



Australian Government  
Australian Research Council



# OzGrav

ARC Centre of Excellence for Gravitational Wave Discovery

# Highlights of the Gravitational wave Multi-messenger Program

Kendall Ackley and Eric Howell



# Facilities and Programs and People

- Optical: Zadko, GOTO, SkyMapper, ANU 2.3-m
  - Radio: ASKAP, Compact Array, MWA, Parkes
  - Deeper, Wider, Faster (50+ facilities, 7 continents)
- Eric Howell (UWA)
  - Teresa Slaven-Blair (UWA)
  - Giulia Stratta (Italy)
  - Tara Murphy (U Syd)
  - Travis Mong (Monash)
  - Bruce Gendre (UWA)
  - Michele Boer (CNRS, France)
  - Wei Liu (BNU, China)
  - Nikhil Sarin (Monash)
  - Xiaoliu Lin (BNU, China)
  - Chi Chi Chu (UWA)
  - Sara Webb (Swin)
  - Manoj Kovalam (UWA)
  - David Coward (UWA)
  - Phil Edwards (CSIRO)
  - Susan Scott (ANU)
  - Hayden Crisp (UWA)
  - Kendall Ackley (Monash)
  - Duncan Galloway (Monash)



# Zadko telescope

## Activities done so far

- Recoating of the mirrors: gain in luminosity of about 66%
- New set of computers for robotization control, moving from Windows XP to Fedora Core 28
- New method of roof control, for increased observation time
- Complete re-organization of the network, offering a better protection against external attacks, improving the reliability of the observatory
- New storage units for the data (4Tb in RAID architecture)
- New server, with updated tools and services



# Zadko telescope

## Activities to be finished

- A new filter wheel with more filter for better observations
- Recalibration of the telescope (campaign planned for February 2019)
- A new scheduler to handle the GW alerts, first hand (i.e. received directly from LVC)
- A new part of the program to handle the requests of OzGrav, with a dedicated communication channel.
- A new pipeline to extract information from the calibrated images, to be circulated automatically to OzGrav

