Slow transients with the MWA

in Pictor A field and EOR fields

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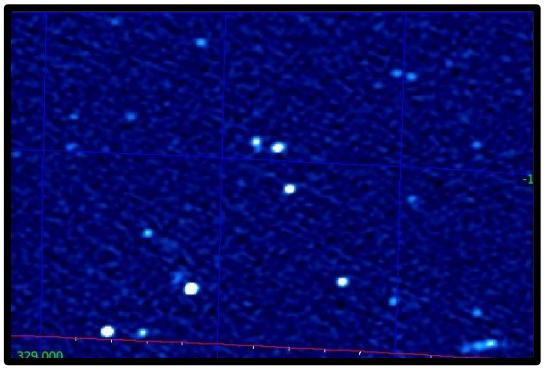
Ephemeral Universe Workshop, 13/11/2013, Perth

Outline

Slow transients with MWA 32T prototype



Transients and variables in the EOR field

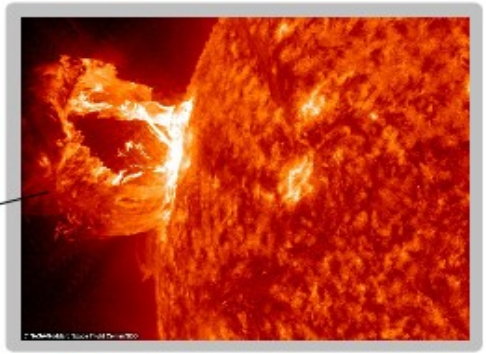
First results with MWA 128T array

Introduction

Slow transients at low frequencies

Matter falling from a star companion onto a black hole – X-ray binary

Internal collapse of a star – Gamma-ray burst, Supernovae



Outbursts from low-mass stars and brown dwarfs

Disruption of stars by black holes - Tidal Disruption Events

TRANSIENTS

slow > 5 seconds, emit at low radio frequencies

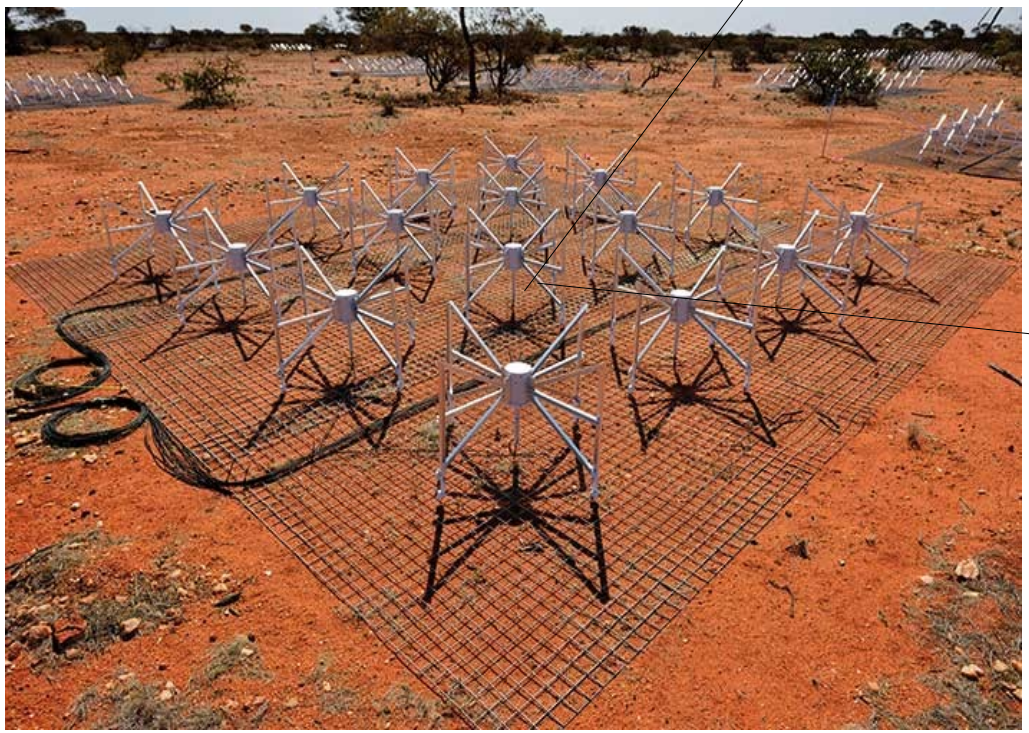
Flares from exoplanets – planets outside our Solar system

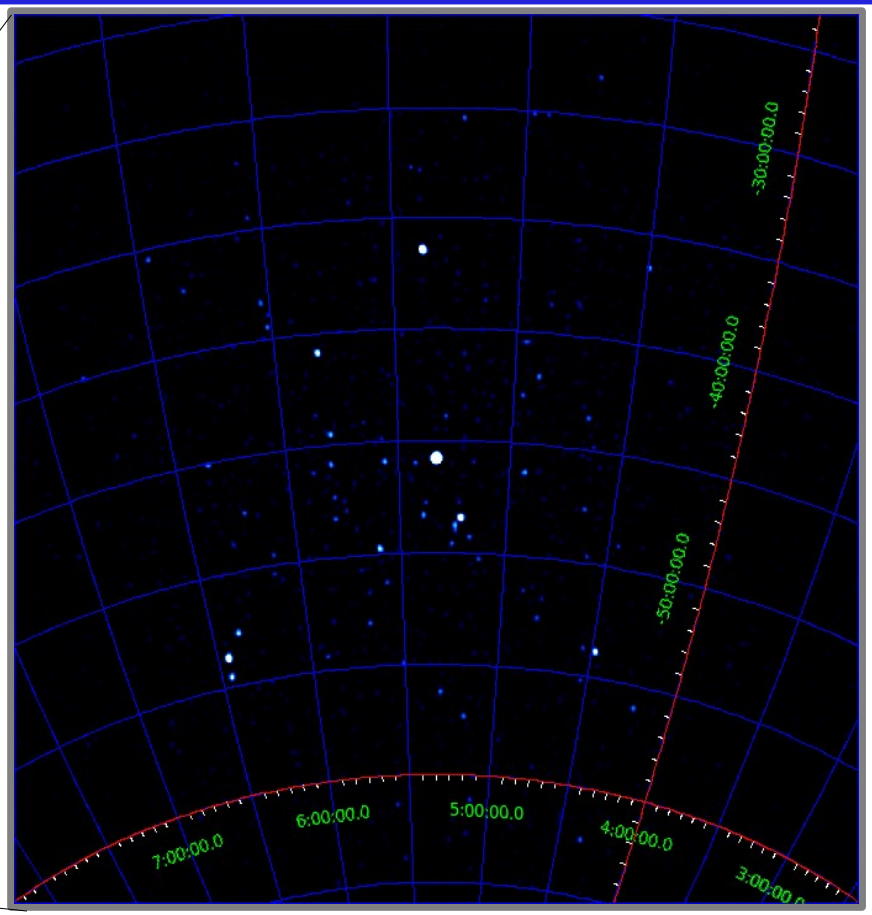
Matter falling onto a super-massive black hole in the centre of a galaxy – Active Galactic Nuclei

