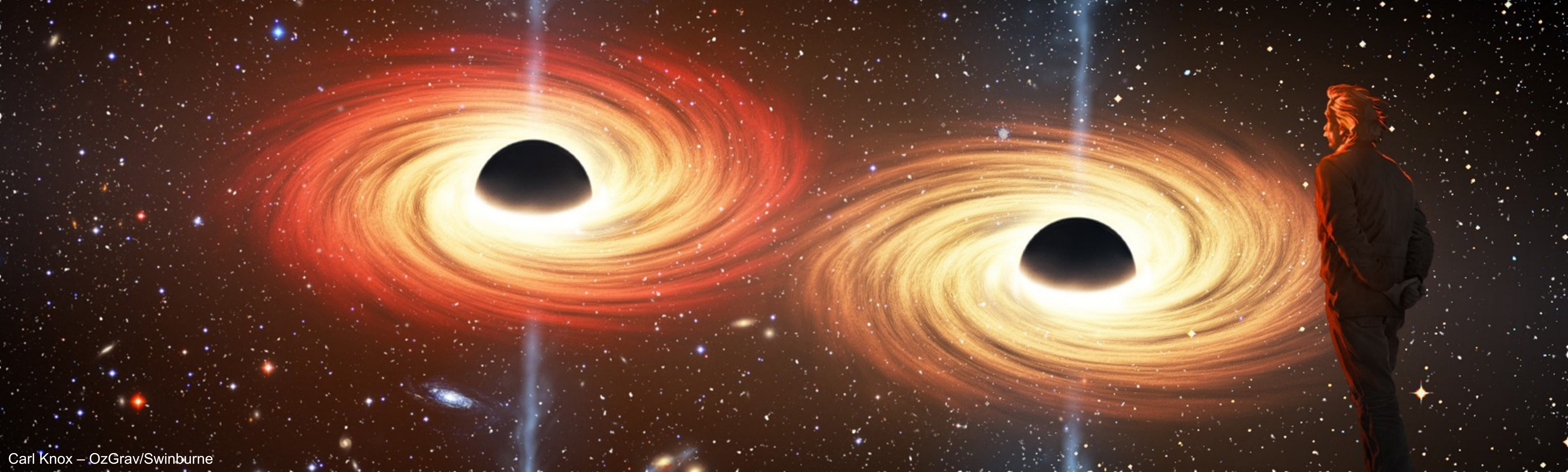




Carl Knox – OzGrav/Swinburne

Towards an Australian gravitational-wave observatory

Paul Lasky



MONASH
University

1994



1994



2024



1994

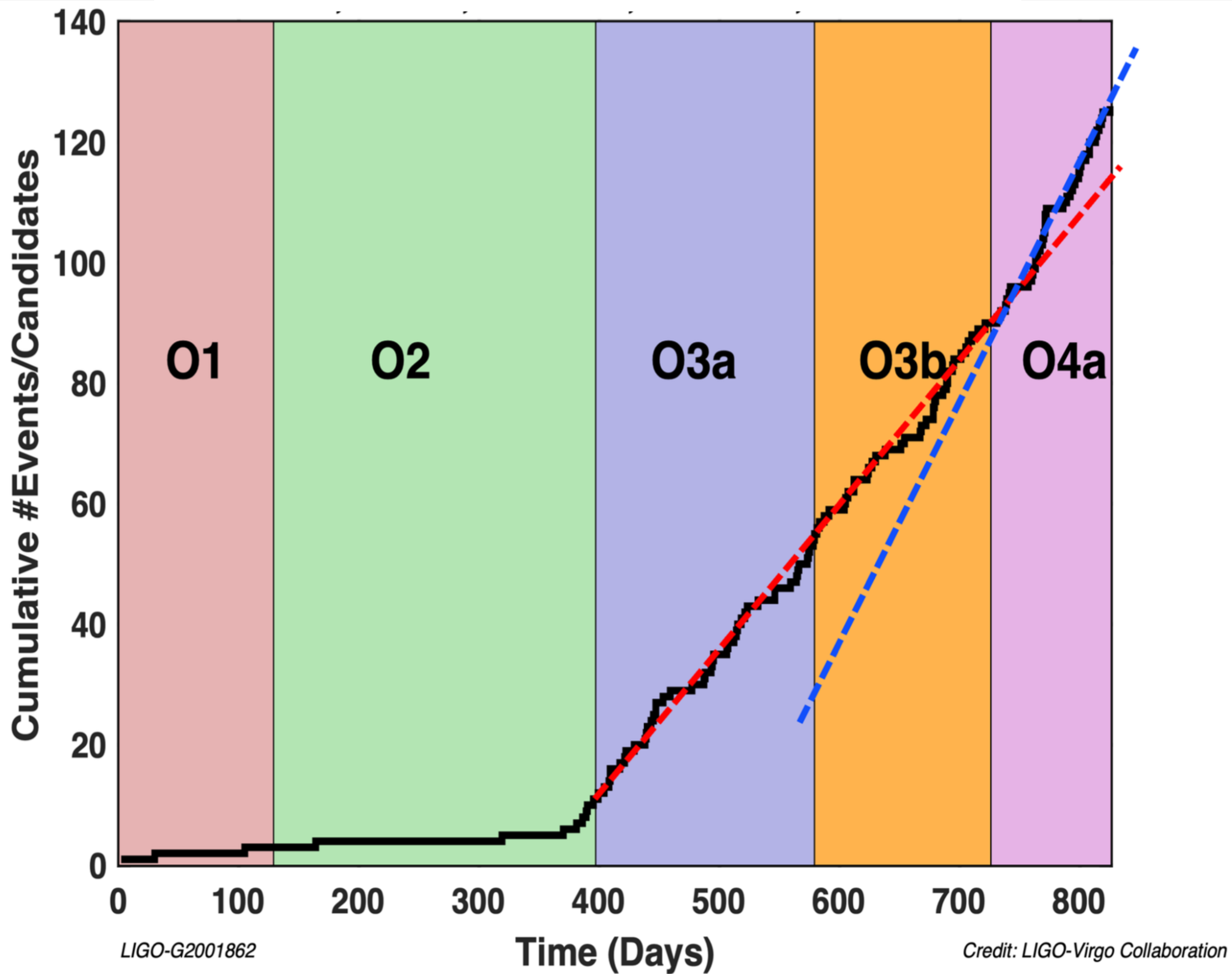


2024



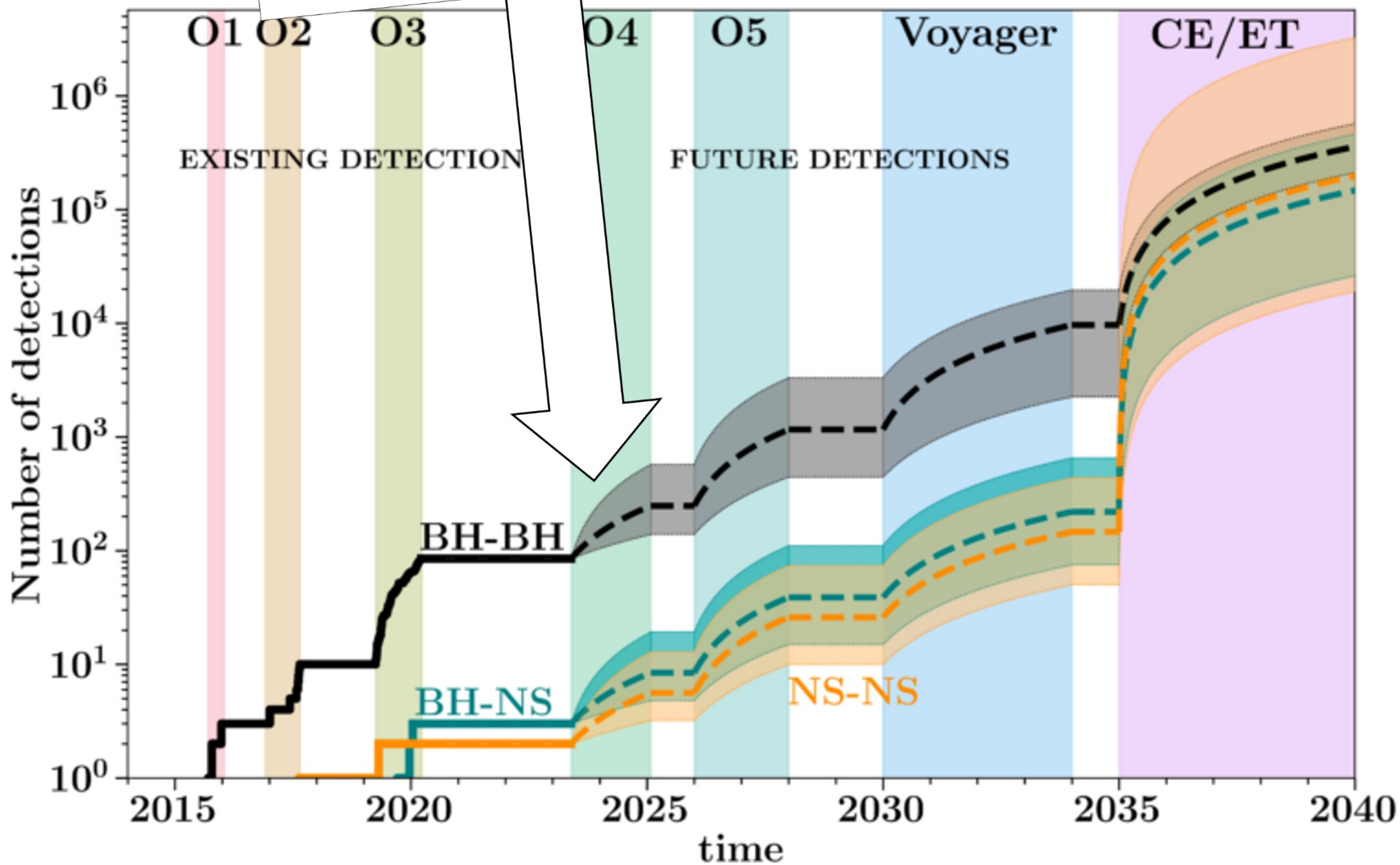
2056

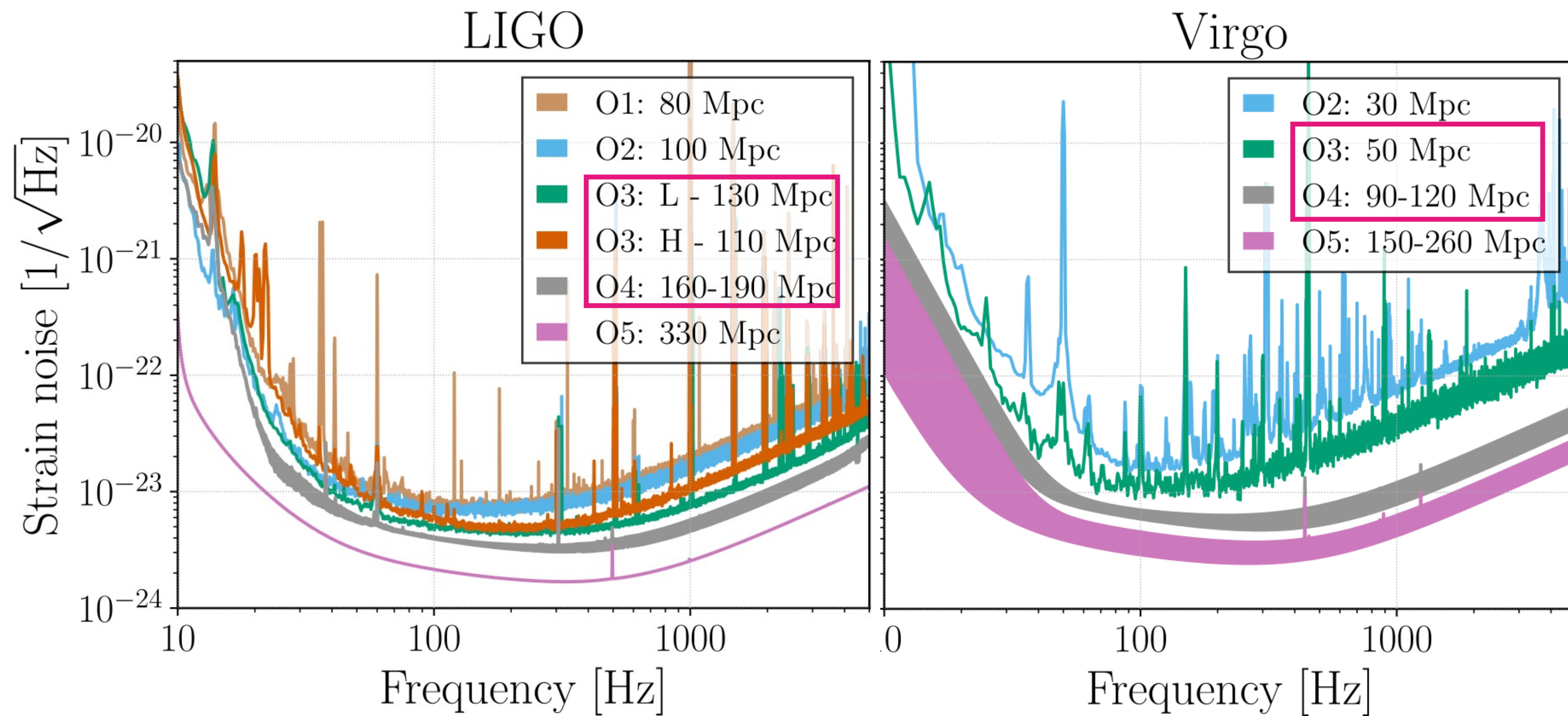




You are here!

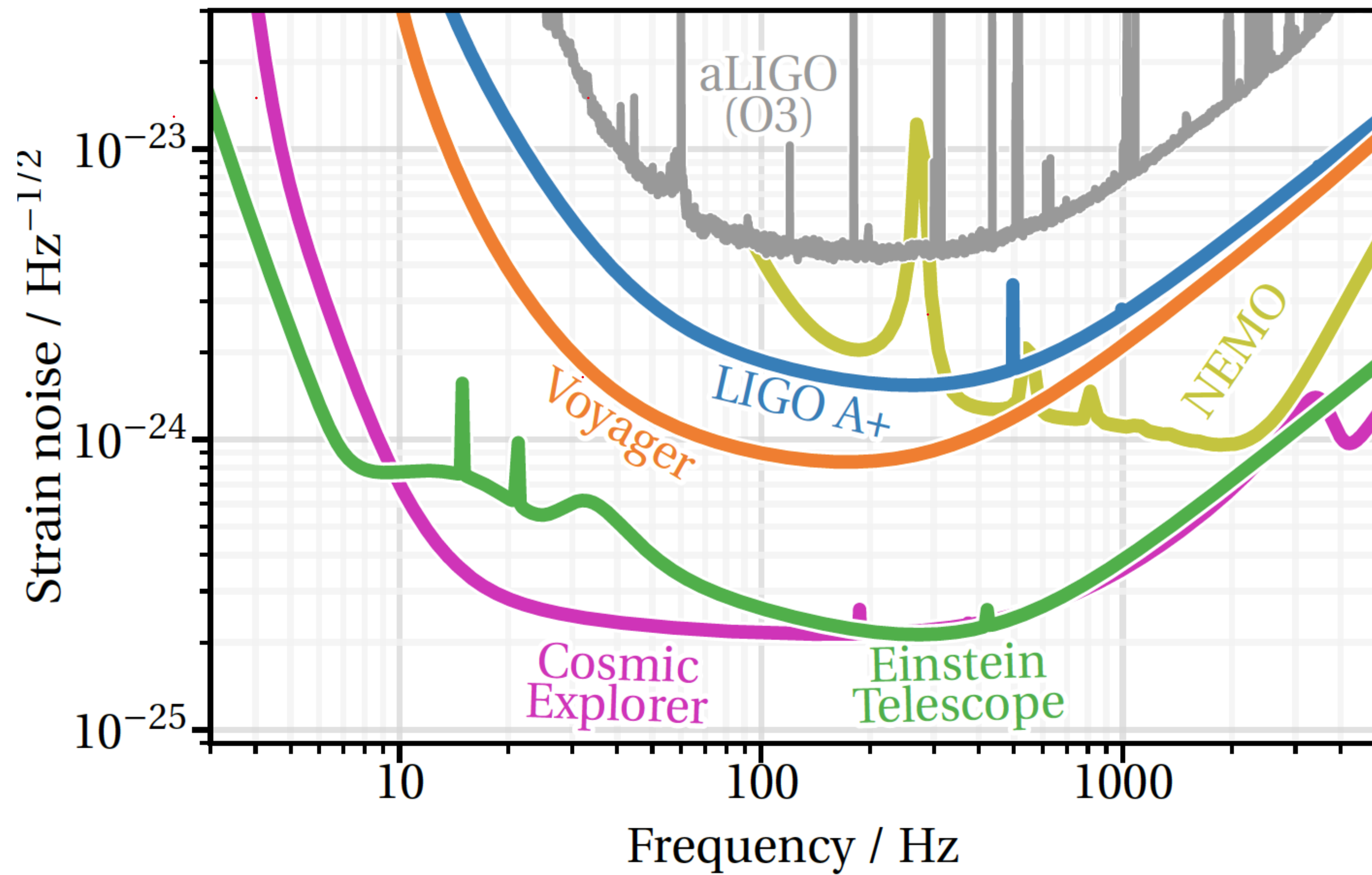
Floor Broekgaarden

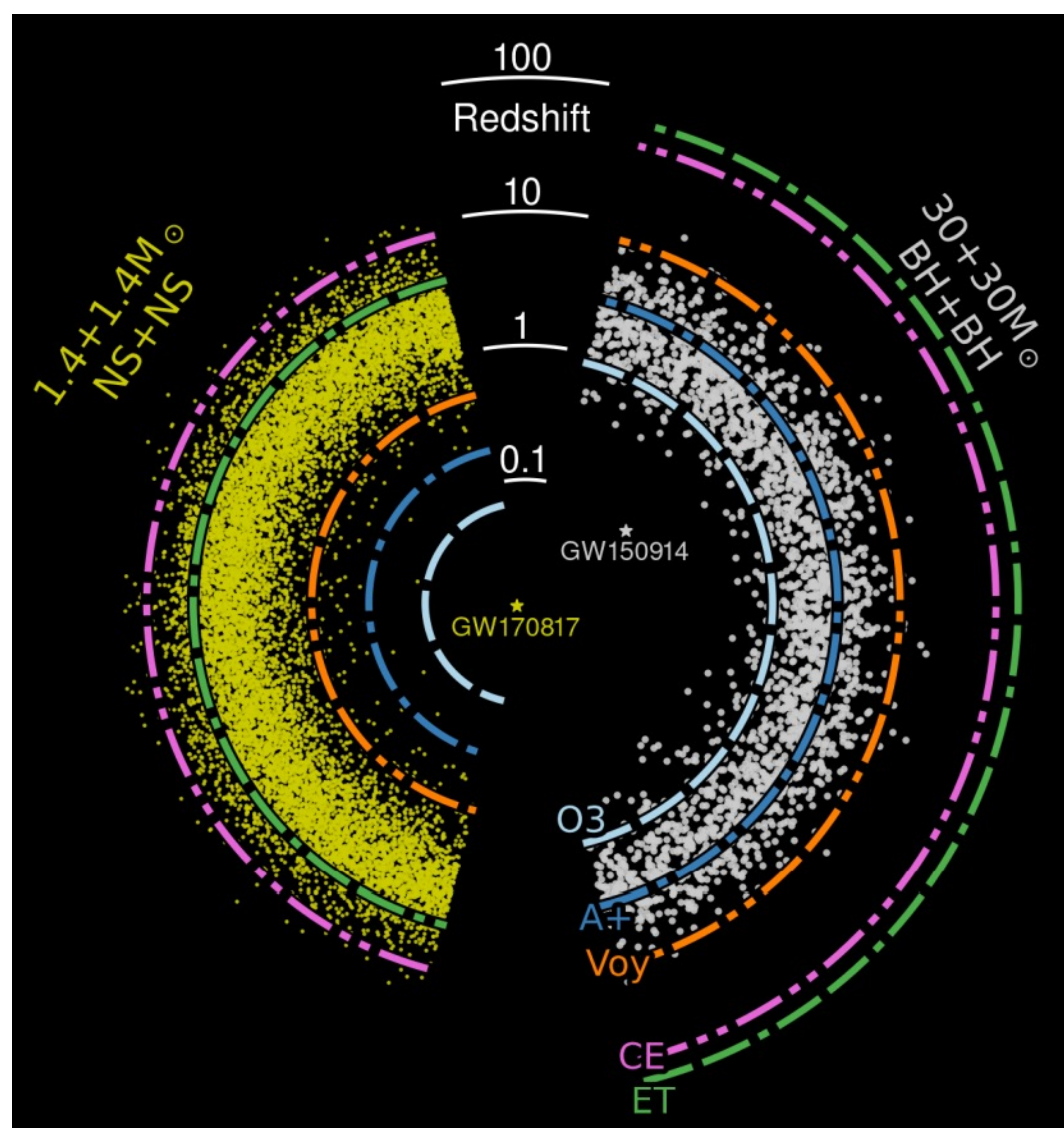
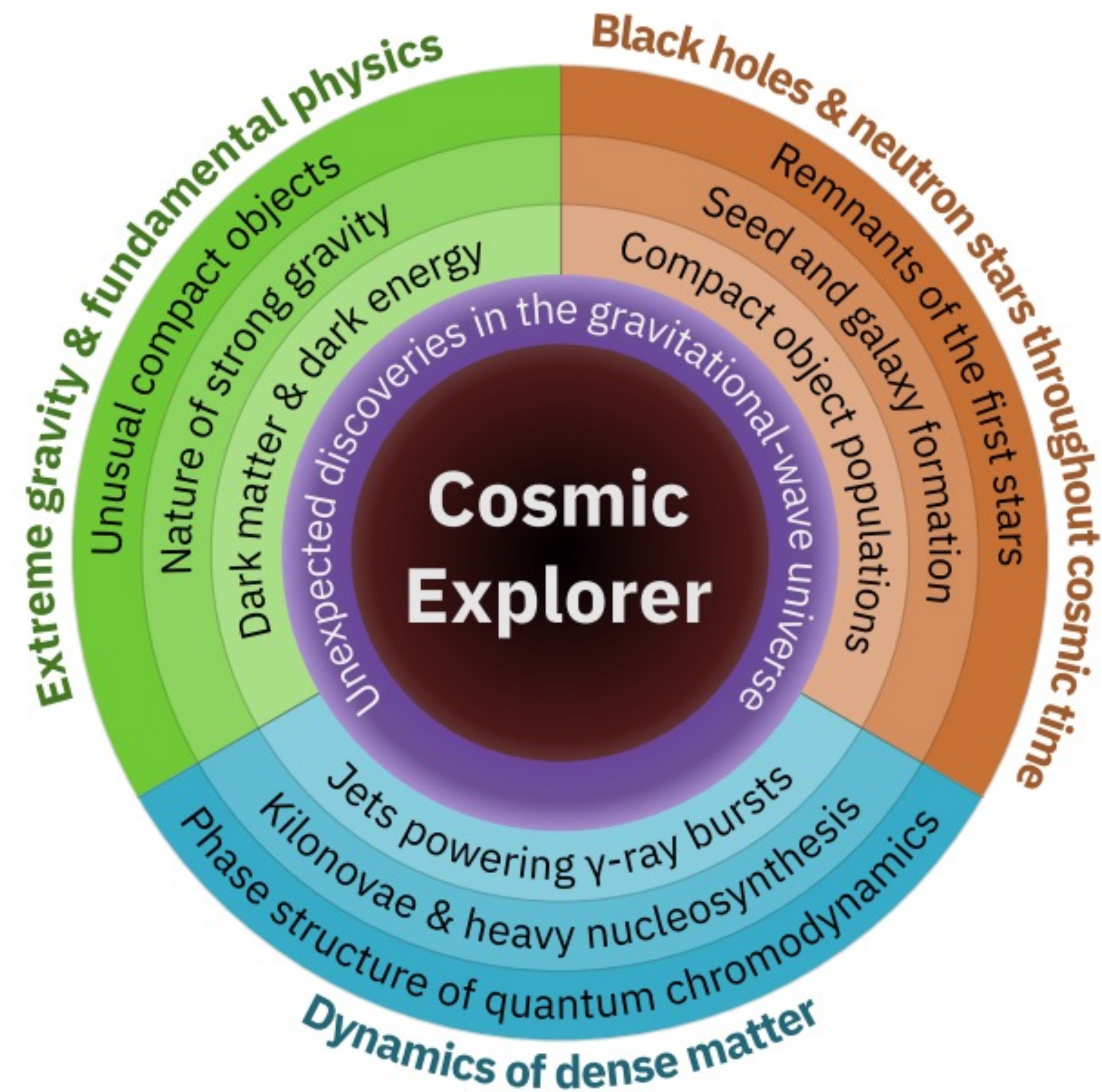




