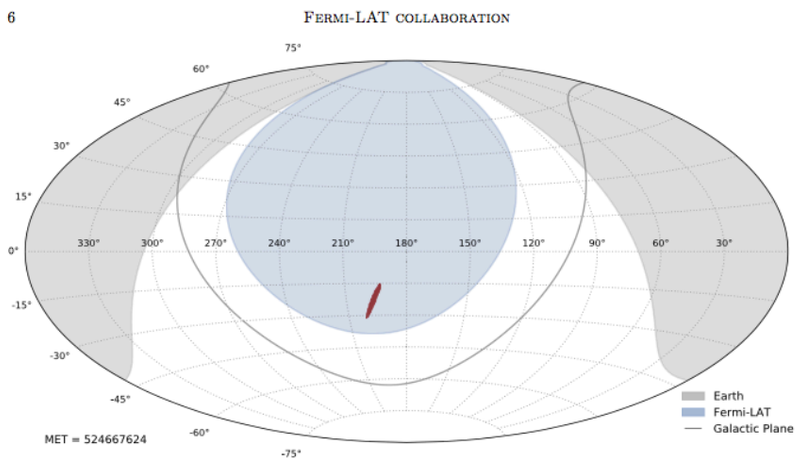
- **The Pipeline at SLAC is automatically triggered by e-mail**
- **Hard at SLAC machines to use mysql and web servers:**
  - **Move results file at Stanford, store them in a database**
  - **Using the same infrastructure than http://fermigrb.stanford.edu (supeople, leland)**

Getting ready for O3

- **Localization might not be an issue for some joint LIGO/Virgo events ~ 30% of the cases**
  - **No need to scan large region of the sky: followup strategy similar to standard GRB**
    - **Lat Transient Factory and BATool triggered on GW GCN.**
  - **Still for the majority of cases these infrastructures will be needed**

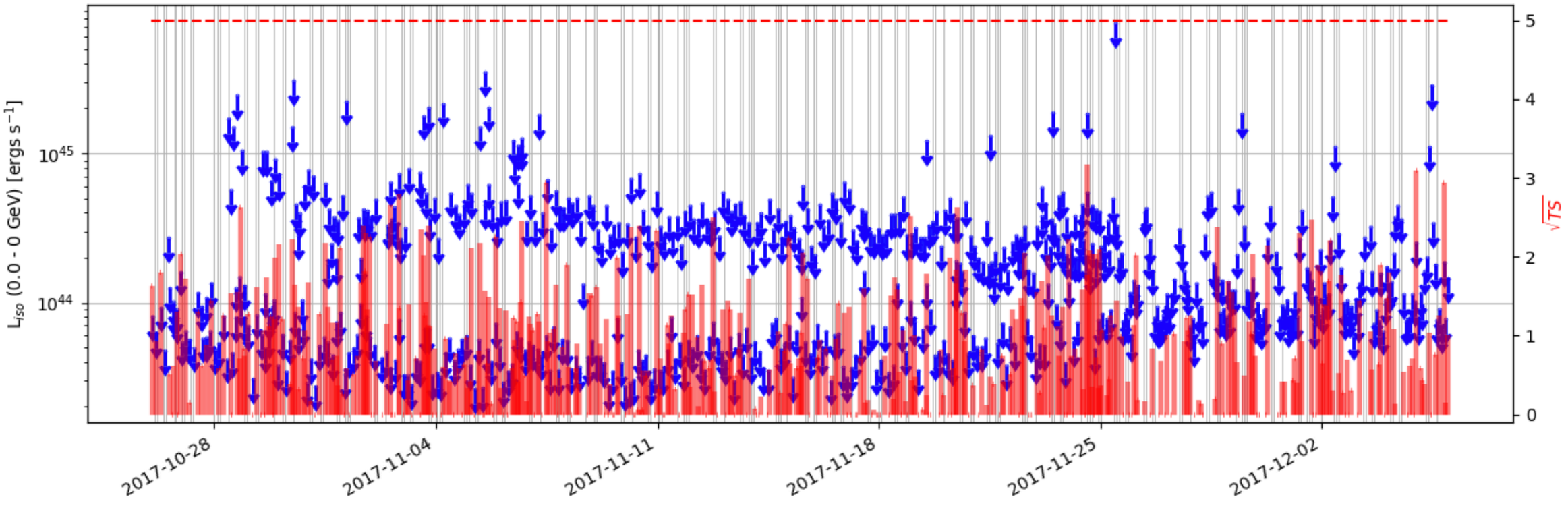




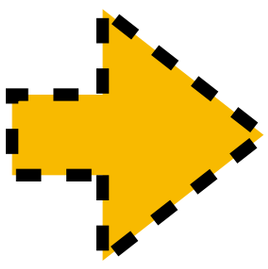


Long time monitoring

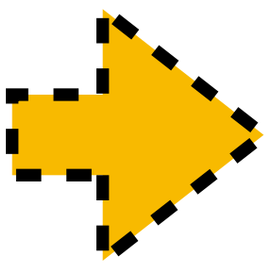
- **Localization might not be an issue for some joint LIGO/Virgo events ~ 30% of the cases**
  - **No need to scan large region of the sky: followup strategy similar to standard GRB**
    - **Lat Transient Factory and BATool triggered on GW GCN.**
  - **Still for the majority of cases these infrastructures will be needed**
- **Long time monitoring**
  - **Given the surprisingly long X-ray afterglow of GW171017, and the fact that we don't really know much about the source, we should keep monitoring all the sources detected in GW**