Exploration of unknown – not yet discovered transient events

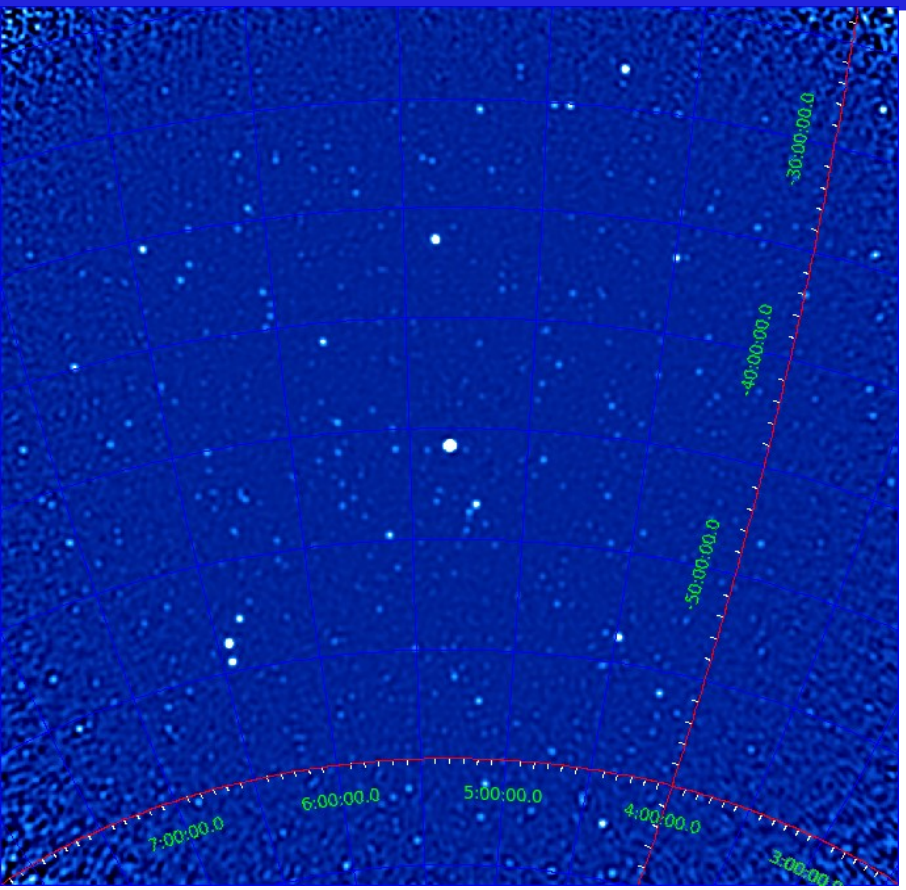
MWA 32T observations

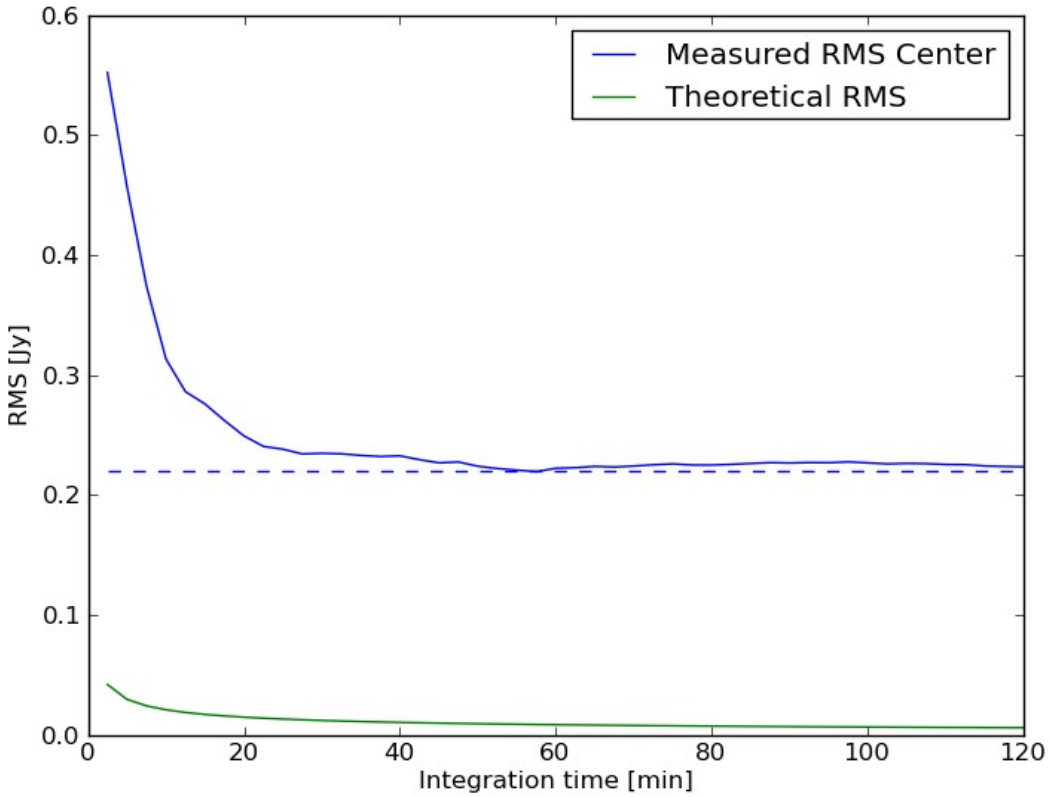
- 116 snapshots at 154 and 185 MHz
- Between March 2010 and September 2011
- 30 degrees field of view
- 7.5 hours of observations total