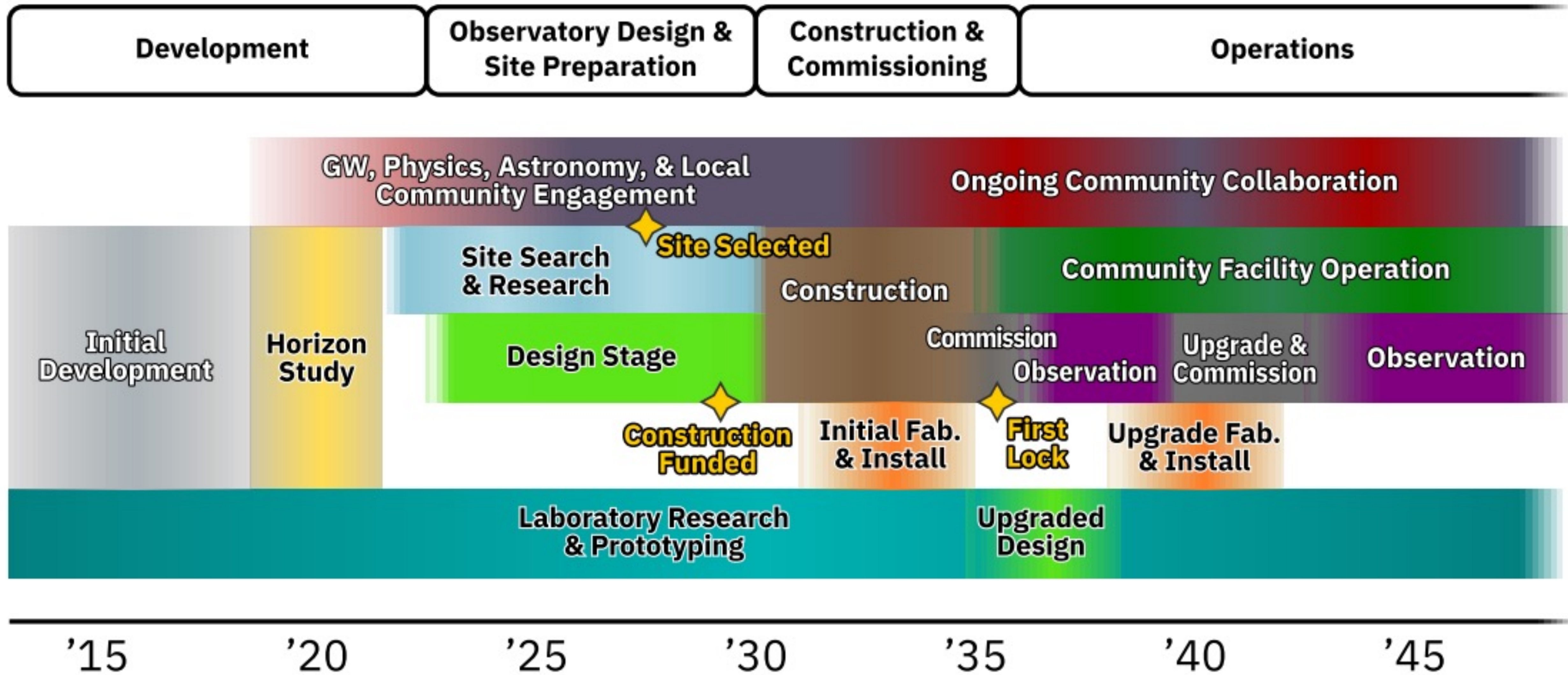
Strain $\sim 1/\text{distance}$

LIGO-Virgo-KAGRA Fourth Observing Run
observation every ~ 2 days





Cosmic Explorer Horizon Study



Cosmic Explorer Horizon Study

Fast forward → 2056

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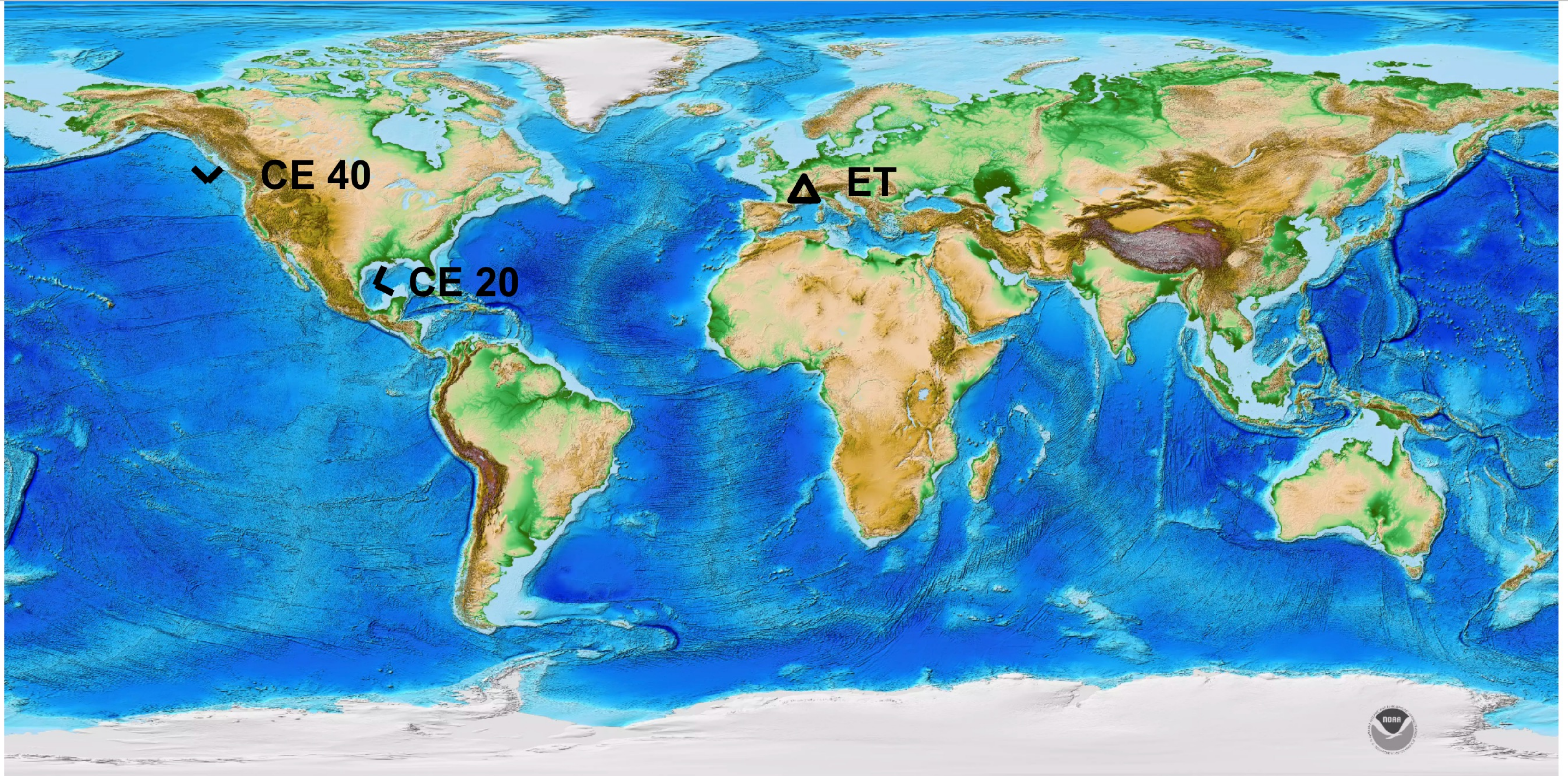
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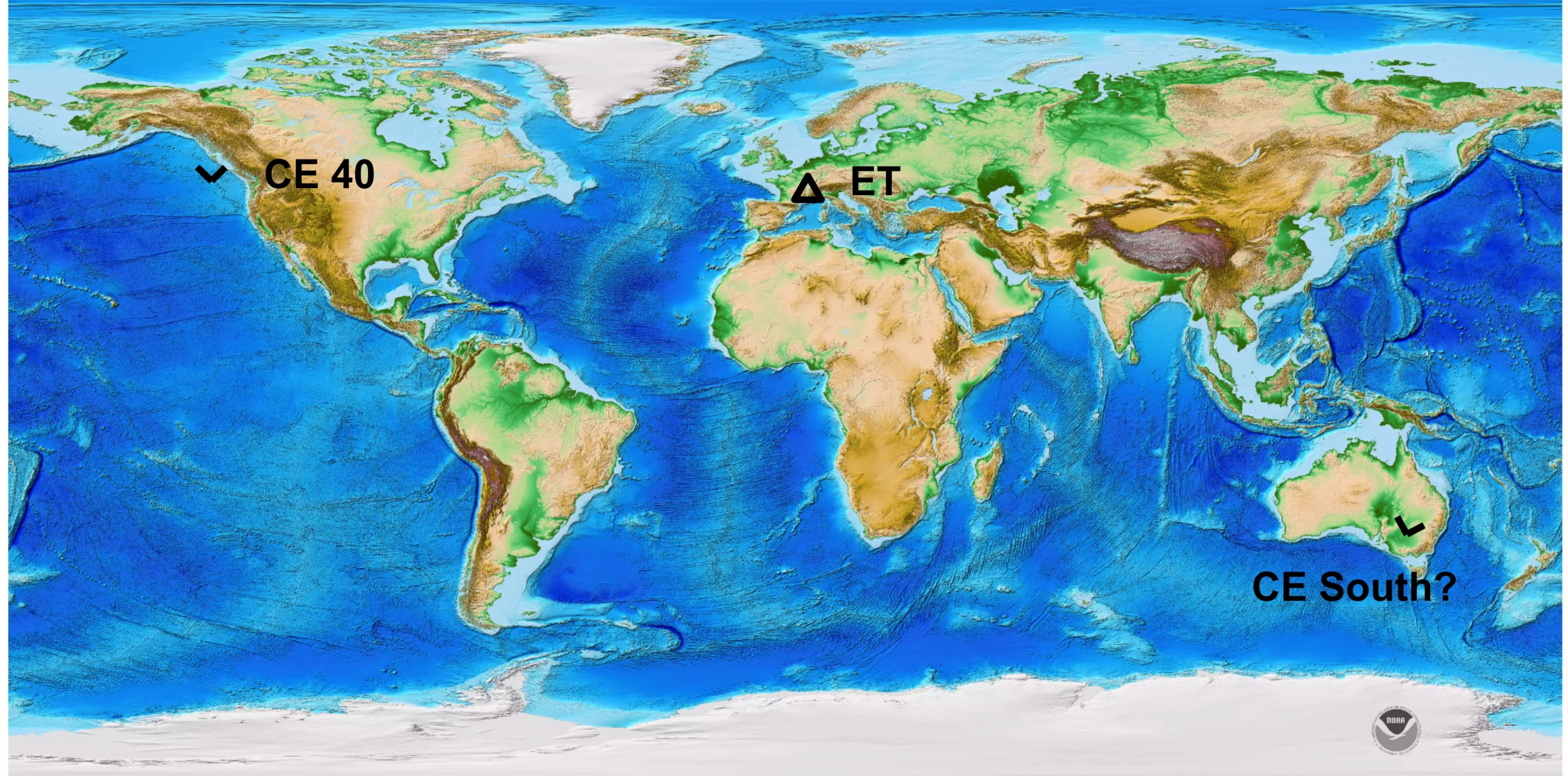
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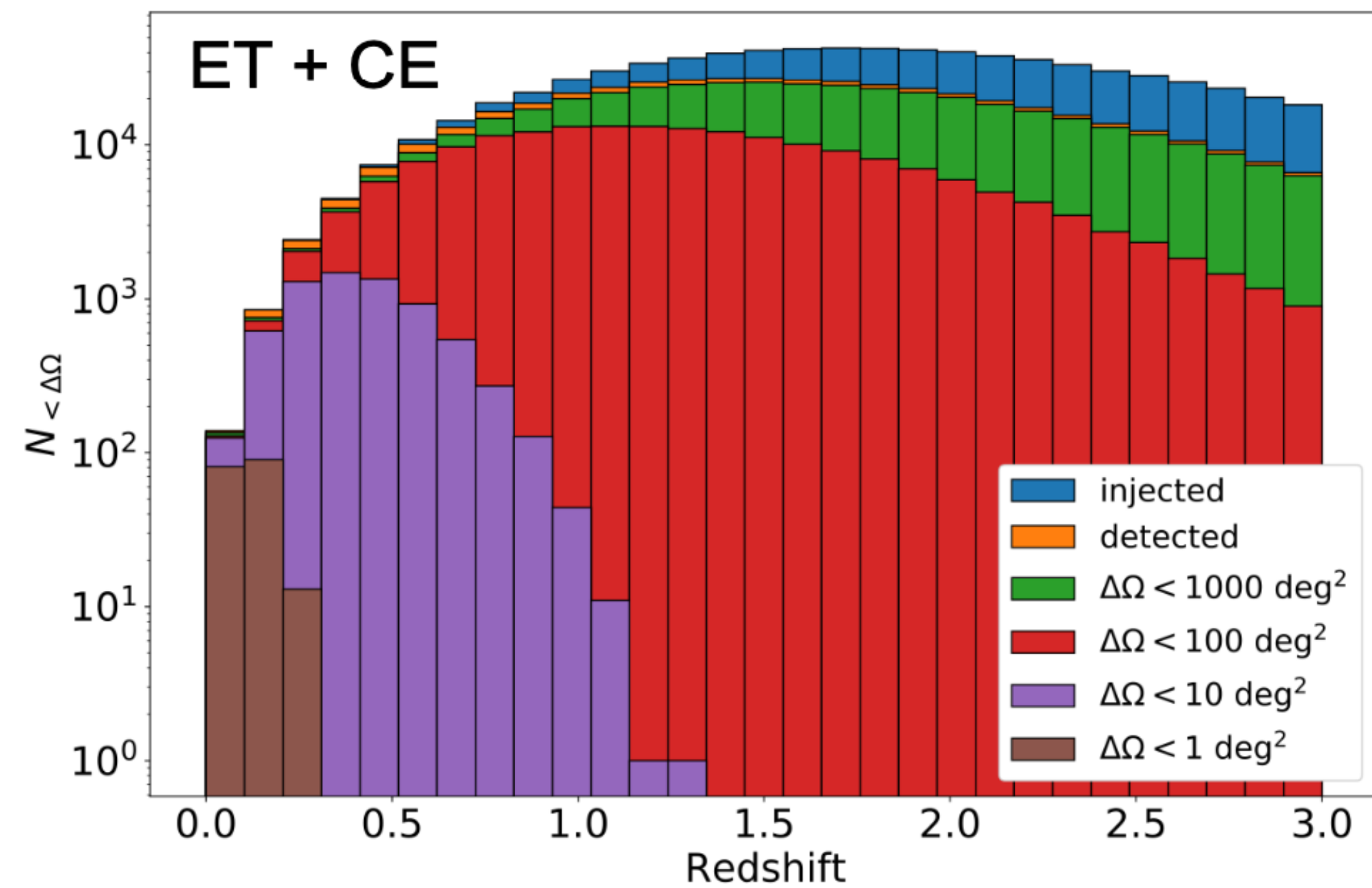
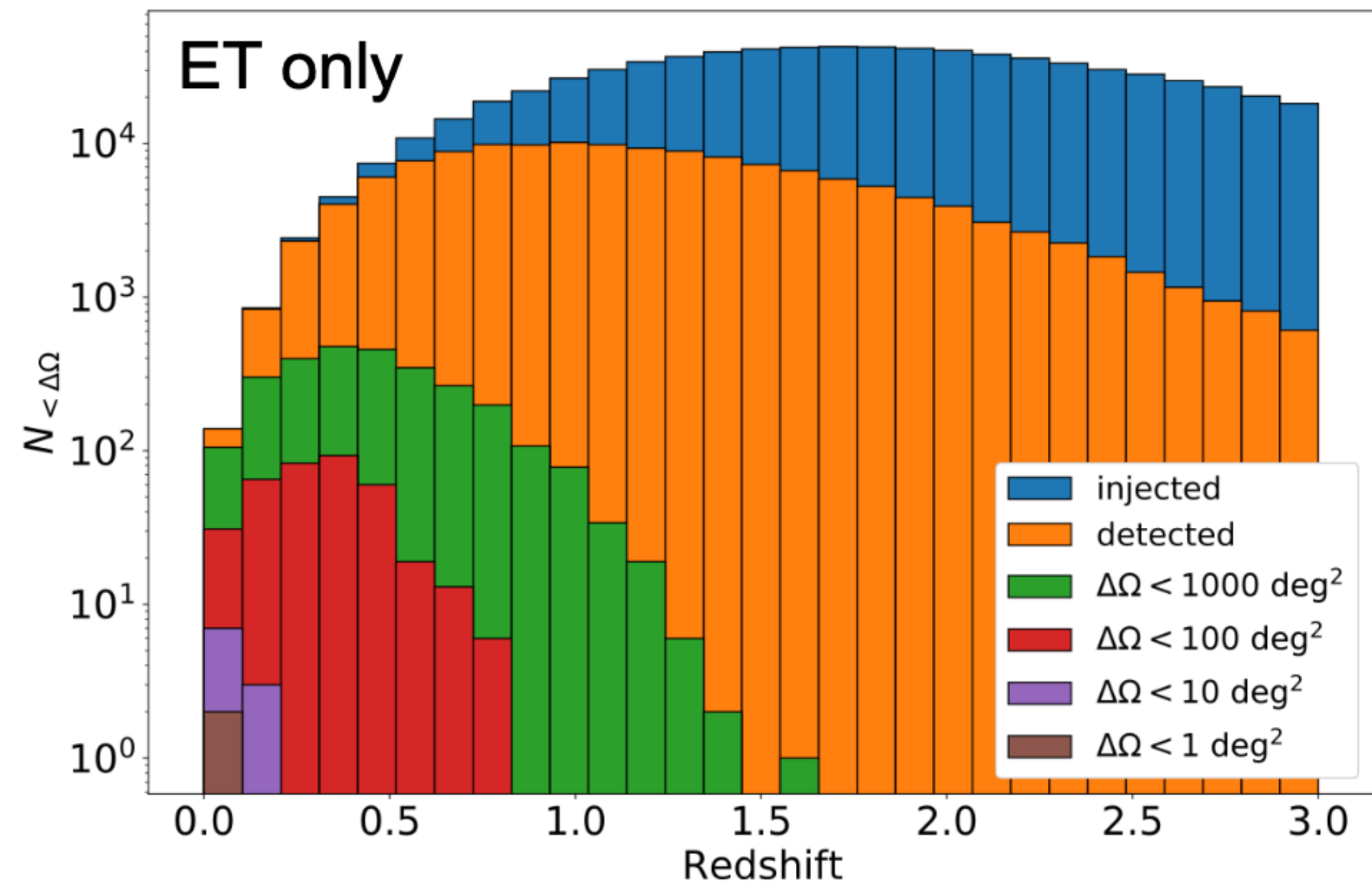
.

