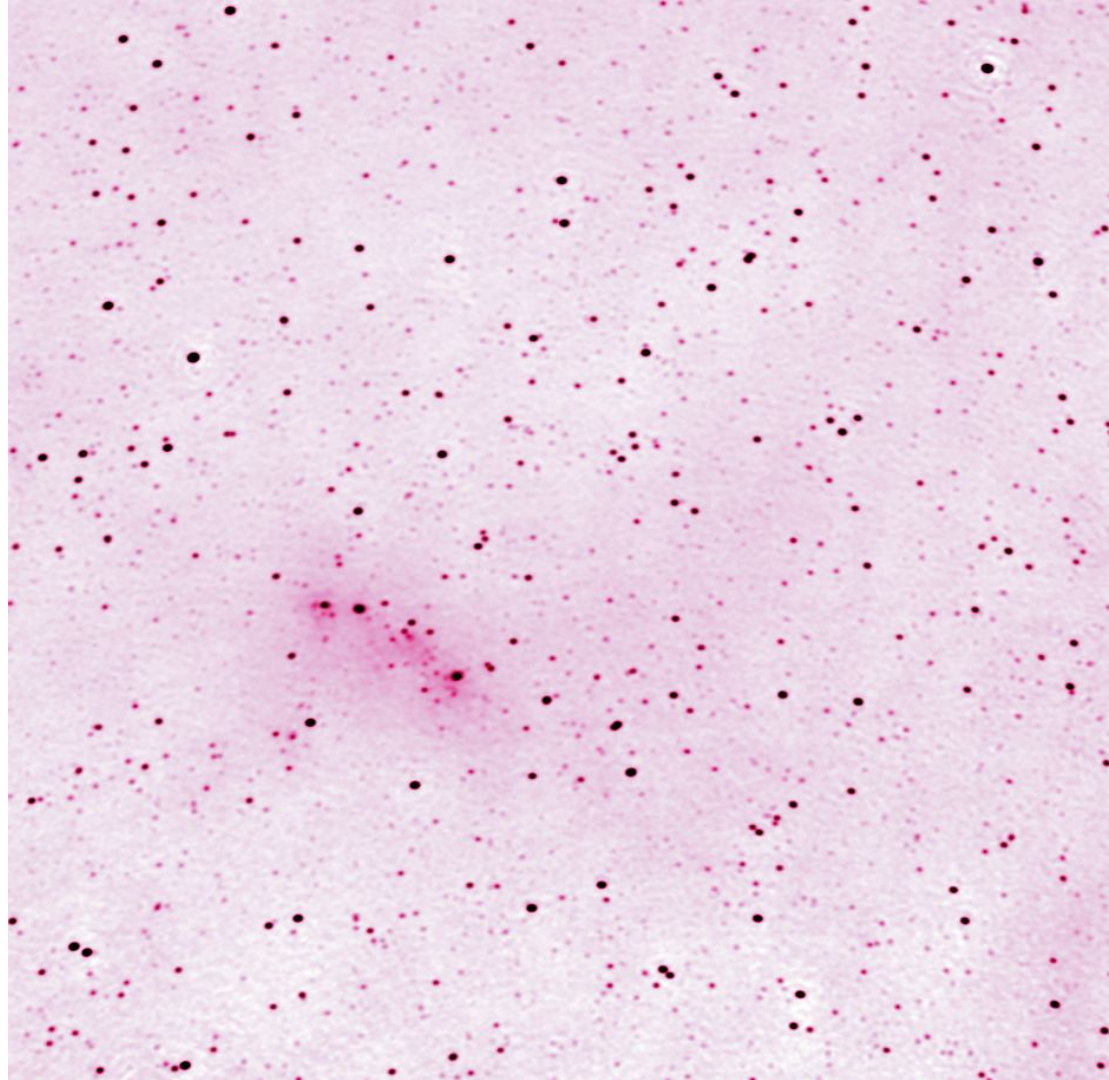




GLEAM-300: The Galactic and Extragalactic All-sky MWA survey at 300 MHz

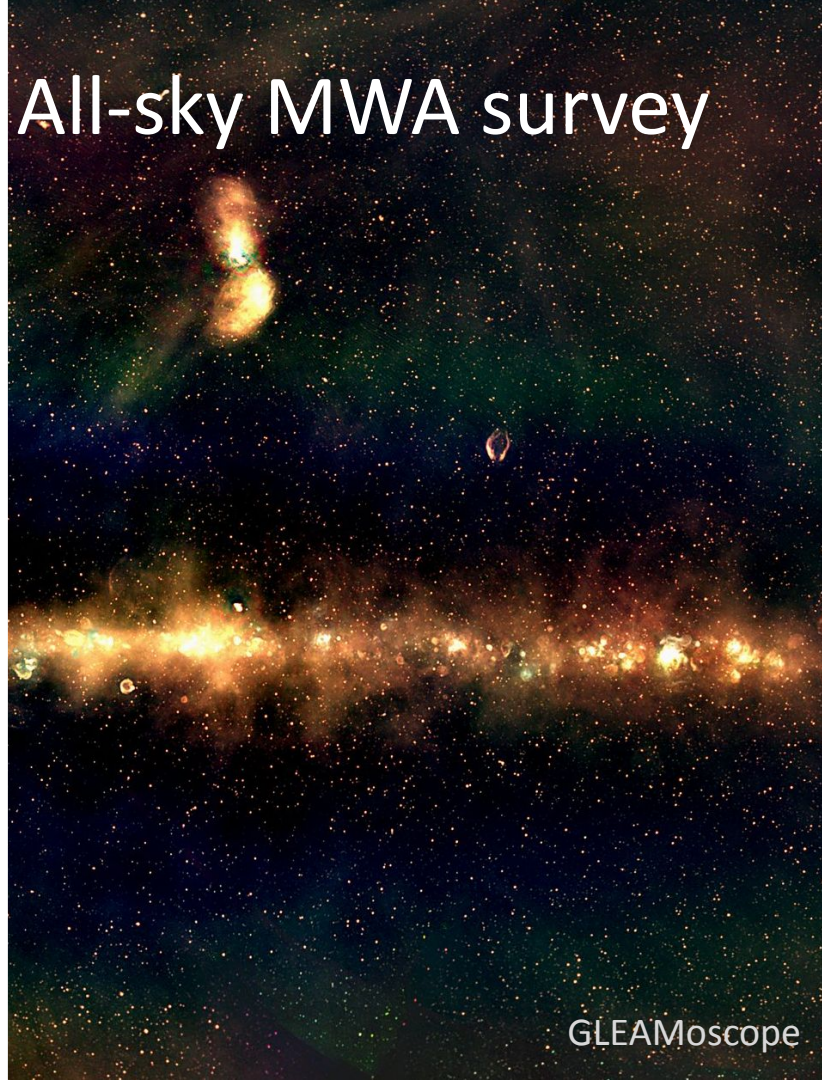
Stefan Duchesne | August 2024

Australia's National Science Agency



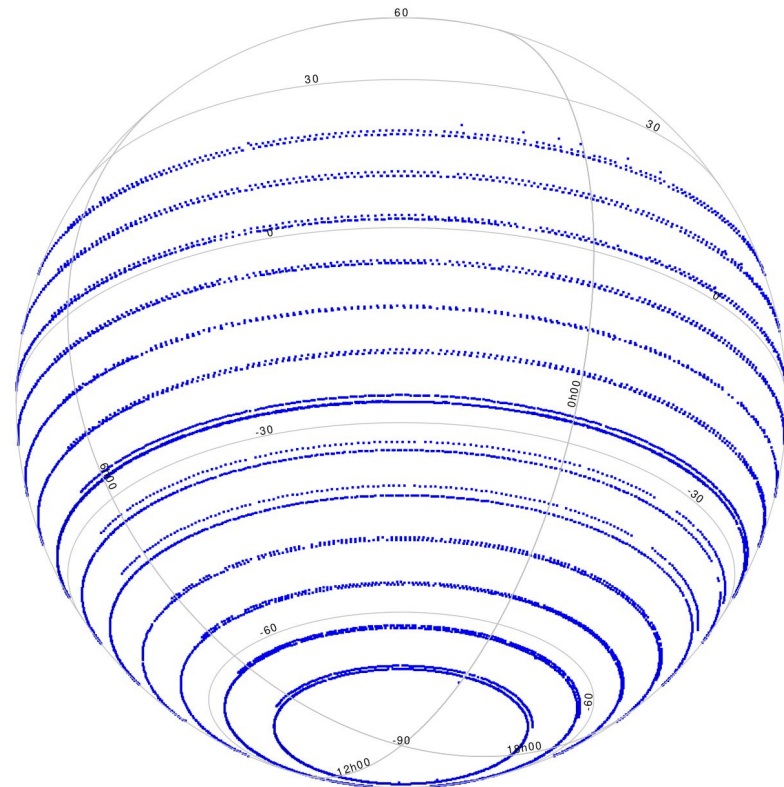
The Galactic and Extragalactic All-sky MWA survey

- 72-231 MHz in five frequency bands (88, 118, 154, 185, 216 MHz)
- Meridian drift-scan observing strategy
- 2-min observations - stacked to form deeper mosaics
- Wideband (60 MHz) image created as a reference (at 200 MHz)
 - Source-finding done with respect to this image
 - Median rms = 9 mJy/beam
 - Median resolution = 137" x 131"
 - 307 455 components (excluding GP)