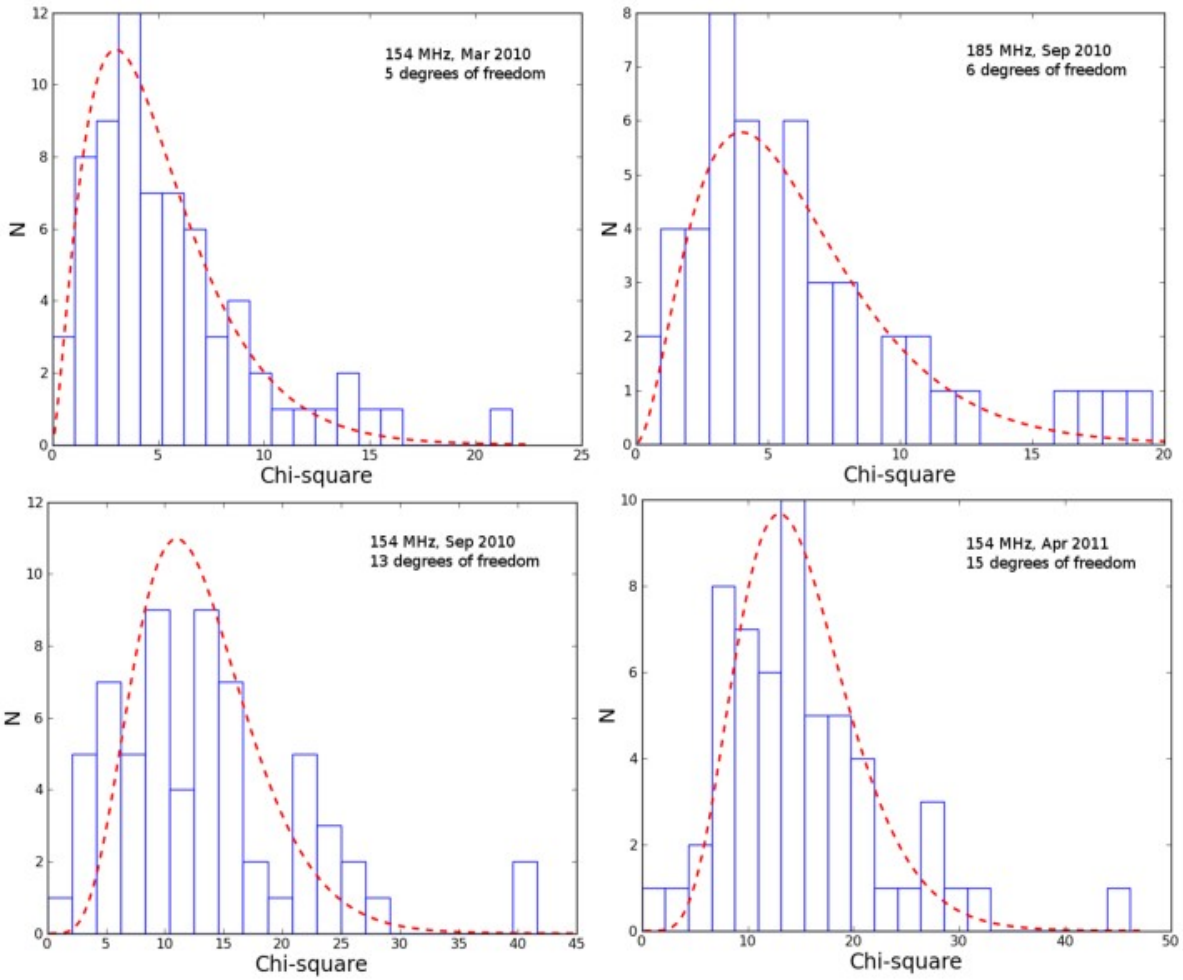
MWA 32T Observations





- Noise levels 300 – 400 mJy
- Resolution: 18 arcminutes
- Confusion limit = 220 mJy
- Snapshots are confusion limited

Variability: minutes-days



- ~70 sources monitored

  Found four sources variable on timescales minutes-days:

- MWA J0547-4431 – T-dwarf HIP 38939B in a binary system, orbiting subdwarf B star. Has mass of 38±20 M_{jup}, T_{eff} = 1090±60 K (Deacon et al. 2012).

- MWA J0548-4552 – M-dwarf PM I05487-4555 (Lepine & Gaidos 2011)

- MWA J0548-4817 -

  M-dwarf (Upgren et al. 1972)

- MWA J0534-4456 – binary system with possible NS companion (Geier et al. 2008)

Variability: minutes-days

3 out of 4 variable sources (75 percent) are low-mass cool stars (M and T dwarves). Probability of chance coincidence < 1%.
1 source is in a rare T-dwarf – subdwarf B binary system

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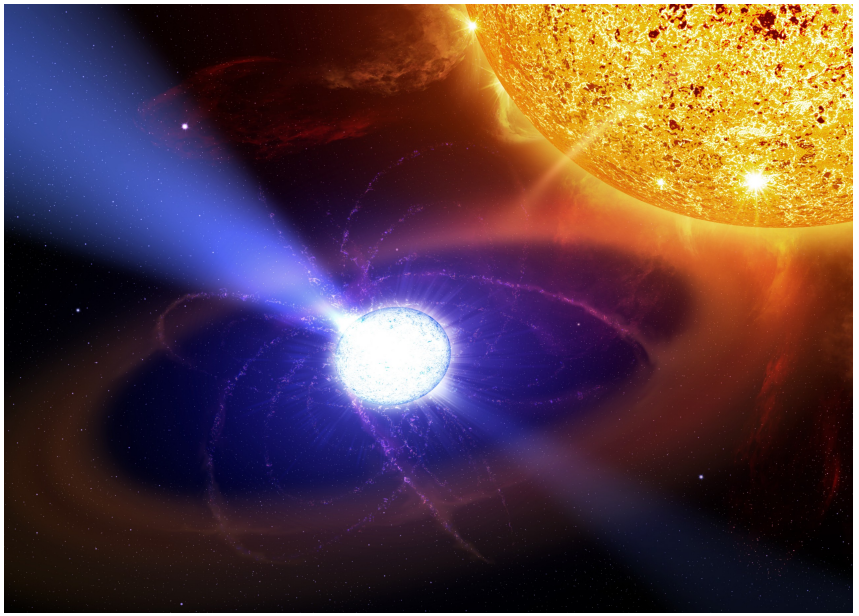
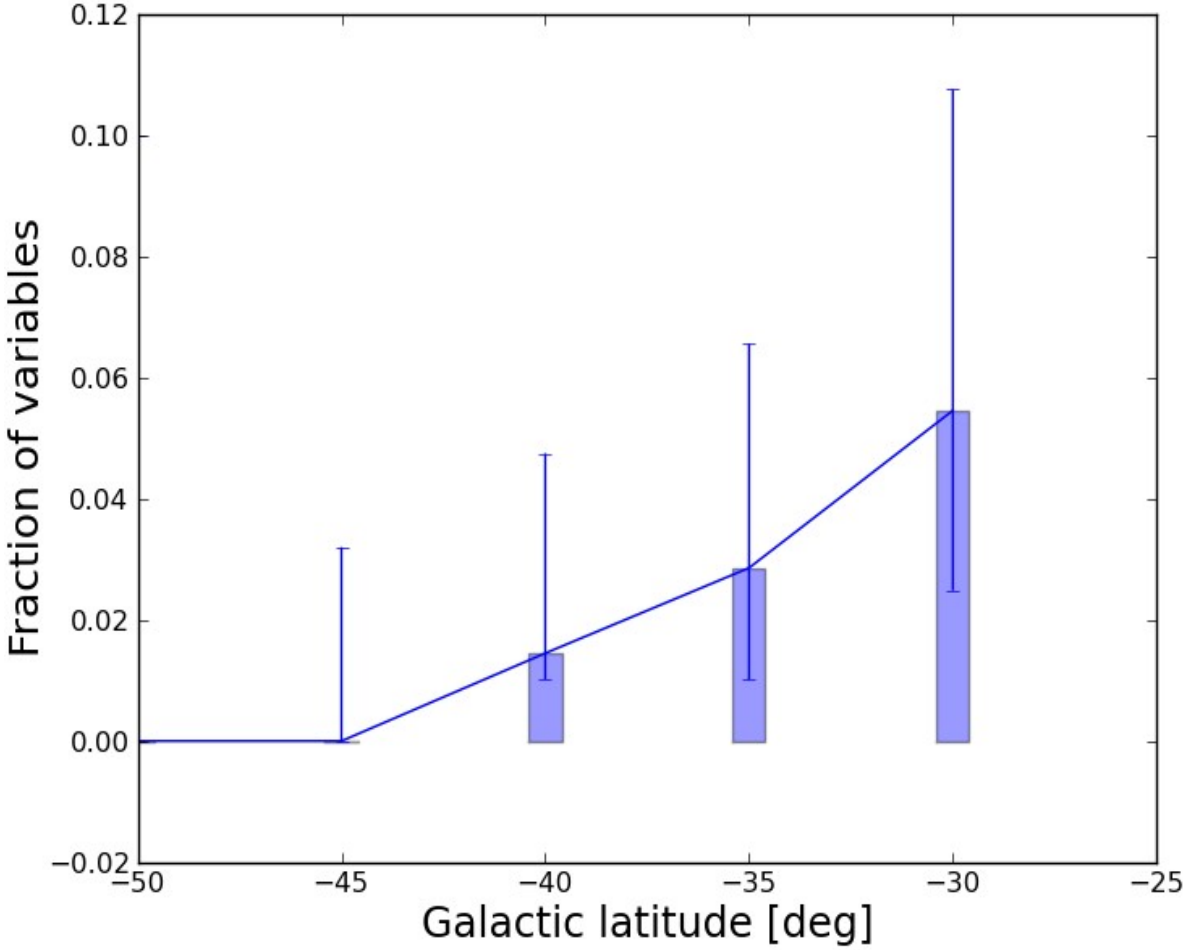
1 source MWA J0534-4456 can be explained with scintillating pulsar. Geier et al. 2008 measured the mass of the companion to be consistent with NS. However no pulsations in radio were detected (Coenen 2011)