Fast forward → 2056

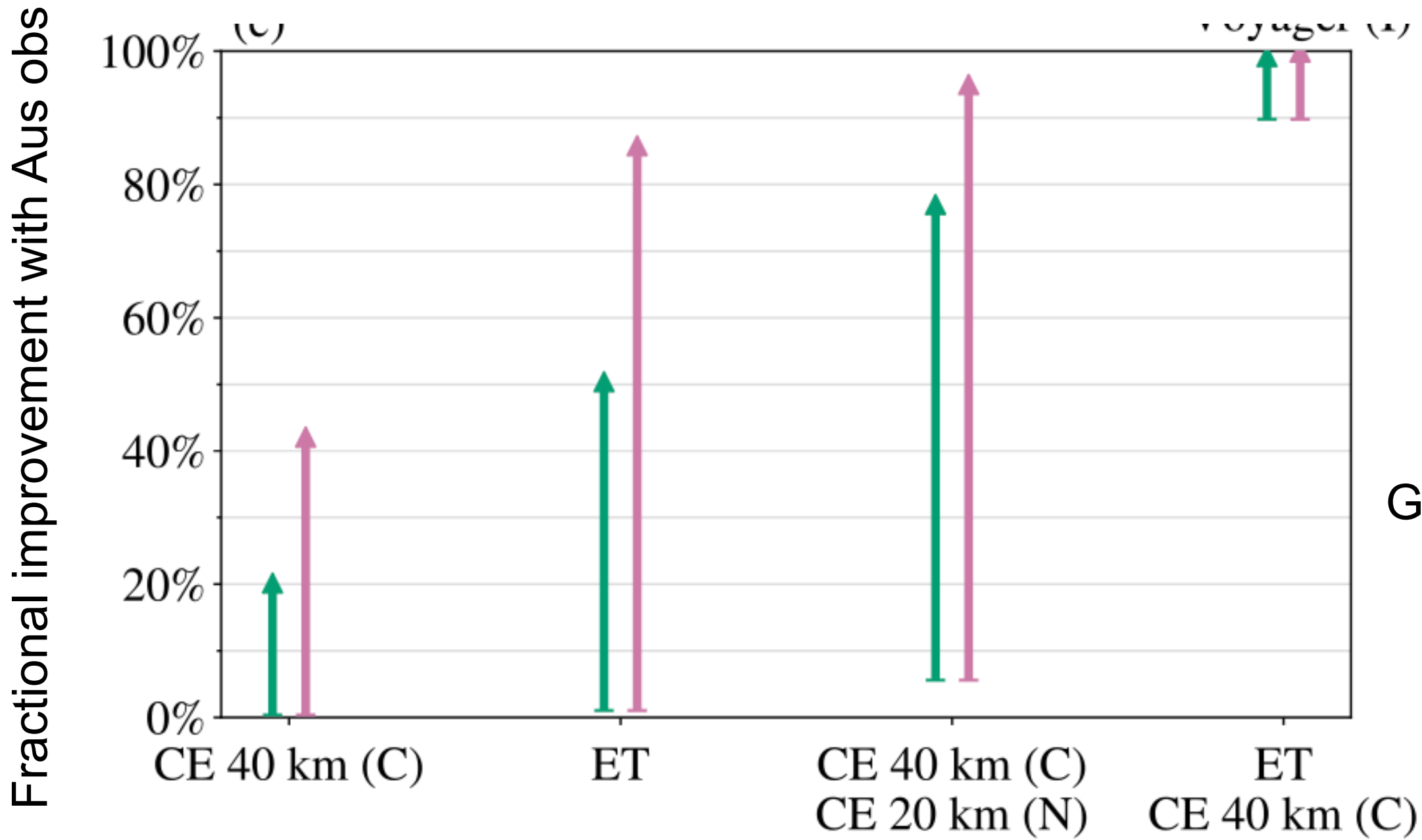
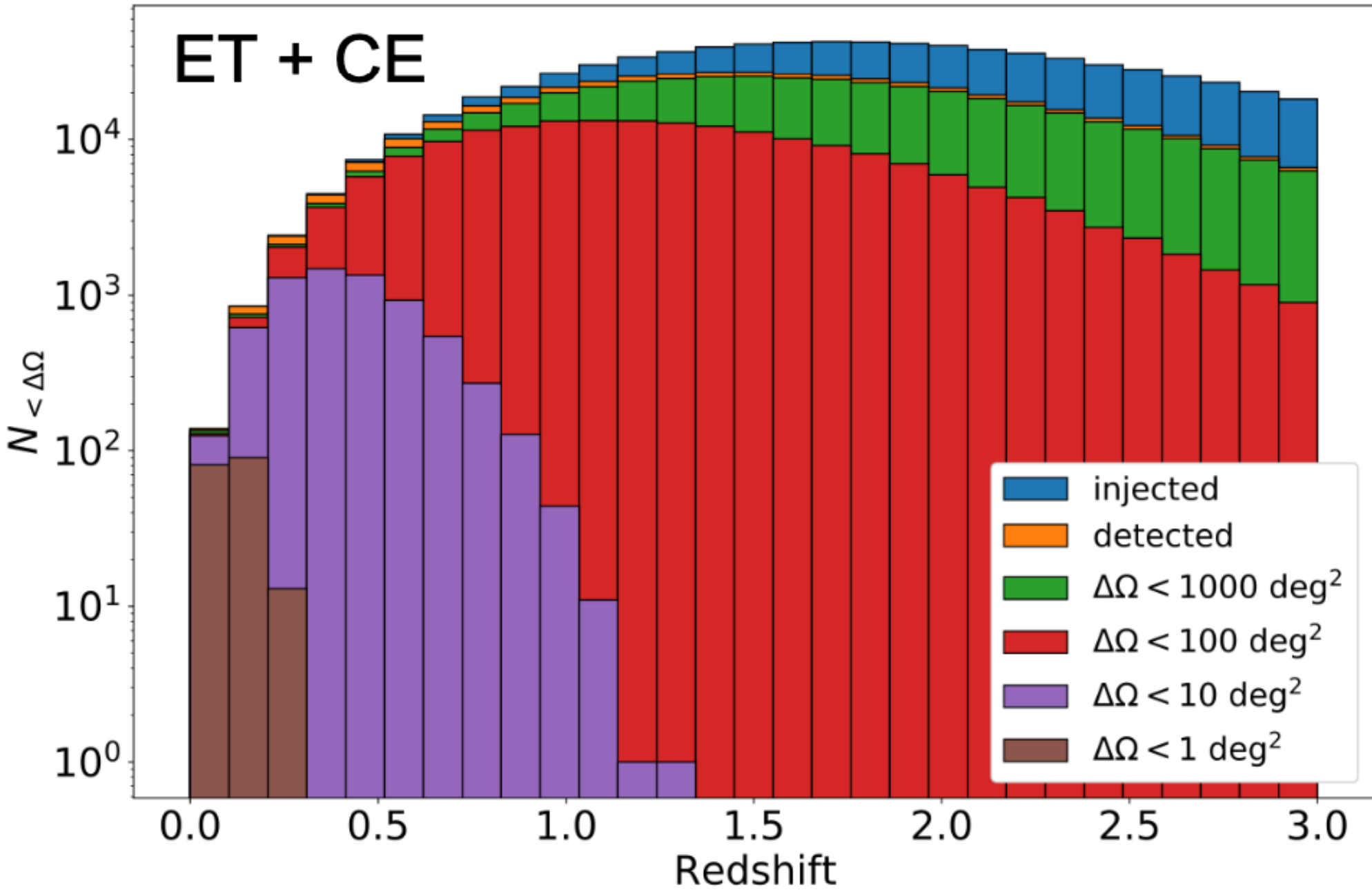
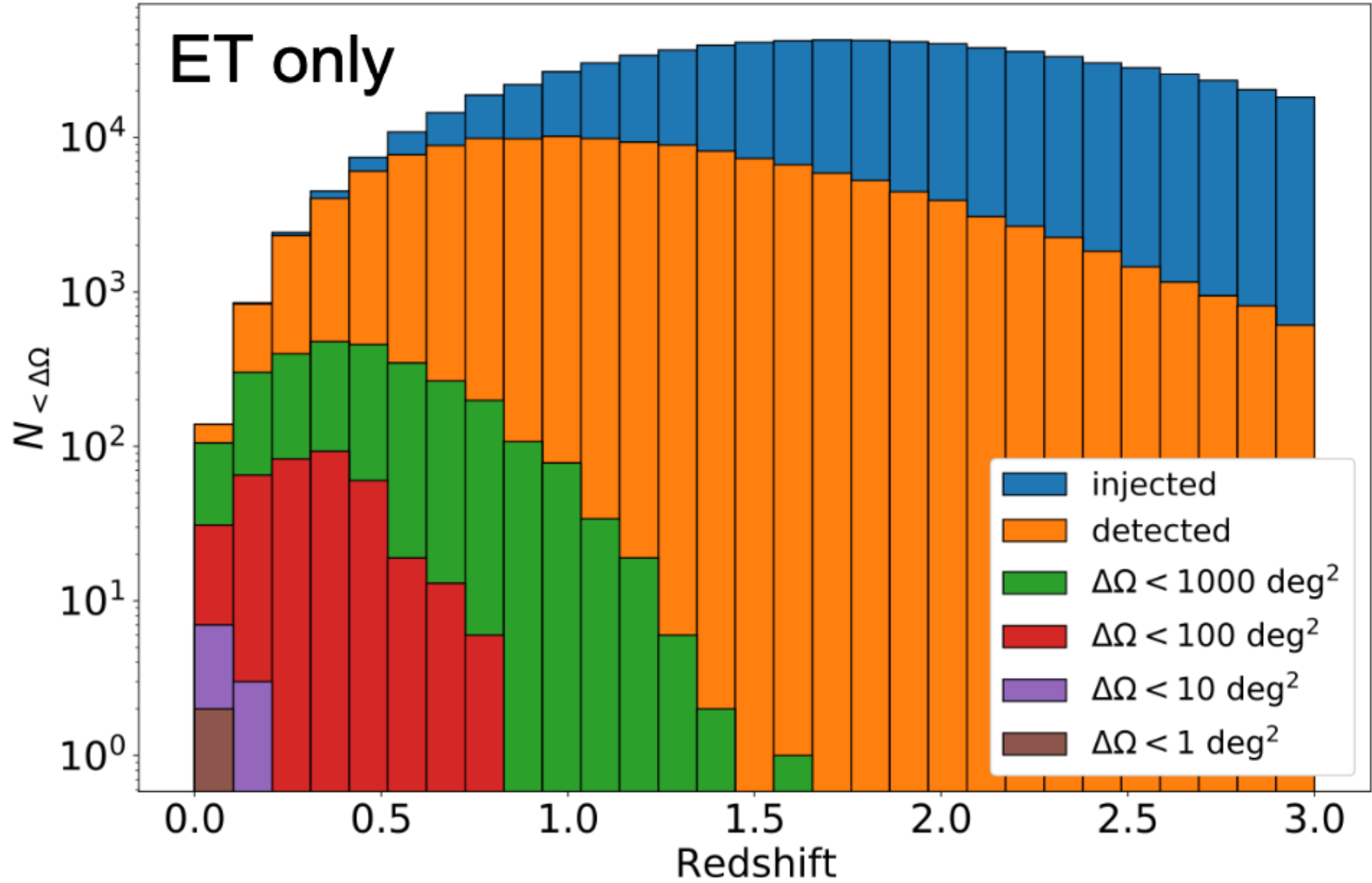








One year of operation!



Gardner, Sun, et al. 2023

Hambleton et al:
arXiv:2208.04499

Rubin:

~10 million alerts per night
lots of source confusion!



(WST = Rubin on steroids!)

Hambleton et al:
arXiv:2208.04499

Rubin:

~10 million alerts per night
lots of source confusion!



(WST = Rubin on steroids!)

- **Source localisation:**
 - Multimessenger astrophysics with neutron star binaries
 - Gamma-ray burst astrophysics, kilonovae, jet launching, black-hole formation, ...
 - Gravitational-wave cosmology/cosmography
 - Burst (SNe, magnetars, ...) source localisation

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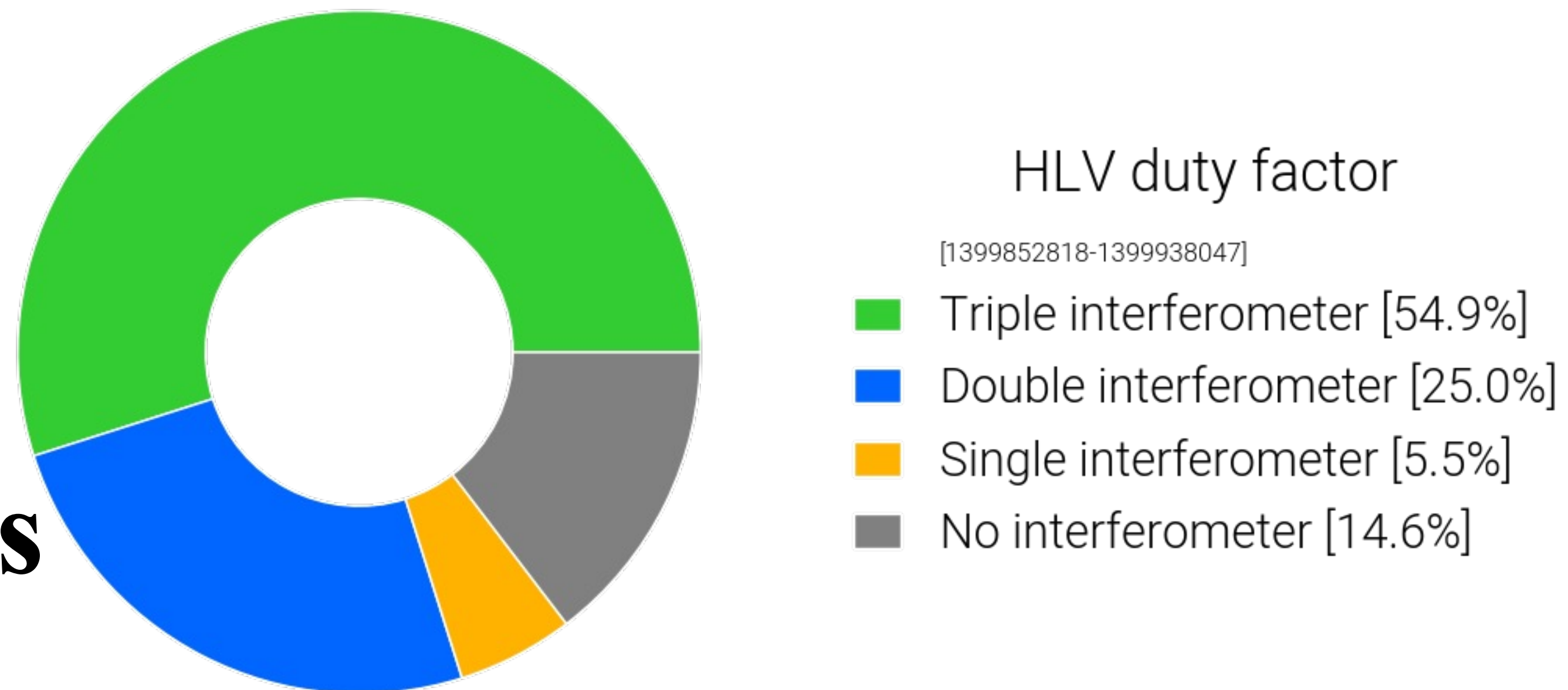
- **Polarisation tests of GR**

- **Sensitivity**

- **Duty cycle**

- **Risk mitigation**

- **R&D capabilities**



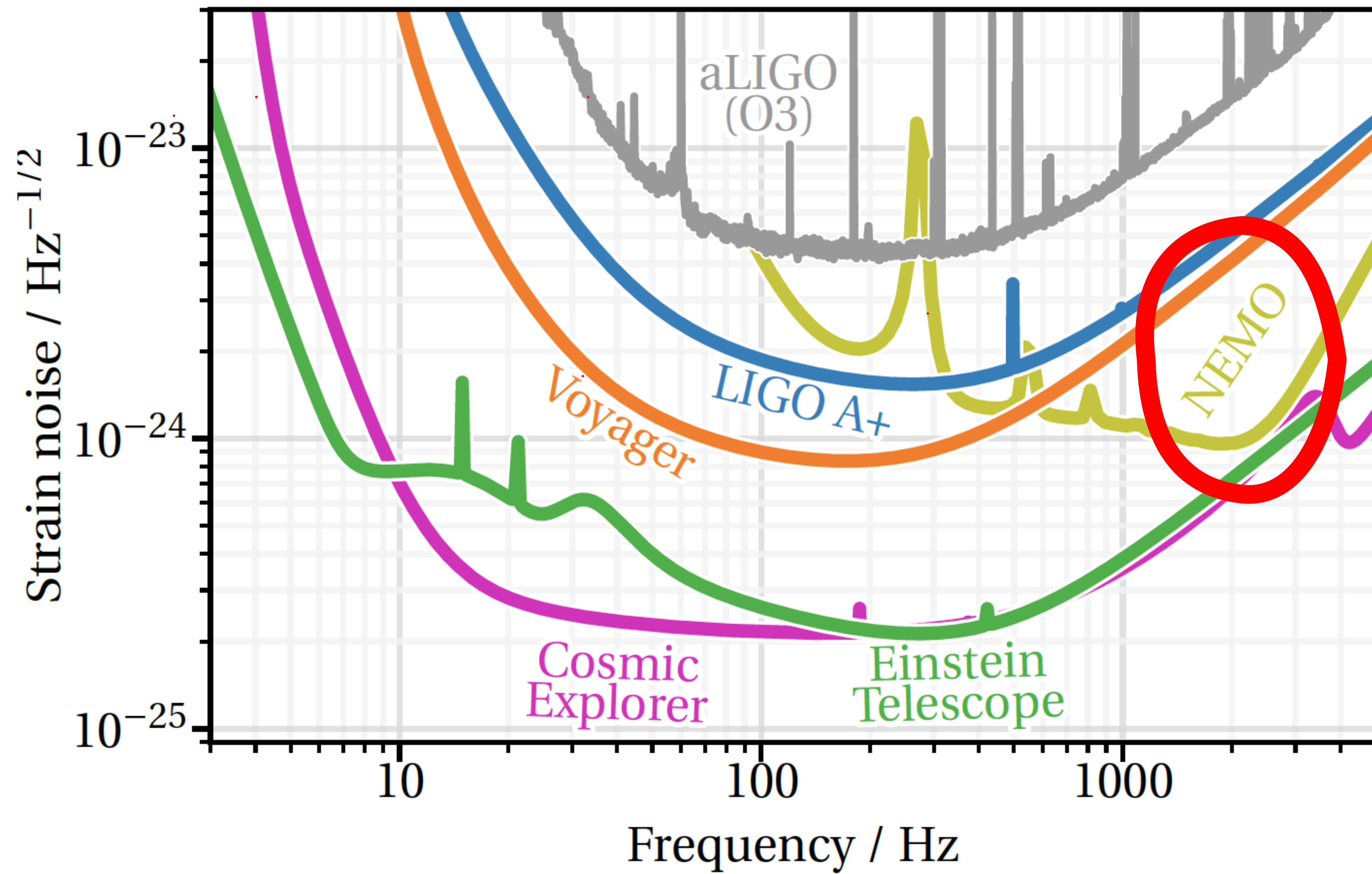
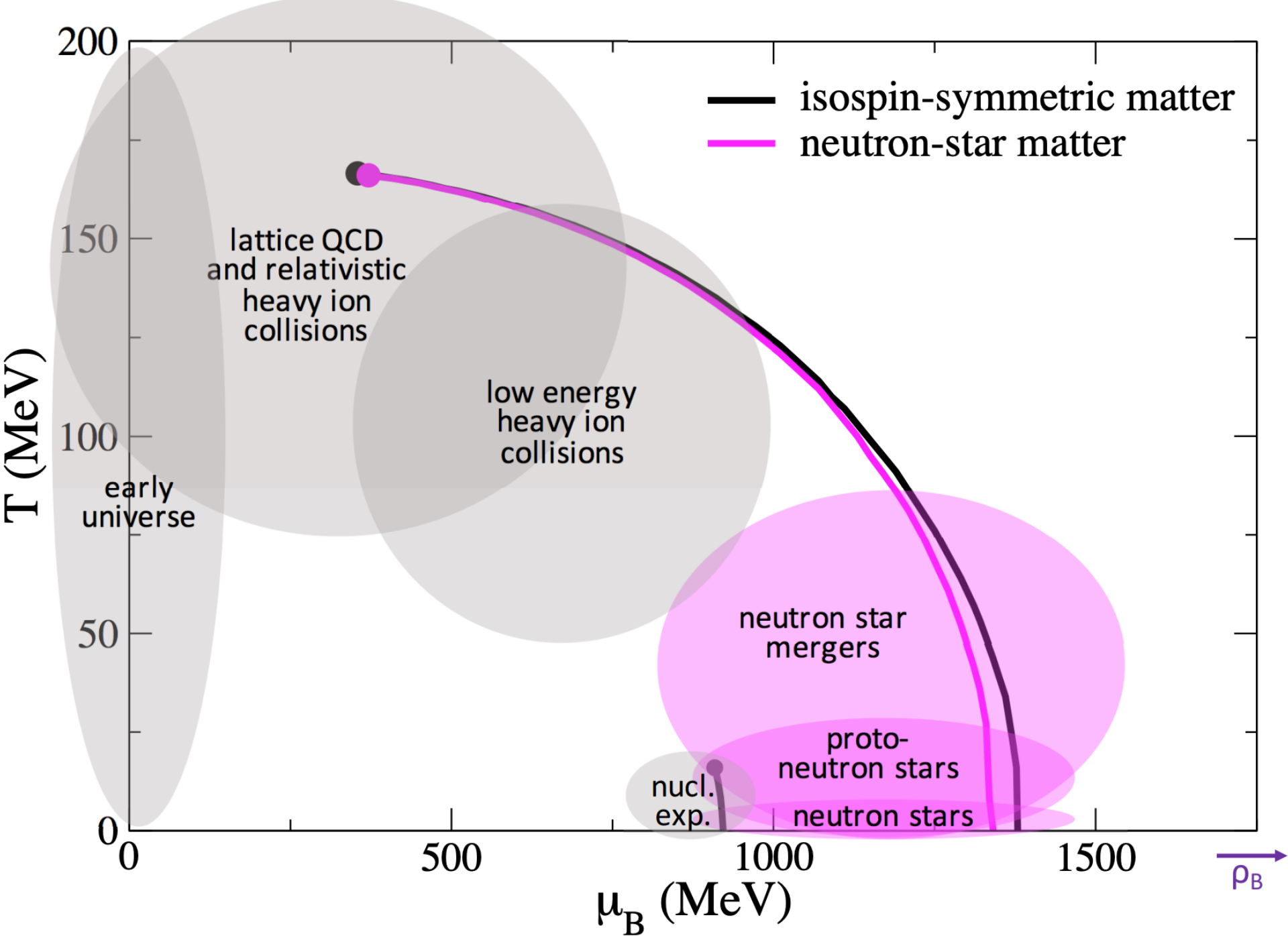
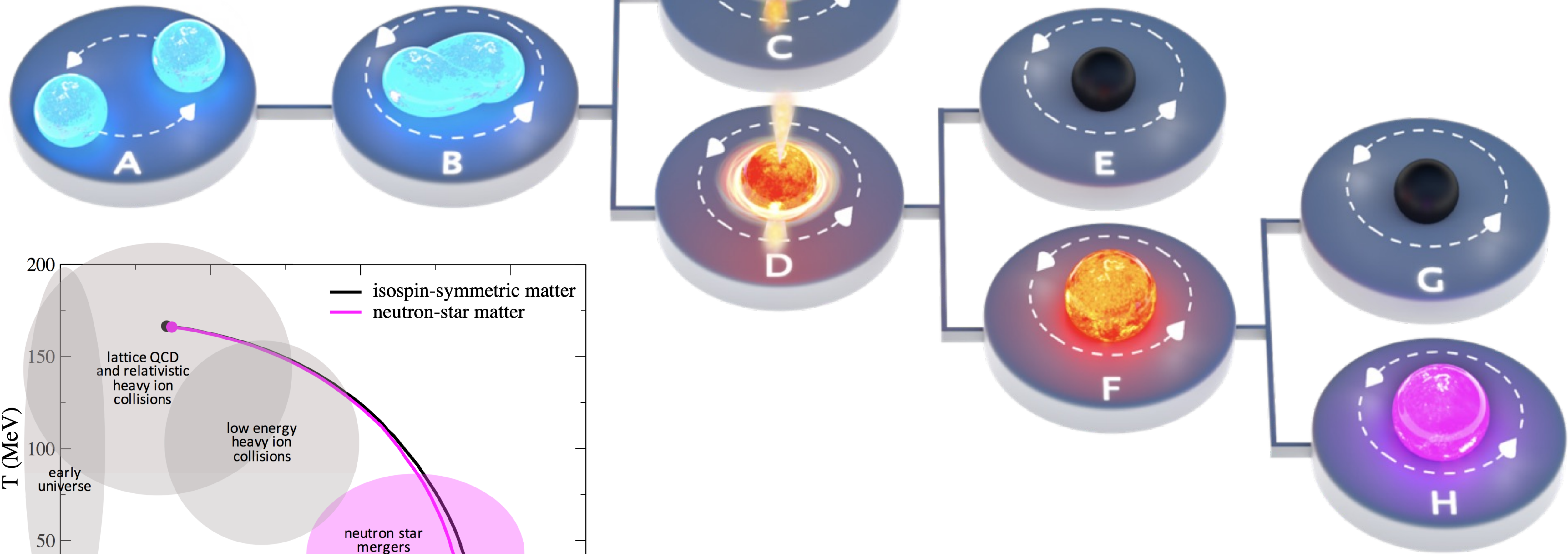


