TOROS: The O1 Advanced LIGO science run

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LIGO Gravitational Wave observatory scientific run O1 spanned September trough January 2016.
It produced two positive detections of GW events.

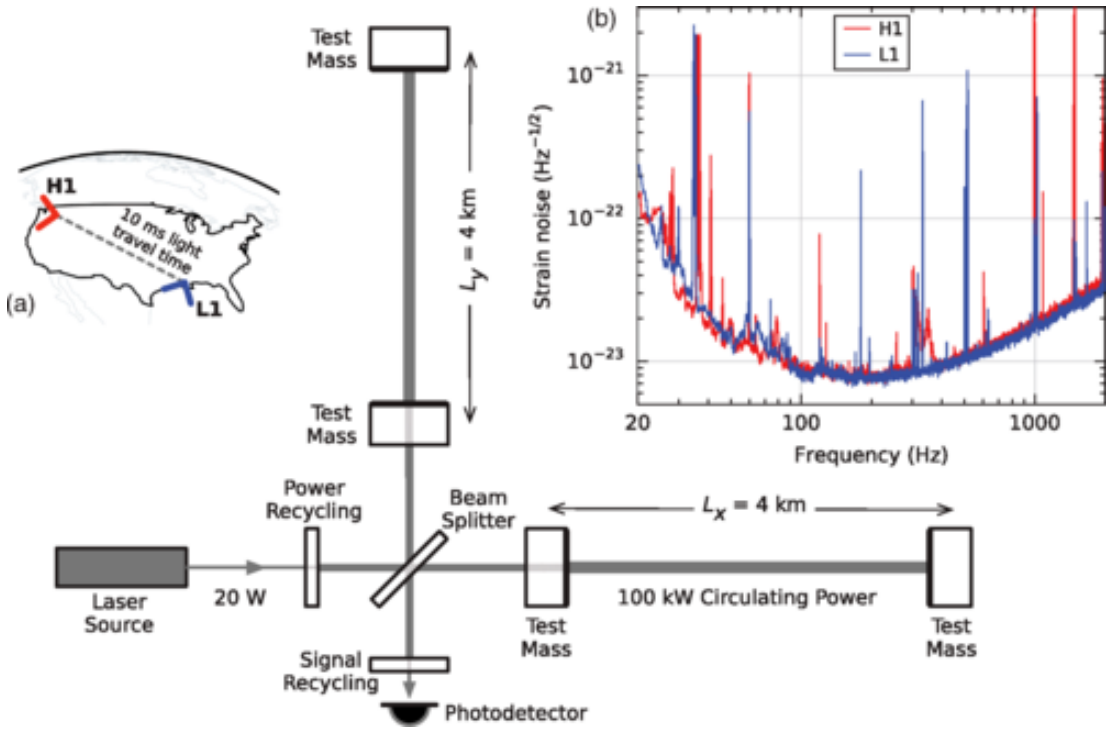


Figure: The detector configuration.

There was a positive detection in September 14 of 2015, 4 days before LIGO O1 scheduled observations start, with an estimated S/N ratio of almost 24.
The pipeline final calibration for event detection was completed just 2 days before cWB pipeline reported a candidate.