- See Wayth+2015 and Hurley-Walker+2017



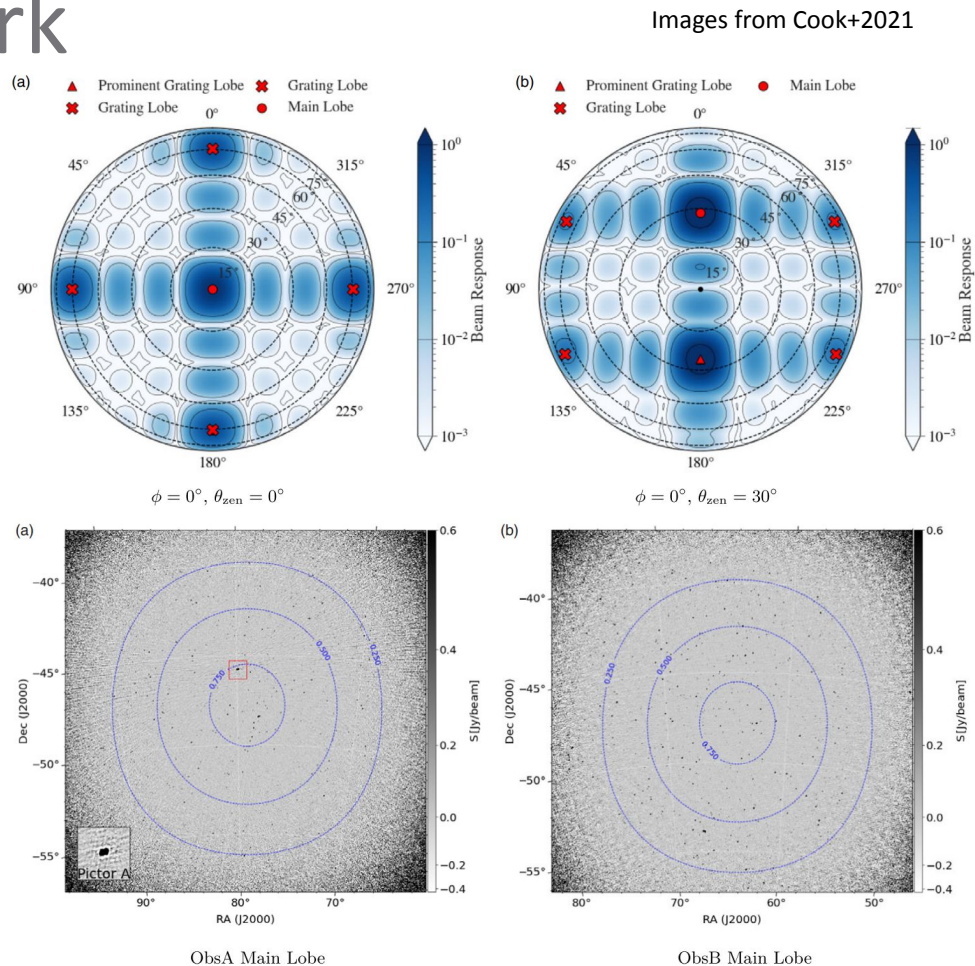
The 300 MHz observations

- Taken between 2015-2016 - Phase I data
- Similar to GLEAM, but 13 declination strips
- 12 000 snapshots
- No observations covering the South Celestial Pole**
- Typically 5 nights of observing per declination strip



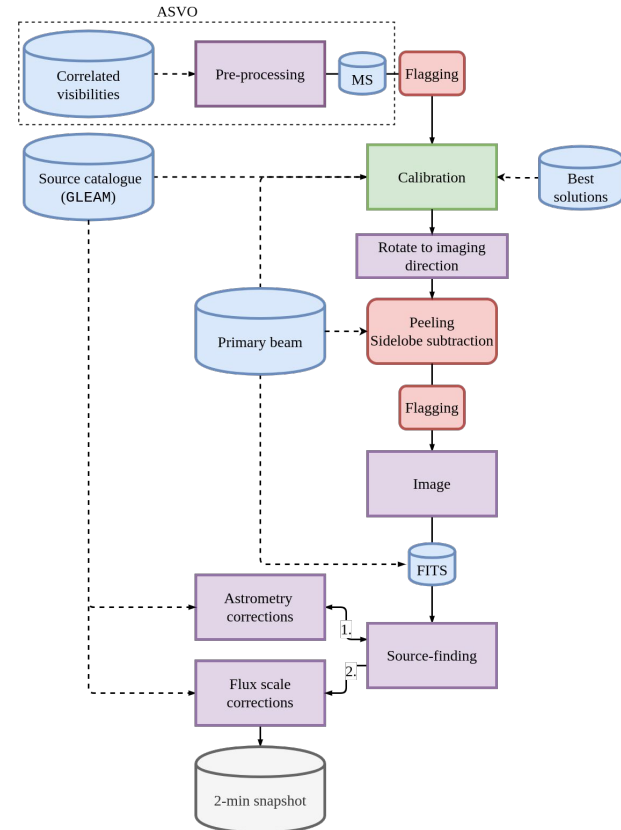
Previous 300 MHz work

- Jaiden Cook et al., 2021 (10.1017/pasa.2021.55)
- A proof-of-concept to calibrate and image 300 MHz using dedicated calibrator observations of Pictor A
- Multi-frequency sky model
- Imaging of sidelobes for subtraction
- ~ 2.3 by 2.1 arcmin resolution
- ~ 30 - 50 mJy/beam noise