Image: Carl Knox
In Sarin & PL (2021)



Veronica Dexheimer

Science Case

- Binary neutron star mergers
- Supernovae (Jade's talk)
- Continuous Waves (Karl's talk)
- Burst sources (Jade's talk)
- Exotica



Where? Preliminary site-selection study

Bram Slagmolen & Daniel Toyra

Need to be delicate around indigenous land rights and relationships

- 20 km sites
- < 200 km from town of > 20k
- < 140 km from airport
- > 50 km from ocean
- < 1 M cubic meter Earth moving

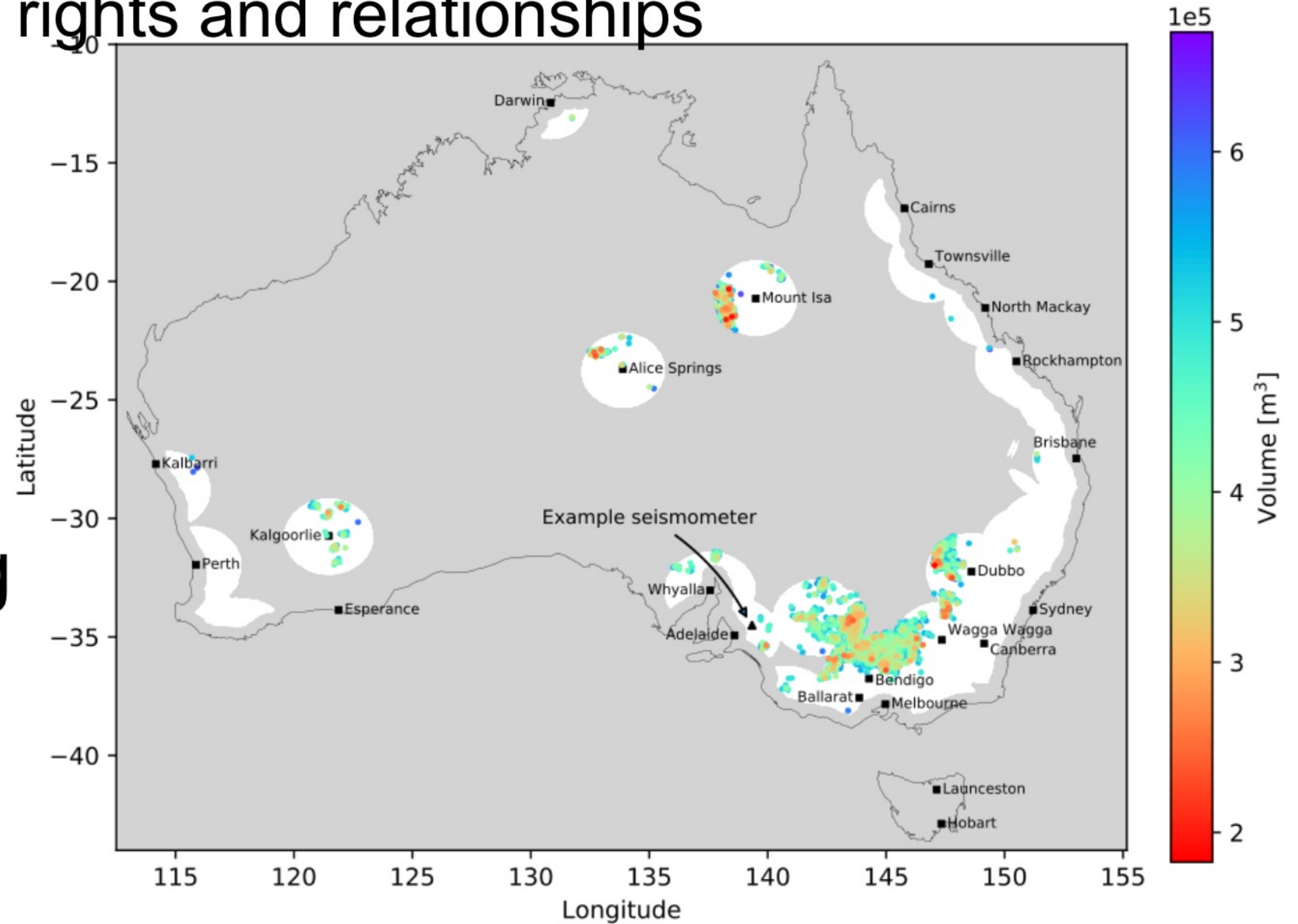


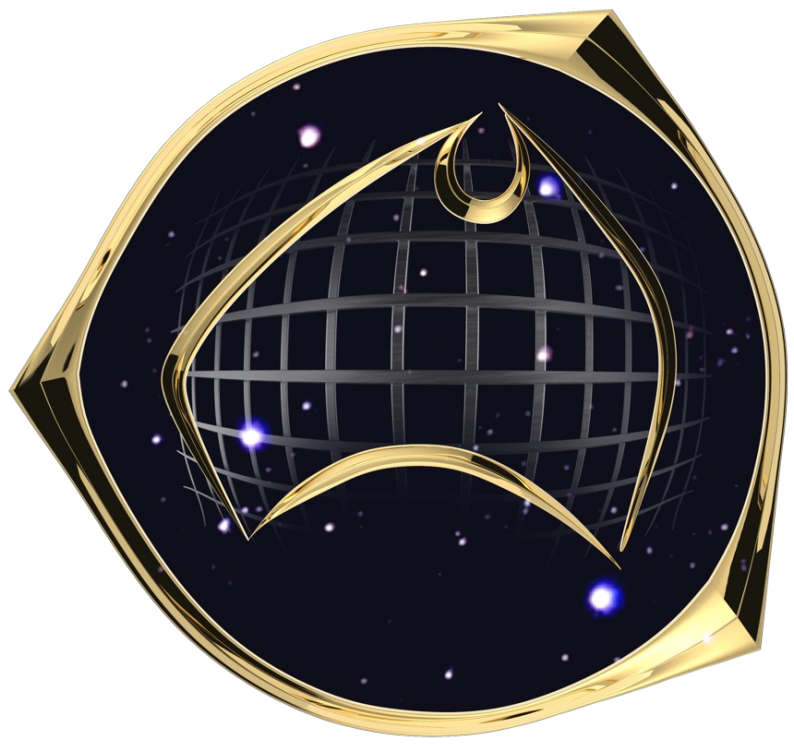
> 3M sites! (2096 shown)

Remove sites within
5km of better site



1062

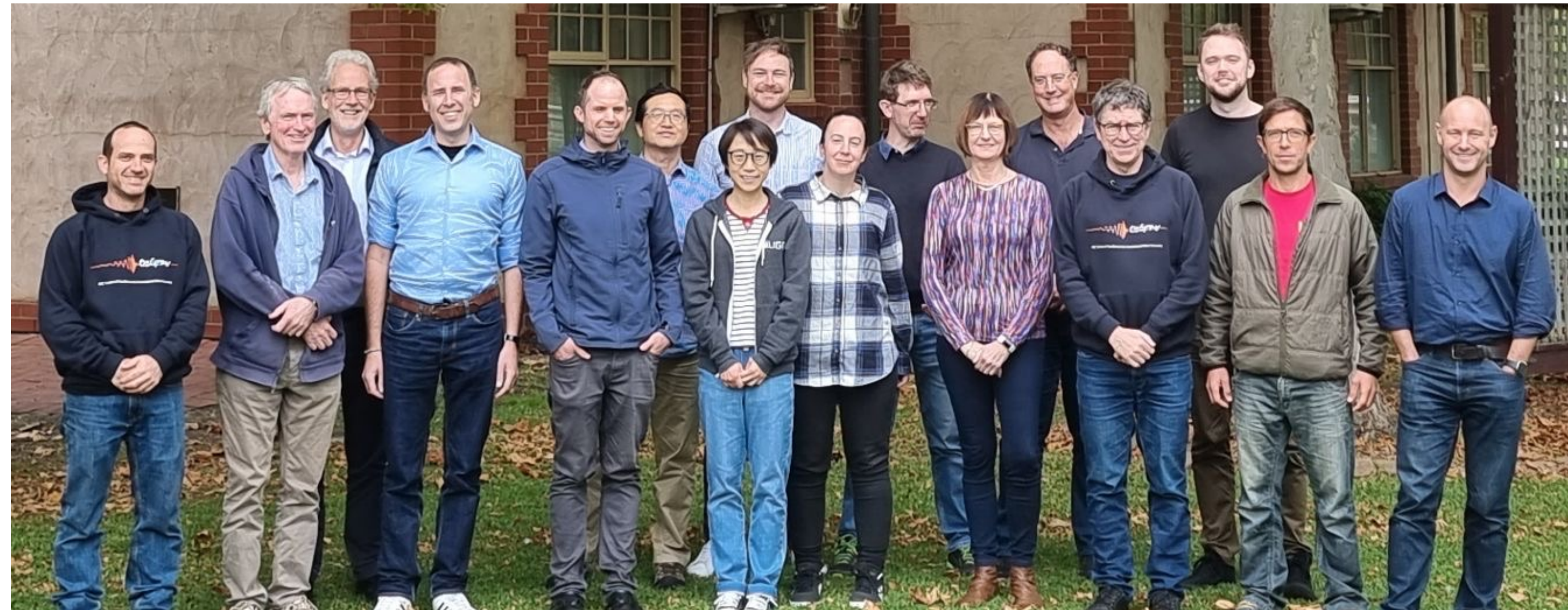


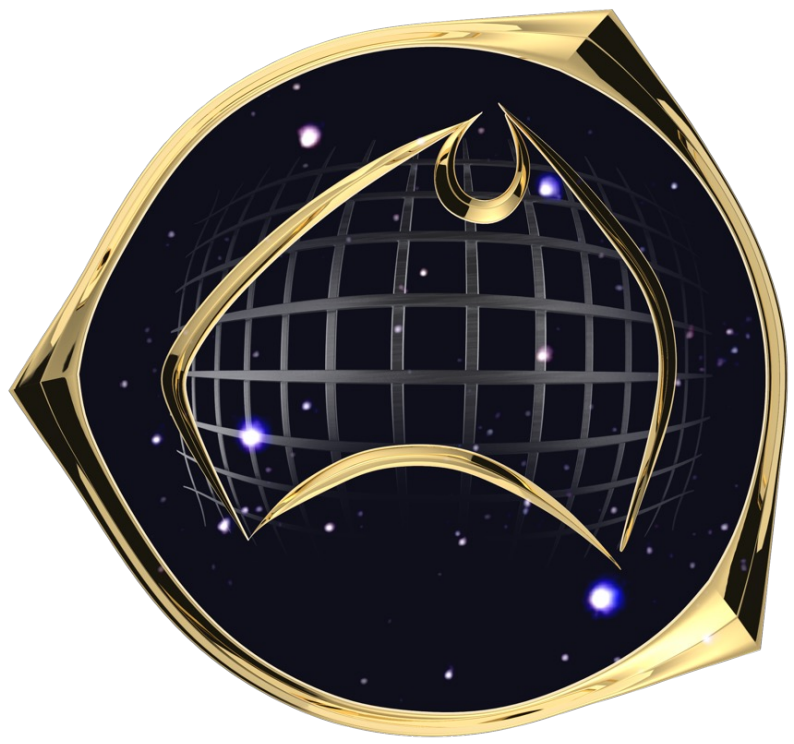


Australian Gravitational Wave Observatory Project

- Develop a Project Office with executive structure and oversight to manage and develop an Australian Gravitational-Wave Observatory project.
- Establish community that speaks with one voice to stakeholders including government, industry, fellow scientists, and international partners.

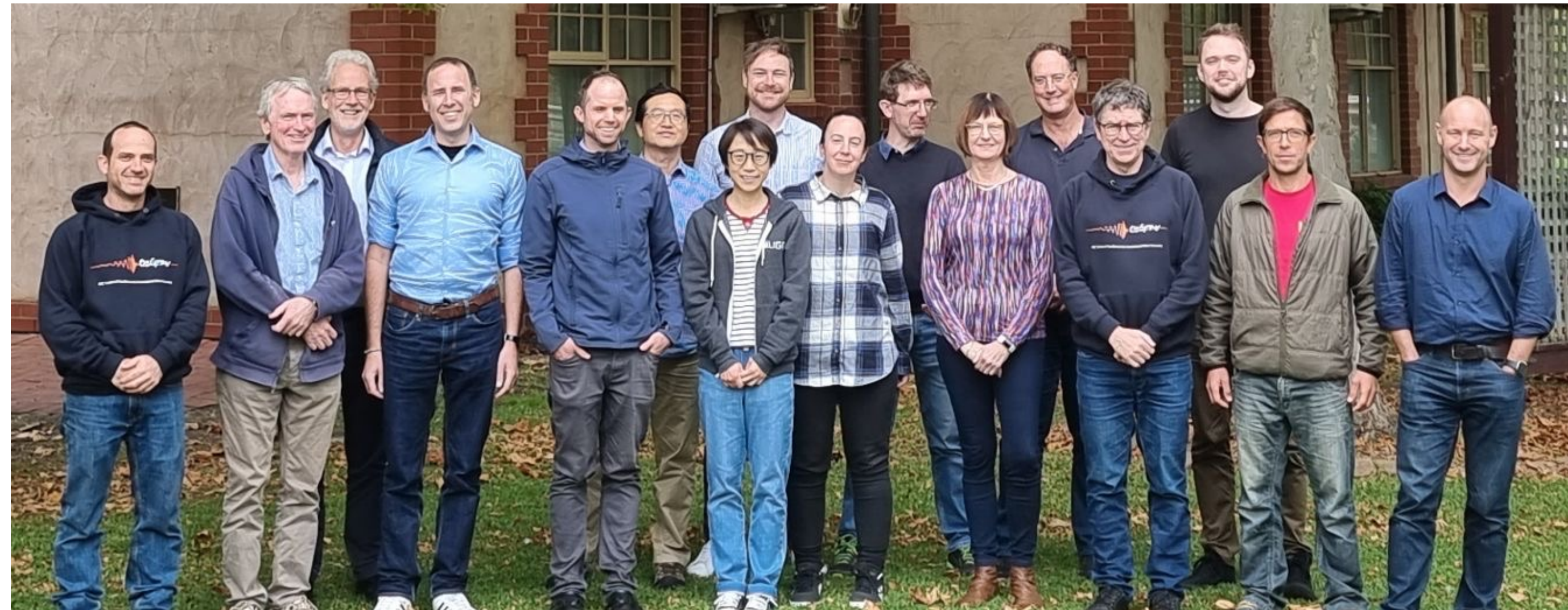
Paul Lasky (Chair), Yeshe Fenner, Ju Li,
David McClelland, David Ottaway

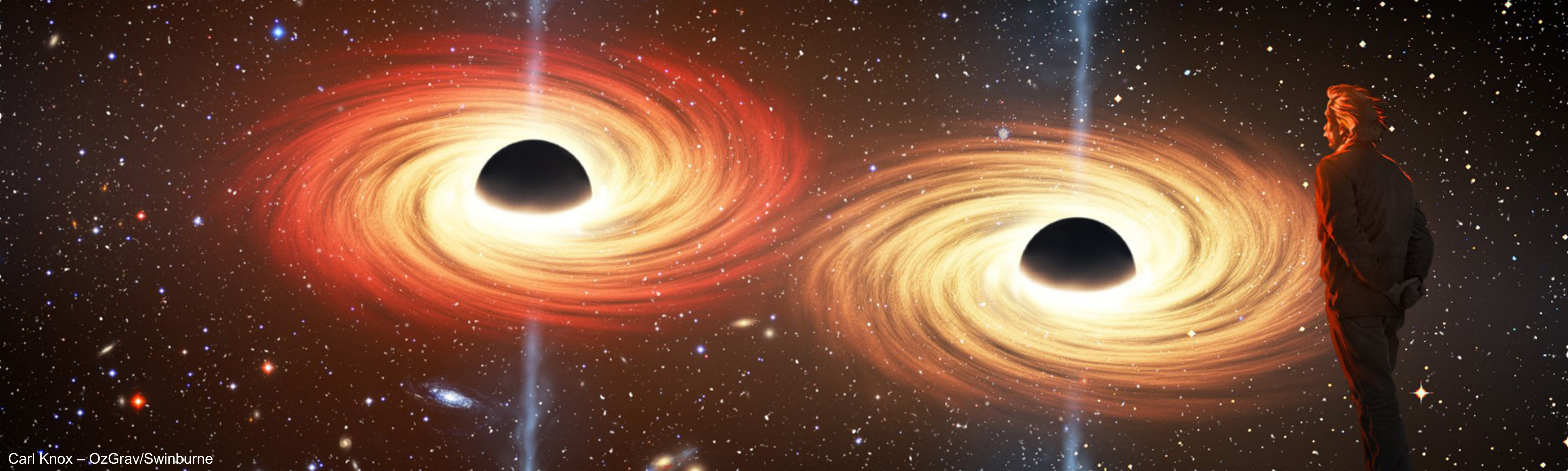




Australian Gravitational Wave Observatory Project

- Options:
 - NEMO?
 - A#-10km in Oz?
 - CE South?
 -
Paul Lasky (Chair), Yeshe Fenner, Ju Li,
David McClelland, David Ottaway

