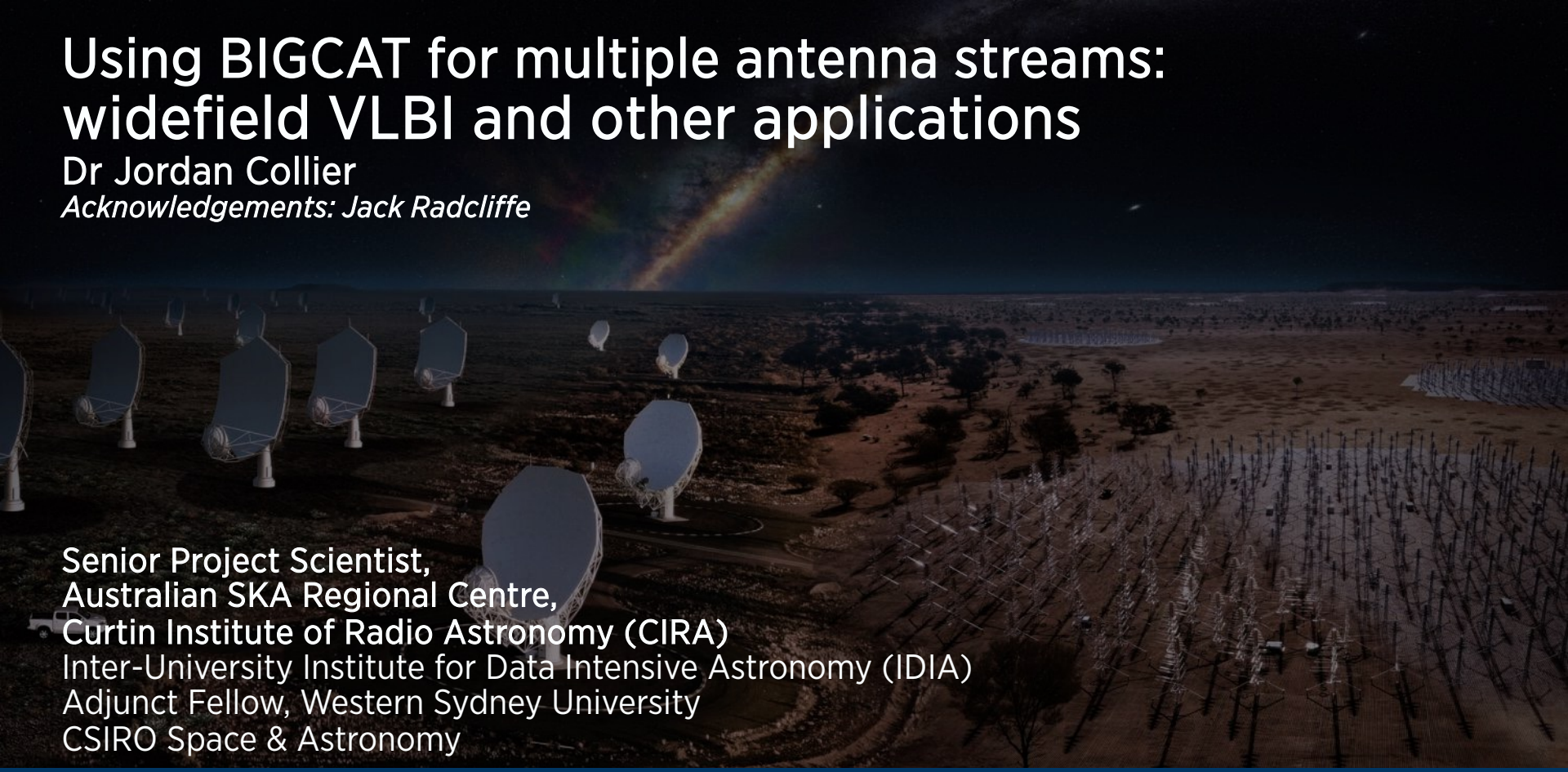
Using BIGCAT for multiple antenna streams: widefield VLBI and other applications