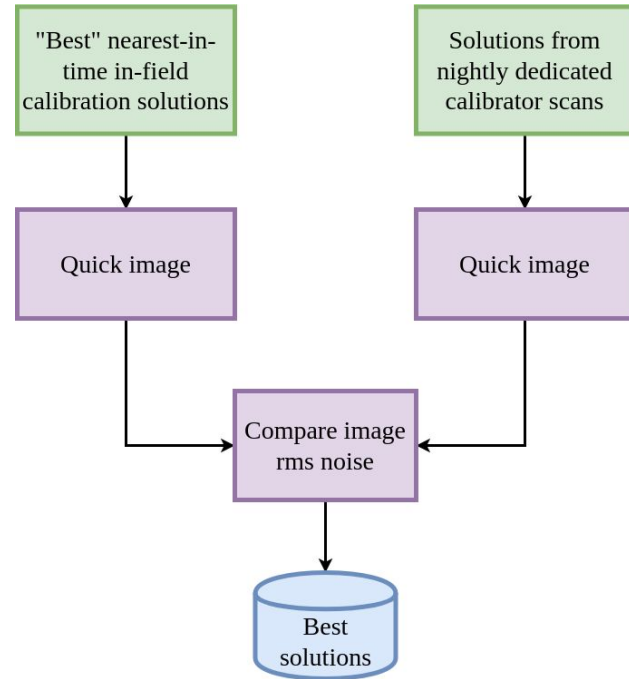
A “standard” continuum pipeline

- Fairly standard MWA continuum imaging pipeline
- More tedious calibration strategy**
- Lots of flagging - automated CASA flagging tasks do a lot of work
- Peeling of bright sources and sidelobe subtraction one of the longest steps
- Standard imaging
- Post-imaging corrections include brightness scaling**
- All processing on Garrawarla and Setonix (CPU-only)



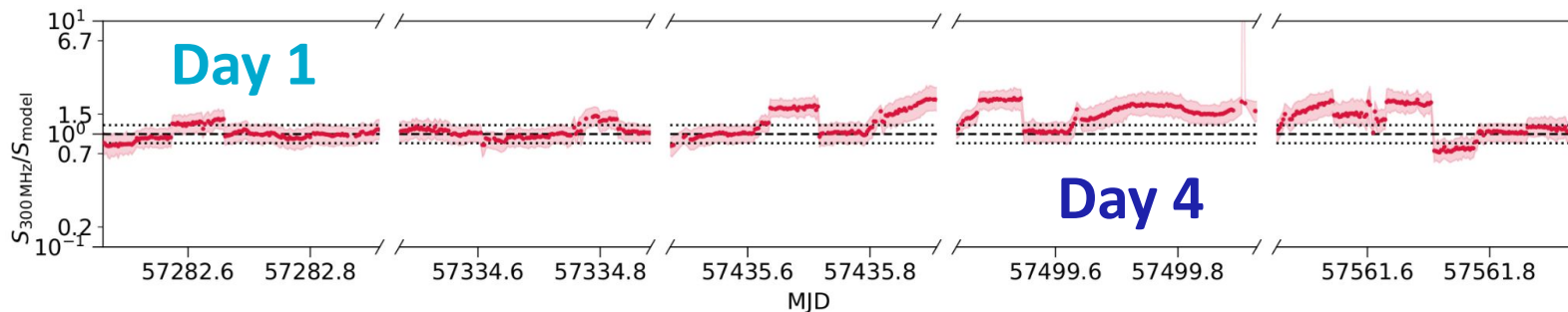
The calibration strategy

- Using a GLEAM-based local sky model for each observation
- Test a range of strategies:
 - Nightly dedicated calibration scans work “well-enough” about 40% of the time
 - In-field calibration works “well-enough” about 30% of the time
 - Nearest-in-time solutions work “well-enough” about 30% of the time
- Find the solutions that return the best image (with the lowest rms noise)

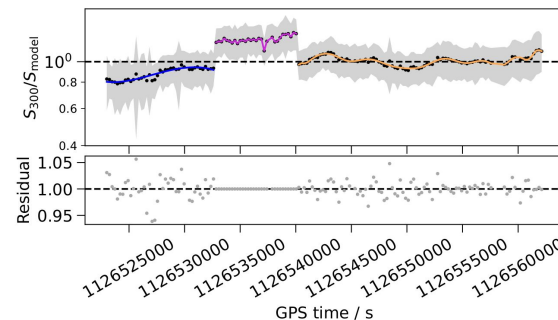


Brightness scaling

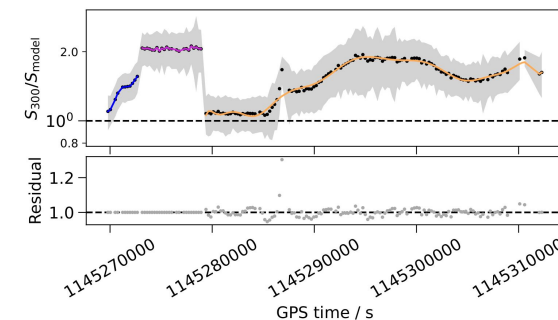
- No significant position-dependent brightness fluctuations per snapshot
- Time-dependent fluctuations
- Almost certainly related to the calibration solutions/sky model
- Cross-match to GLEAM and fit a polynomial to each “chunk” of snapshots