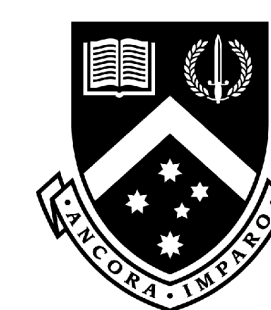




Carl Knox – OzGrav/Swinburne

Towards an Australian gravitational-wave observatory

Paul Lasky



MONASH
University

Image: Carl Knox
in Sarin & PL (2021)

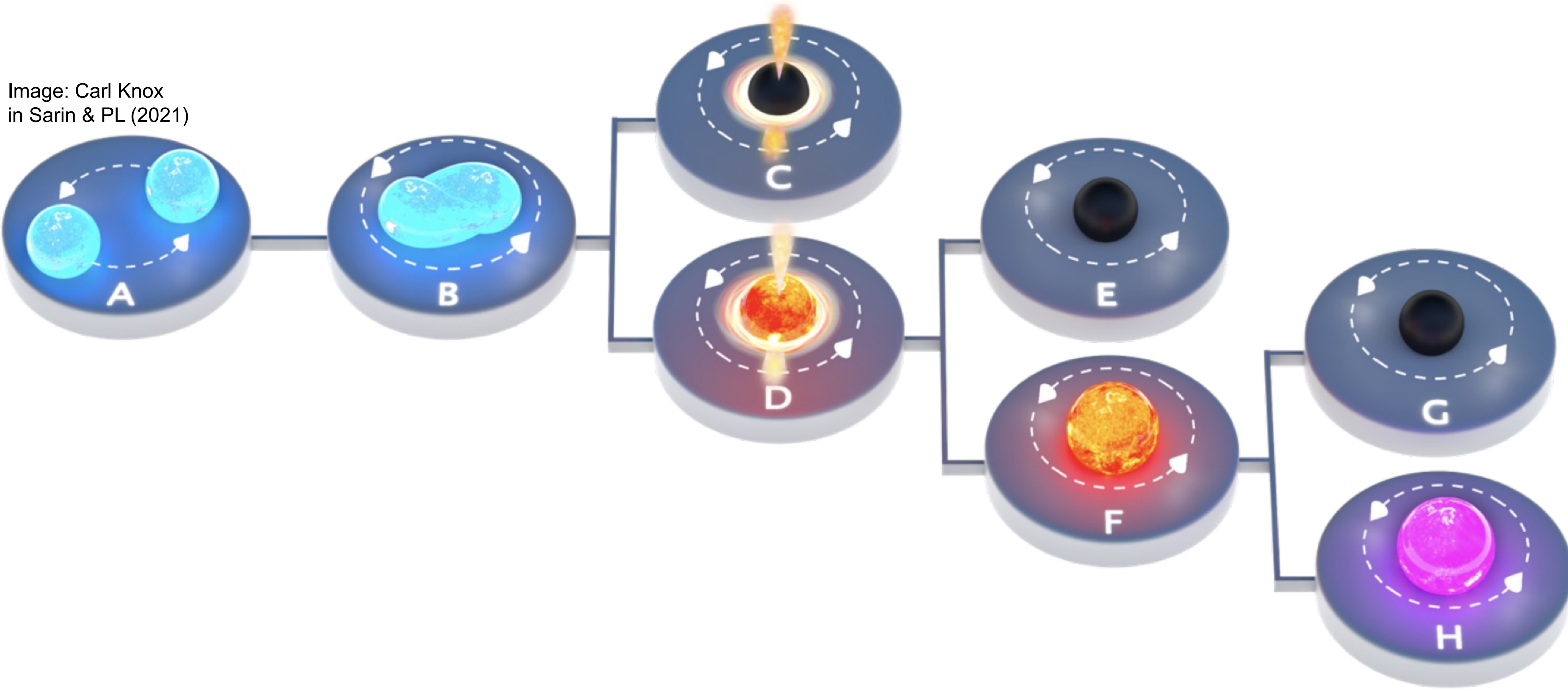


Image: Carl Knox
in Sarin & PL (2021)

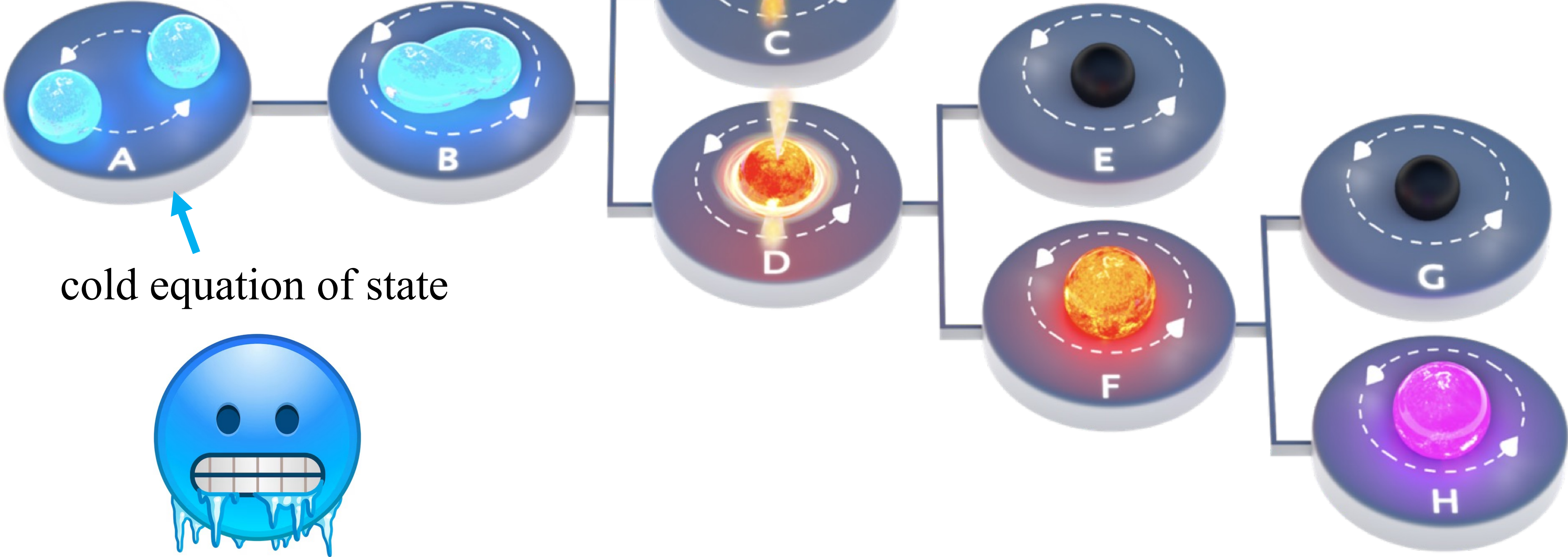


Image: Carl Knox
in Sarin & PL (2021)

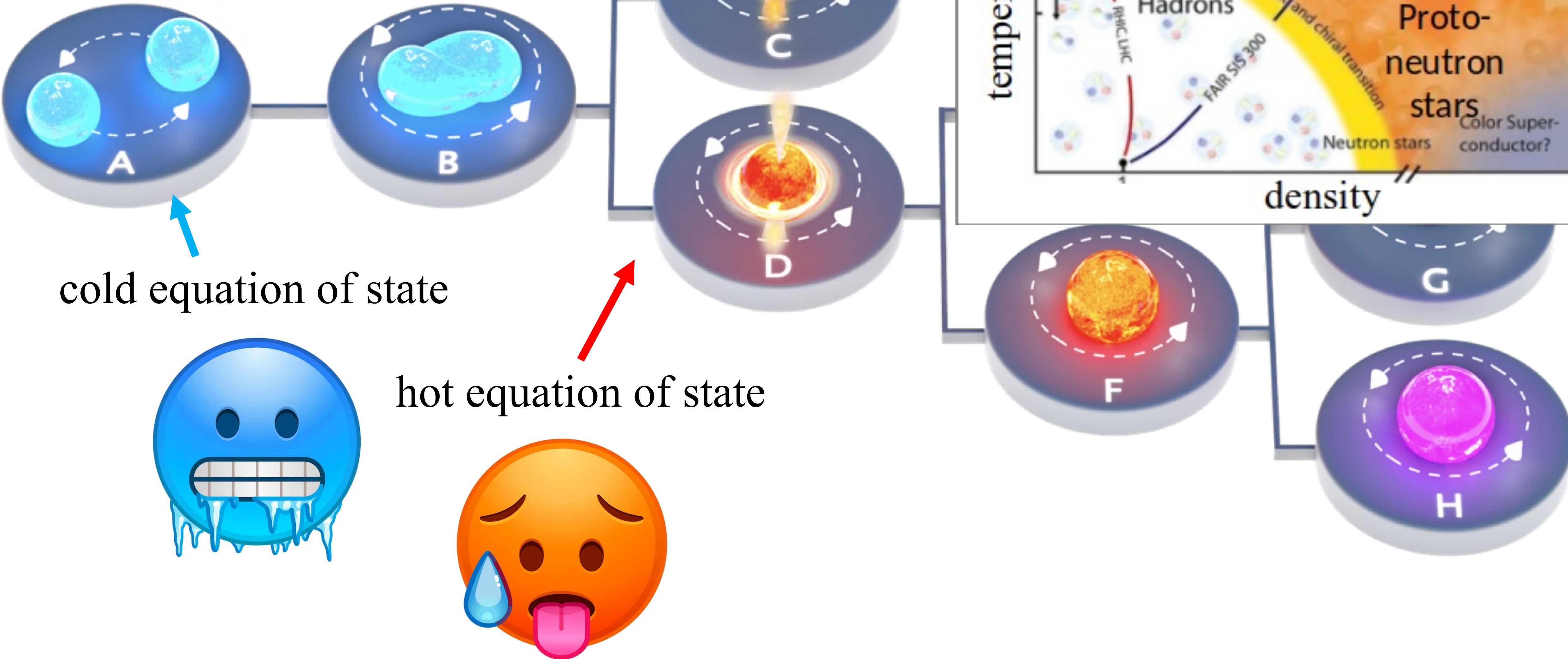
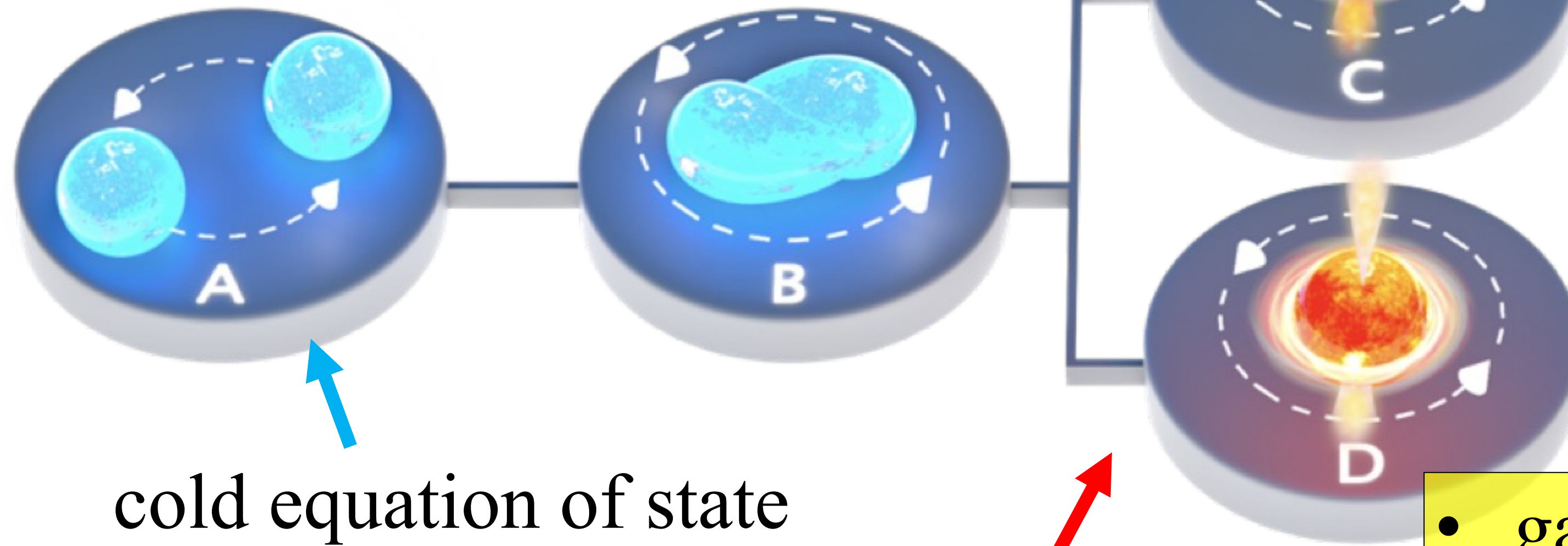


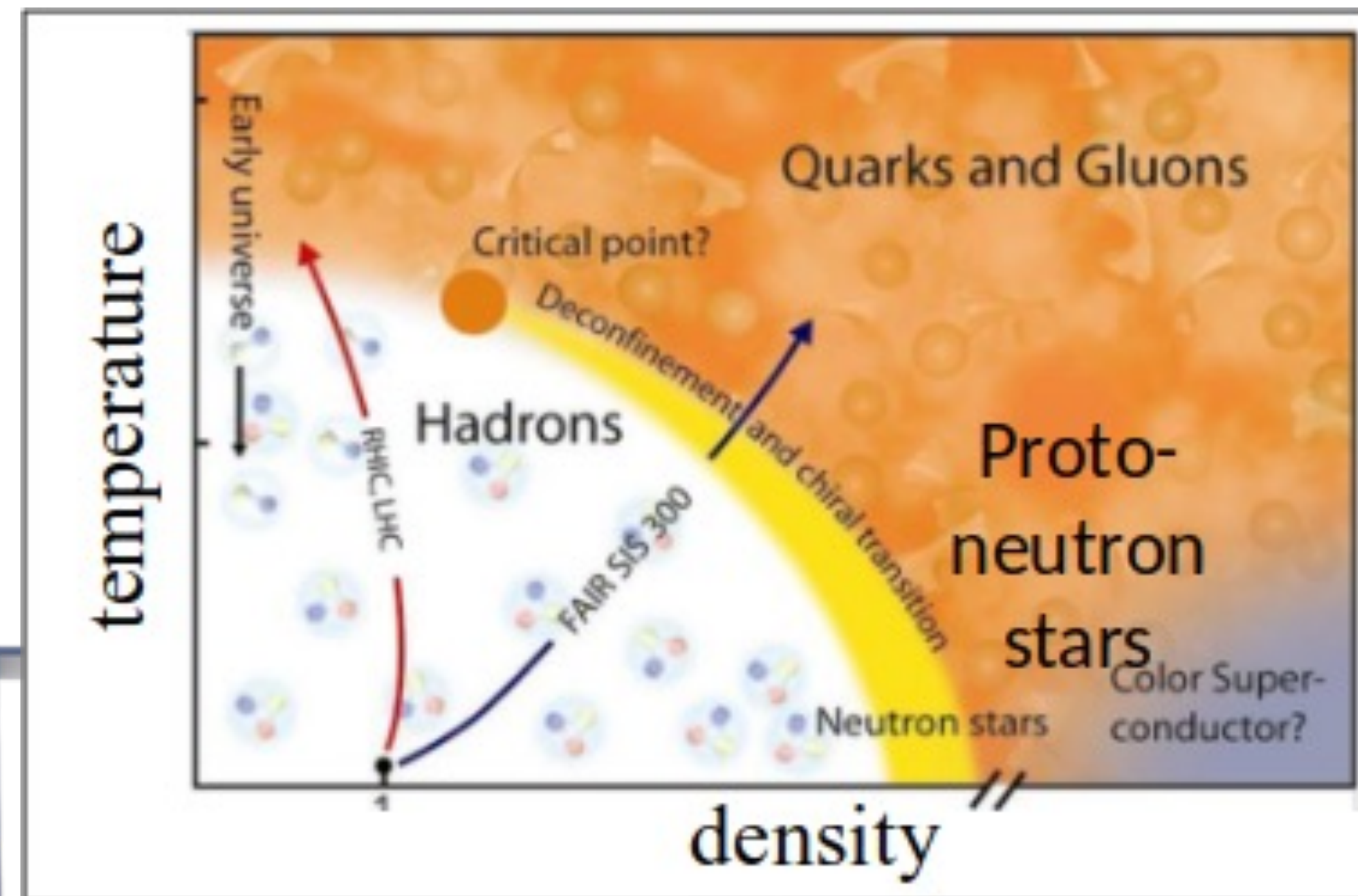
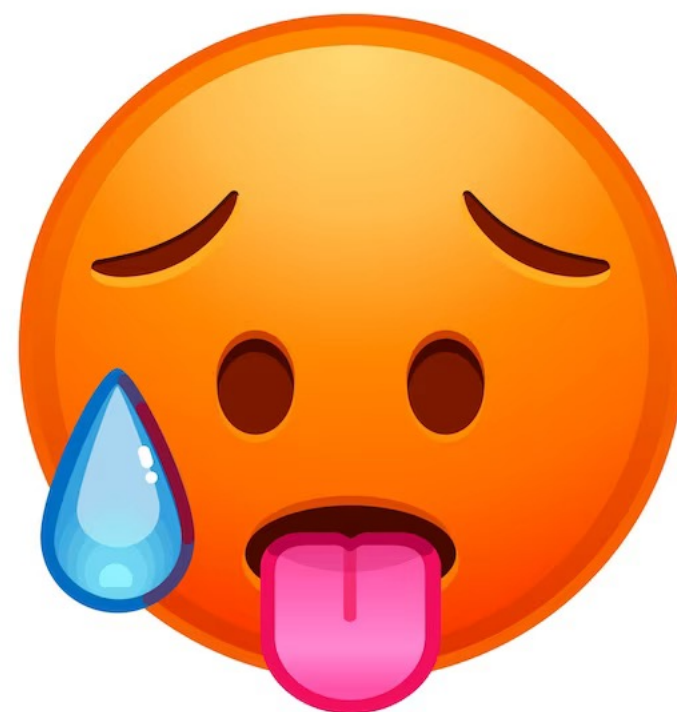
Image: Carl Knox
in Sarin & PL (2021)



cold equation of state



hot equation of state



- gamma-ray burst physics
- jet-launching,
- Black-hole formation
- Heavy-element nucleosynthesis
- Interstellar medium and extragalactic physics
- Cosmology!



Carl Knox – OzGrav/Swinburne

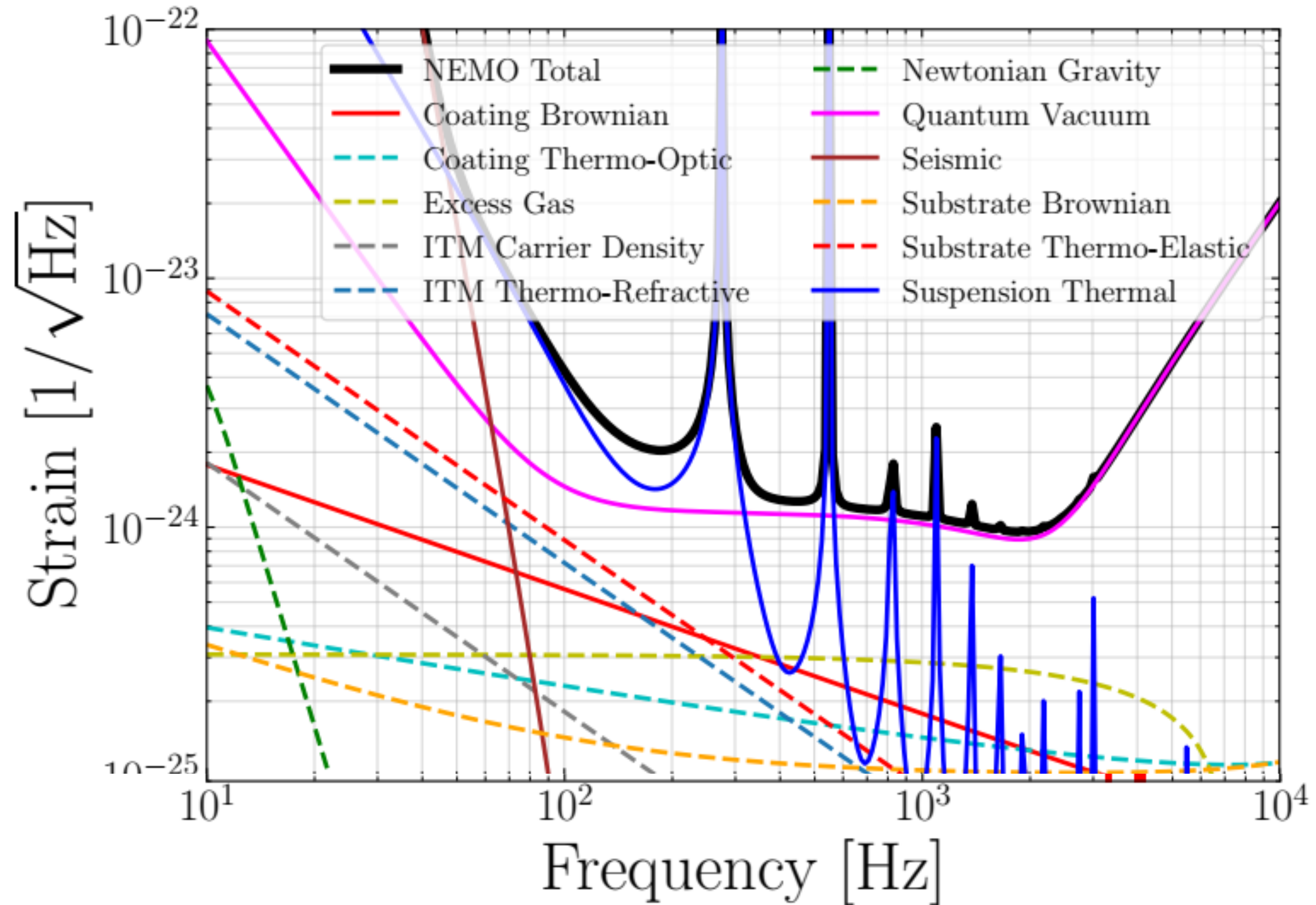
What's next in gravitational-wave astronomy?

