The role of radio transient science in ATNF's future

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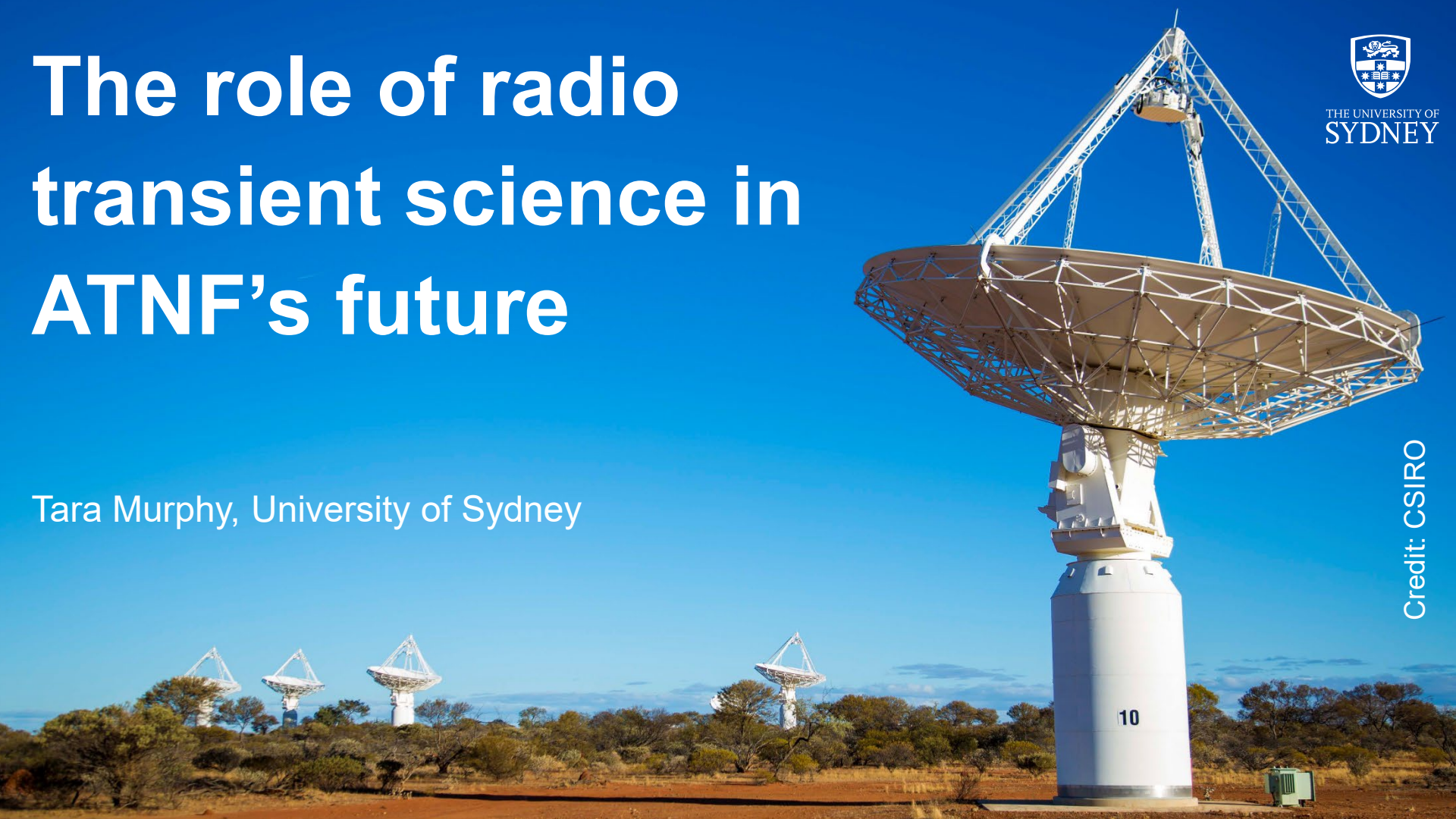

Credit: CSIRO

Significant (slow) transient results from the last decade

- 2016: An extreme scattering event in real time *(Bannister et al. 2016)*
- 2017: A radio afterglow from GW170817 *(Hallinan et al. 2017; Dobie et al. 2018)*
- 2017: Radio emission from Type Ia supernova *(Kool et al. 2017)*
- 2021: Delayed radio flares from a tidal disruption event *(Horesh et al. 2021)*
- 2021: Merger-triggered core collapse supernova *(Dong et al. 2021)*
- 2022: Discovery of long period transients *(Hurley-Walker et al. 2022 Caleb et al. 2022)*
- 2024: Expansion of the radio star population *(Driessen et al. 2024)*

- *Possible detection of a GRB orphan afterglow…*
- *Tentative detection of radio emission from exoplanetary system/s…*

Where are we now?