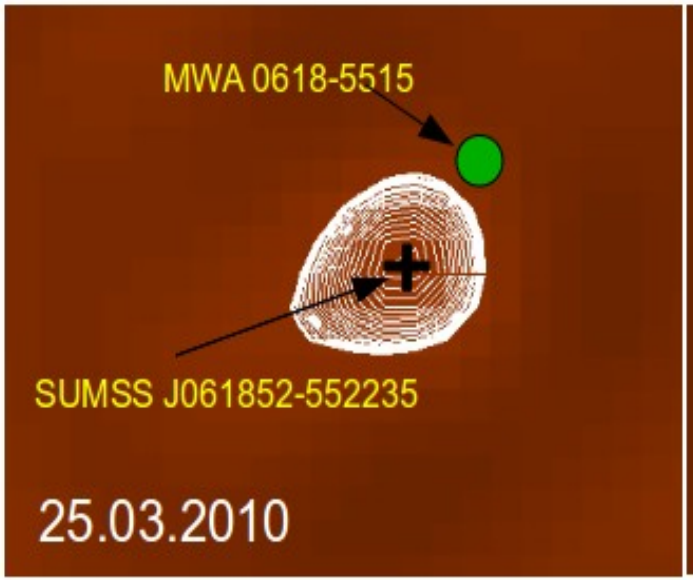


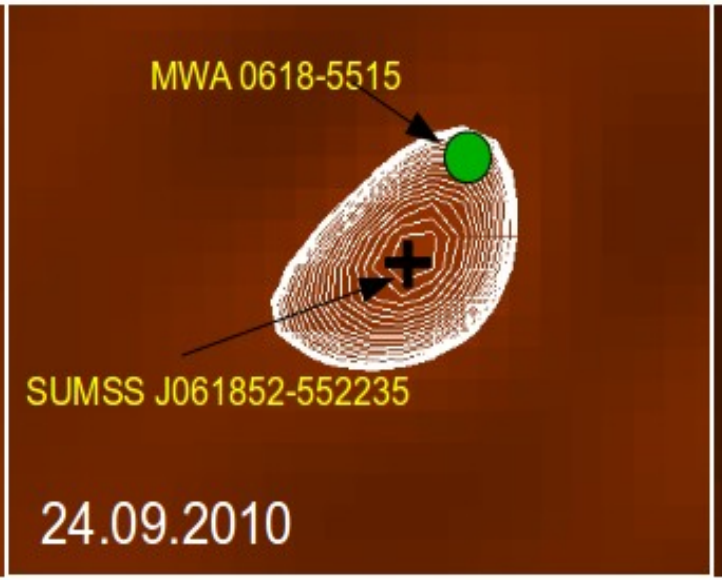
Variability: years

- ~300 sources monitored
- Seven variable sources at 154 and 185 MHz, timescale > 0.5 years
- All sources associated with AGN (Sy1, QSO, Blazars)
- The brightness temperature $T_b > 10^{12}$ K → interstellar scintillation
- Mean fraction of variables: 0.019
- Assuming binomial probability distribution → we rule out uniform distribution of variables with 97.6% confidence