Day 1

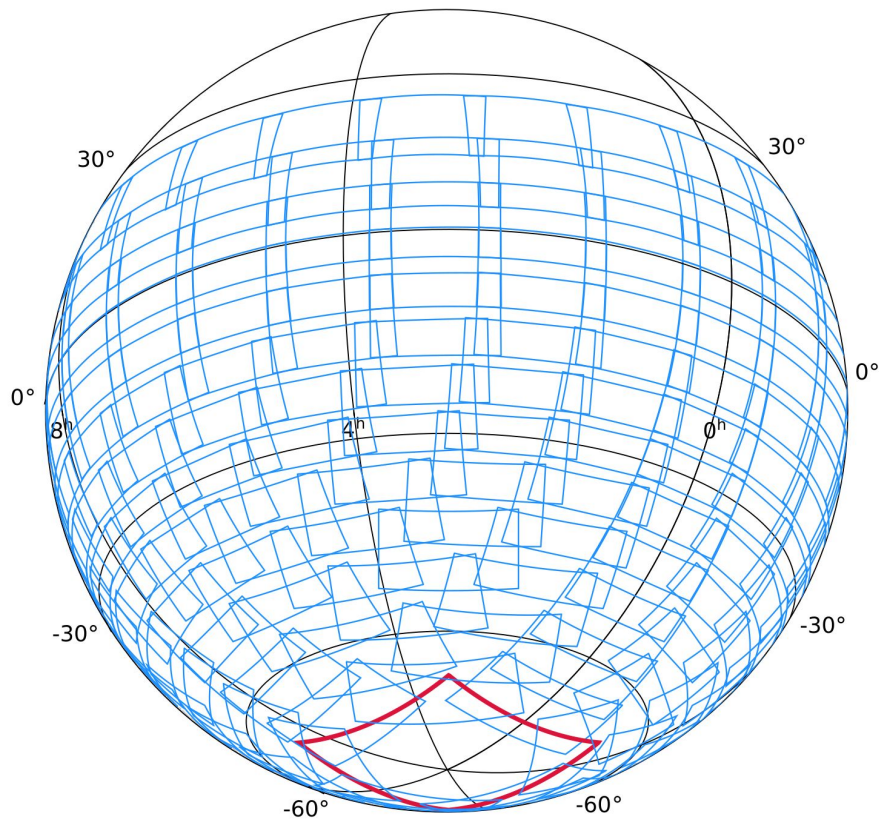


Day 4

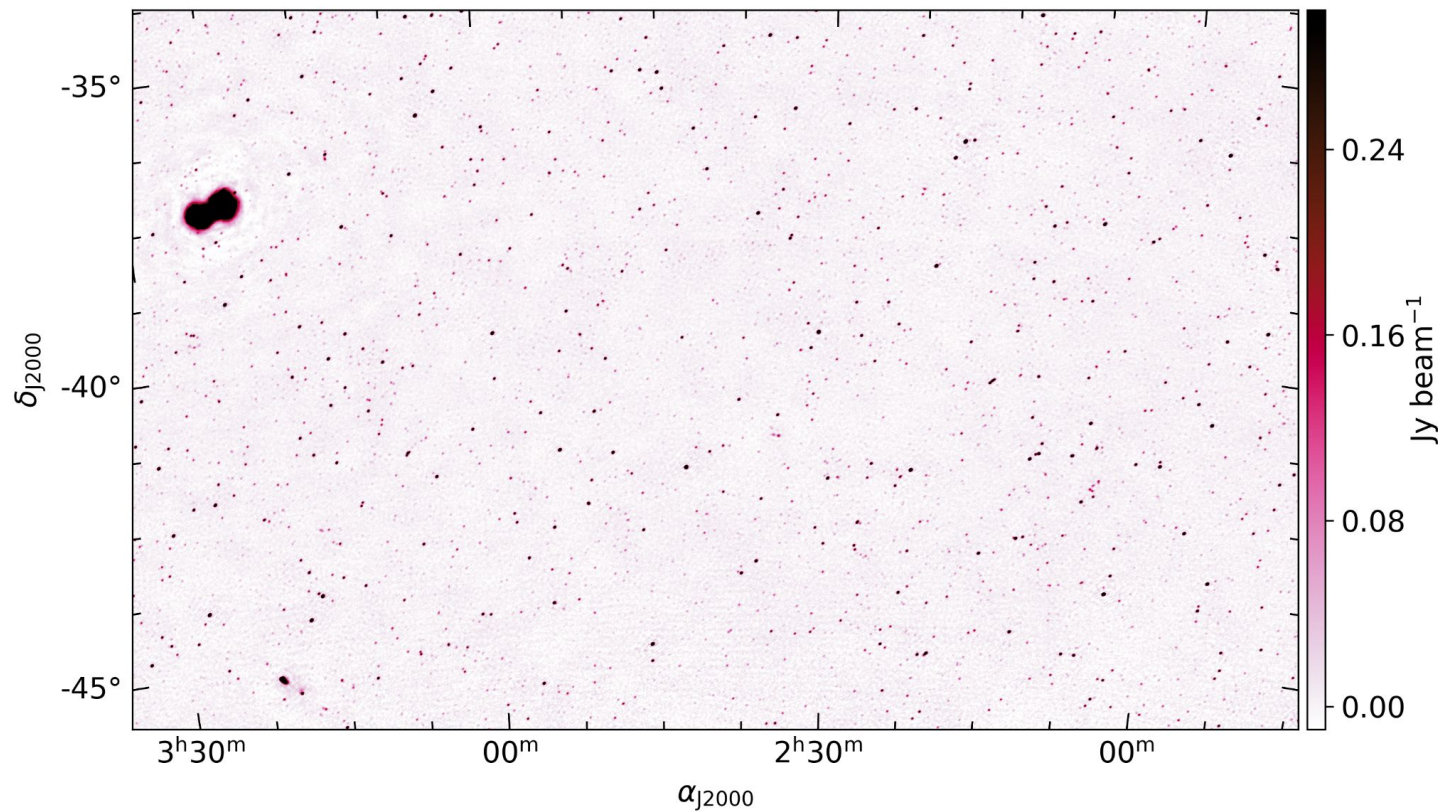


Making mosaics

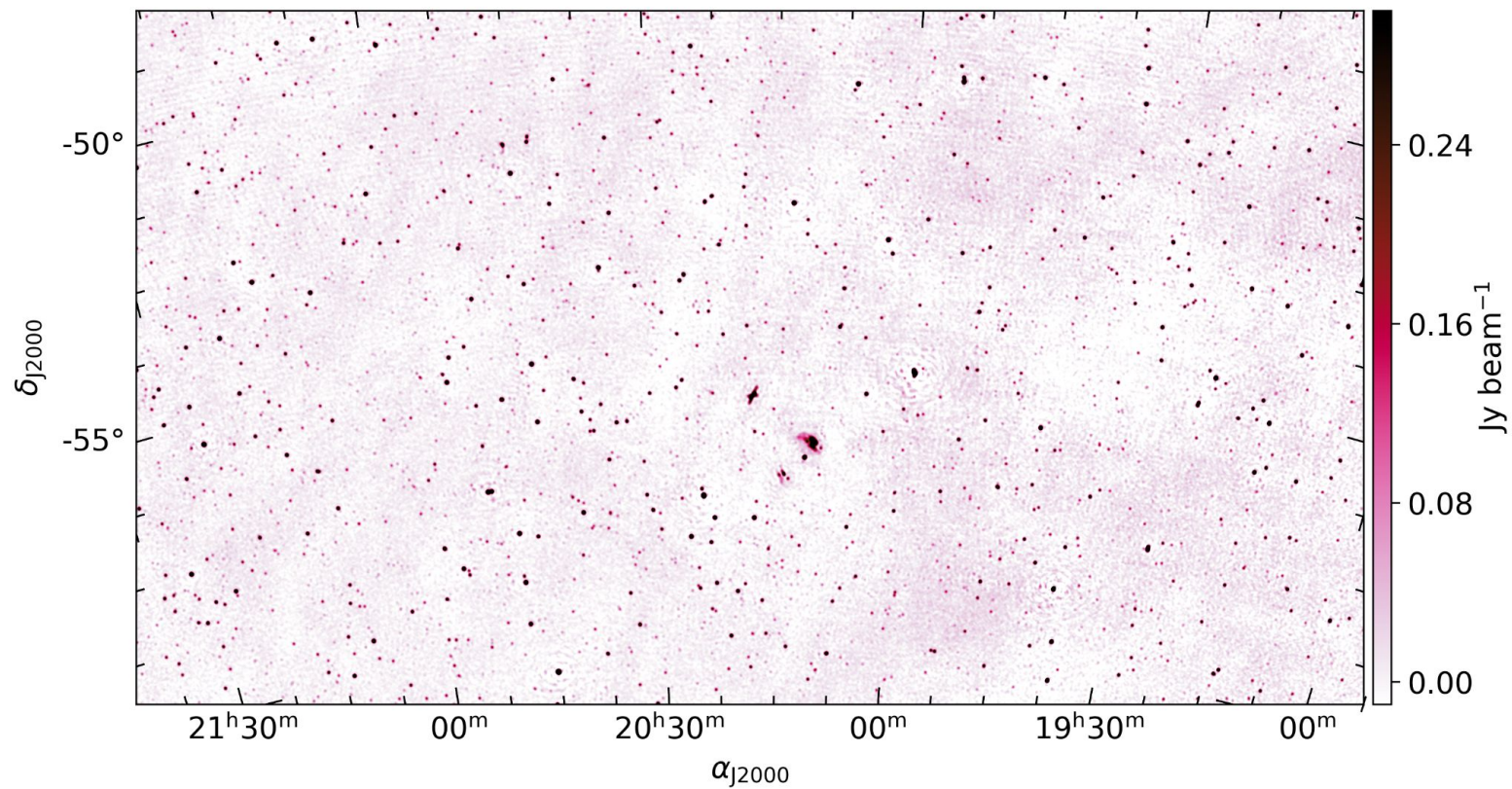
- Stack 2-min snapshots to form linear mosaics
- Use smaller $10 \times 15 \text{ deg}^2$ regions instead of full declination strips
 - Somewhat reasonable as the FoV is small (less overlap)
 - 241 regions for mosaicking
 - 120-480 snapshots per mosaic
- Reject snapshots:
 - with the Moon (there are a few)
 - high rms
 - large PSF
- Convolve all images to a common resolution
- Source-finding with Aegean