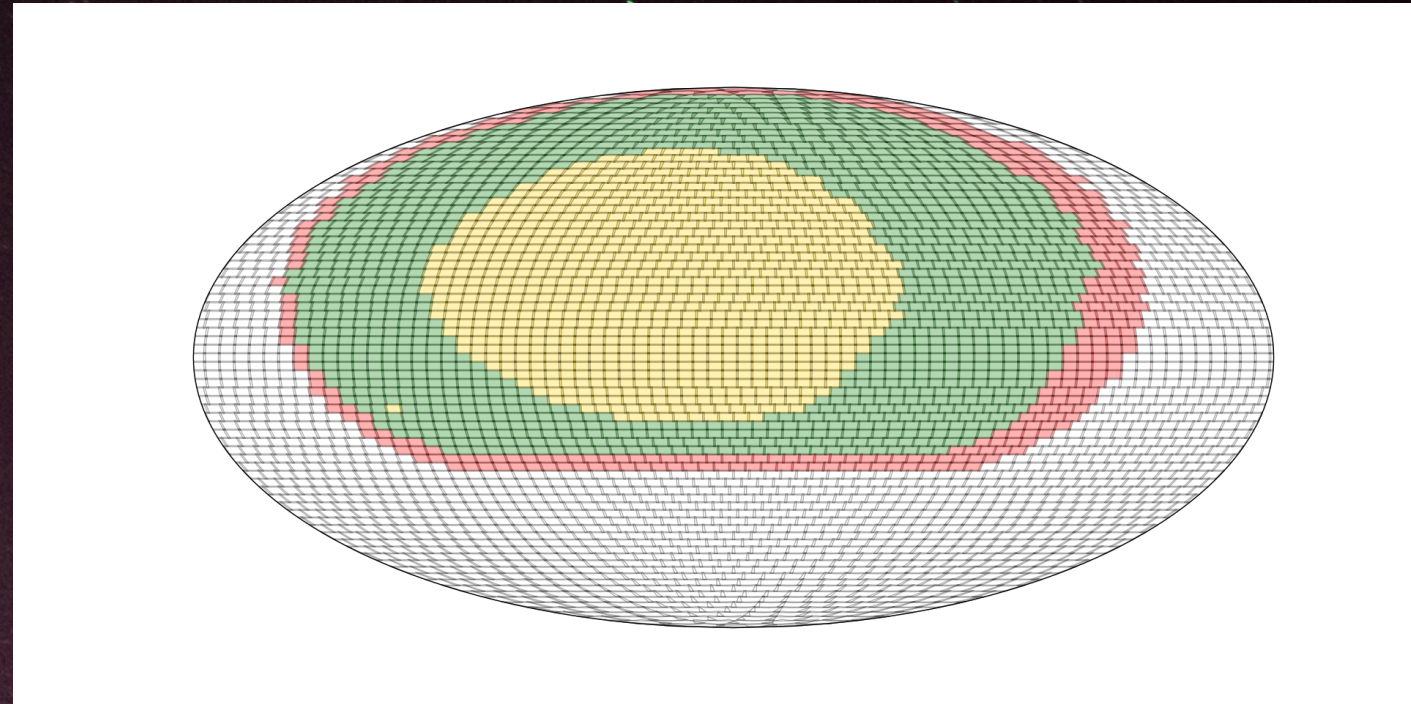
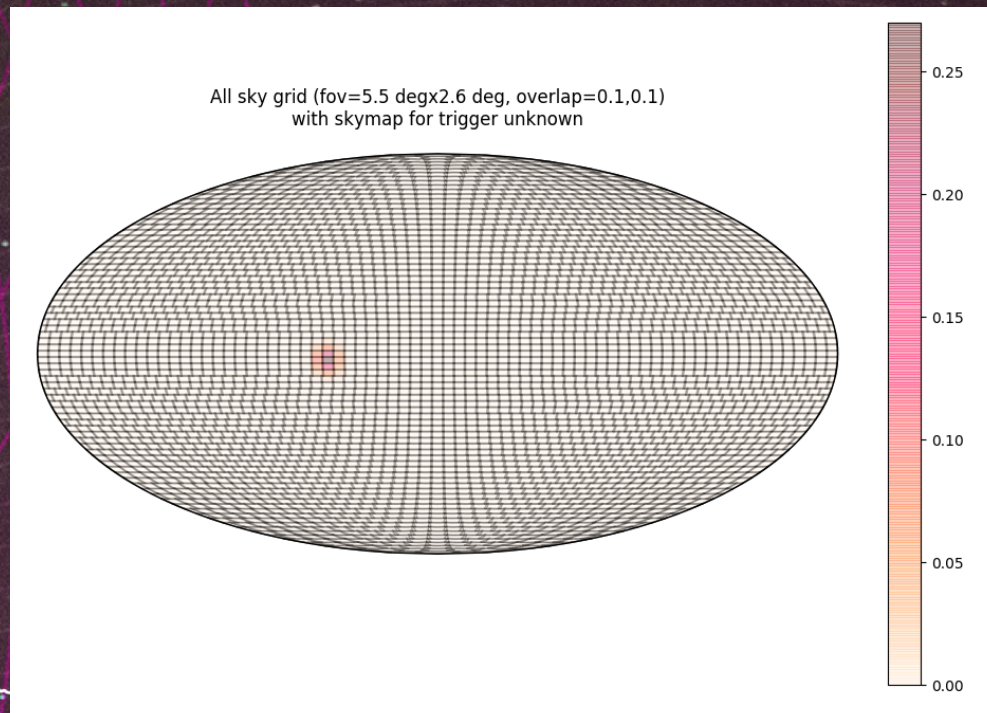