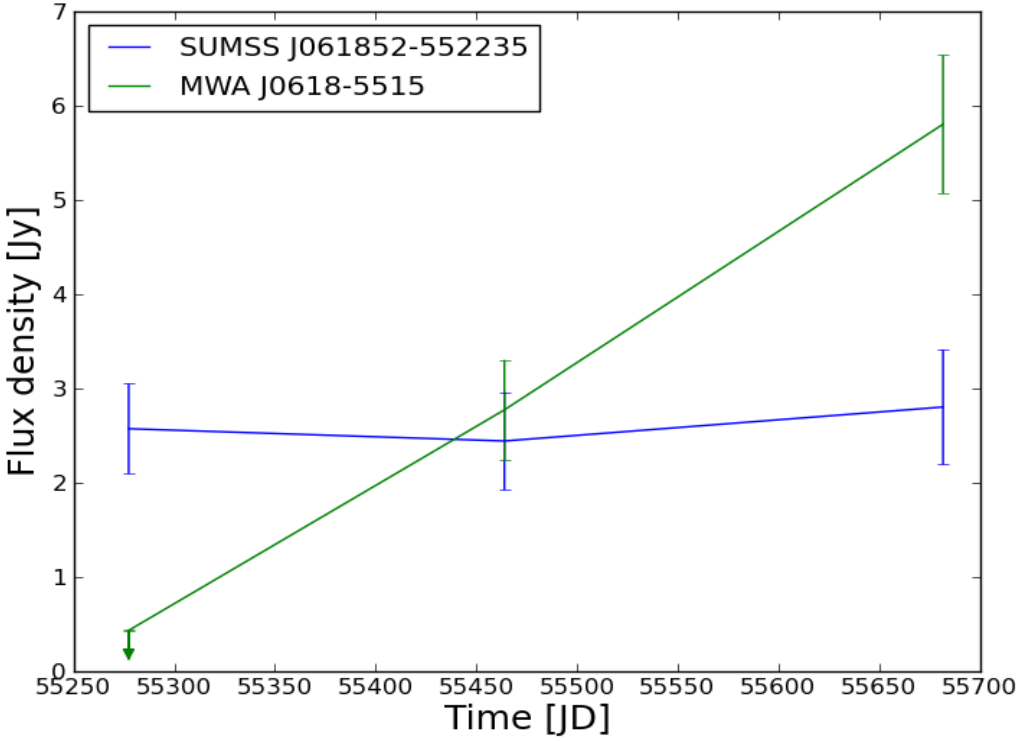


Transients

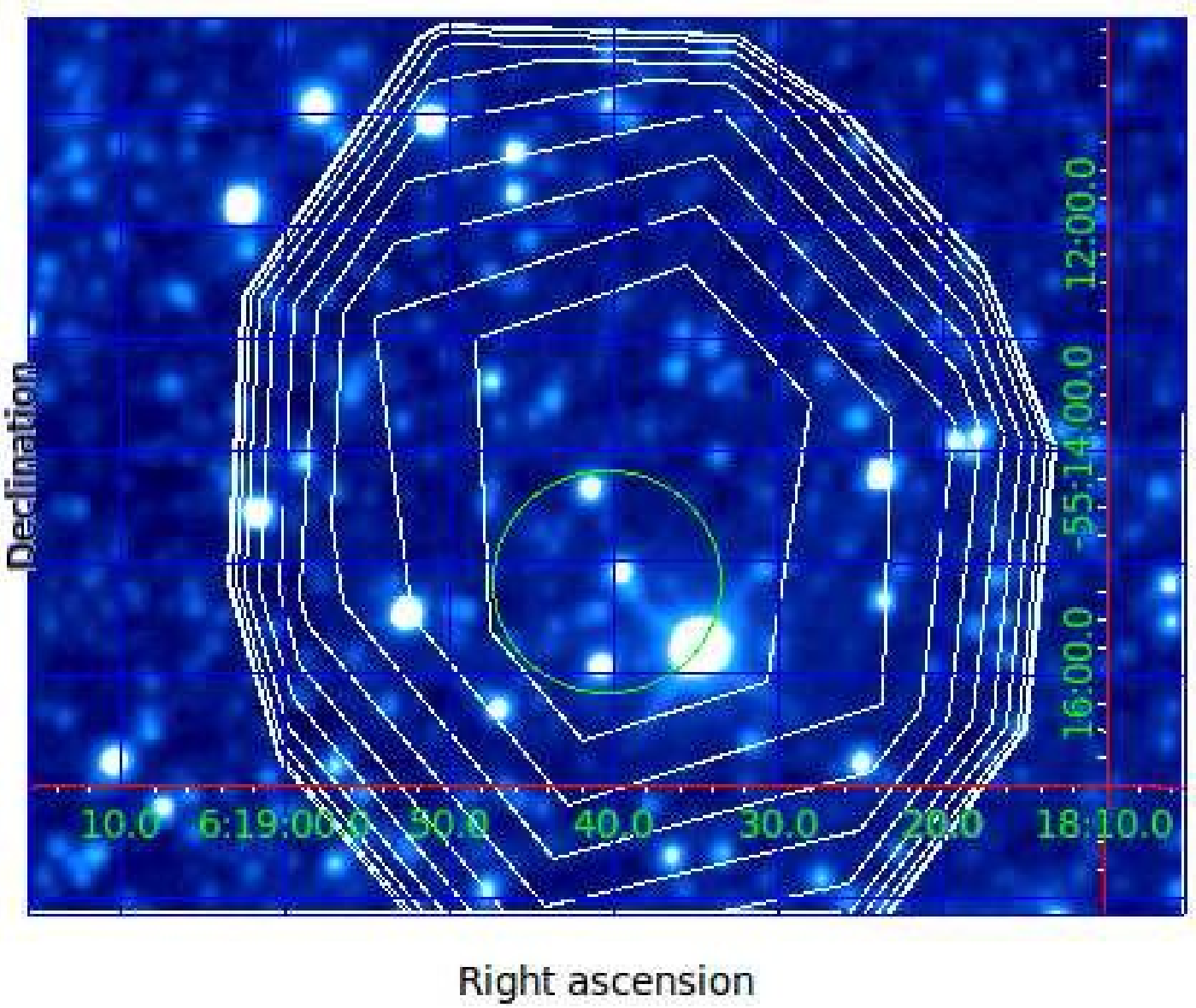




- The variable source at 154 MHz is actually a transient!
- Reaches 5.9±0.3 Jy
- 19 sigmas detection
- Timescale > 1 year → can be AGN, GRB afterglow, tidal disruption event

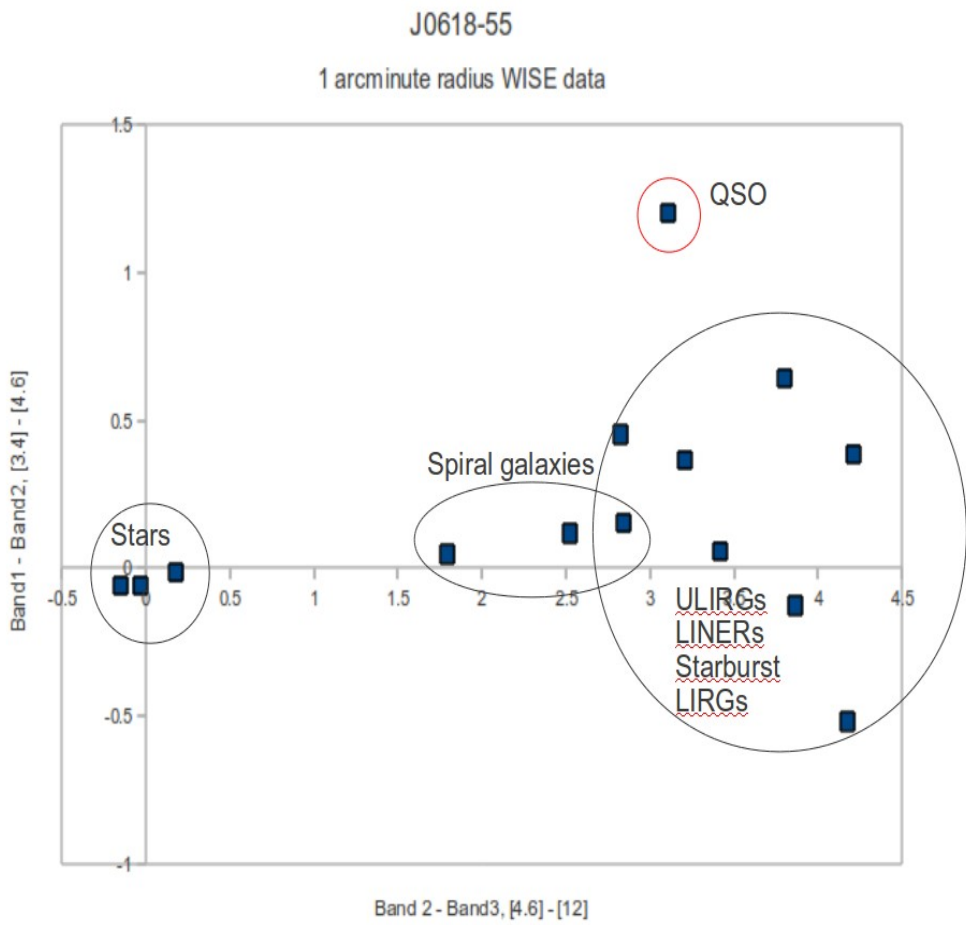


MWA J0618-5515



WISE image centered at MWA J0618-5515. Contours show levels 5 – 5.8 Jy with step Of 0.08 Jy. The green circle shows a typical positional error of 0.84 arcminutes

MWA J0618-5515



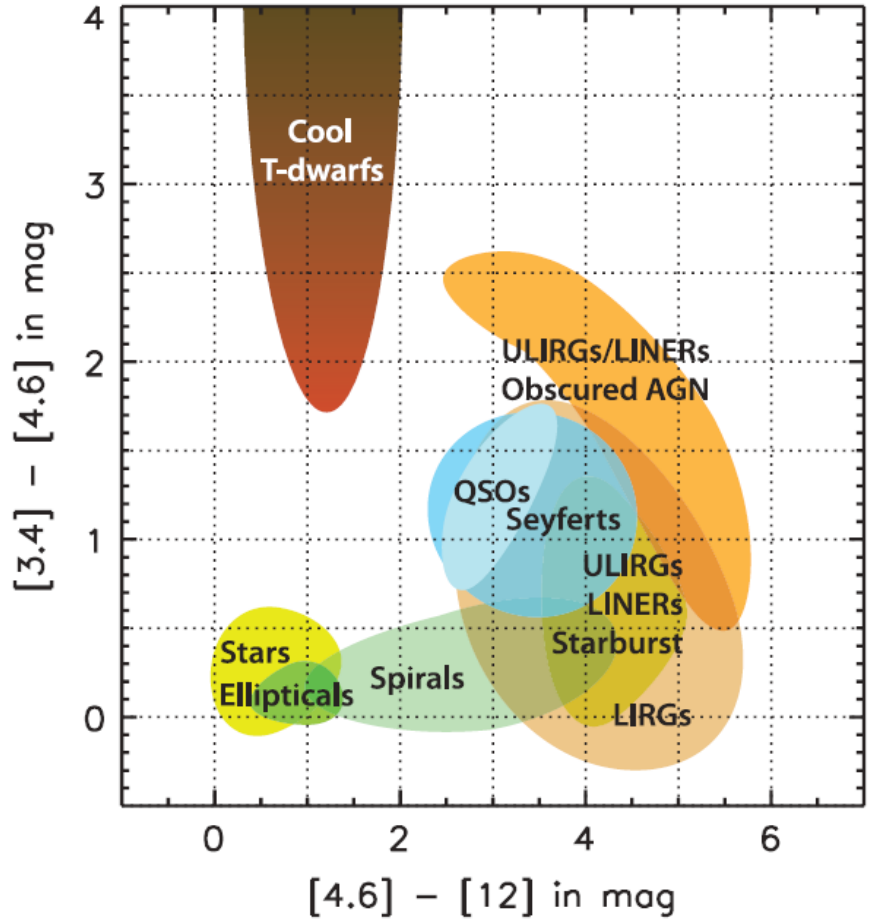


Figure 12. Color–color diagram showing the locations of interesting classes of objects. Stars and early-type galaxies have colors near zero, while brown dwarfs are very red in *W*1–*W*2, spiral galaxies are red in *W*2–*W*3, and ULIRGS tend to be red in both colors.