Dr Jordan Collier

Acknowledgements: Jack Radcliffe



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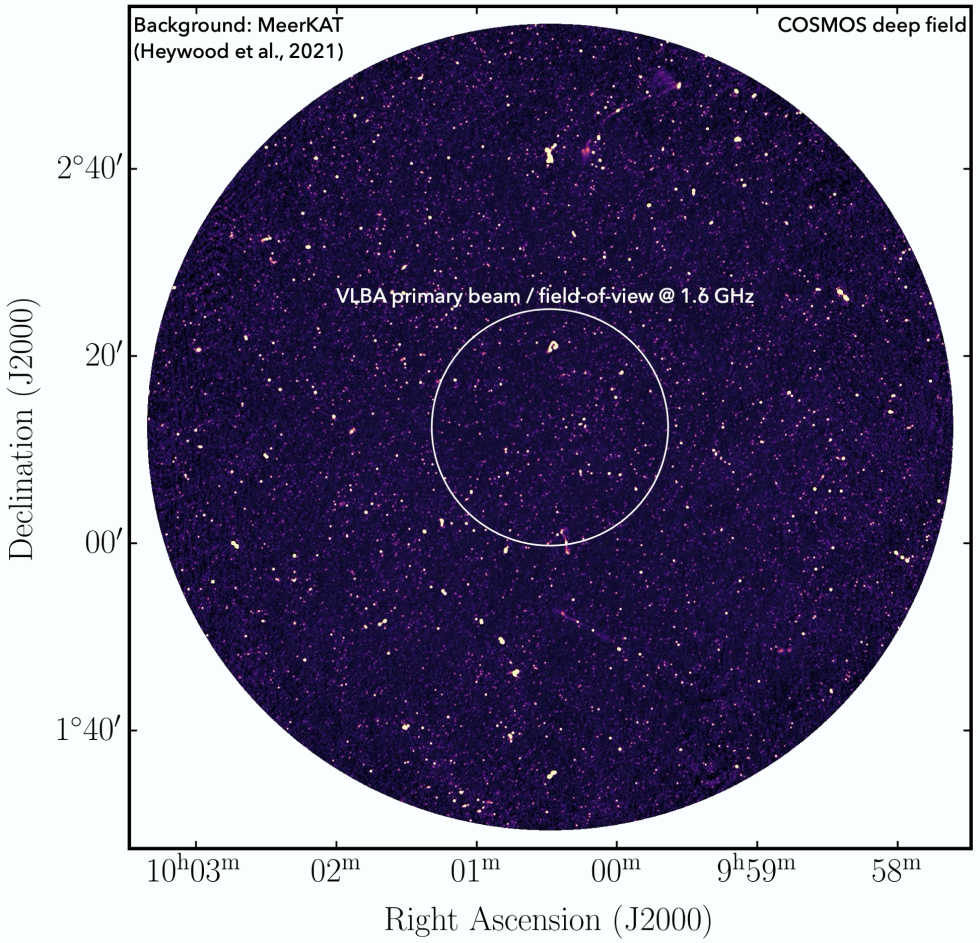
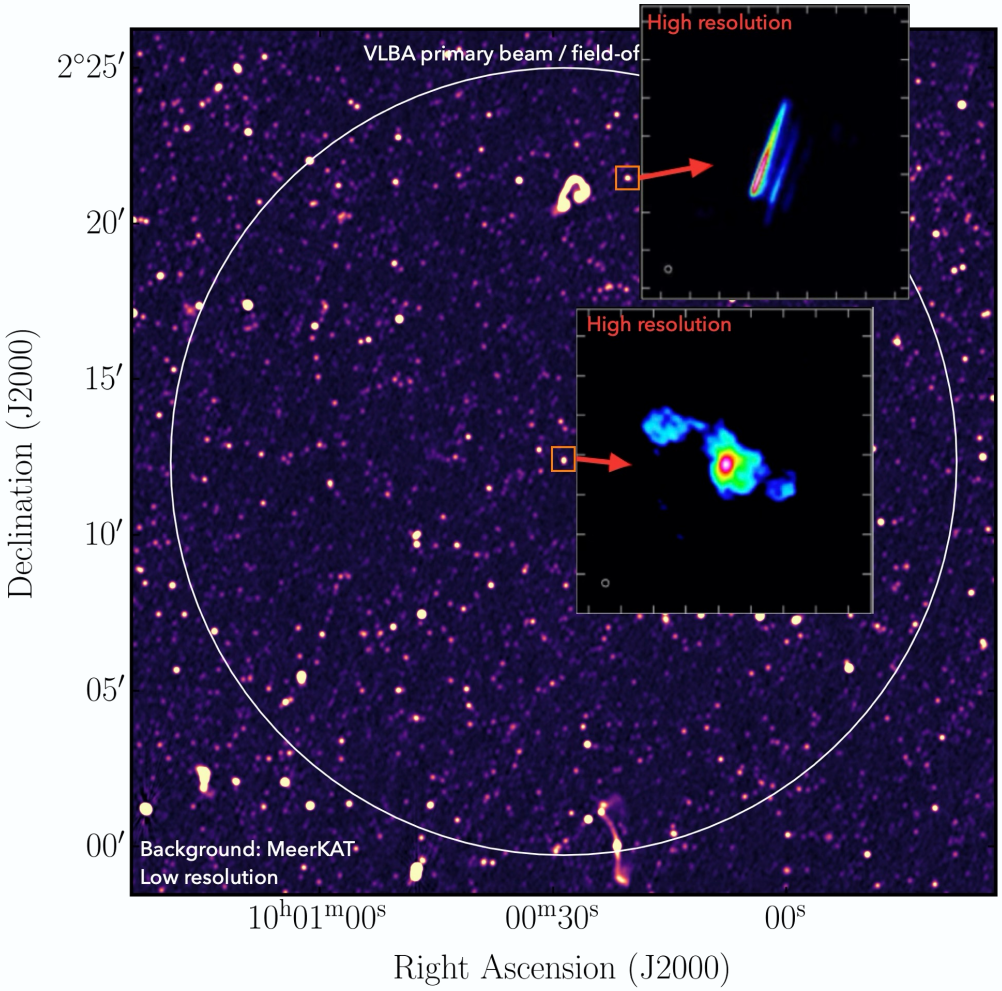
Widefield VLBI