# Zadko: Recoating of the mirrors



# GOTO

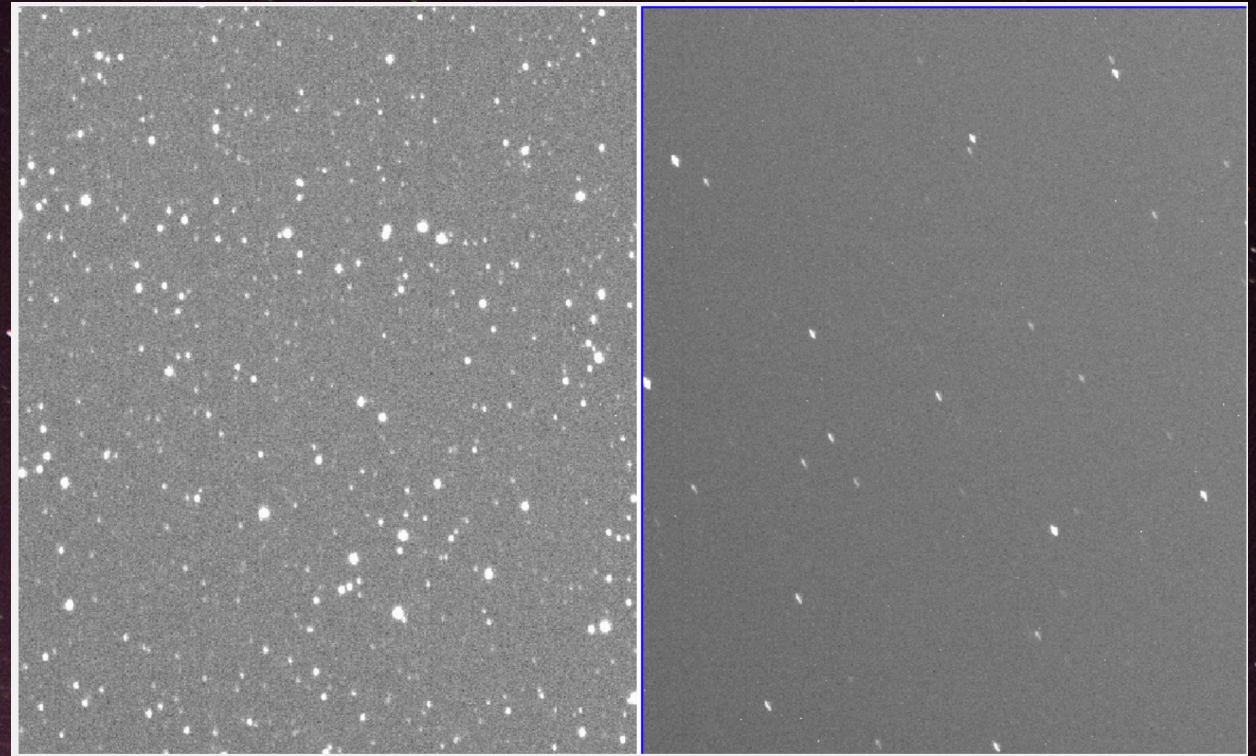
- RED: 13% never done (295)
- GREEN 87% done at least once (1904)
  - 50% done once (1108)
  - YELLOW 36% done twice (796)



- Will attempt test run mode using Fermi triggers

# GOTO

- Upgrades to mirrors and collimation
- Pipeline/control system nearly finalised for fully robotic system for ER13



GOTO-OBS / gotophoto Private

Unwatch 11 Star 0 Fork 3

Code Issues 26 Pull requests 0 Projects 0 Wiki Insights Settings

Labels Milestones [New milestone](#)