→ Most likely QSO flare

Wright et al. 2010

Outline

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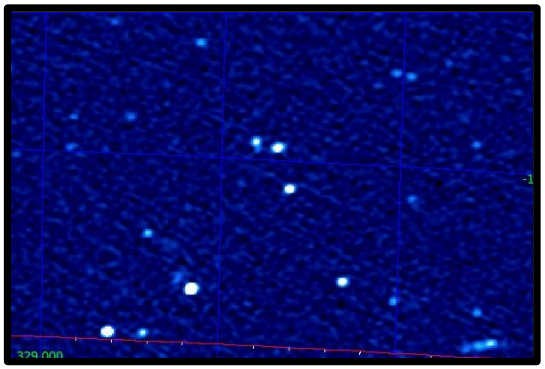


Transients and variables in the EOR field

First results with MWA 128T array

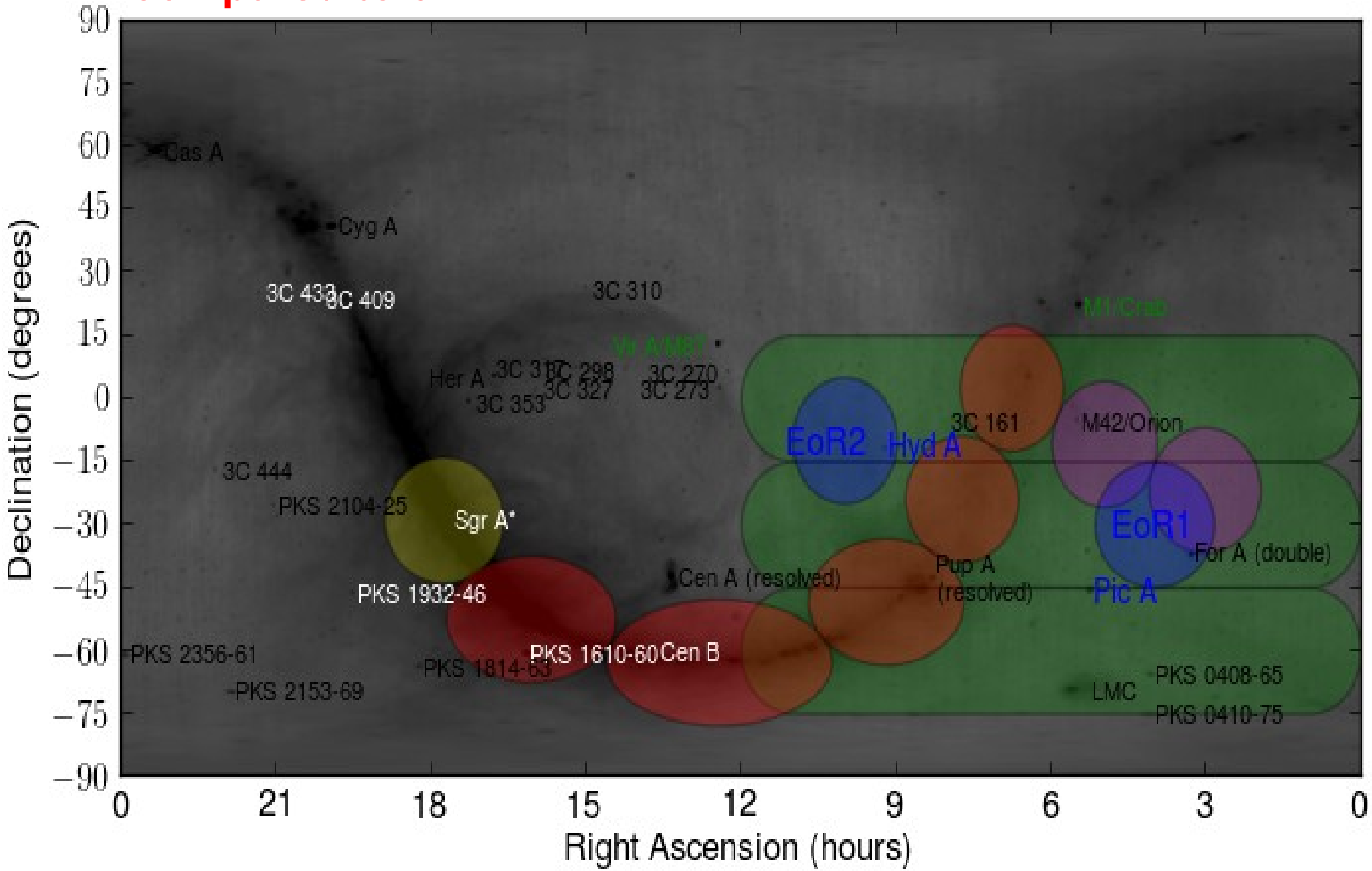
Transient survey in the EOR fields

- 353 hours of guaranteed time approved
- Submitted proposal for 350 hours
- Commensal with the EOR key science project
- Main scientific goals – variability of brown dwarfes, exoplanets, scintillation of AGN, and transient survey with high cadence of observations.