Paul Lasky



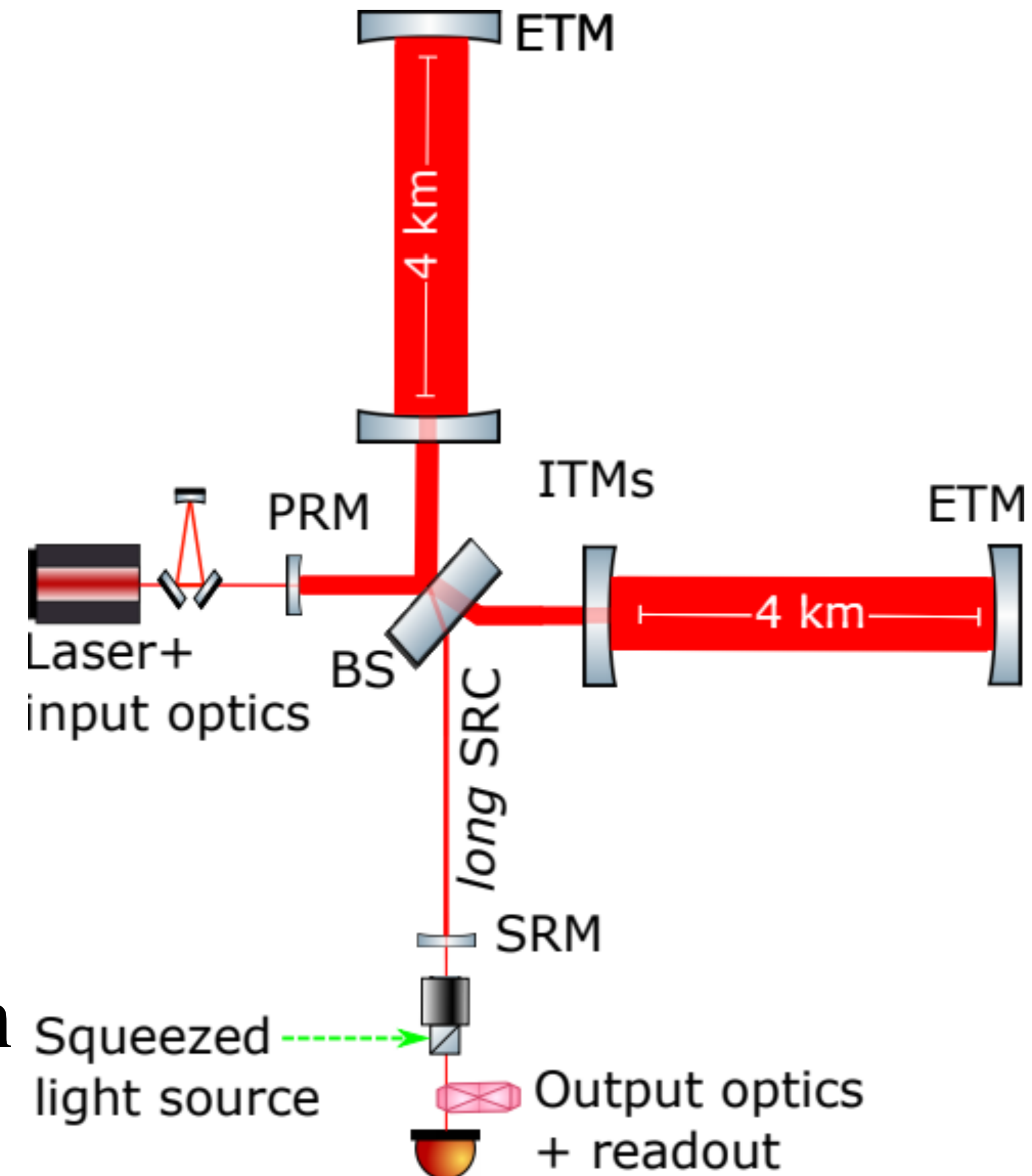
MONASH
University

NEMO: preliminary design

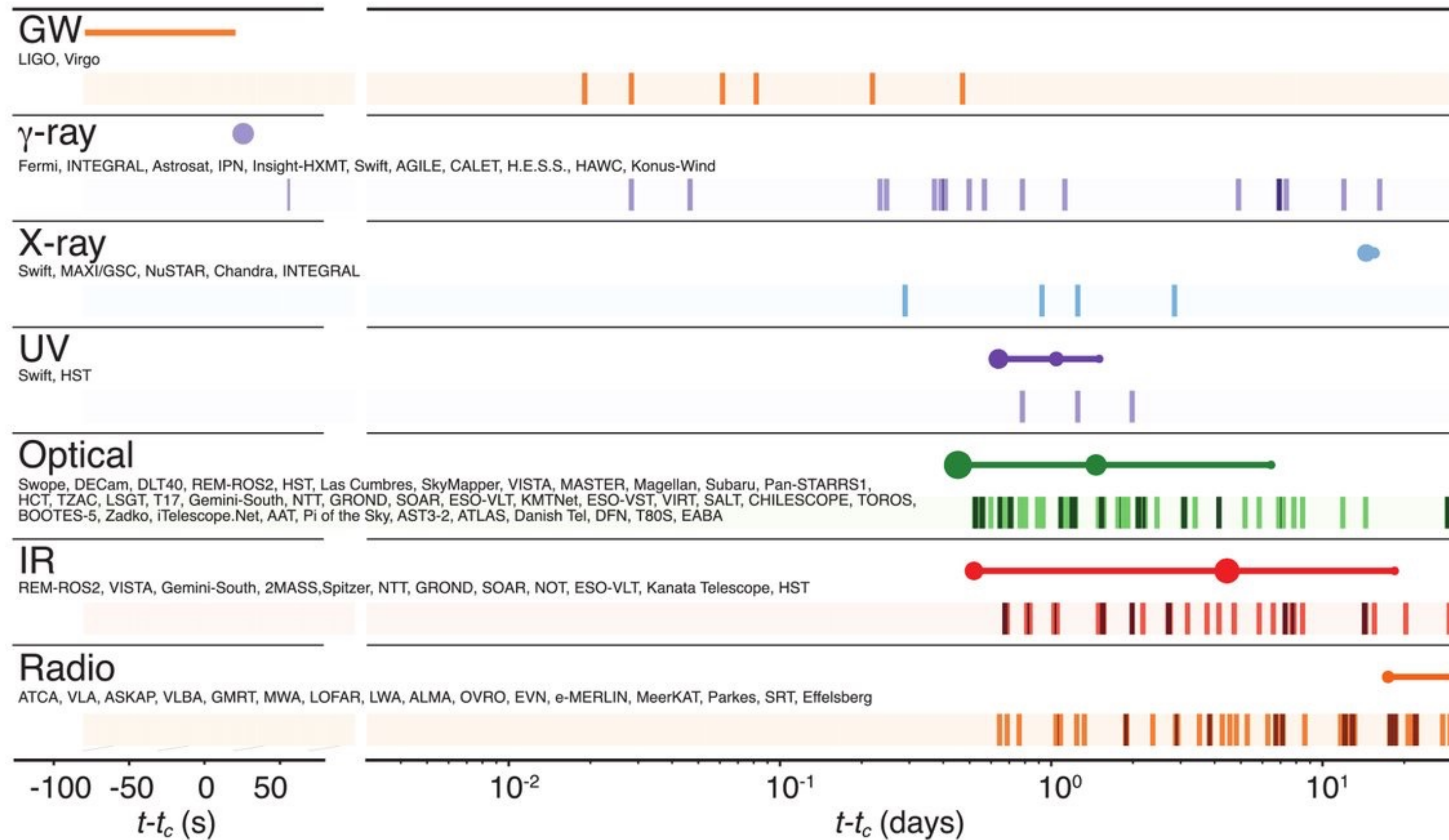


NEMO: preliminary design

- 4km arms
- 74 kg Silicon test masses
- Cooling: 123K
- 2 micron wavelength
- 500 W input power
- 4.5 MW in arms
- 7 dB Squeezing
- Suspension: steel
- **Neglect low frequency isolation**

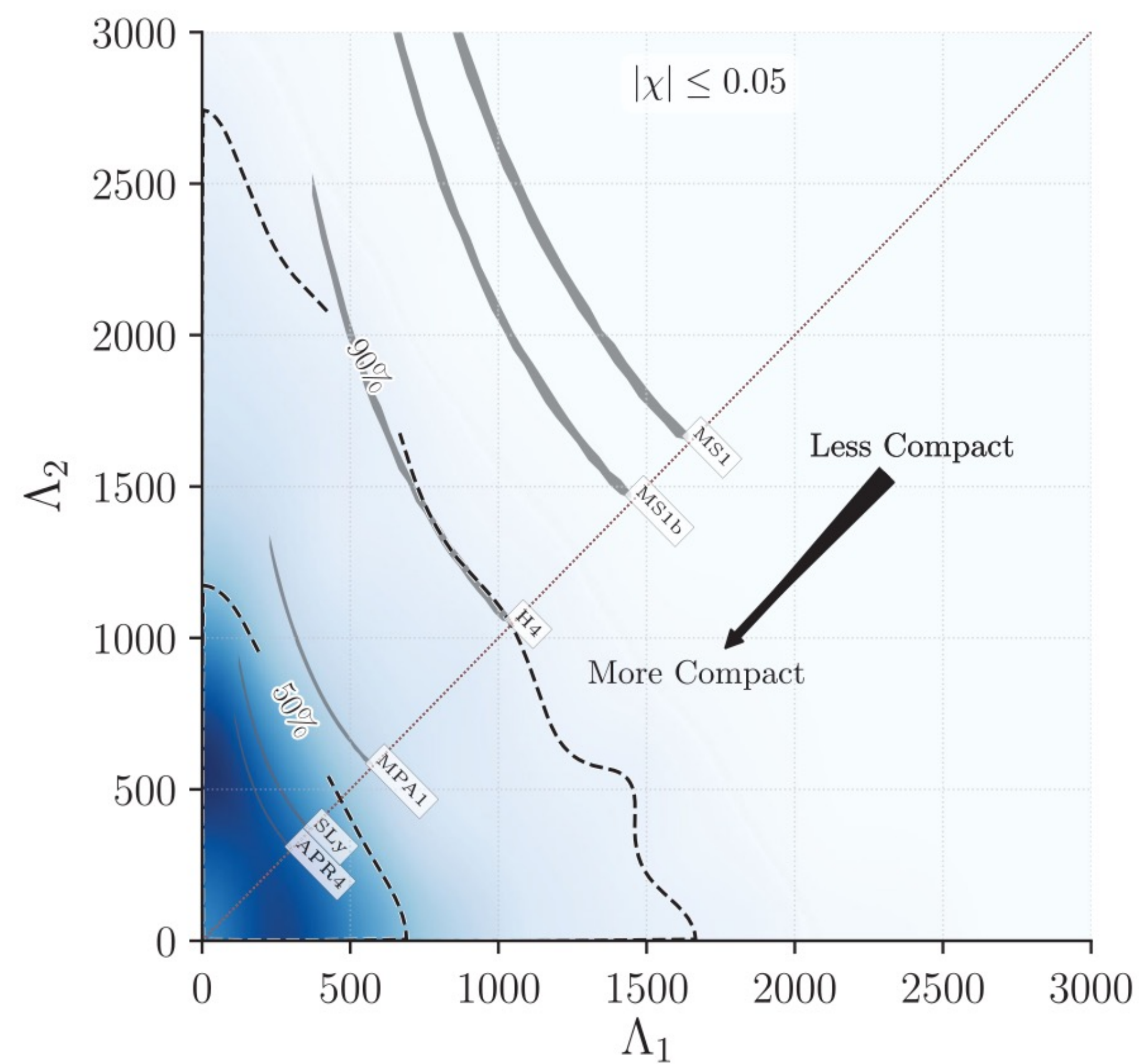
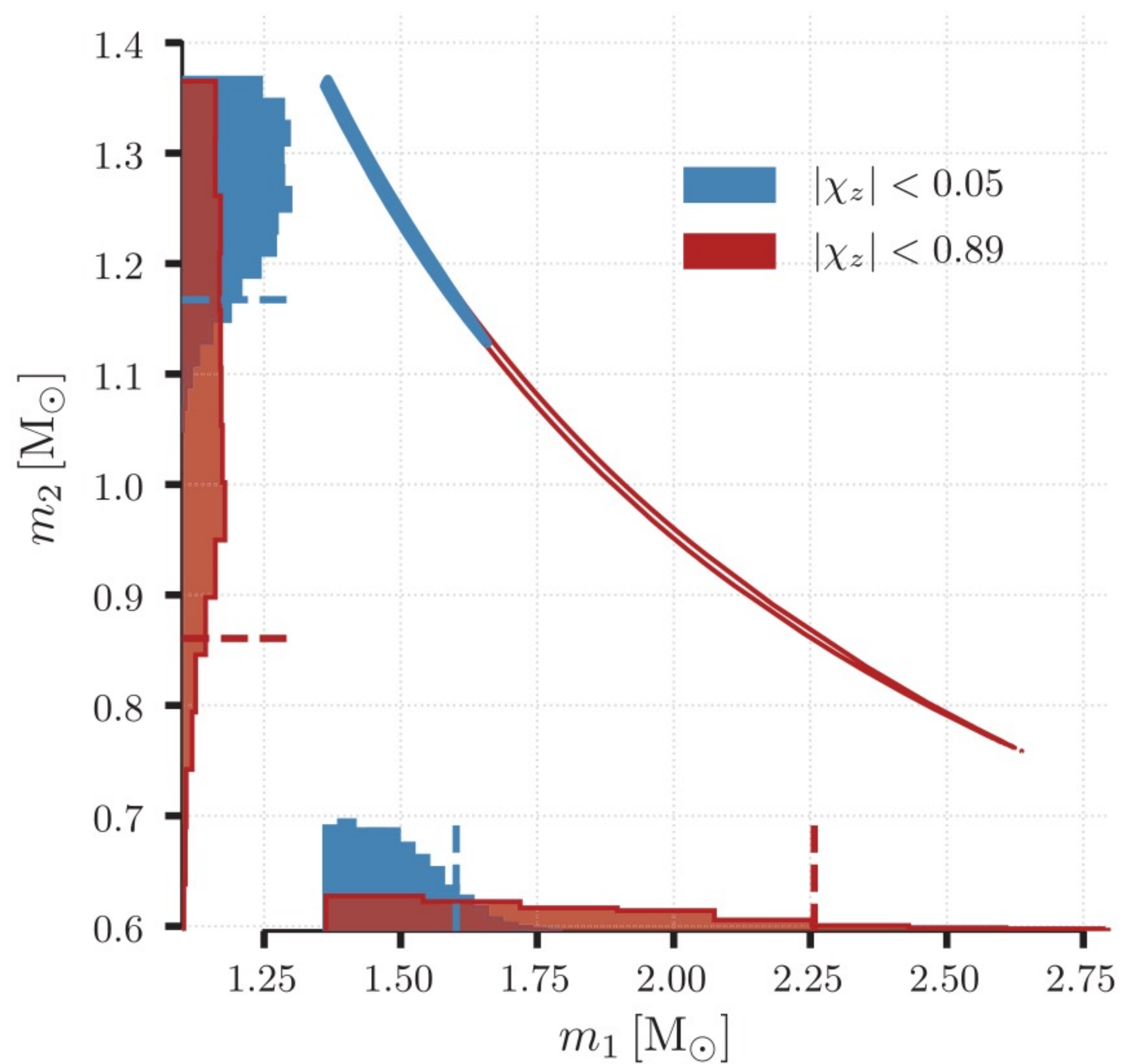
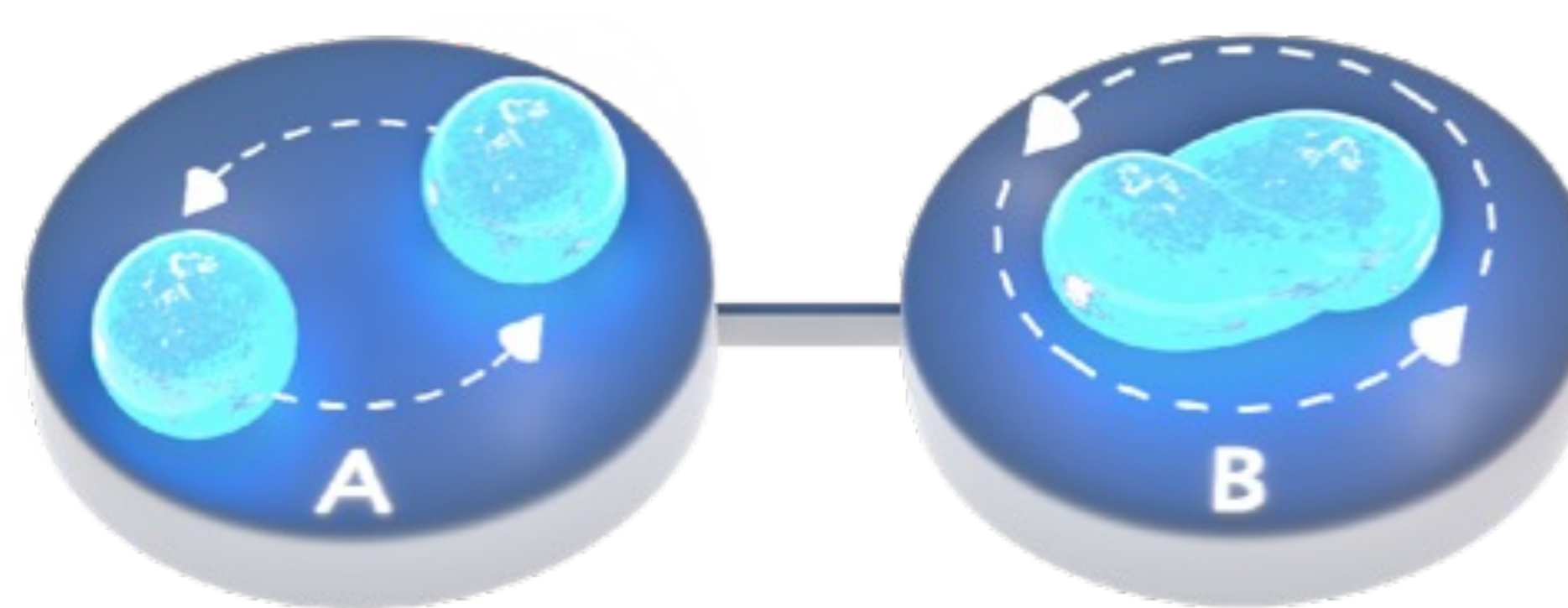
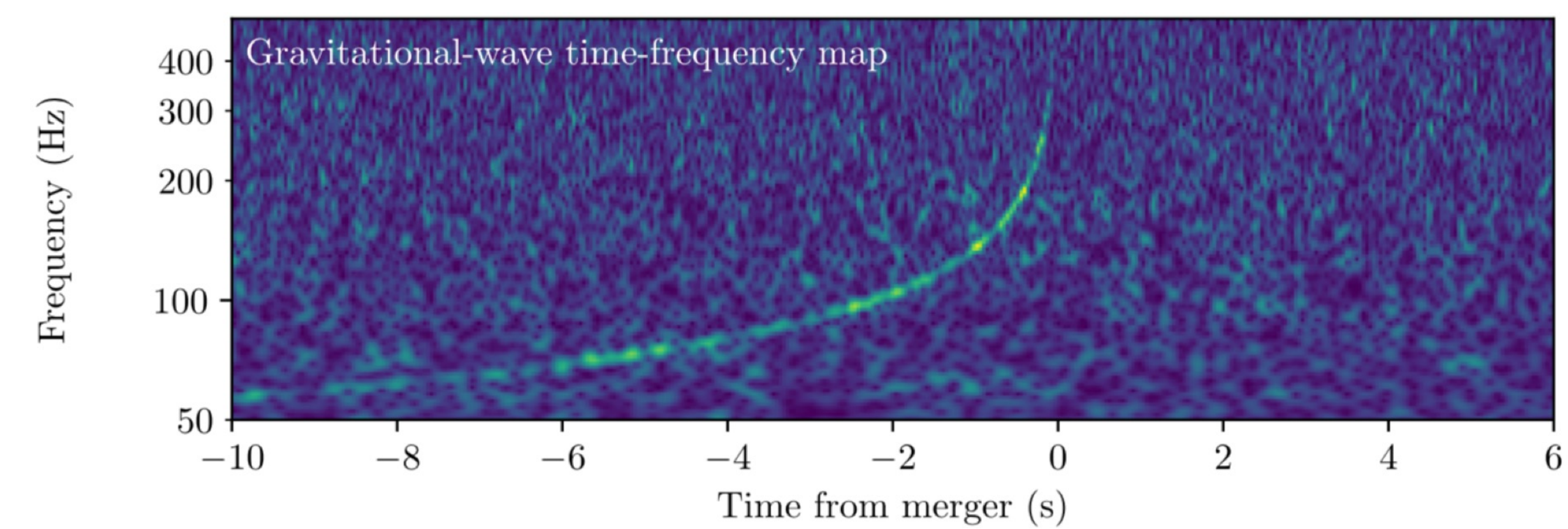