1 Open 0 Closed Sort

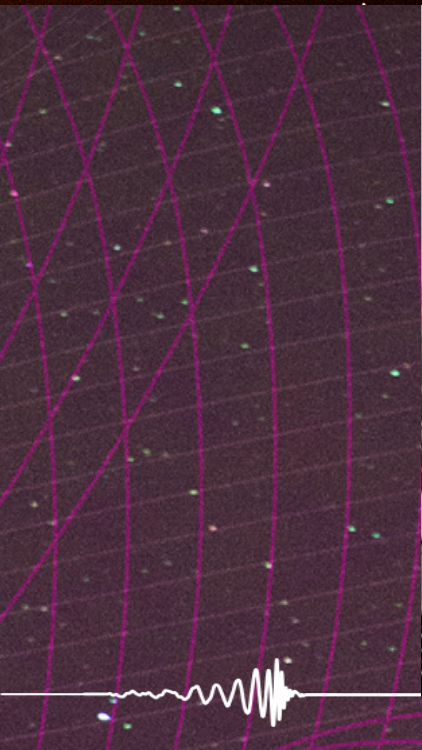
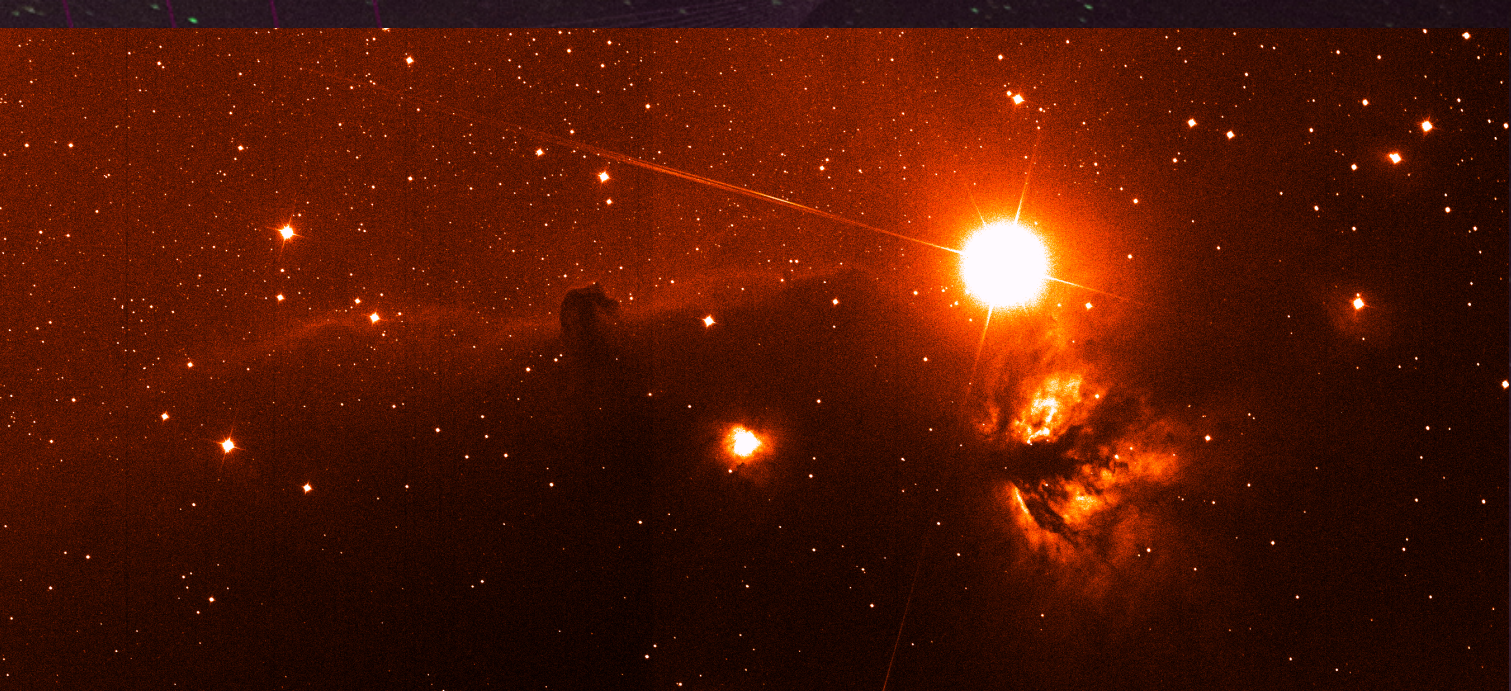
**Pipeline version 1.0**

Due by December 15, 2018 Last updated 2 days ago

A pipeline version that contains all the requirements to robustly a...[\(more\)](#)

63% complete 4 open 7 closed

[Edit](#) [Close](#) [Delete](#)





# Deeper, Wider, Faster Program - 2018 Highlights:

- **January** - Japan-Swinburne fast transient workshop for DWF:  
~80 Participants from NOAJ Subaru and ~40 facilities from all over the globe
- **Two DWF runs:**
  - **February** - Subaru HSC and 30 other simultaneous/follow-up facilities (radio, infrared, optical, x-ray, gamma ray, cosmic ray, and neutrino)
  - **June** - CTIO DECam and ~20 other simultaneous/follow-up facilities (radio, infrared, optical, x-ray, gamma ray, cosmic ray, and neutrino)
- **August** – IAU Vienna exhibition on StarSound and SOFIA – Data sonification tools developed in collaboration with RMIT
- **Future** – VR/AR data visualization/publications/much much more!



