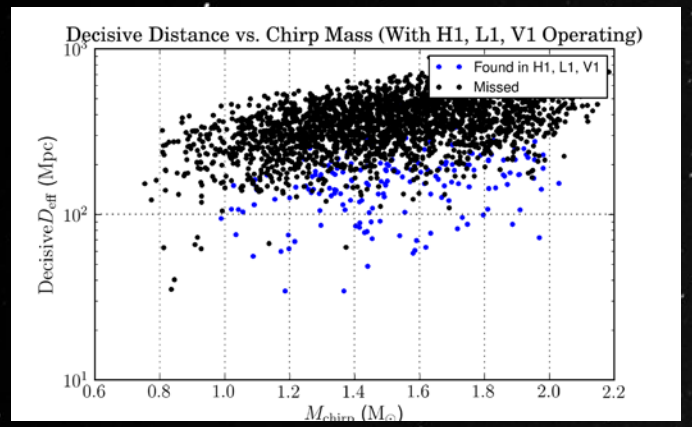
Search for Gravitational Waves with Interferometric Detectors

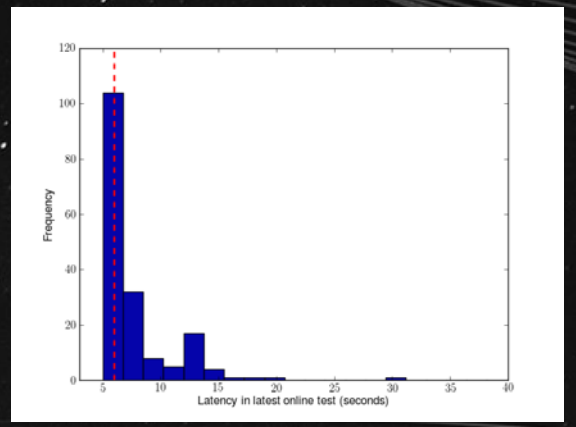
Chairs: Qi Chu (UWA) and Karl Wette (ANU)

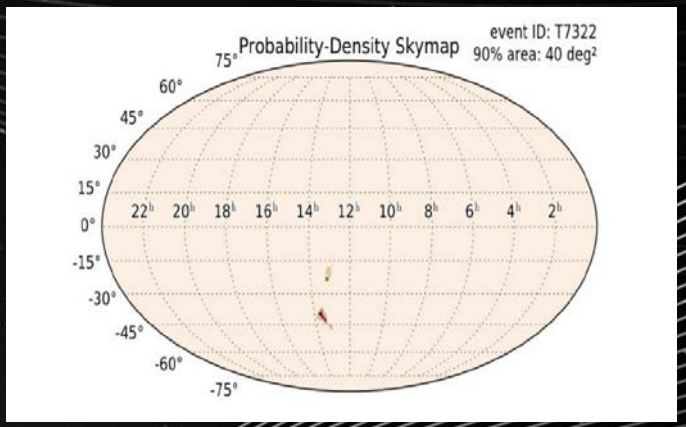
- LIGO-Virgo searches led by OzGrav members
  - SPIIR CBC search pipeline preparations for O3
    - (Qi Chu, Joel Bosveld, Linqing Wen and others, UWA)
  - BayesWave burst search pipeline, O1 and O2 all-sky burst search paper
    - (Meg Millhouse, UniMelb)
  - CW O2 Sco X-1 Viterbi 2.0 search
    - (Patrick and others,, UniMelb)
  - Stochastic group O2 directional searches
    - (Pat Meyers, UniMelb; Boris Goncharov & Colm Talbot, Monash)
- OzGrav participation/contribution to LIGO-Virgo searches
  - Long-duration post-merger search
    - (Lilli, Andrew, Paul, Nikhil, others; UniMelb+Monash)
- OzGrav activities
  - CW workshop Aug. 2018
    - Organised by Karl Wette
  - OzStar task force
    - (Karl Wette, Qi Chu)

SPIIR Online CBC Search pipeline -- preparation for O3

- Online search performance:
  - Sensitivity of mock O2 online tests
  - High-significance glitch triggers down to zero
- Latency from 20 seconds down to 6 seconds
- Prompt skymap uploading







SPIIR Online CBC Search pipeline

Aiming for first NSBH !

- O3 search plan:
  - Search for BNS, NSBH, and BBH
  - Online triggers with HLV (and HL if quality of Virgo data is unsatisfying), with prompt skymaps
  - Online triggers with HLVK when KAGRA data is usable (subject to review)
- Ongoing and future work:
  - Incorporating KAGRA data processing
  - SPIIR catalog on O1 and O2 data
  - SPIIR search of sub-threshold events with FRB triggers.
- Preparation for ER13/ER14/O3:
  - Code review: pass milestones with online HLV analysis
  - Officially documented as one of the online CBC pipelines in O3 EM followup userguide
  - First round of SPIIR O3 readiness document circulated
  - Computing resources allocated for SPIIR online runs
  - Point persons for O3 operation: Qi Chu and Linqing. Manoj and Xiaolin, 2 PhDs, are being trained for O3 operation and follow up events. More persons welcome.

BayesWave burst search

- Bayesian reconstruction of unmodeled GW bursts using sine-Gaussian wavelets
  - Online follow-up of coherent wave-burst search
  - Robust distinction between signals and glitches
  - Waveform reconstruction with minimal assumptions on souce

- Preparation for O3:
  - Continue to run as on online follow-up
    - No major changes between O2 and O3

- Ongoing and future work
  - O2 short-duration burst search paper nearly done
    - See O1 All Sky Paper for reference: arxiv:1611.02972
  - Planned O3 paper with results from taht run

CW O2 Sco X-1 Viterbi 2.0 search

- Search for continuous gravitational waves from the low-mass X-ray binary Scorpius X-1
- The Viterbi 2.0 search pipeline builds on two techniques:
  - a hidden Markov model (solved by the Viterbi algorithm), which makes the search robust against spin wandering: that is, unpredictable stochastic variation in the GW frequency
  - the J-statistic: a matched filter that fully accounts for the motion of the source neutron star in its binary orbit
- Will be published before the O2 data release in Feb 2019

Ongoing and future work, O3 plans

- Will re-run Sco X-1 search on full O3 dataset
- Aim to do a search for LMXBs other than Sco X-1
- GPU version of the core algorithm exists, produces the right results, runs super-fast
- Working on sensitivity improvements for the hidden Markov model

Stochastic O2 directional searches

- Search over persistent narrowband gravitational wave point-sources in 20-1726 Hz band at directions of Scorpius-X1, SN1987A and Galactic Center.
- Search for gravitational wave point sources with a broadband spectrum over all sky locations.
- Search for extended in space sources of gravitational waves using spherical harmonics decomposition.

- O3 detection possibility and preparation
  - Possibility of a low-significance detection of an isotropic stochastic background in O3
  - Unknown possibility of isolated, narrowband sources, Sn1987a and Galactic centre
  - ScoX-1, sensitivity unlikely to reach torque-balance limit in O3

- Ongoing and future work
  - Finish and publish O2 results

Long-duration post-merger searches

- Search & Sensitivity (arXiv:1810.02581)
  - Two unmodeled algorithms
  - Two model-based algorithms (power-law model)
  - Up until the end of O2; no detection claimed
  - Detectors with lower noise level are needed
  - Beyond detectability even with optimal matched filter
- O3 detection possibility and preparation
  - Methods are ready for future analysis
  - Working on improvement of the methods, e.g., hidden Markov model tracking of cross-power map, using 3 IFOs, etc.
  - Not likely to have detection in O3