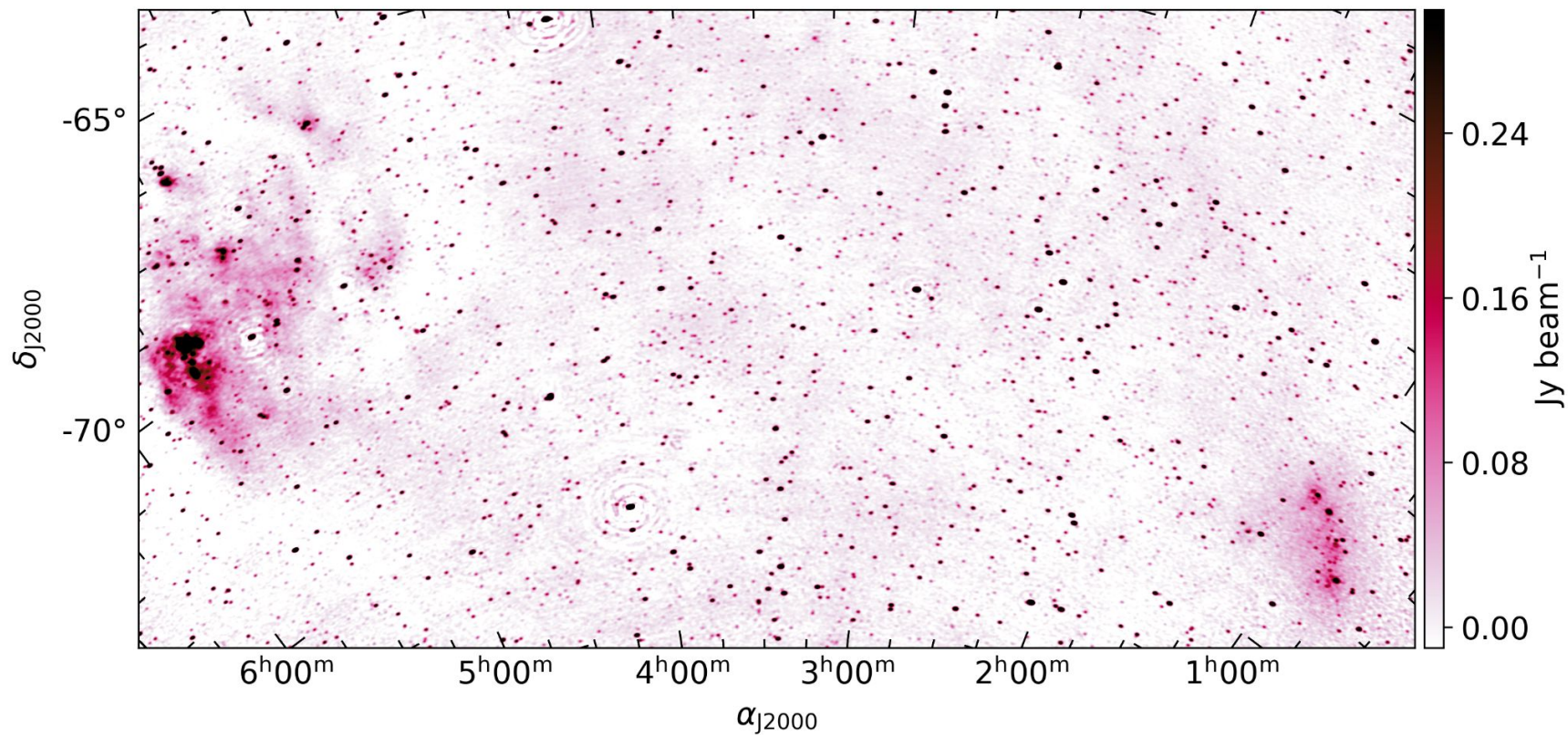
Mosaic examples



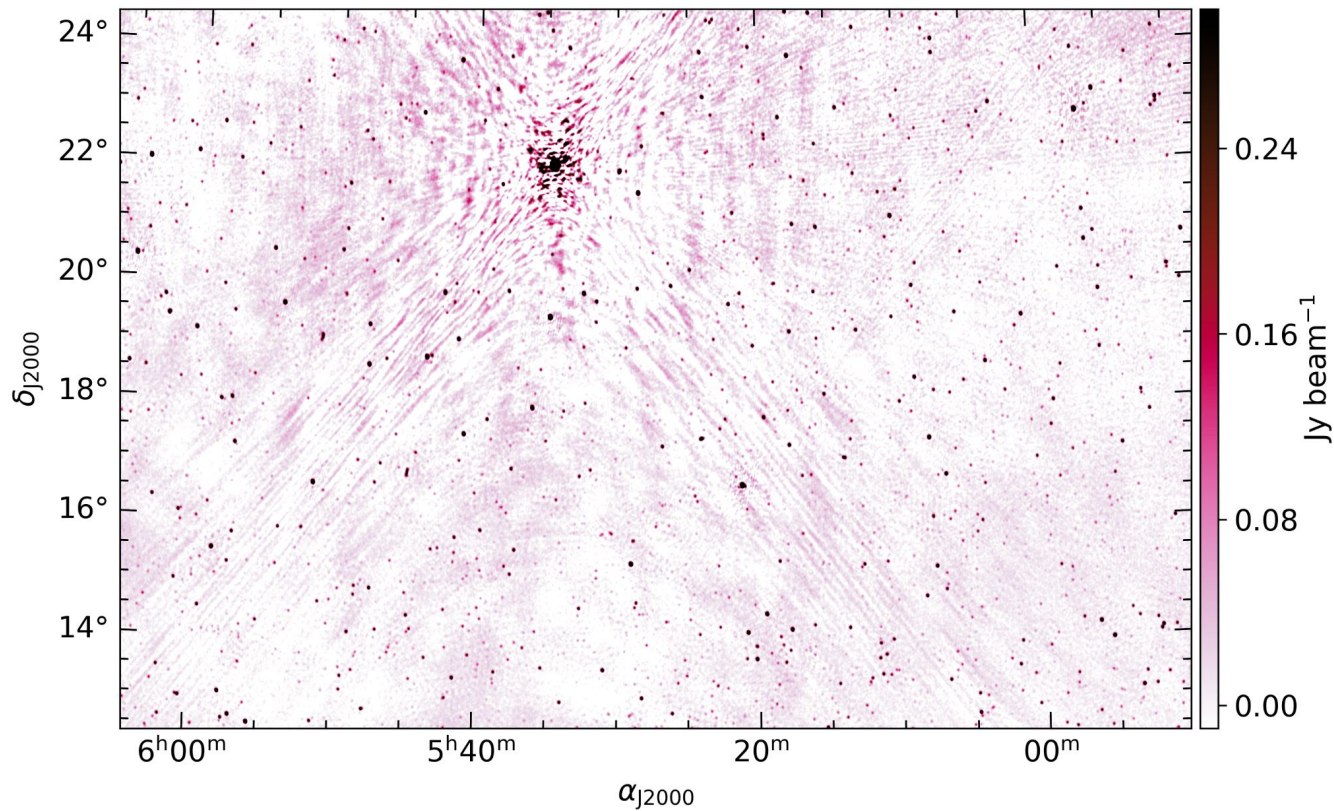
Mosaic examples



Mosaic examples