- Imaging / mapping sources across the whole primary beam
- Zooming into one of these pointings →



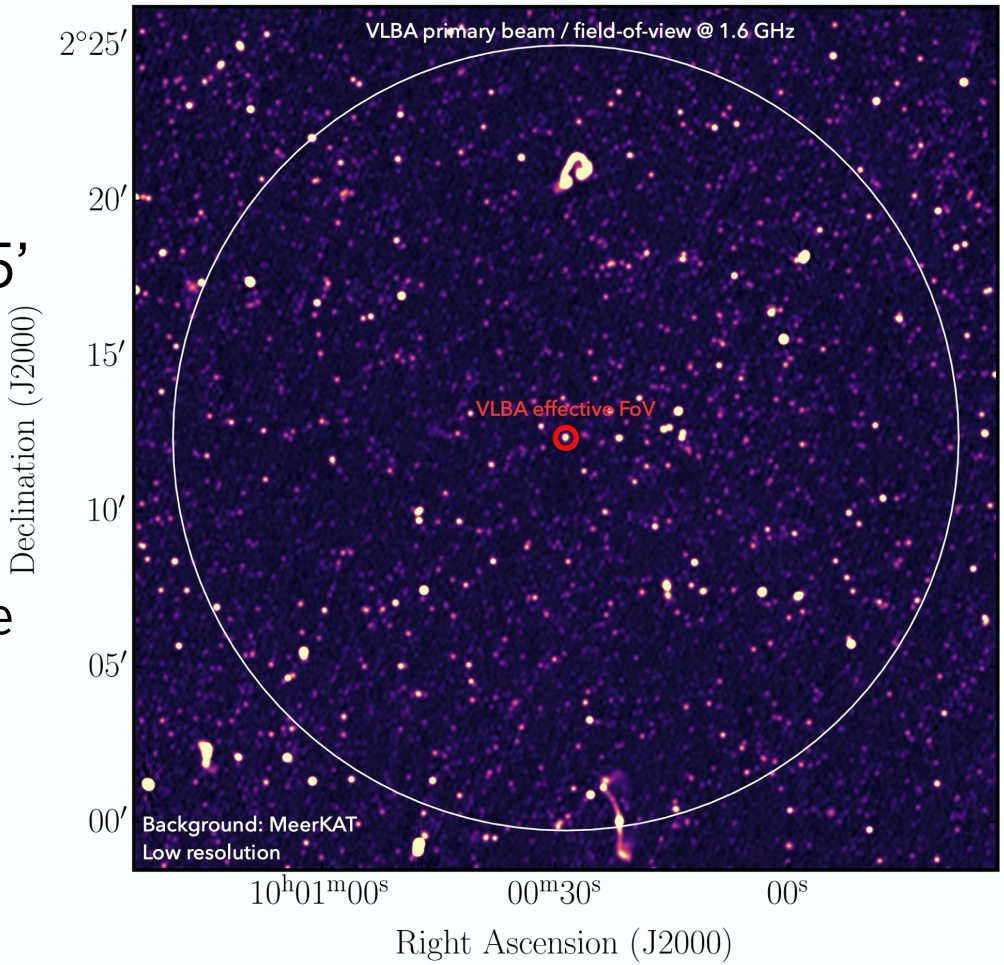
Widefield VLBI – smearing

- Can't simply just go back to data sets and image rest of the primary beam
  - Smearing irrecoverably distorts images due to averaging of data in frequency and time
  - Smearing amount proportional to baseline length so affects VLBI more severely
  - At the image centre, images look fine!
  - Further away, images distorted irreversibly



VLBI surveys

- With same averaging as MeerKAT, VLBA's effective FoV just 40"!
- Much smaller than PB of ~25'
- Can't go back and undo averaging
- Most VLBI surveys targeted
  - PI observes single central source



