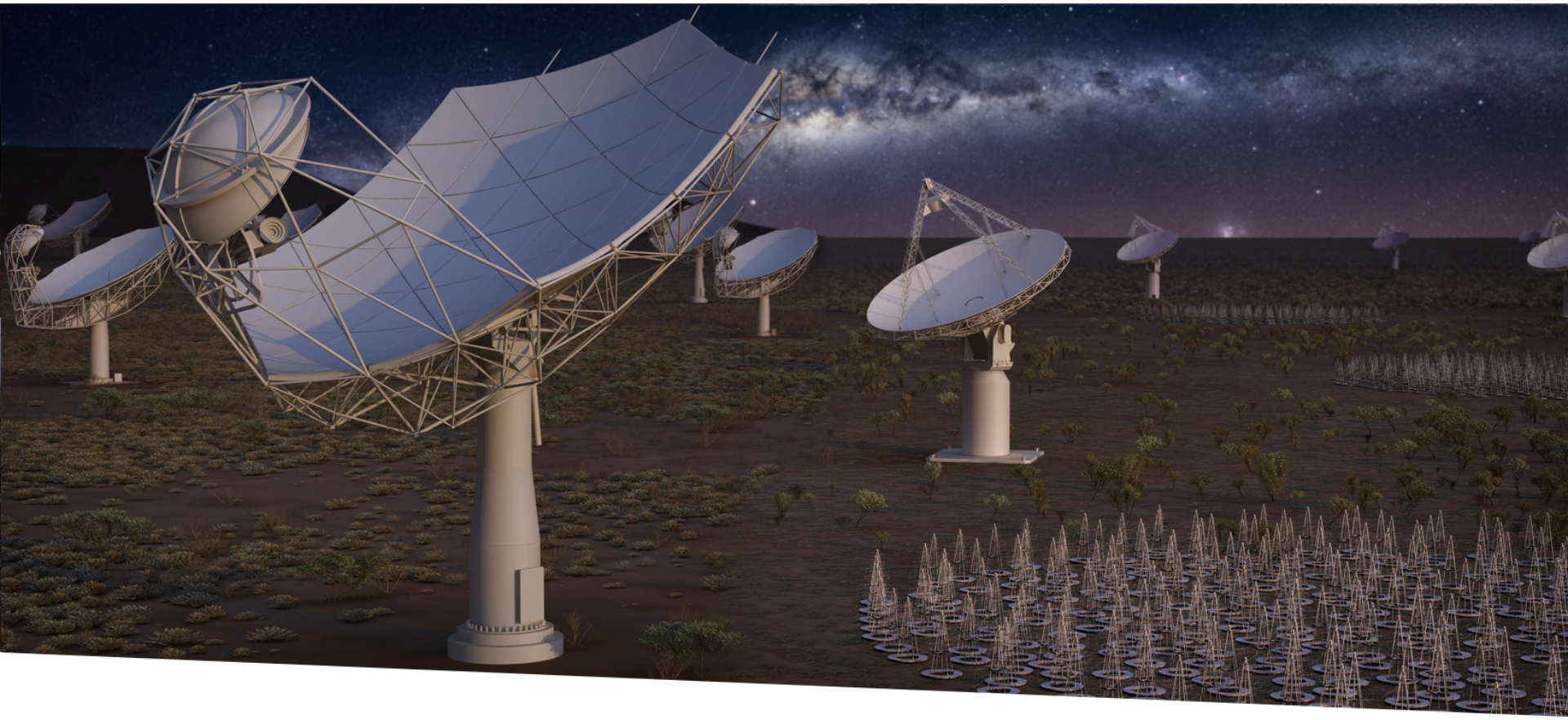
Towards Interferometry



SQUARE KILOMETRE ARRAY

Exploring the Universe with the world's largest radio telescope

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Objectives

- Carry out astronomical tests to:
  - Commission the Low and Mid EPAs
  - Verify system performance to the extent that this is feasible with the available hardware and software
  - Identify components which do not meet requirements/need rework/are unreliable
  - Work with hardware and software engineers to debug, optimise and improve the system.
- Develop methods and working practices for full production
  - Commissioning team organisation
  - Training
  - Test scripts and analysis software

Bring forward planned activities for Array Assembly 1

Key Tests 1

- Correlator products
  - Cross and autocorrelations
  - RFI characterisation/develop heuristics
  - Spurious signals
- Form Low station beams
- Basic interferometry
  - First fringes
  - Broad-band and multichannel images
  - Time and frequency reference stability
- Antenna tests
  - Mid antenna pointing, surface accuracy and stability (interferometric pointing tests and holography) – as high a frequency as possible for accuracy
  - Low station beam optimisation and pointing
  - Measured antenna/station voltage patterns and comparison with EM models

Key Tests 2

- Antenna locations
  - delay calibration and stability
- Complex gain stability (= amplitude/phase closure)
  - Transfer between targets and beams
  - Self-calibration and dynamic range
  - Flux scale
- Bandpass stability
- Polarization leakage
  - On-axis Jones matrices
- System sensitivity
- Form single Mid pulsar timing beam?

Test observations

- Mid observations
  - Pointed observations of bright, unresolved calibrators
  - “Blank” sky
  - Raster scan for holography
  - 5-point for pointing
- Low observations
  - Drift scans (Galactic centre, Sun, Orbcom satellites) and drone observations to monitor station beams
  - Interferometric observations of “A-team” sources
  - Raster scans

Requirements

- Infrastructure
- Antenna (Dish/LFAA)
  - Band 2, Band 5 for Mid (high frequency to enable antenna tests)
- Time and frequency reference
  - reduced requirements
- CSP
  - Limited number of stations
  - Limited bandwidth and fixed channelisation
- Telescope management
  - Basic monitor and control
  - Interfaces (partial functionality)
  - Pointing and delay models
  - Control low beam weights
  - Simple scripting layer
- Data written to measurement set for analysis in CASA
  - Pointing measurement requires a work-round if SDP real-time pipeline is not available
  - Pointing and delay calibration analysis off-line

Organisation, Skills, Schedule

- Commissioning astronomers work with the hardware and software engineers as part of an integrated team
  - Understand the system as a whole and be able to diagnose (possibly complex) faults
  - Experience with technically similar projects
  - Data reduction and scripting skills essential
  - Same location, at least initially
- Very few people meet all of these requirements
  - Need ~2 experienced astronomers for each array
  - Full time for EPA sky tests
  - Train more (younger!) people
- Mid Stage 3 (Q2 2020 – Q1 2022)
  - Start earlier (Q1 2020) at lower level (ITF, software tests)
- Low Stages 2-3 (Q4 2019 – Q4 2020)

Training and Community Involvement

- Use EPA to train new commissioning team members
- Serious commitment essential
  - At least 3 months full-time initially
    - Exceptions for experienced specialists only
  - Same location as engineering/commissioning team
    - Remote data analysis may then become useful
  - Requires careful management
    - Allocate specific tasks
    - Train/evaluate new commissioning astronomers

We are not trying to do Early Science/Shared Risk Observing!

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