# Joint GW-sGRB detection rates

Cornell University Library

arXiv.org > astro-ph > arXiv:1811.09168

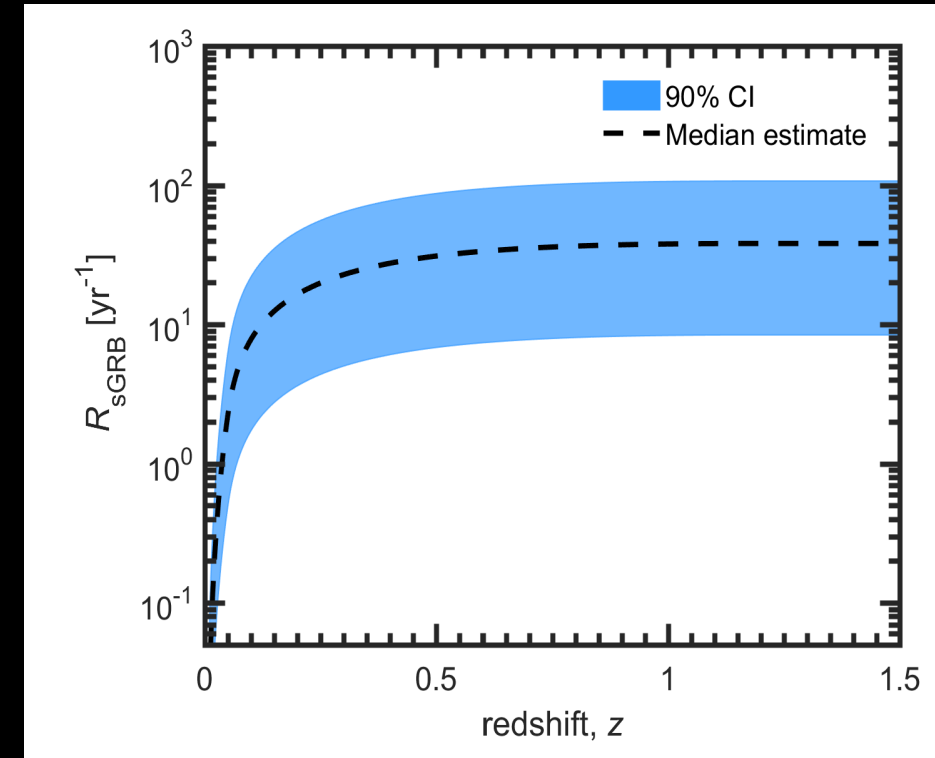
Astrophysics > High Energy Astrophysical Phenomena

## Joint gravitational wave - gamma-ray burst detection rates in the aftermath of GW170817

E. J. Howell, K. Ackley, A. Rowlinson, D. Coward

(Submitted on 22 Nov 2018)

- Inferred a structured jet profile for GRB170817A using EM observations
- Fermi and Joint GW/sGRB detection rates
- The percentage of BNS with sGRBs counterparts decrease with GW detector sensitivity
- Modelling used for 3G and O2 GRB paper



Fermi sGRB detection rate

# Unsupervised transient detections

## AN UNSUPERVISED ALGORITHM FOR AUTOMATED TRANSIENT DETECTION IN IMAGE-SUBTRACTED DATA

KENDALL ACKLEY<sup>1</sup>, STEPHEN S. EIKENBERRY<sup>2,3</sup>, CEREN YILDIRIM<sup>3</sup>, SERGEI KLIMENKO<sup>2</sup>, AND ALAN GARNER<sup>3</sup>