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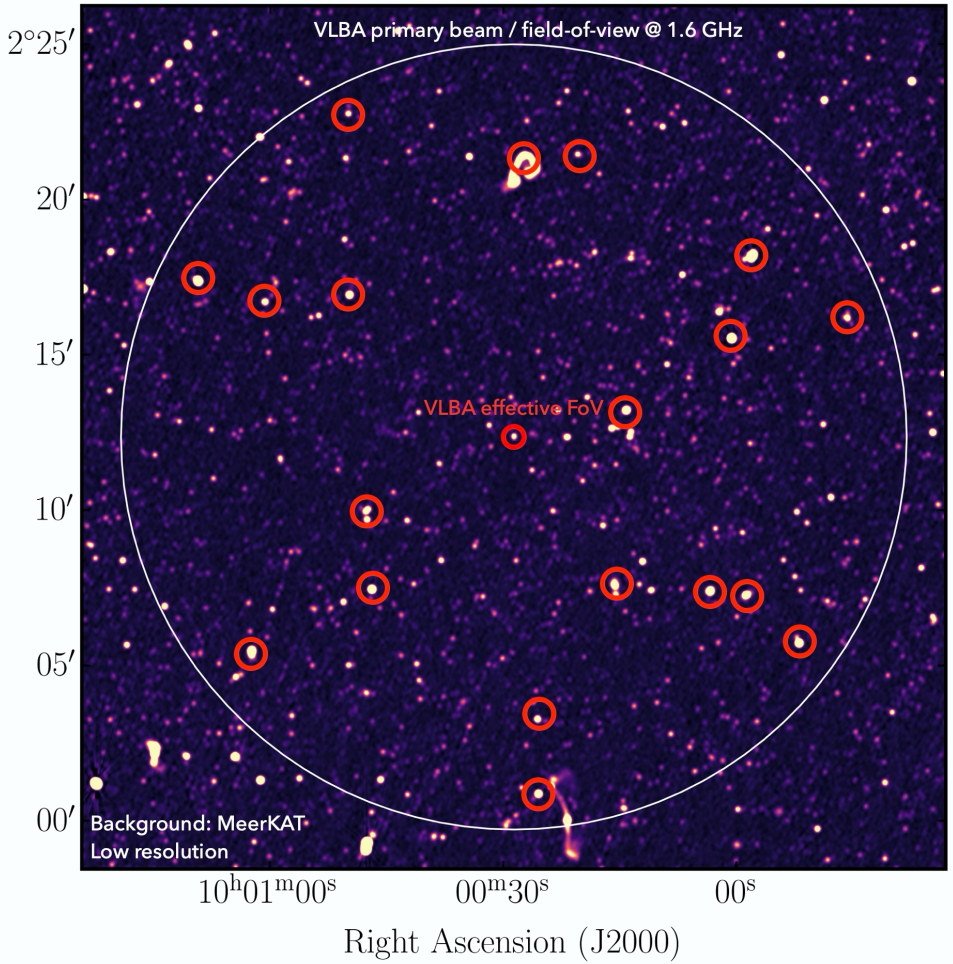
  - PI observes single central source
- We want to use special correlation mode (multiple phase centre observing) to target sources across PB



Commensal LBA observing

- ATUC recommendation to support fully-commensal widefield VLBI with Australian Long Baseline Array (LBA)
  - ATNF will begin supporting in October 2025 semester
- Proposal (Collier, Radcliffe) includes protection of PI-led observations and proprietary periods
  - e.g. opt-out via proposal submission form
  - e.g. only correlate outside frequency-dependent radius (generally ~10”) of approved targets
    - For any proposal, not just current one

ID	5.1(a) (ATUC-49)
Owner	Phil Edwards
Summary of request	ATUC recommends adapting LBA user policy as necessary to enable commensal widefield correlation of LBA data, and communicating this to the broader user community.
Response	This will be included in the call for proposals for the 2025OCT semester. We will also communicate these plans to current LBA users to determine whether there are any concerns or queries from the user community.

Using BIGCAT for multiple antenna streams

- Standard VLBI observing uses five ATCA dishes as tied array
  - Assuming baselines between 31 m to 3 km
    - At 1.4 GHz, PB 29’ to 18”! – not useful for widefield VLBI
  - Single ATCA dish PB ~41’ @ 1.4 GHz
- BIGCAT capable of multiple antenna streams
  - MVP: separate 6th antenna stream
  - Ideal: 6x single antenna streams, in addition to tied array
- Stretch goal: use ATCA-only correlations for source finding to inform further widefield VLBI phase centres
- Storage needs to be considered
  - On-site storage; possible streaming service (e.g. to Pawsey)
  - Archival (CASDA) storage

Using BIGCAT for multiple antenna streams

- Other possible applications
  - Pulsar / FRB localisation
    - Offline coherent beam-forming, like MWA VCS (e.g. SMART survey)
  - Single dish streams
    - Galactic plane survey, like MALT-45
  - SETI?
- Allows for alternative data products to be captured without infringing upon PI's science
  - May require opt-out option and written agreements
- Sub-arraying capability?
- Open to floor – other people's thoughts?

THANK YOU

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