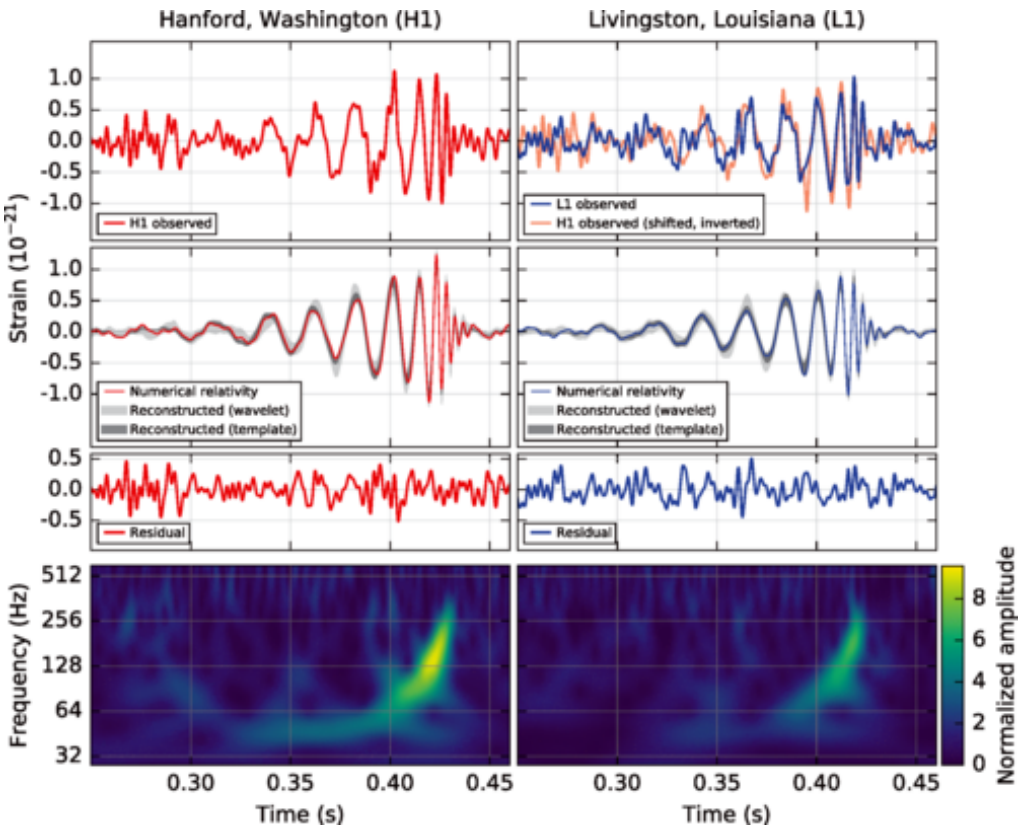
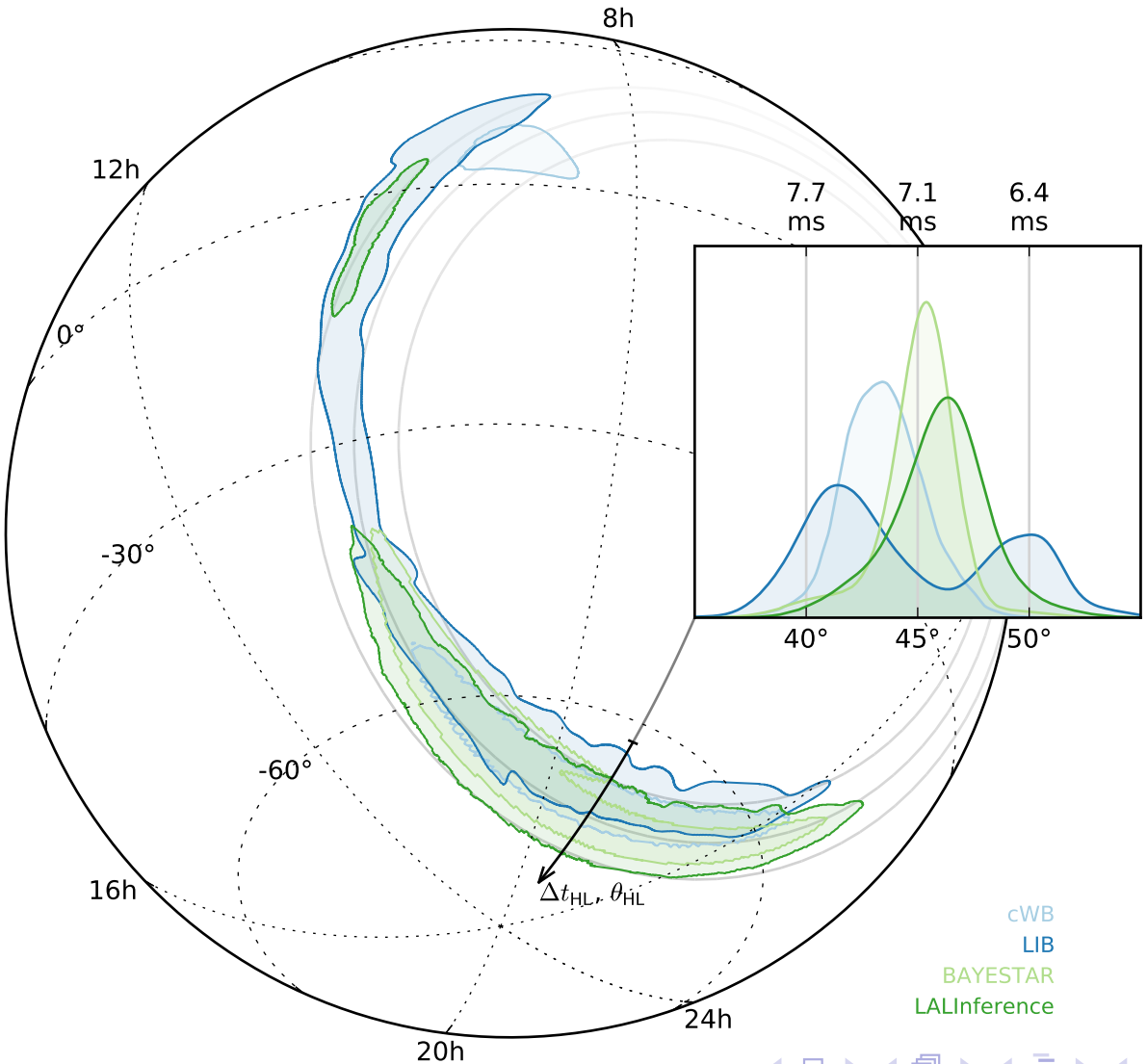