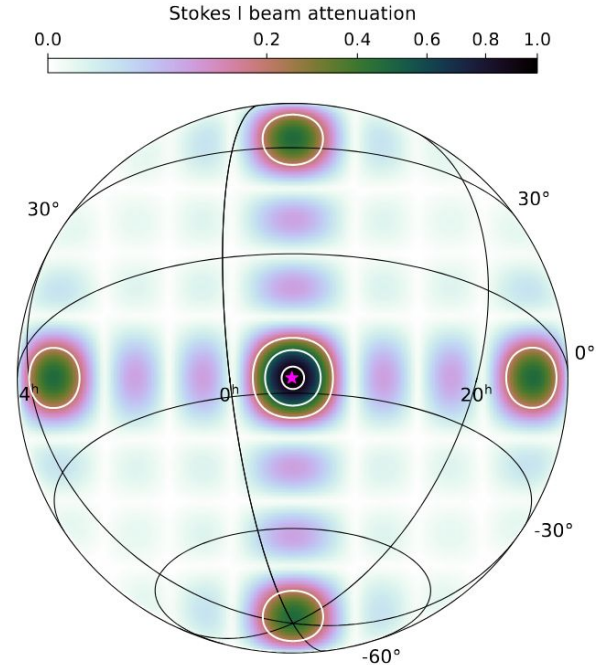


Mosaic bad examples

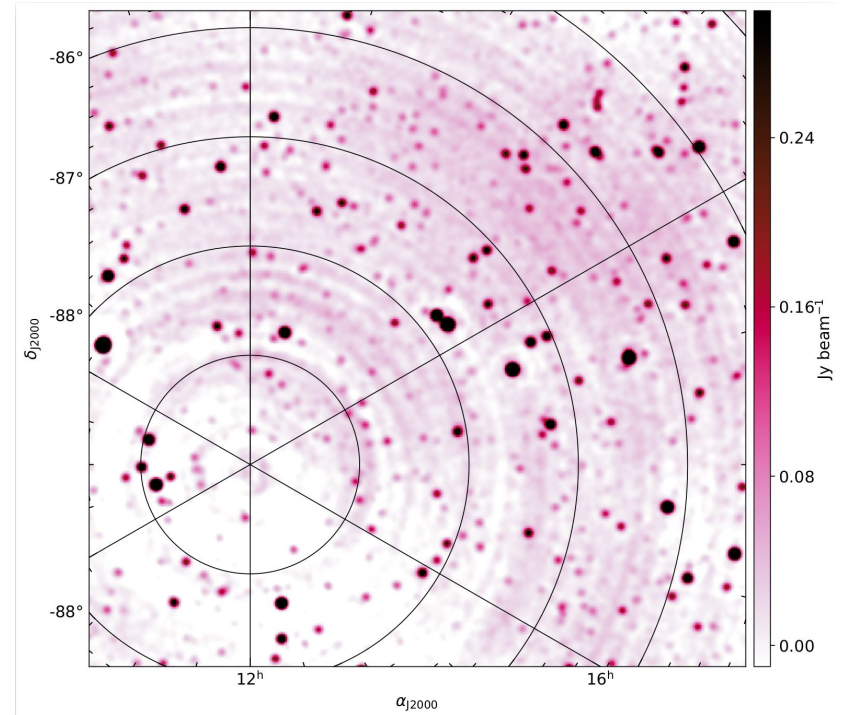
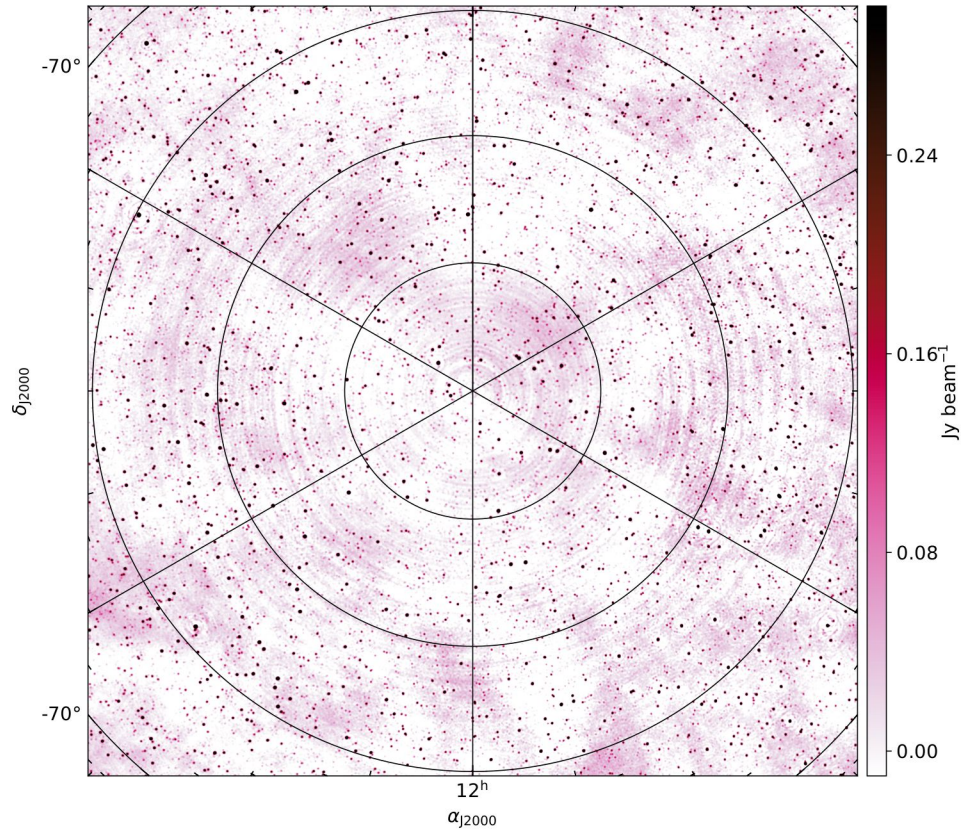