most studied astronomical event ever



Huge Australian Involvement

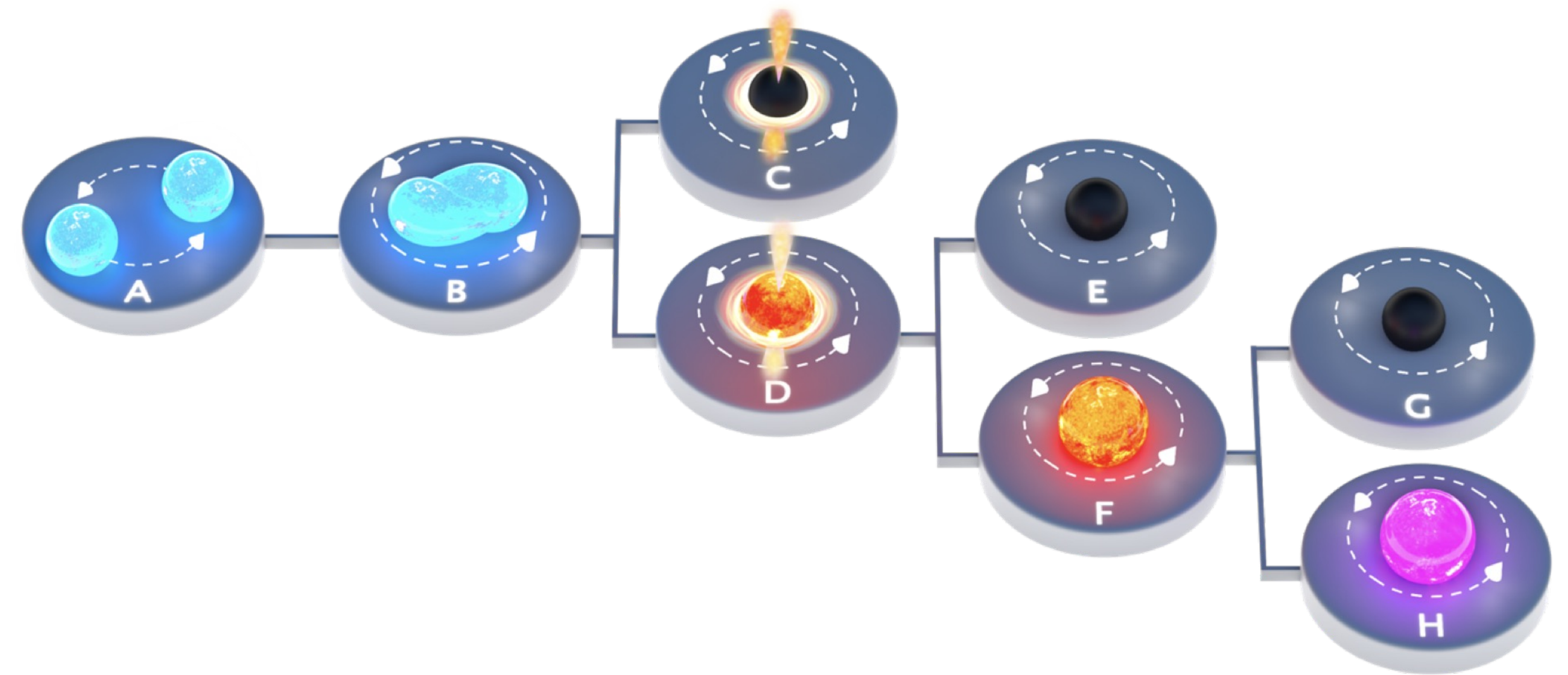
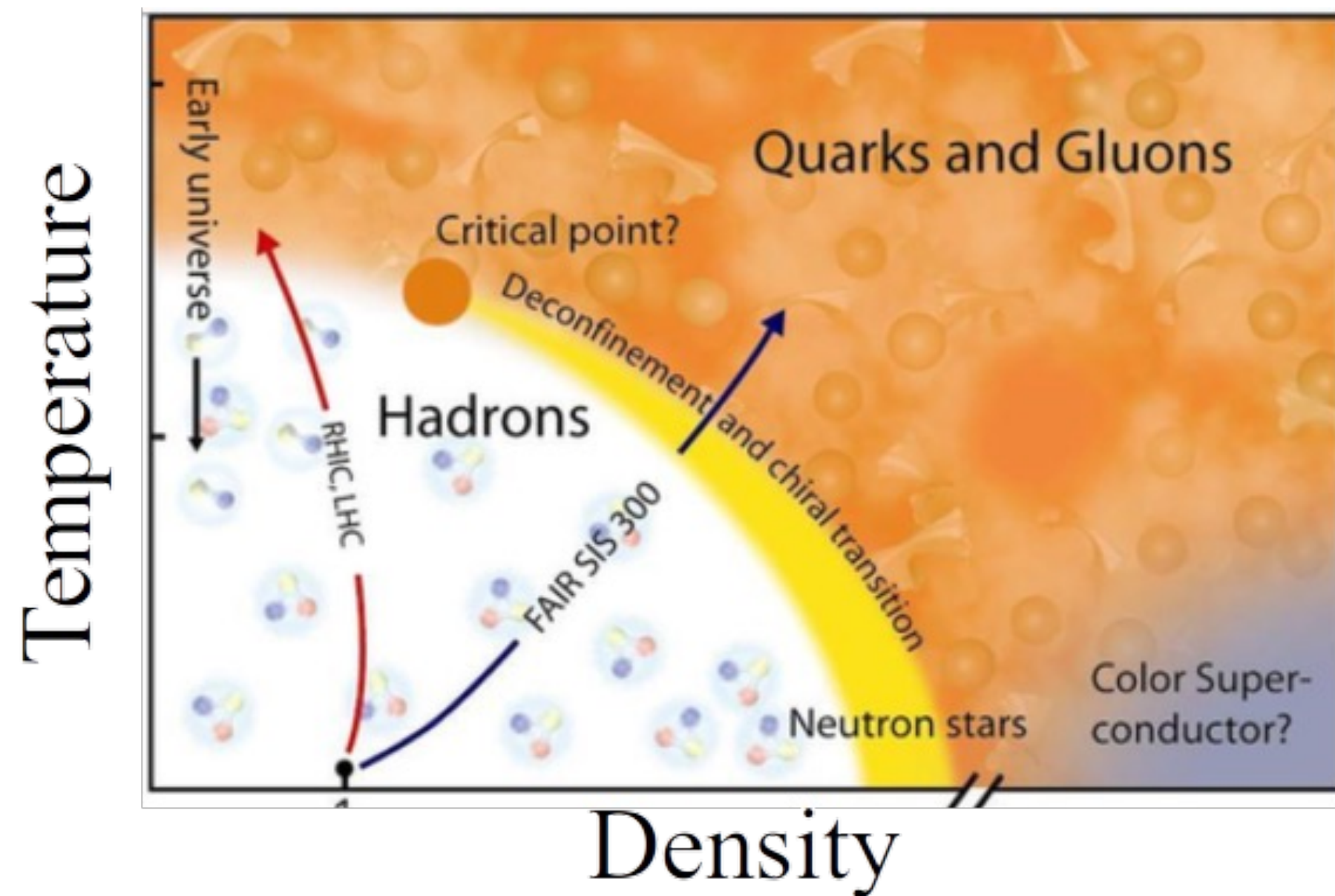
- ASKAP
- MWA
- SkyMapper
- Zadko
- Parkes
- DWF
- ATCA
-



Physics and Astrophysics

Neutron star mergers:

- Inspiral: cold equation of state, populations, cosmology (Davis – next!), ...
- Post-merger: hot equation of state, jets, ...
- Multimessenger: gamma-ray burst physics, neutron star astrophysics, ...

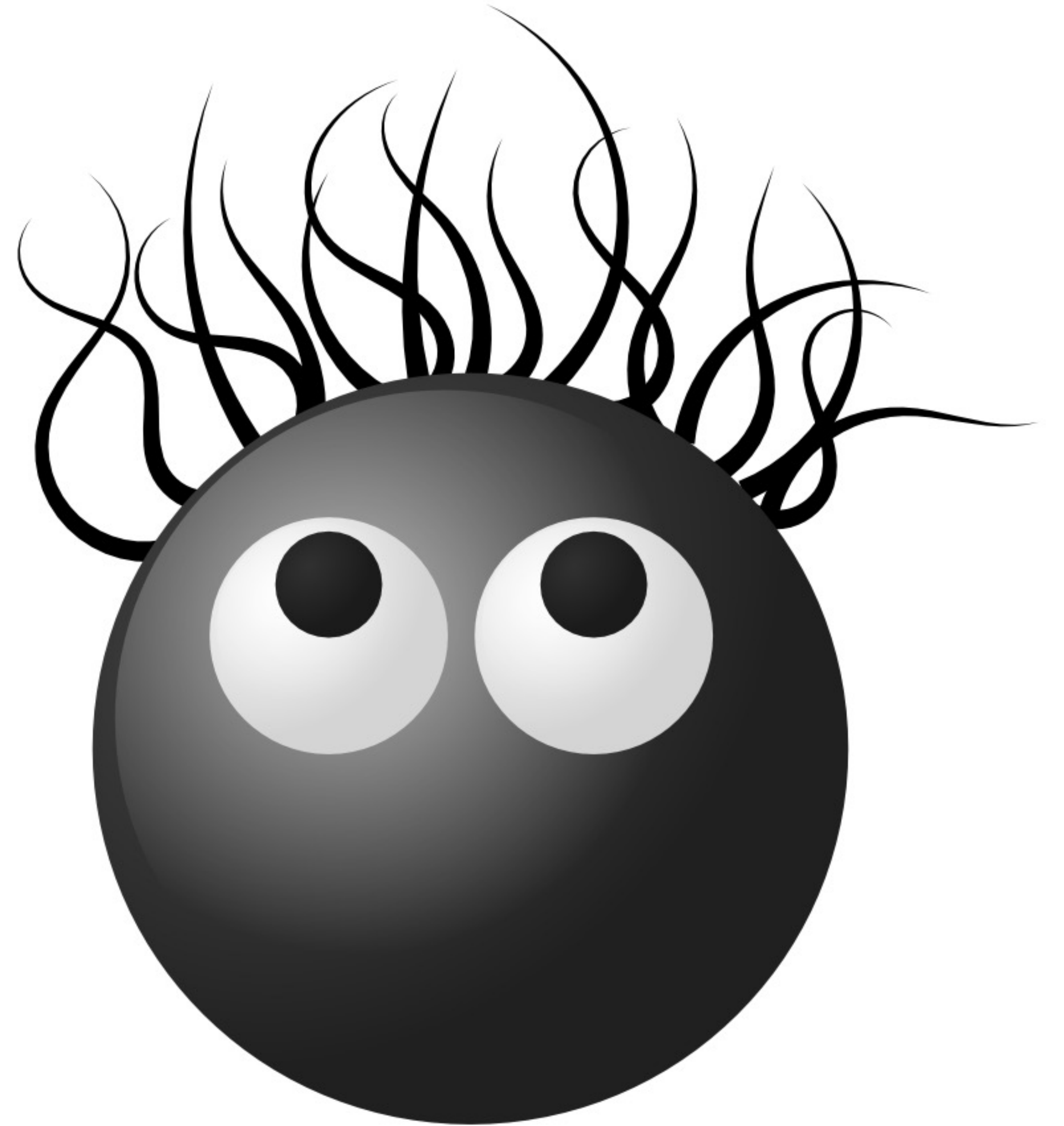


Physics and Astrophysics

Neutron star mergers

Black hole mergers

- How do black holes form and merge?
- Galactic astrophysics
- Tests of general relativity



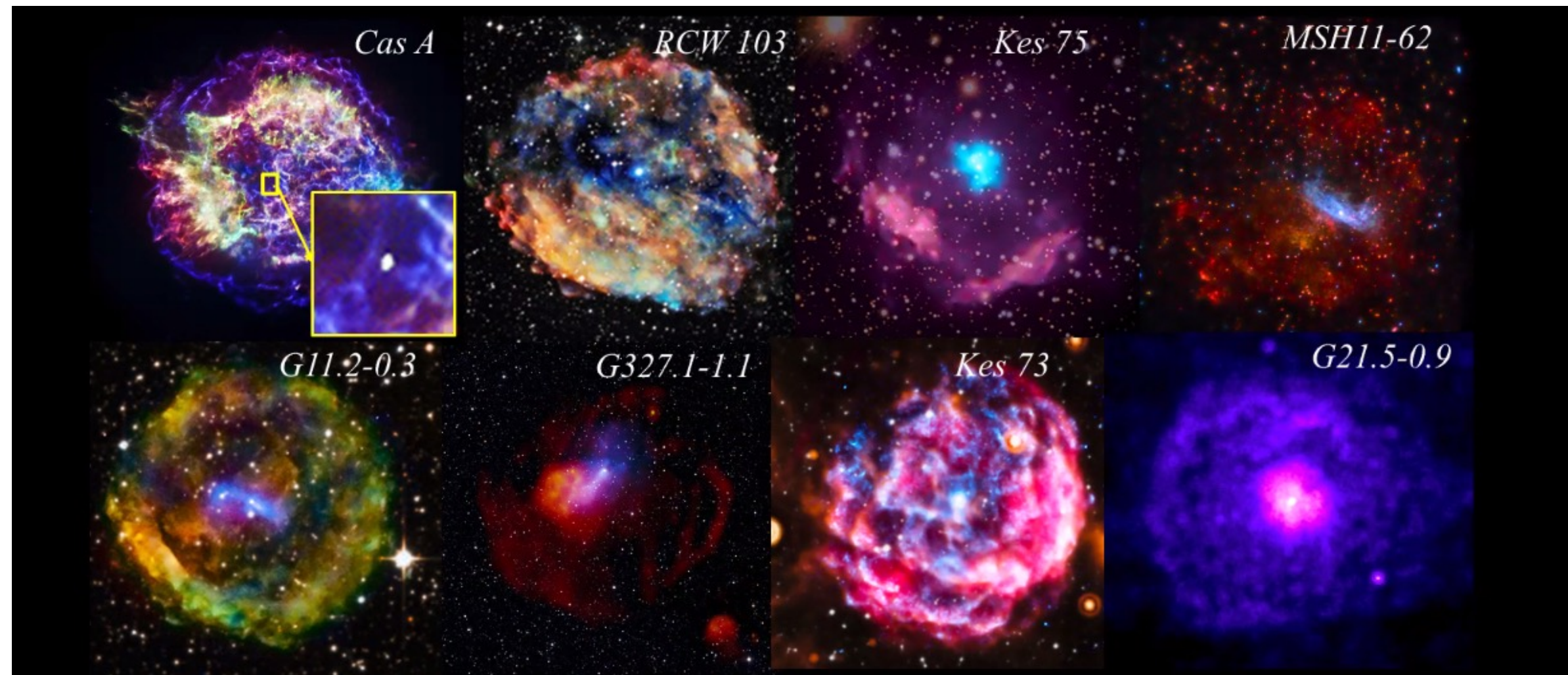
Physics and Astrophysics

Neutron star mergers

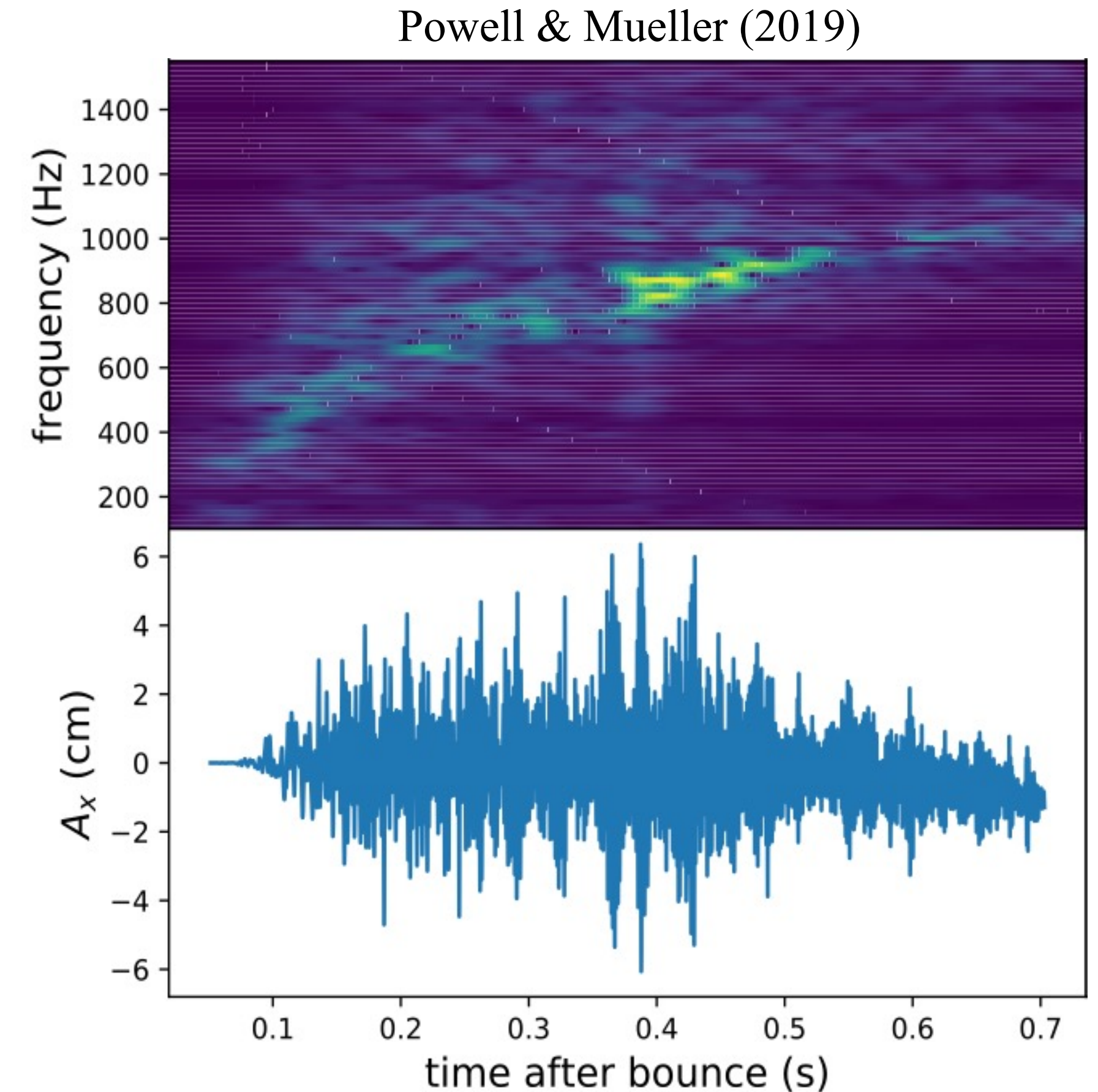
Black hole mergers

Supernovae

- Core bounce + protoneutron star oscillations
- Supernova explosion mechanism
- Multimessenger (SN remnants, pulsar kicks, ...)