Figure: Pipeline results, for matched filter techniques.

The candidate was estimated to come from a huge area in the sky.



There are several pipelines for different purposes:

cWB Means coherent Wave Burst, and searches for unmodeled bursts of energy in the power-time-frequency space. Mostly based on antenna pattern, and minimal assumptions of waveform morphology.

oLIB Stands for omicron+LALinference Burst. Also searches for bursts that are not modeled as a binary. LIB works assuming that the signal is a sinusoidally modulated Gaussian, this pipeline performs sky localization bayesian inference.

Bayestar This method triangulates the times, the phases, and the amplitudes of the signal arrival in both detectors.

LALinf. This pipeline uses Compact Binary Coalescence (CBC) template matching, by modelling the data with a parametrized CBC waveform. This is the most accurate pipeline, but it takes longer to compute due to high dimensionality.

The full area of the 90% confidence in the final LALinference map, which could be shared almost 2 days after detection, is 630 deg^2
At this time there was no information about the true nature of the source. And the scenario was urging for more data, specially electromagnetic (EM) follow up.

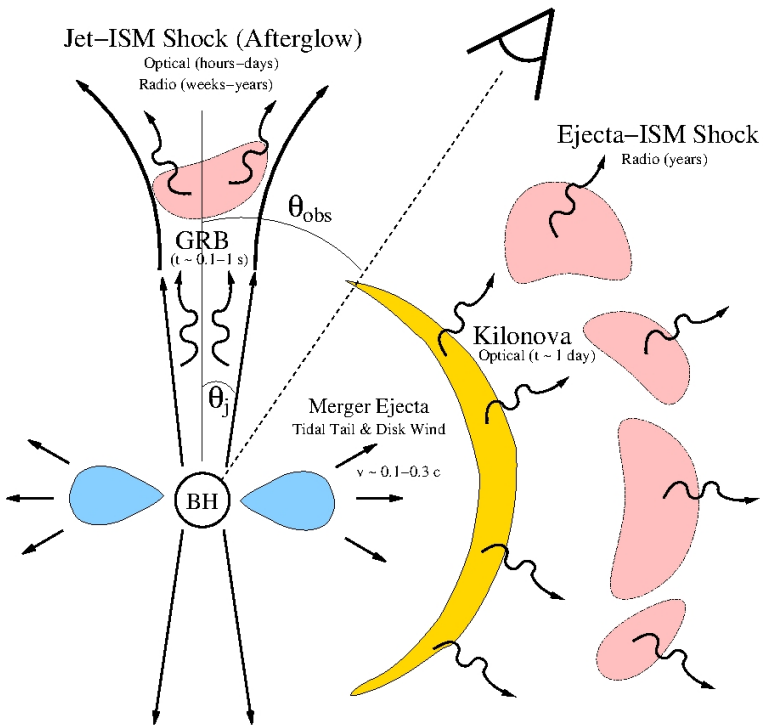


Figure: Compact object merger cartoon

Transient Optical Robotic Observatory of the South

The project TOROS, and its pilot campaings named TORITOS, are a collaboration for the installation of optical telescopes at the Puna montains in Salta, at nearly 4600 m.

This places have really great atmospheric conditions for astronomy, and a high percentage of clear nights.