Covering the South Celestial Pole

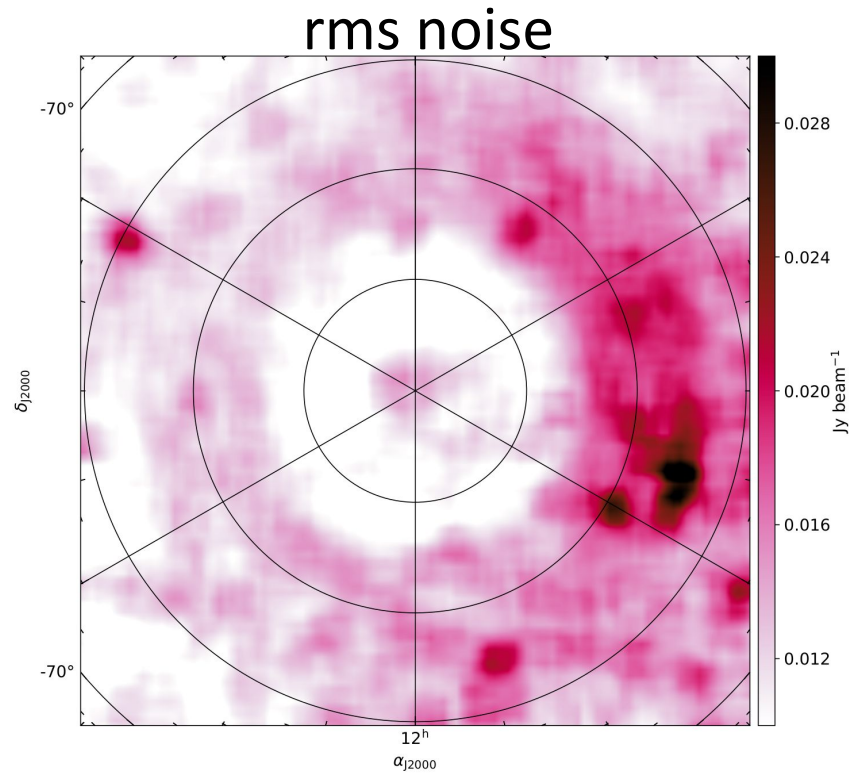
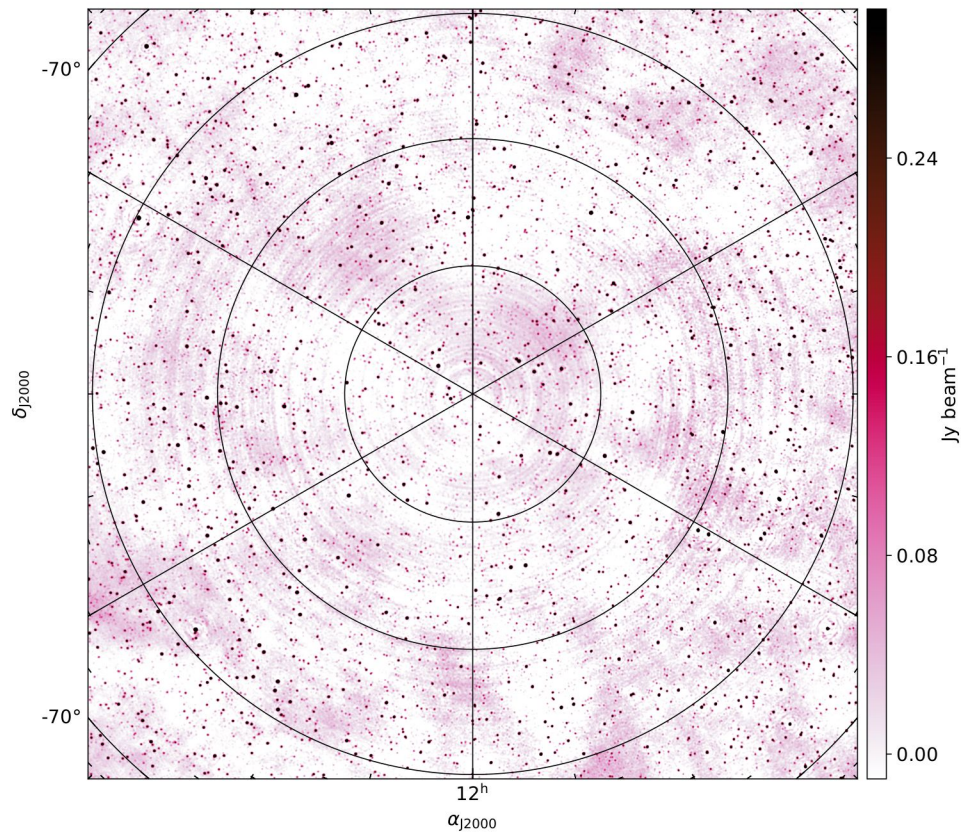
- No pointings covering the SCP
- **However** sidelobes from the dec -27 strip lie at dec -86
- Sidelobes are about 30% the sensitivity, but there is a lot more overlap
- No change to imaging process:
 - apply solutions
 - phase rotate to sidelobe
 - peel and mainlobe/other sidelobe subtraction assuming SCP sidelobe is the main image
 - image as usual