OzGrav
ARC CENTRE OF EXCELLENCE FOR GRAVITATIONAL WAVE DISCOVERY

Phase 1: Targeted studies of individual objects

Phase 2: Use of existing legacy surveys

- → Focus on making detections, very hard to classify or follow up
- → Used to estimate transients rates for planned surveys
- → e.g. *Carilli et al. (2003).; Ofek et al. (2010, 2011).; Bannister et al. (2010)*

Phase 3: Initial custom designed transients surveys

- → e.g. Allen Telescope Array (*Bower et al. 2011*)
- → Approached, but did not reach theoretical predictions e.g. *Metzger et al. (2015)*
- → Limited multi-wavelength information for detections (e.g. *Stewart et al. 2016*)

Phase 4: Untargeted transient surveys – SKAO Pathfinder era

- → Each has different limitations (ThunderKAT vs. VLASS vs. VAST)
- → Focus on detection and identification and (some) analysis

Phase 5: Comprehensive radio transient surveys (SKAO era!)

Murphy & Kaplan (2025), PASA, 43, 6

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Properties of an ideal radio transients survey

Critical properties (currently no survey has all of these)

- High cadence monitoring over long periods of time;
- Dynamic spectra over each integration period;
- High sensitivity (like MeerKAT);
- Wide field of view (like ASKAP);
- High resolution (for multi-wavelength identification);
- Simultaneous pulsar mode observations;
- Full polarization data products;
- VLBI follow-up – ideally rapid response;
- Good (ideally simultaneous) multi-wavelength data;
- Rapid data processing to enable follow-up;
- Transient identification and classification software.

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Make time domain science a first-class citizen

To optimise transient science from the SKA, we need:

- Rapid radio follow-up of interesting candidates
- Dedicated long term monitoring across multiple frequencies
- High resolution / good localisation capabilities

Future ATNF facility development should ensure:

- Telescope scheduling designed to prioritise time variability
- Data processing and ingest happens *with priority*, when data is observed
- Data processing happens *rapidly* to enable follow-up
- Time domain projects have dedicated time

We need to bridge gap (now → SKA) to ensure the Australian radio astronomy community can secure research funding (e.g. from ARC)

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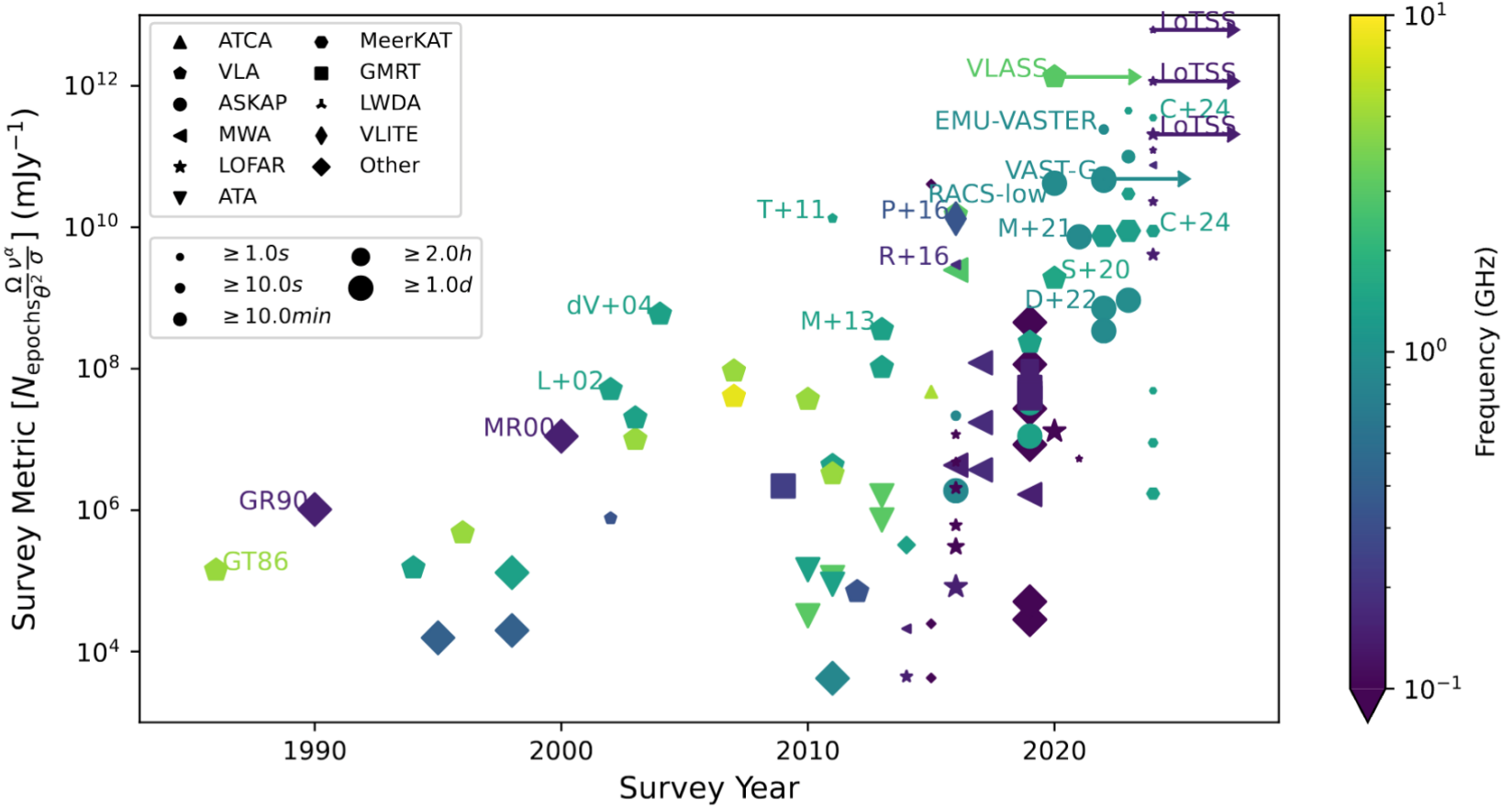
Extra slides