The collaboration participated in the EM searches of GW150914.

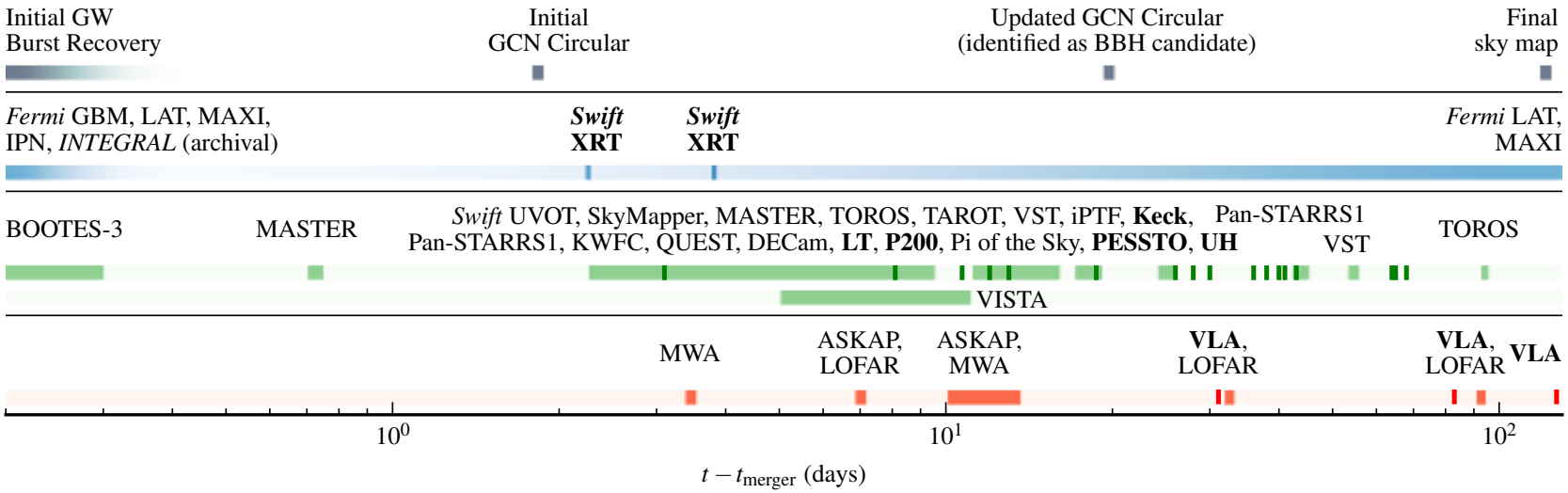


Figure: Timeline of detection

There are several collaborations that signed a Memorandum of Understanding which stated the sharing policies for transient search. Some of them perform wide area blind search, with many telescopes, surveying the area of Likelihood from sky maps.
TOROS collaboration performed a different search method, by crossmatching catalogs of galaxies from White et al. (2011) with the Likelihood map. This is due to small Field of View of telescopes.

We selected galaxies that had both high likelihood ratio, and as at the time the sensitivity of A-LIGO (in engineering run) was limited, also a medium range distance estimation.