ASDC



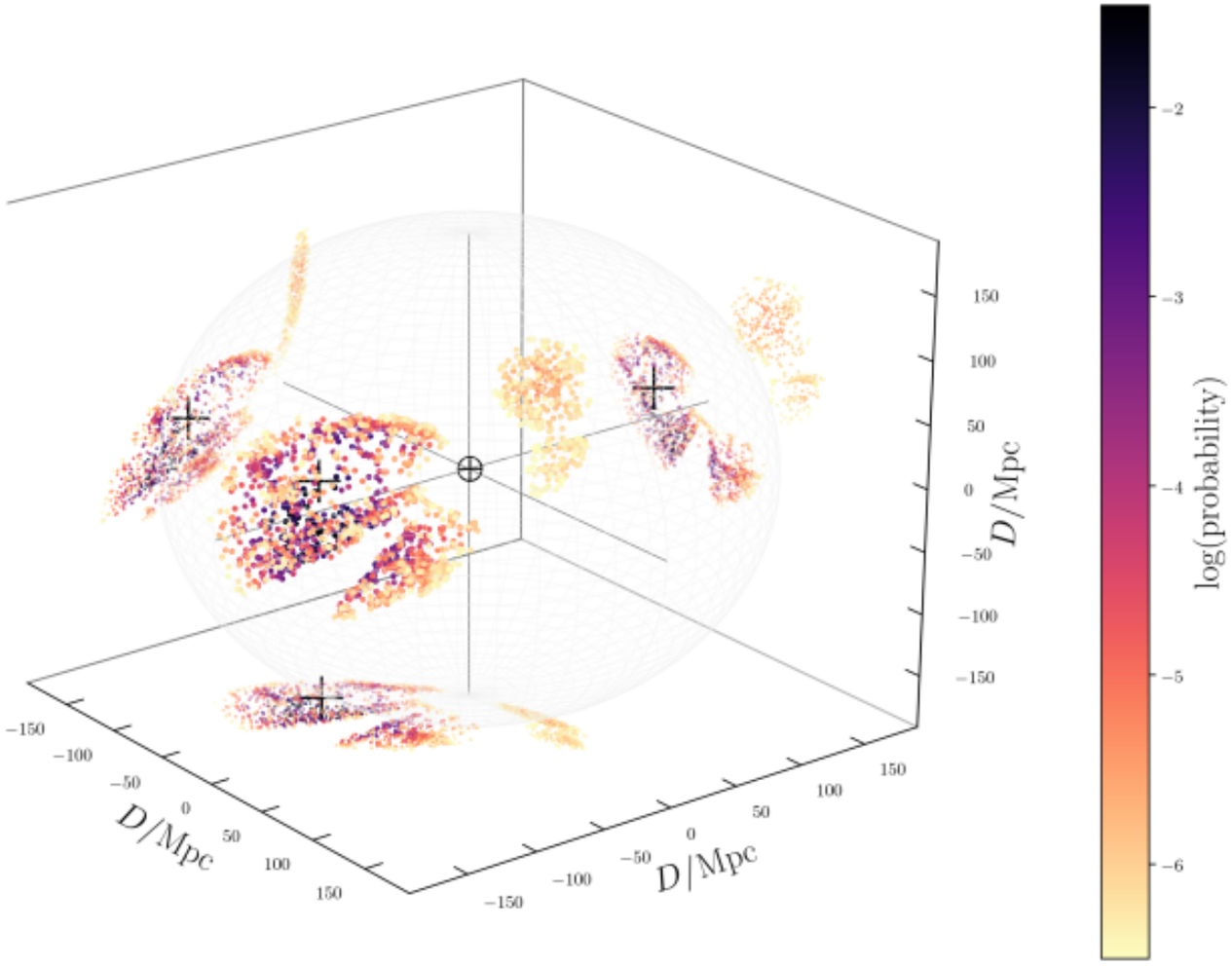
STANFORD



ASDC

- **Results exported to ASDC**
  - **Using ASDC facility for:**
    - **Cross correlation with catalogs (2Mass Redshift Survey - 2MRS: http://tdc-www.harvard.edu/2mrs/ or others)**
  - **Note: the LIGO maps contain information also on the distance (3D), therefore small group of local galaxies can be selected knowing the location and the distance (independently from the LAT results).**

Playing with Bayesian priors



Galaxies in the GLADE catalog (http://aquarius.elte.hu/glade/) within the 90% credible volume (simulated source). From Del Pozzo et al., 2018 (https://arxiv.org/abs/1801.08009)

Similar techniques (2MRS catalog?) have been crucial in determining which galaxies to point for 170817.