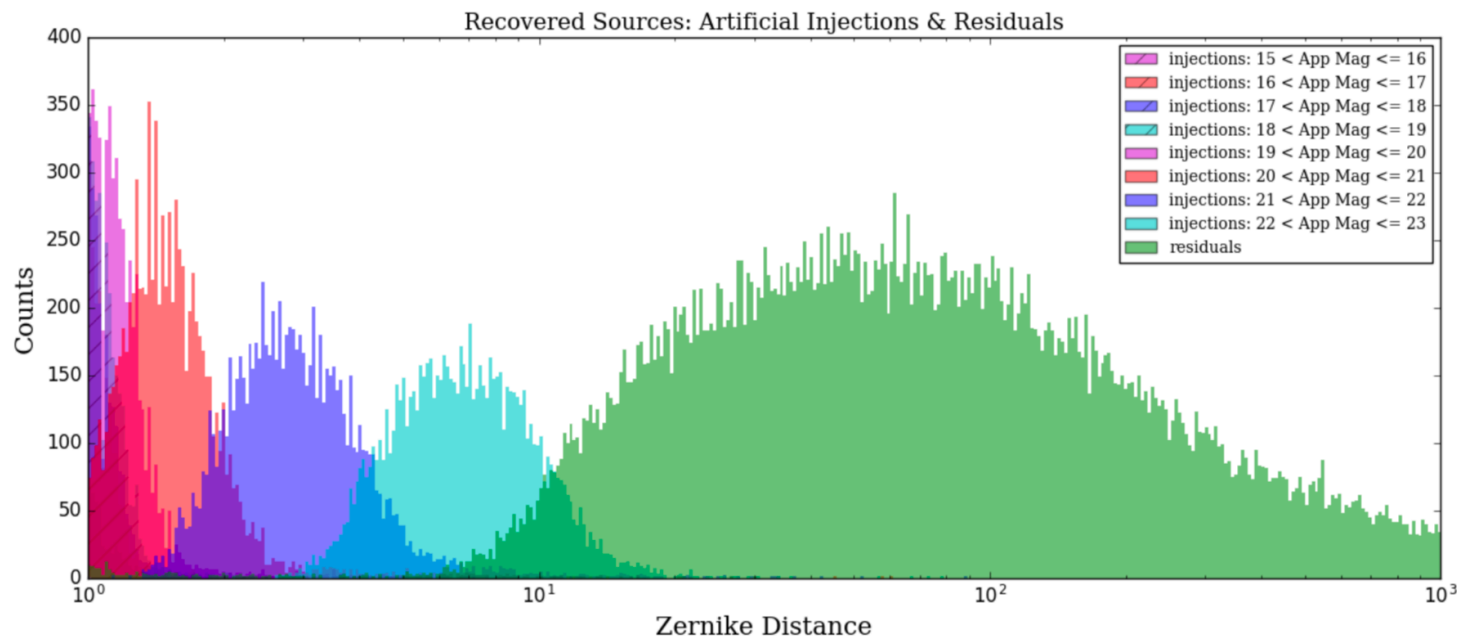
<sup>1</sup> Monash Centre for Astrophysics, School of Physics and Astronomy, Monash University, VIC 3800, Australia

<sup>2</sup> Department of Physics, University of Florida, Gainesville, FL 32611, USA and

<sup>3</sup> Department of Astronomy, University of Florida, Gainesville, FL 32611, USA