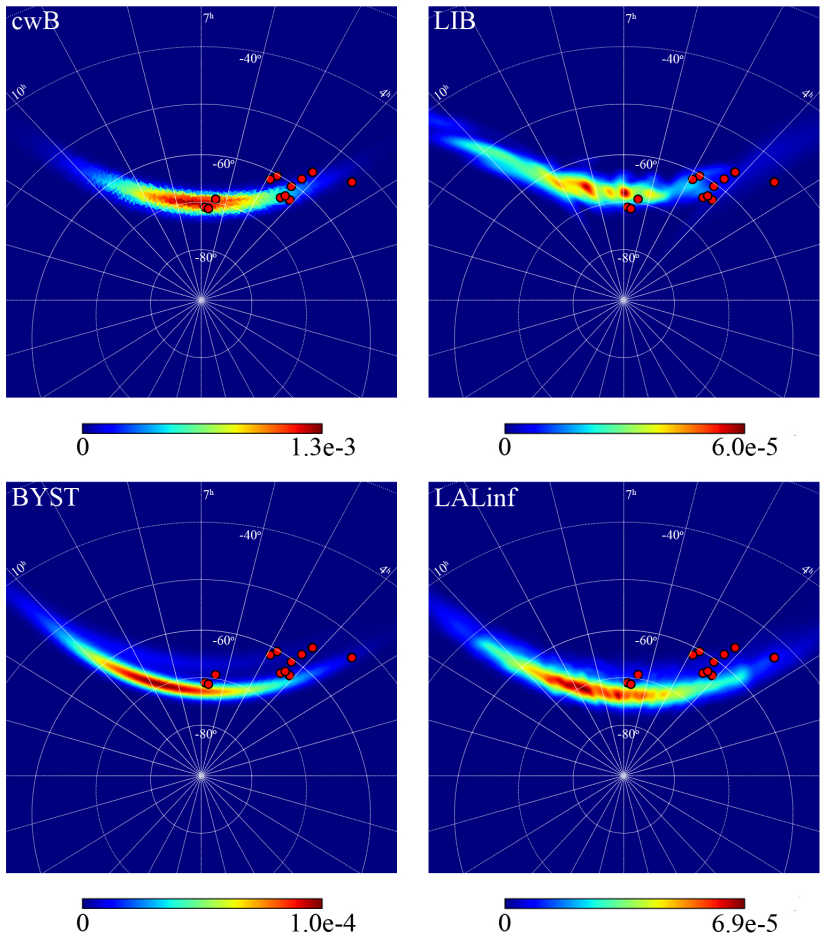
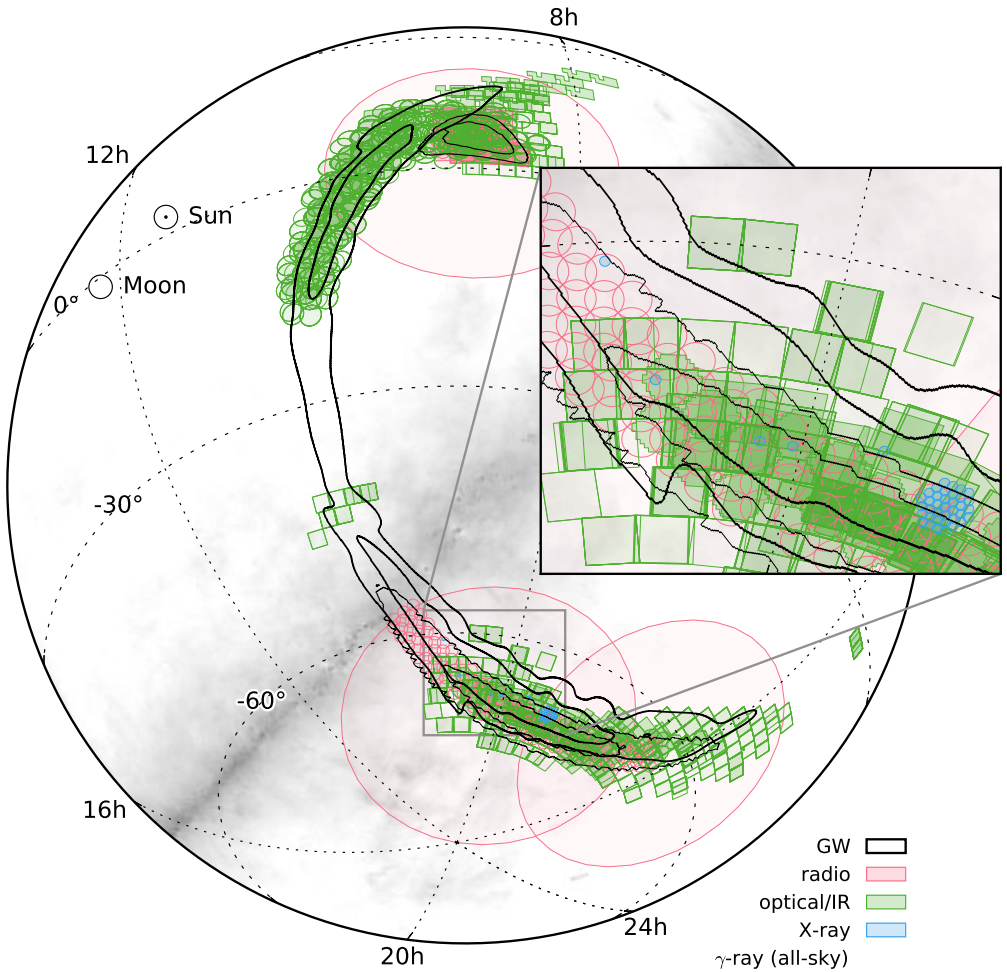
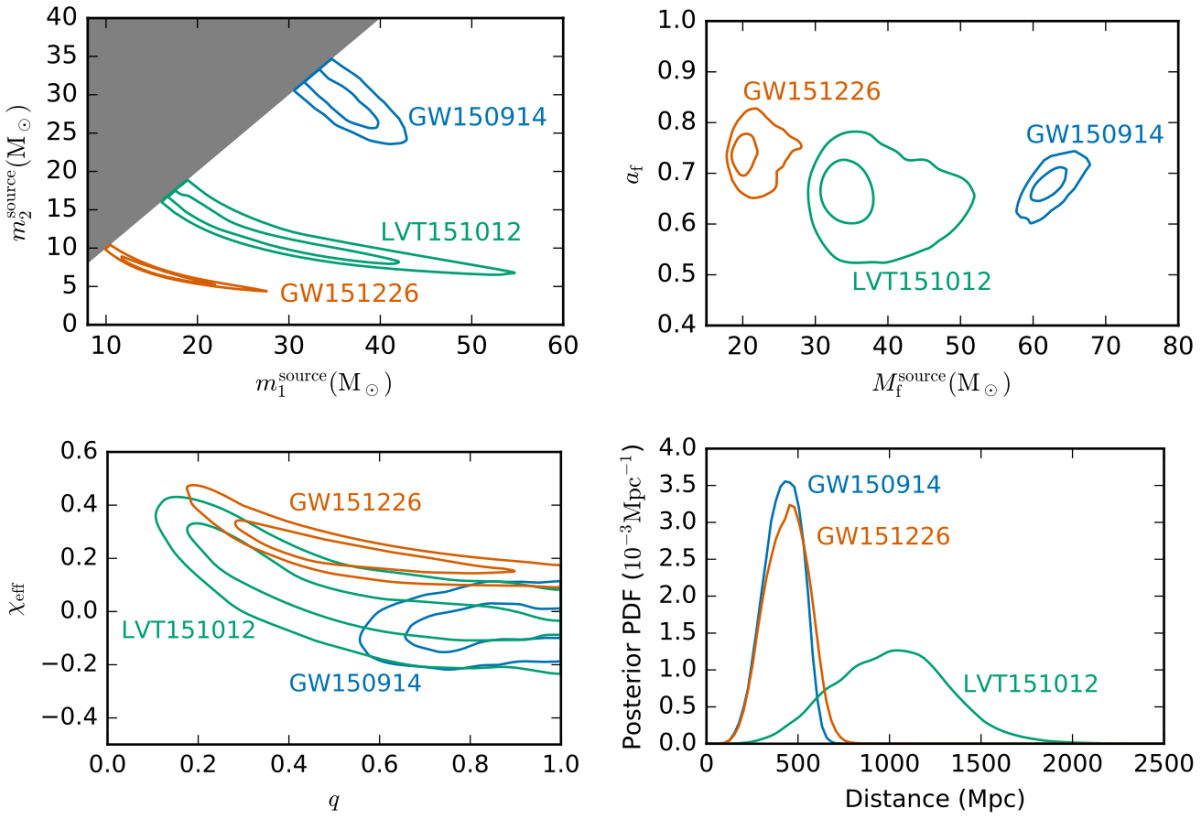


Figure: The galaxies selected by TOROS collaboration

We used the Estación Astrofíca de Bosque Alegre 60 inch (1.54m) telescope.



The observations from several collaborations could not find a transient associated to this Gravitation Wave event.
Although we now know that all of them were likely to be CBC.



Currently the project is operational in O2 observing run of A-LIGO, but due to technical issues at the mountain top, we are working on the installation of telescopes at lower levels (3400m) in Tolar Grande town. The 2017 campaigns are focusing on new moon, 15 days-long, observation runs every month.

- Our experience in follow ups of GW alarms is greater now, we have been following O2 alarms as well.
- TOROS now includes several new associated instruments from Chile (Mamalluca observatory), Texas (at the UTRGV school-telescope) and Mexico.
- In addition we have spectroscopic time in Southern Gemini, and GTC.
- Instruments in Tolar are going to be installed this winter (southern) with a prospect of continue observation capability.

Thanks!