SCP mosaic

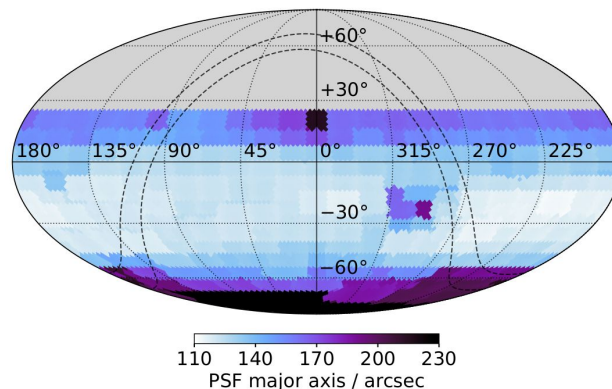
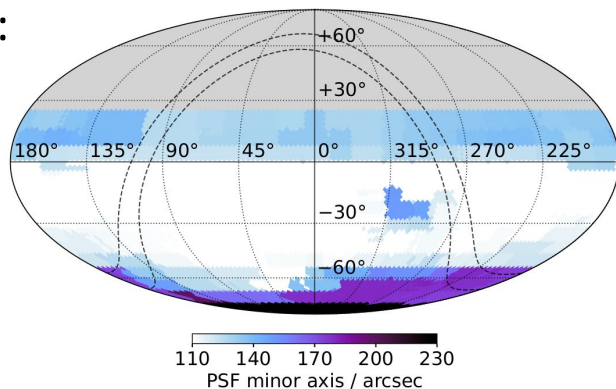
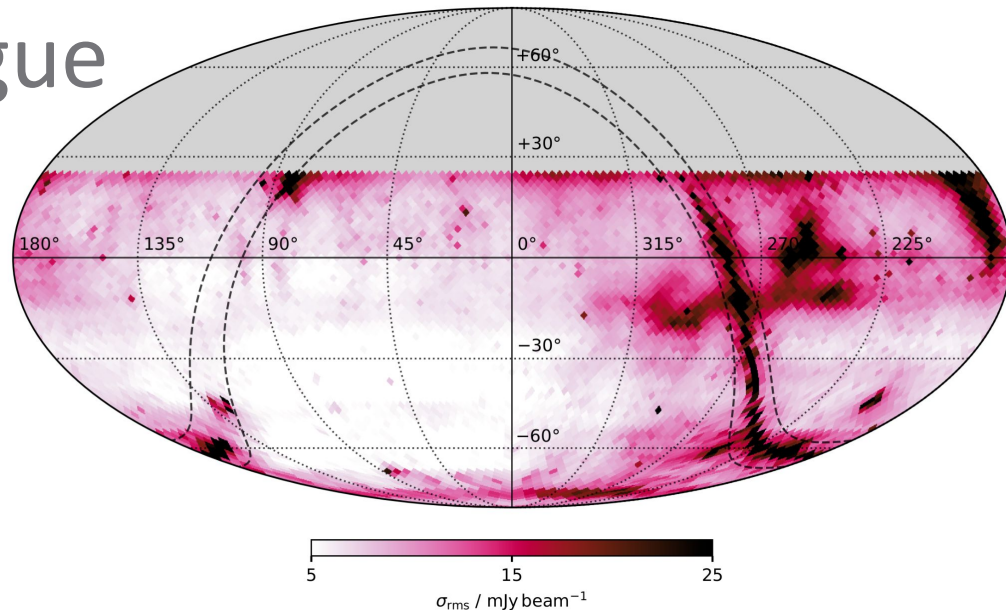


SCP mosaic - sensitivity



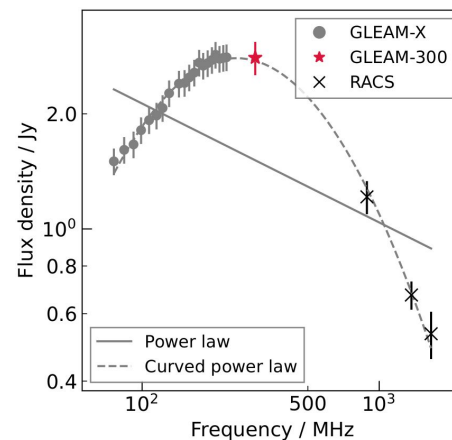
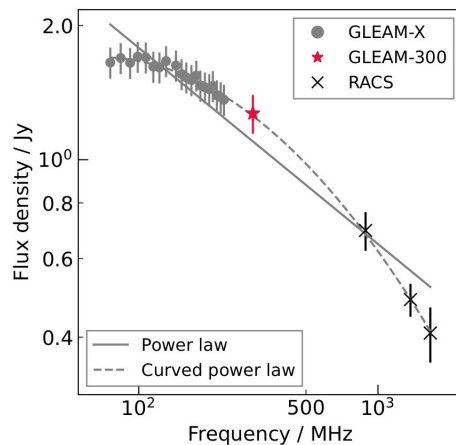
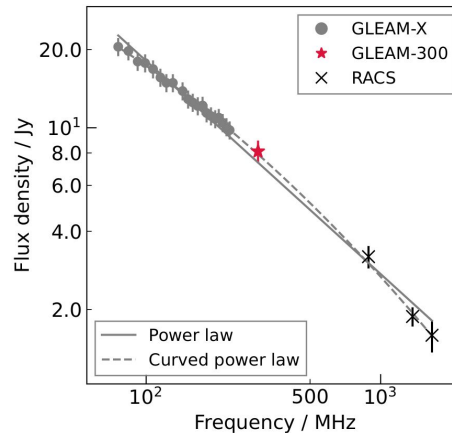
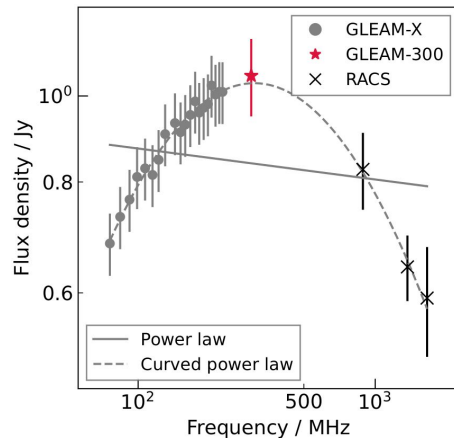
The 300 MHz catalogue

- Source finding on each mosaic
 - merge source lists
 - remove duplicate measurements
- 296 219 sources
 - 277 068 with $|b| > 5$
- Median noise: **~7 mJy/beam**
- Median resolution: **127" x 111"**



Some basic QA

- Check against GLEAM and other near-300 MHz catalogues
 - Texas Survey (365 MHz), VCSS (340 MHz), WISH (352 MHz), MRC (408 MHz)
 - astrometry looks normal
 - brightness scale fine at high SNR
- Cross-match to GLEAM-X and RACS
 - only isolated compact sources
 - fit generic power law models

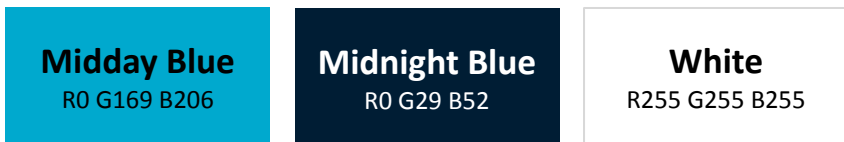


Next steps?

- Validation!
 - Careful checking of the flux density scale may require dedicated observations like original GLEAM - uGMRT?
 - Flux density of extended sources? The Galactic Plane looks poorer than it should
- Source-finding changes?
 - Priorised fitting using original GLEAM catalogue?
 - Incorporate artefact rejection based on proximity to bright sources
- Where to put the data?
 - 242 mosaic images
 - HiPS image collection
 - 1 catalogue
- Feather with GMIMS low-band south???

Use the CSIRO colour palette

Core colours – should be dominant across the presentation



Primary colours



Secondary colours – recommended for graphs, or when all core and primary colours have been used



Core colours – For text, pull out boxes and diagrams





Thank you

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