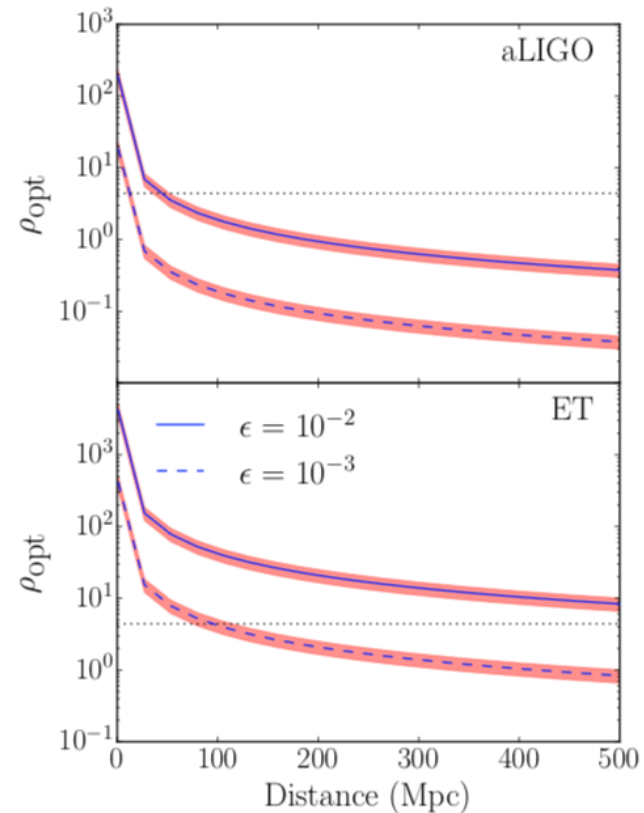
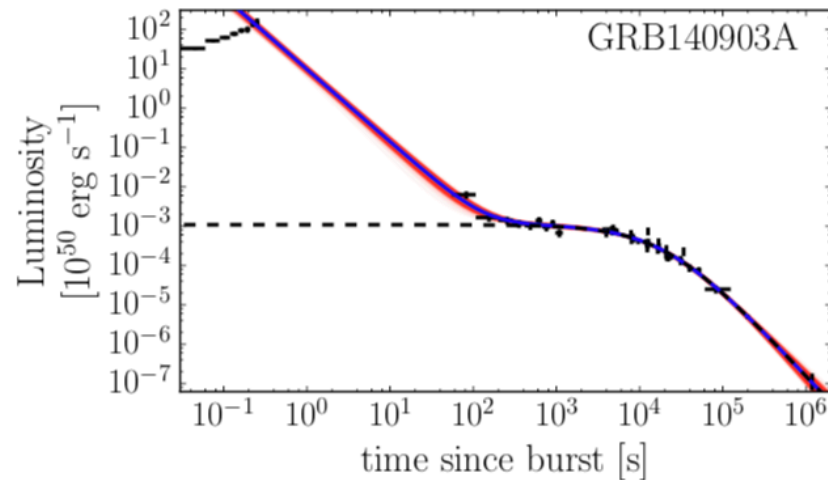
*Draft version November 30, 2018*

- Discriminating between true transients and image subtraction residuals
- Using 1000s of archival iPTF and DECam images
- Introduce a scoring metric to distinguish populations and leave behind the “interesting transients” without manually vetting 100s to 1000s of artifacts