Credit: Katie Auchettl



Physics and Astrophysics

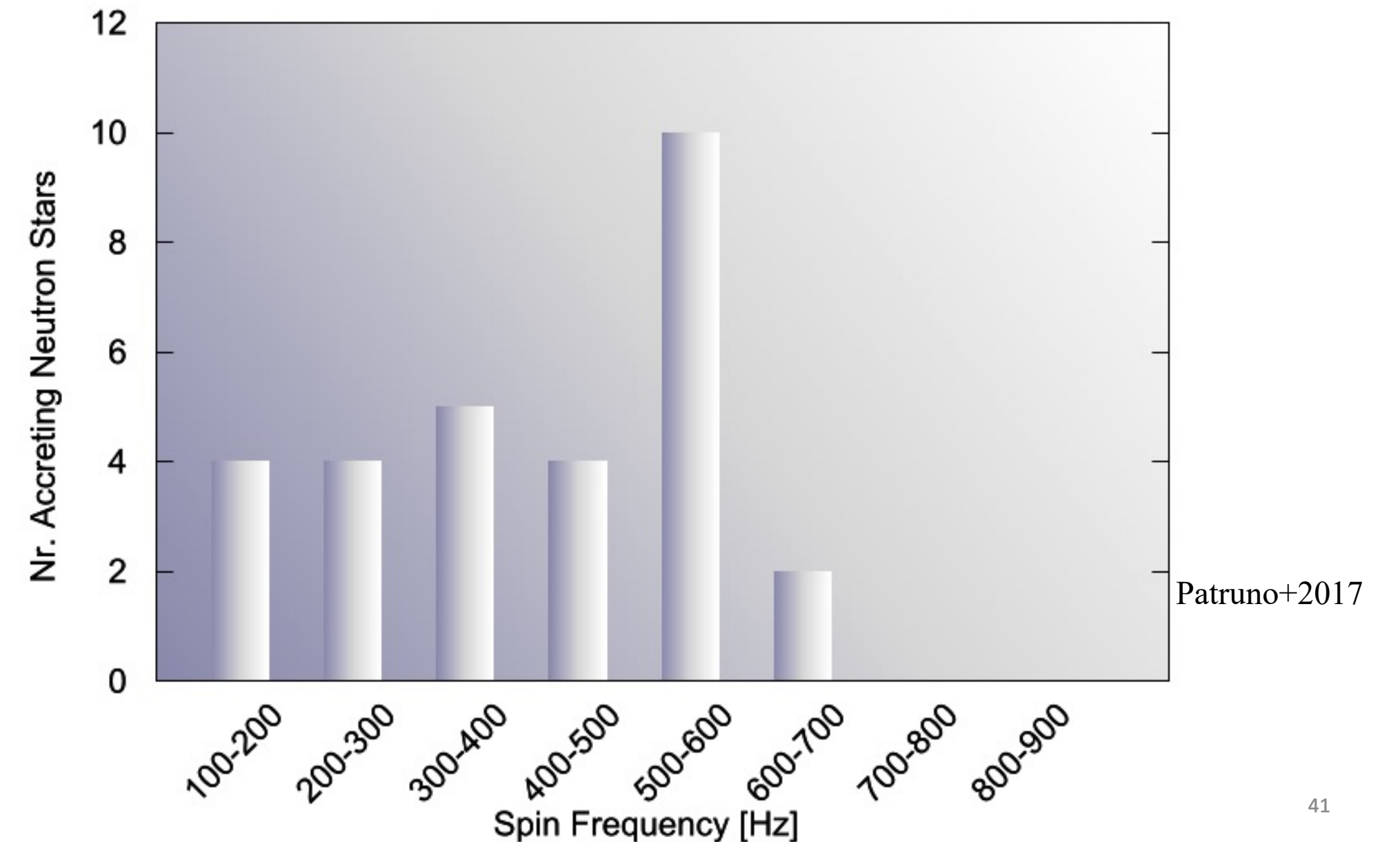
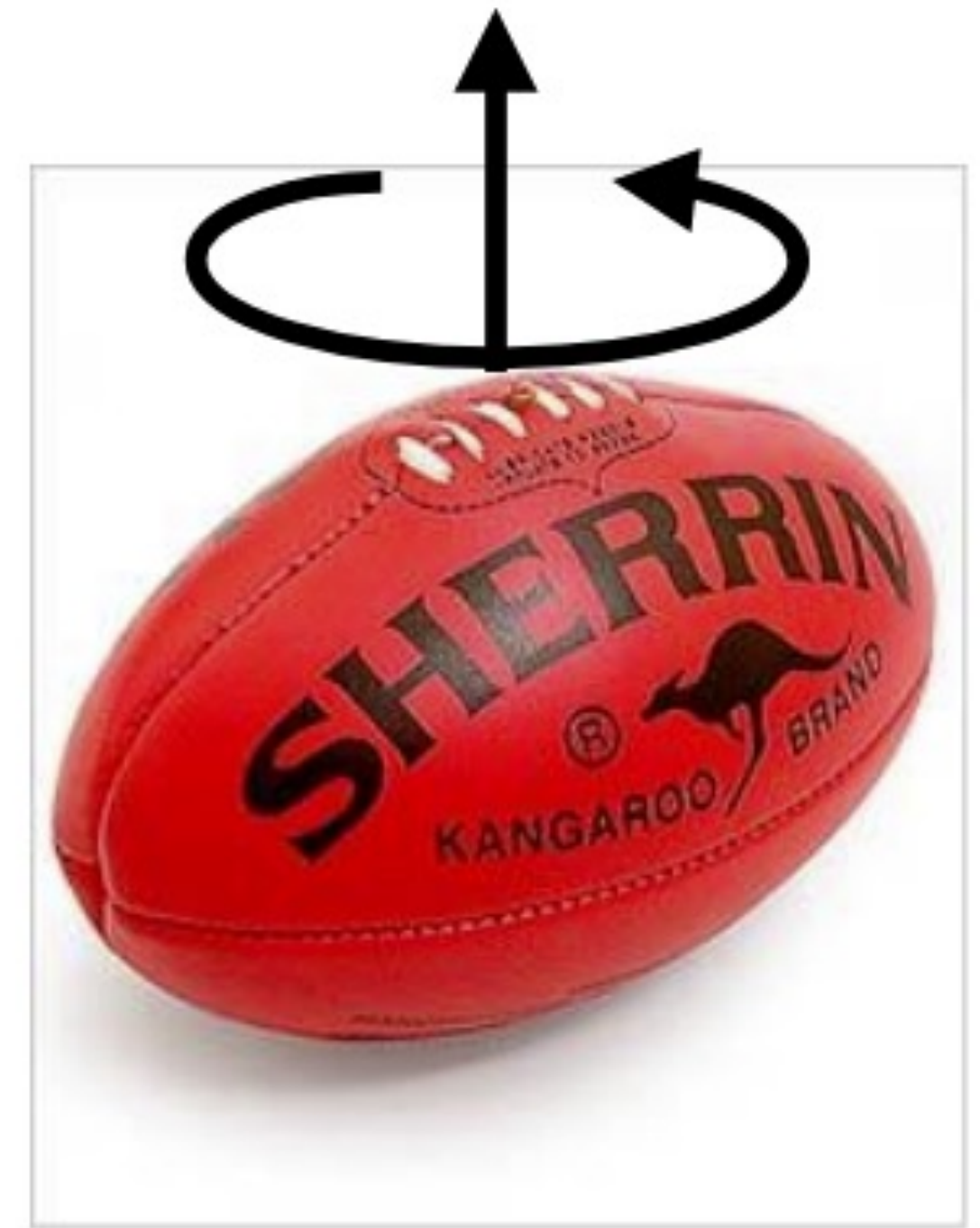
Neutron star mergers

Black hole mergers

Supernovae

Pulsars

- How elliptical are millisecond pulsars? $\backslash$ (ツ) $/$
- Neutron star equation of state
- Pulsar astrophysics



Physics and Astrophysics

NASA

Neutron star mergers

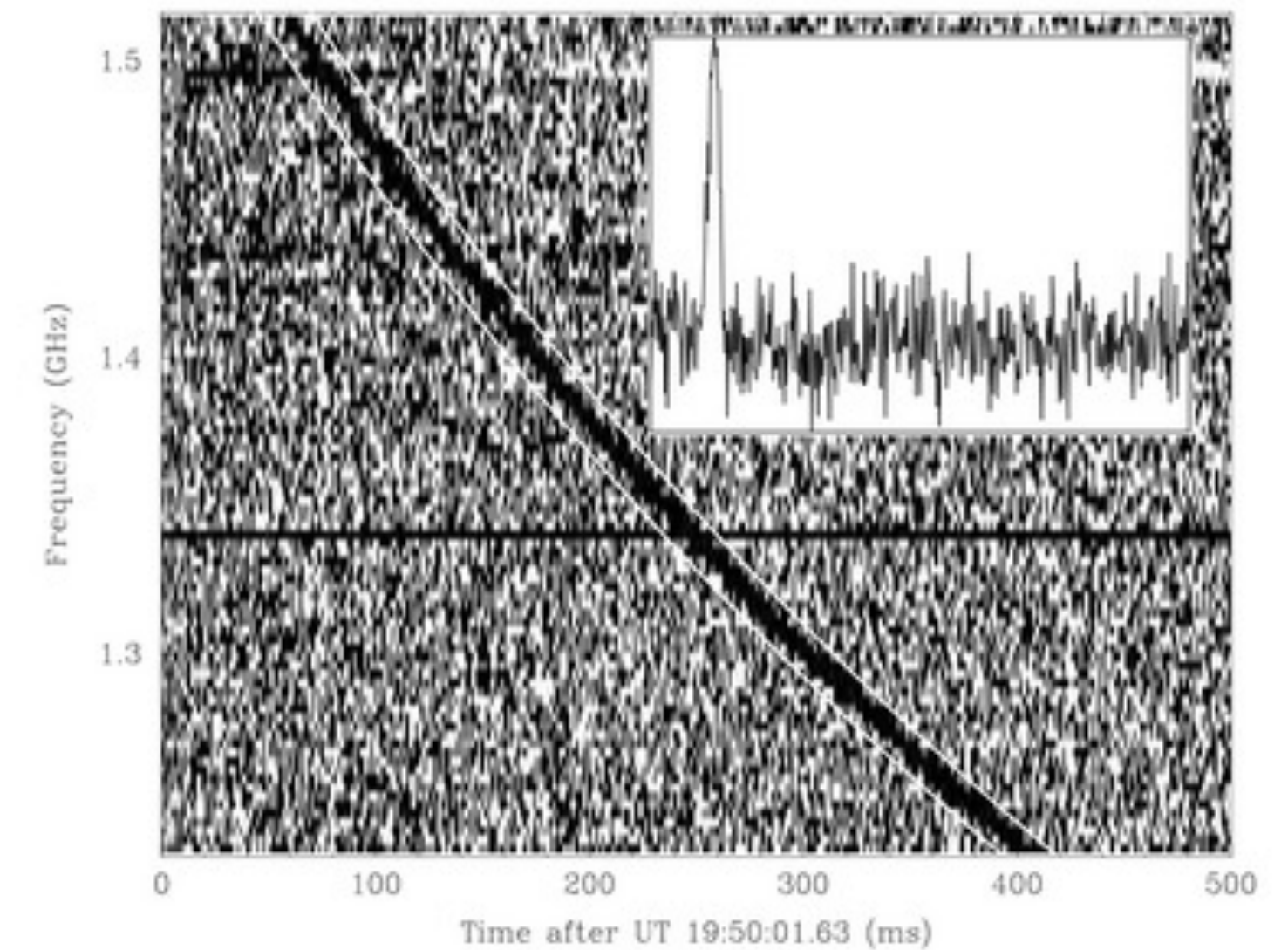
Black hole mergers

Supernovae

Pulsars

Other burst sources

- Magnetar flares (kHz, unknown amplitude)
- Fast radio burst progenitors
- Neutron star glitch's
-



Physics and Astrophysics

Neutron star mergers

Black hole mergers

Supernovae

Pulsars

Burst sources

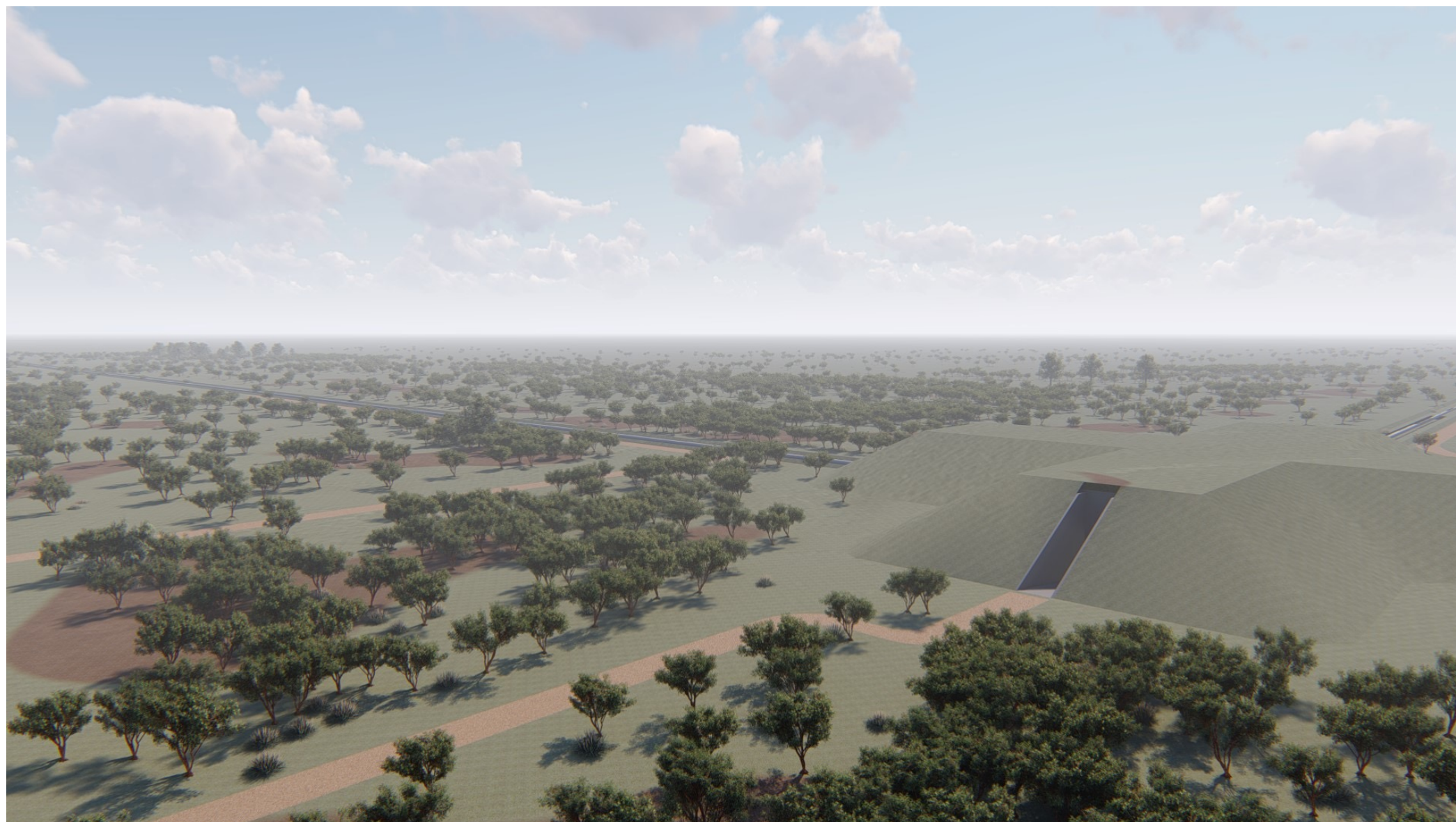
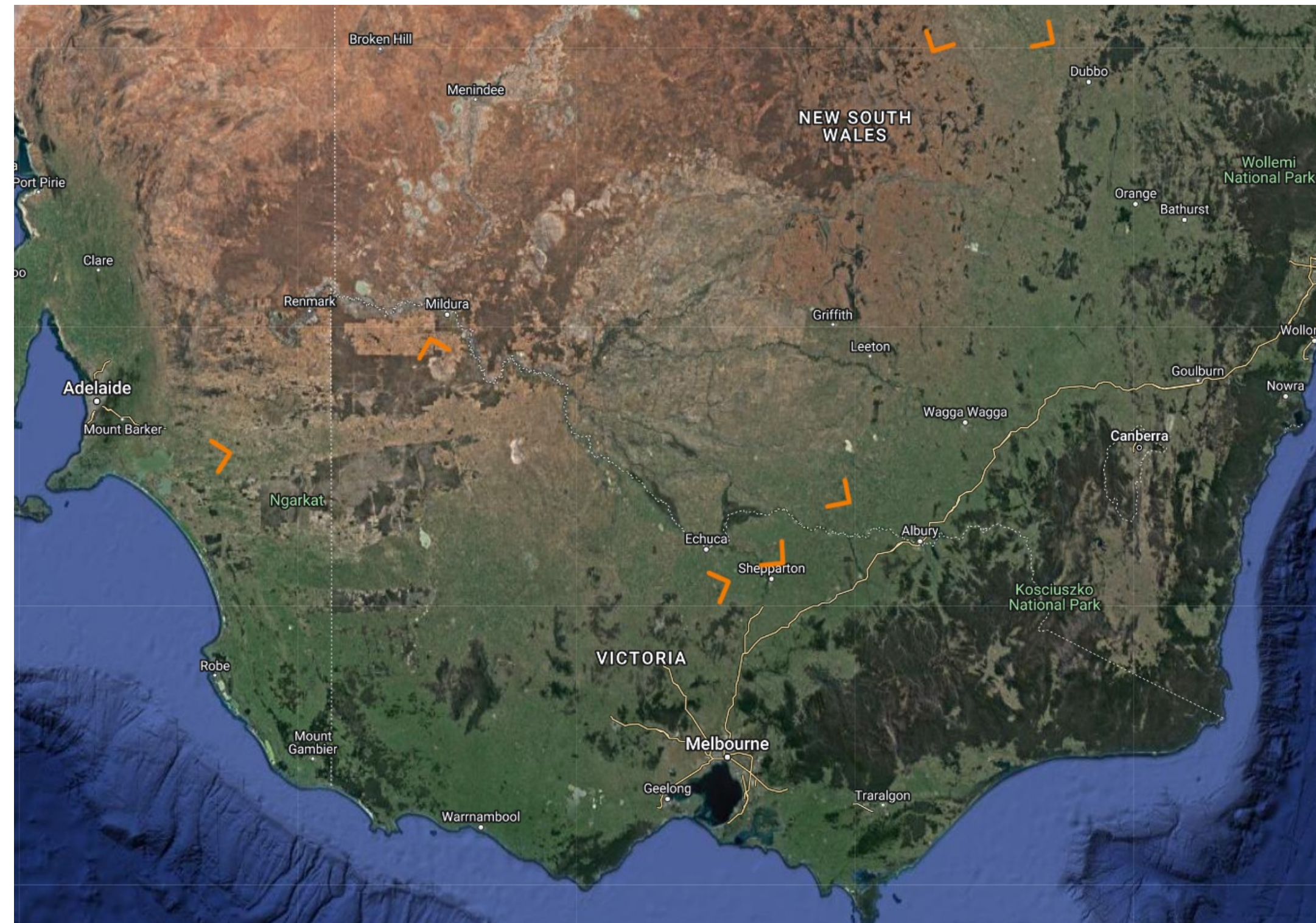
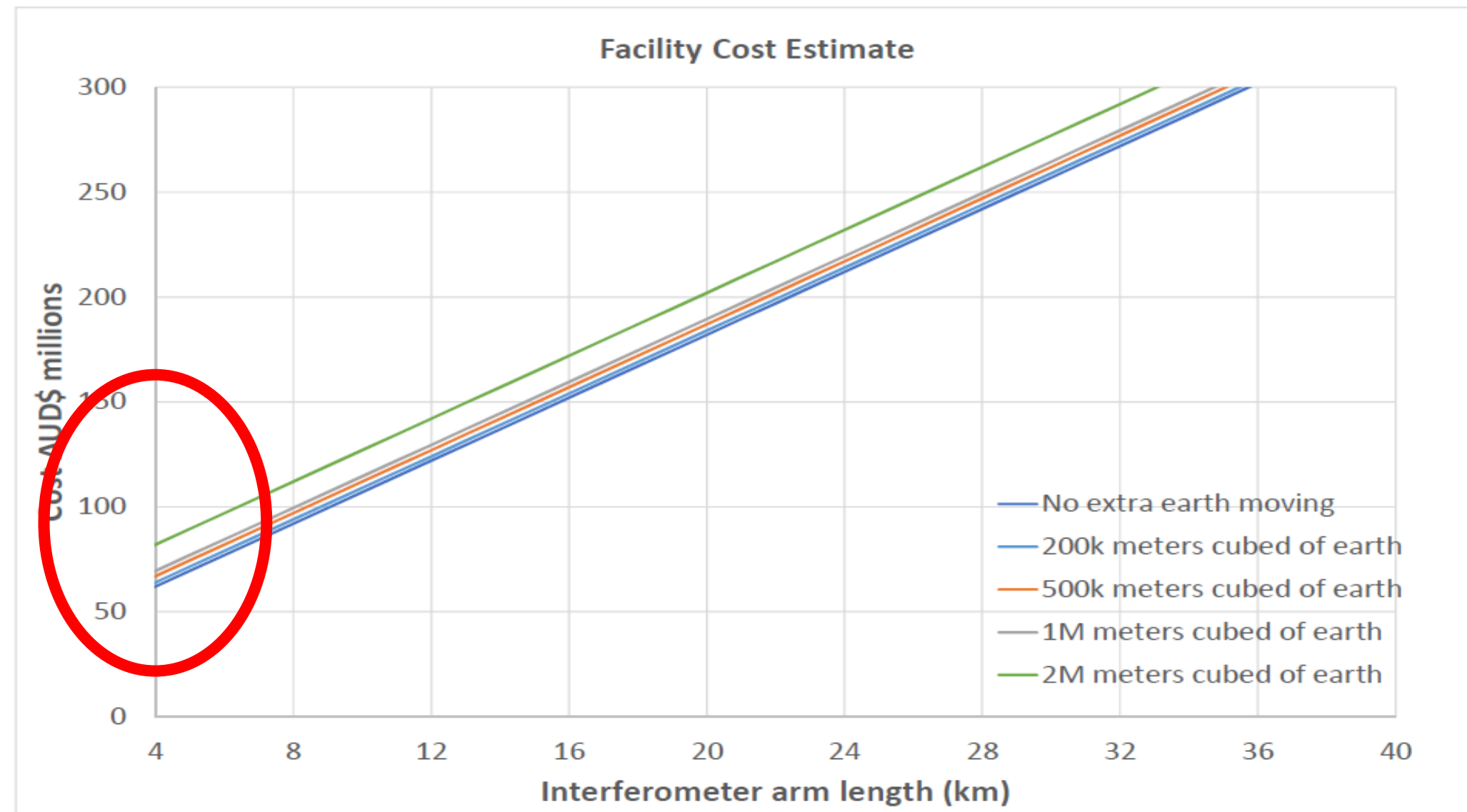
Exotica

- **<cliché alert>**Opening a new window on the Universe**</cliche alert>**
- Cosmic strings, black hole spectroscopy, superradiant instabilities, echos,
....



NEMO: scoping study

Carl Blair et al



Potential sites all over Aus,
including Gingin near Perth

[Flythrough](#)