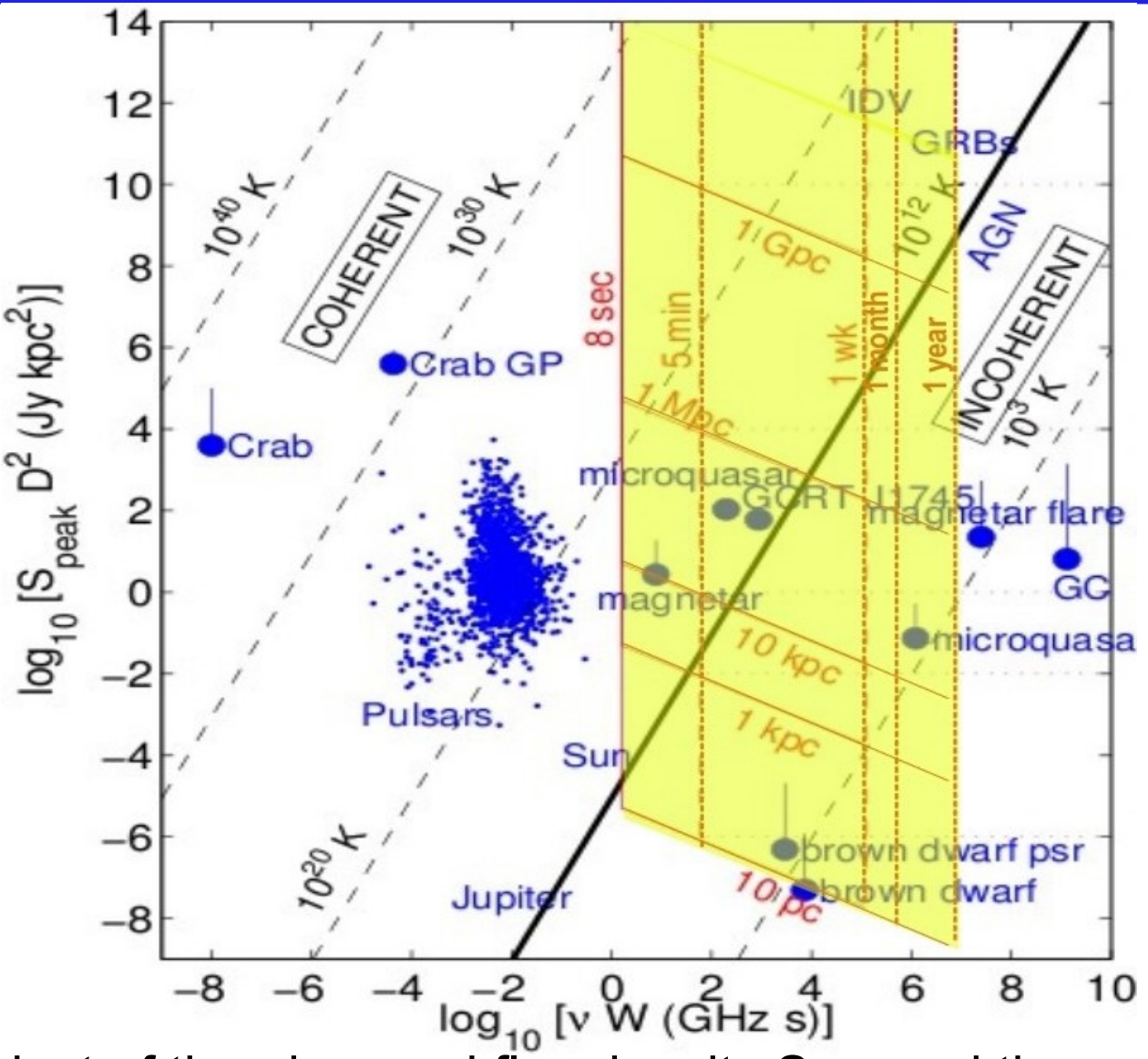
Transient survey in the EOR fields

9 times better resolution
22 times better sensitivity compared to 32T

Tingay et al. 2013, PASA, 30, 7



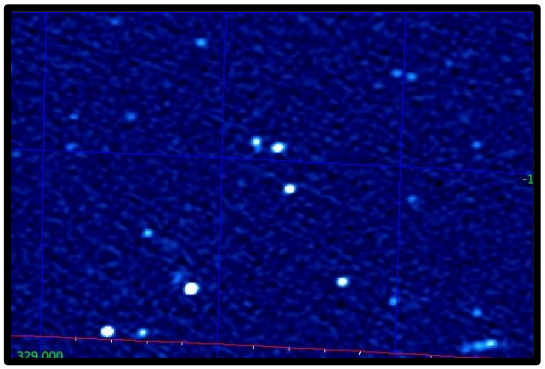
Transient survey in the EOR fields



- Product of the observed flux density S_{peak} and the square of the distance D against the product of the emission frequency and the transient duration W. Figure is adapted from Bowman et al. 2013.