Improvement of radio transient surveys with time



Murphy & Kaplan (2025), PASA Dawes Review

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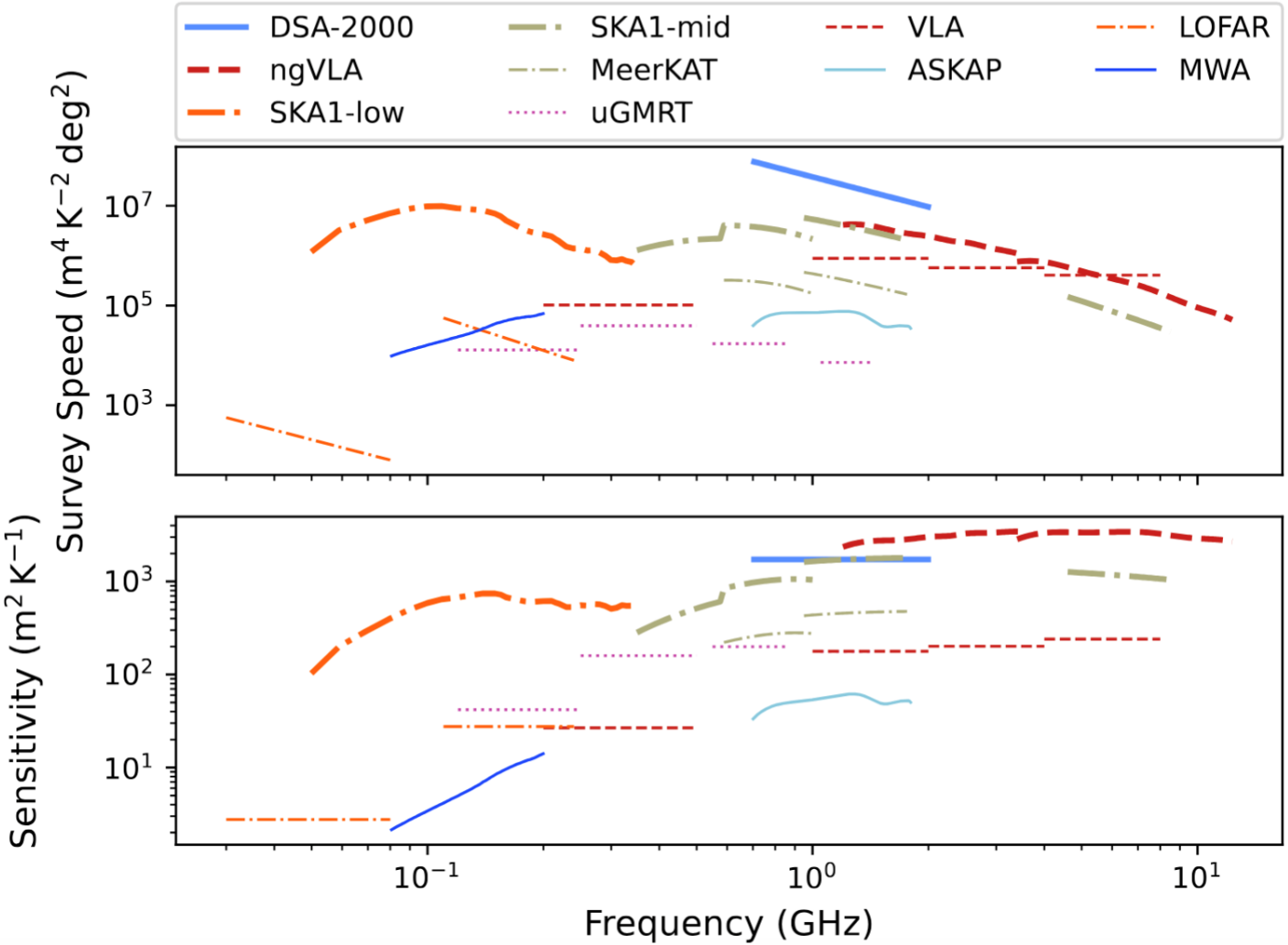
Current and future telescope specs



Murphy & Kaplan (2025), PASA Dawes Review

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