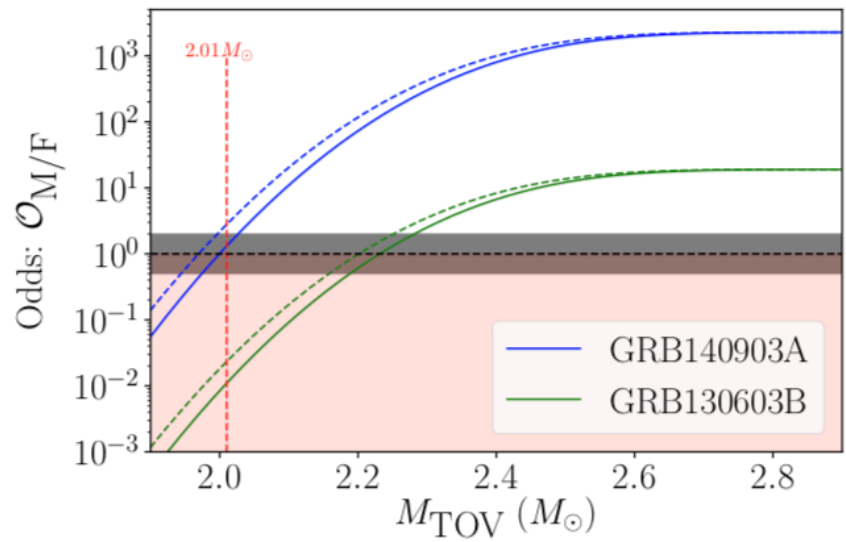
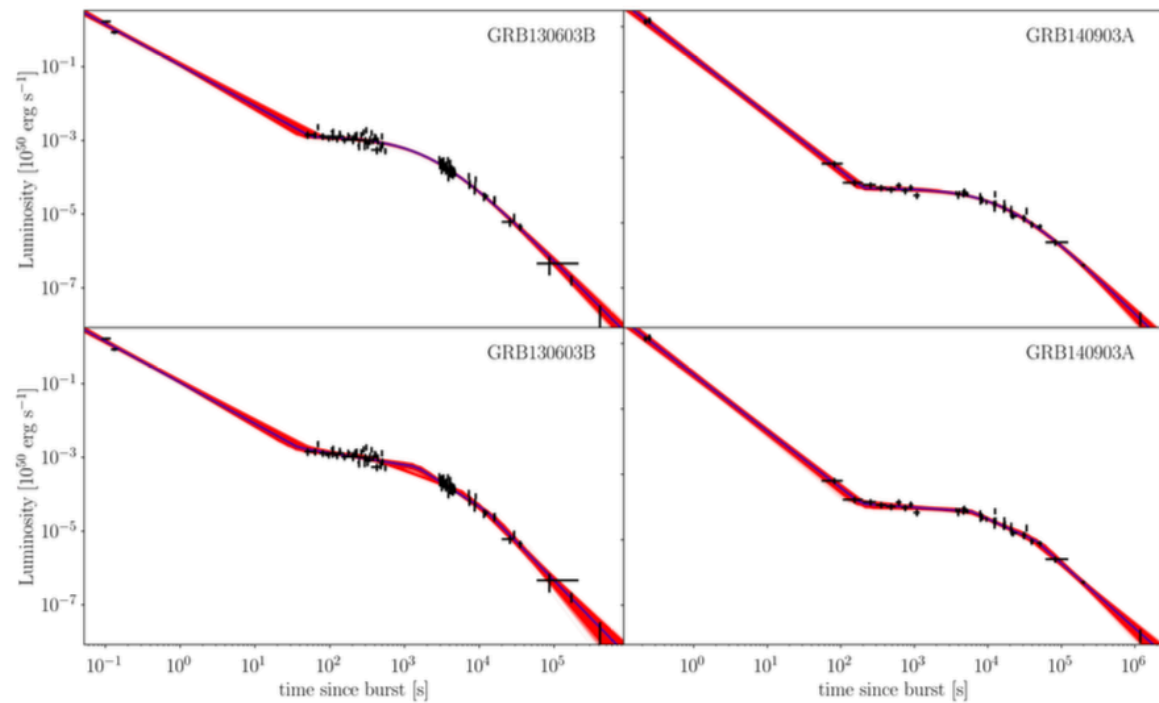
# X-ray guided gravitational-wave search for binary neutron star merger remnants (Sarin, Lasky, Sammut, and Ashton). Published in PRD (arXiv:1805.01481).

- ▶ Using X-ray afterglow observations of short gamma-ray bursts leads to more sensitive gravitational-wave searches for post-merger remnants.



# X-ray afterglows of short gamma-ray bursts: Magnetar or Fireball? (Sarin, Lasky, and Ashton). Submitted to ApJ.

- ▶ Literature highlights a systematic need for model selection between the fireball and magnetar models of gamma-ray bursts.



# Future or continuing work

- CHIME/FRB - GW search (Eric, Haydon C, Dave C, Jade P, Greg Ashton, Brennan Hughey, Ryan Fisher, Karrel Seilez)
- Offline sub-threshold FRB search using SPIIR (Teresa Slaven-Blair and Chichi)
  - SEE POSTER AT POSTER SESSION!
- Recovering sGRB jet morphology with GW events (Eric T and Sylvia B)
- Physical model for GRB X-ray plateaux (Lucy Strang and Andrew Melatos )
  - SEE POSTER AT POSTER SESSION!
- More late time radio follow-ups (Tara and team)
- Automated Transient Detection with Machine Learning (Travis, Kendall, Duncan)
- Collaboration for O3 activities across Australian and Australia-led facilities