Outline

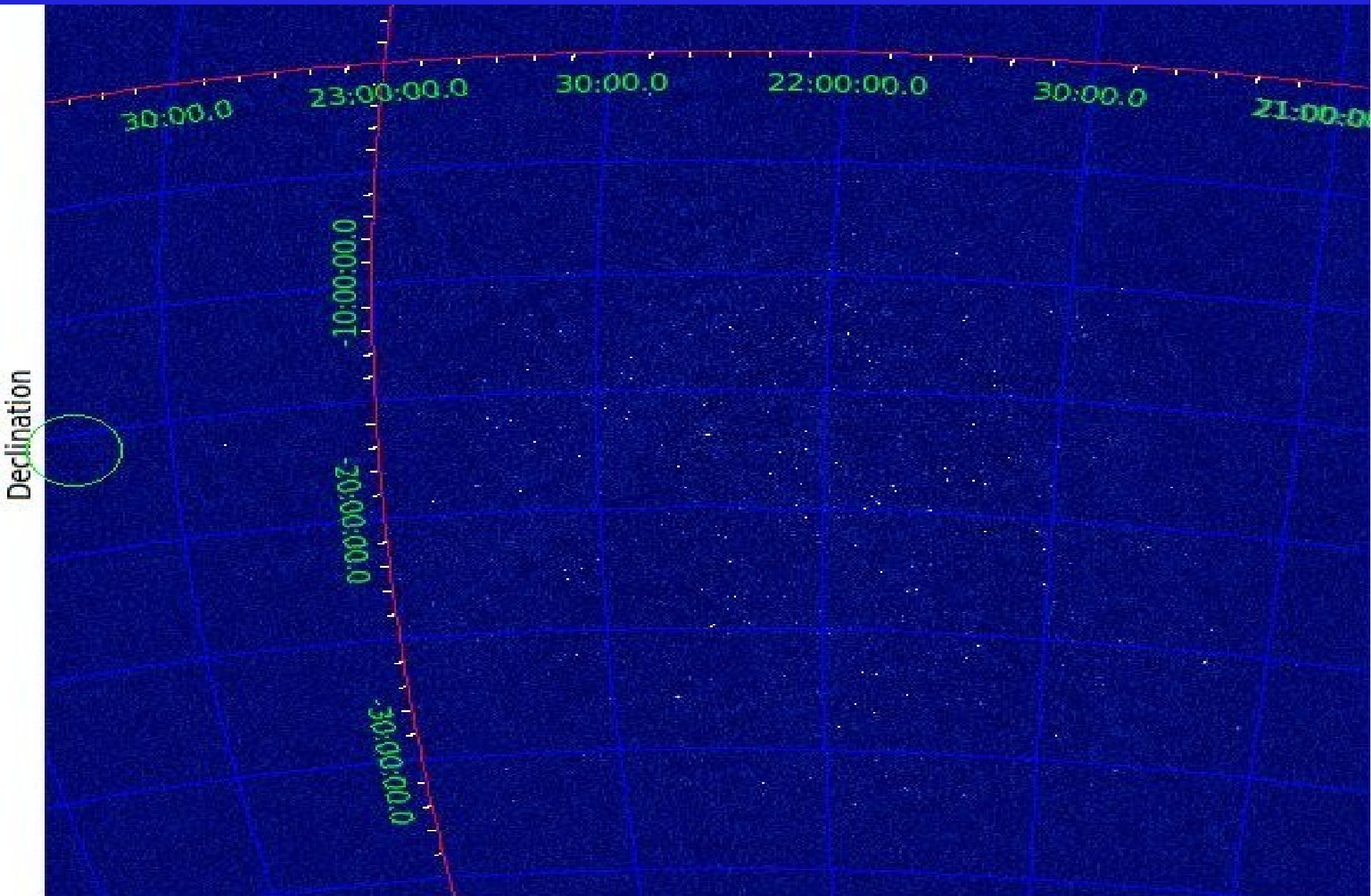
Slow transients with MWA 32T prototype

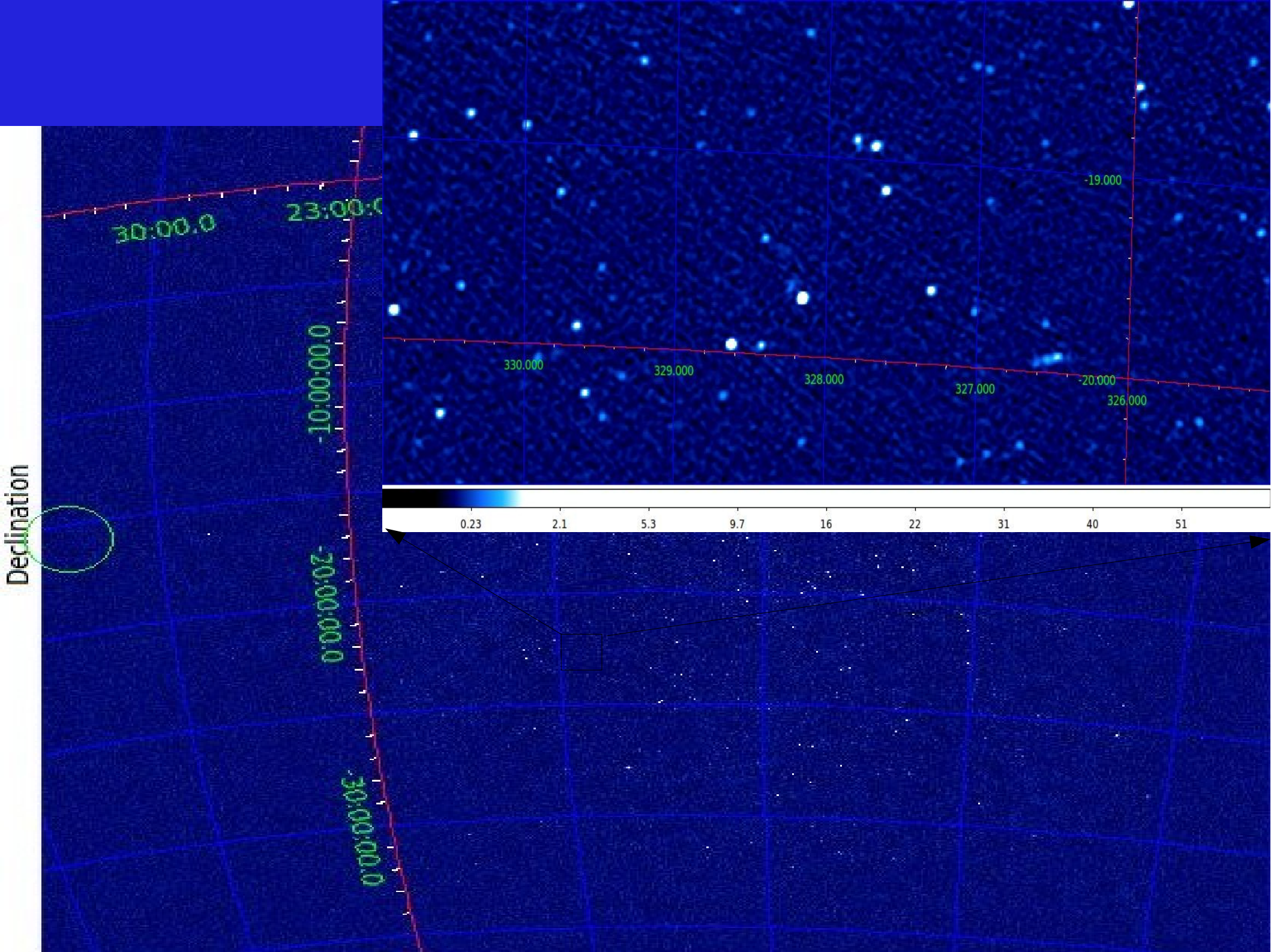


Transients and variables in the EOR field

First results with MWA 128T array

Latest image

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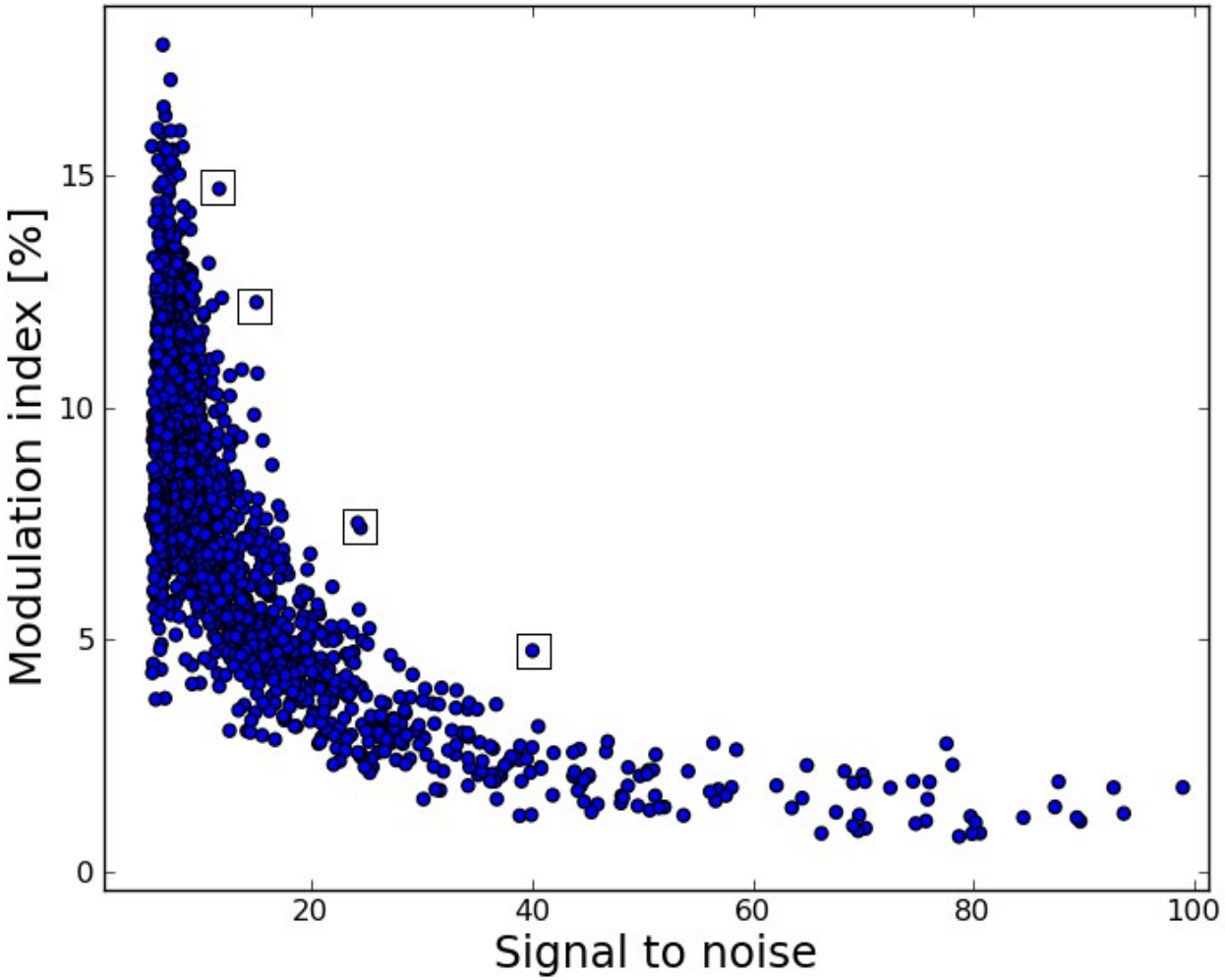
Declination

Transient survey in the EOR fields



- >2000 sources above 5 sigma noise level monitored in a 2 minute snapshot
- Modulation index: 0.1 – 17 percent, 8 percent mean
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Summary

- Found a transient MWA J0618-5515, which is most likely associated with an AGN flare

- 4 variable sources at timescales minutes – days. Three sources explained by variability of M and T dwarfs, one source is possibly a scintillating pulsar

- 7 variable sources on timescales of years – variability due to interstellar scintillation

- 353+350 hours project to search for variable and transient sources