The Long Wavelength Array

Greg Taylor (UNM)
On behalf of the LWA Collaboration

Socorro, 5/23/2018

The LWA Radio Observatory Staff (at UNM)

Faculty and Staff

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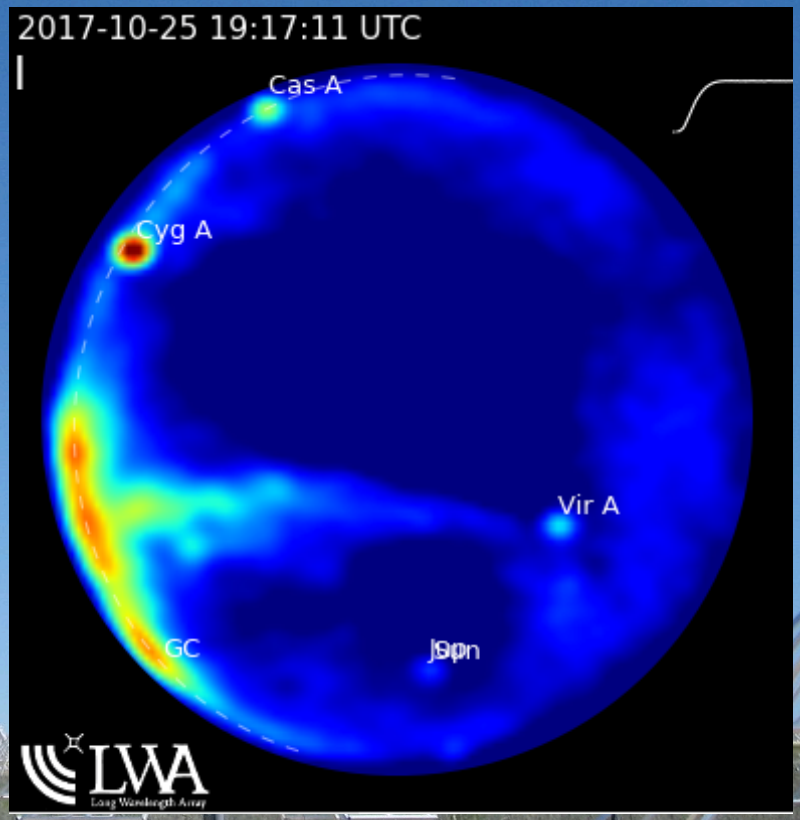

Students

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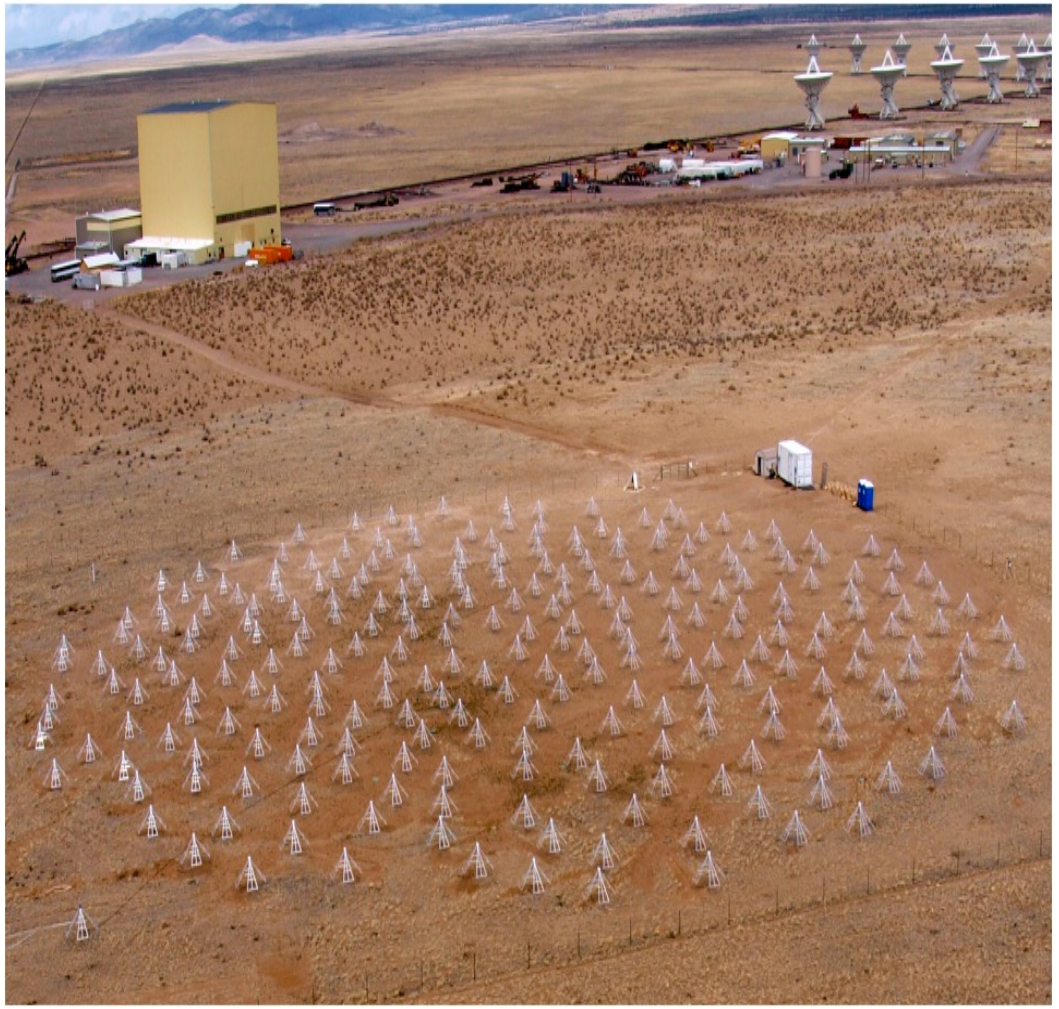
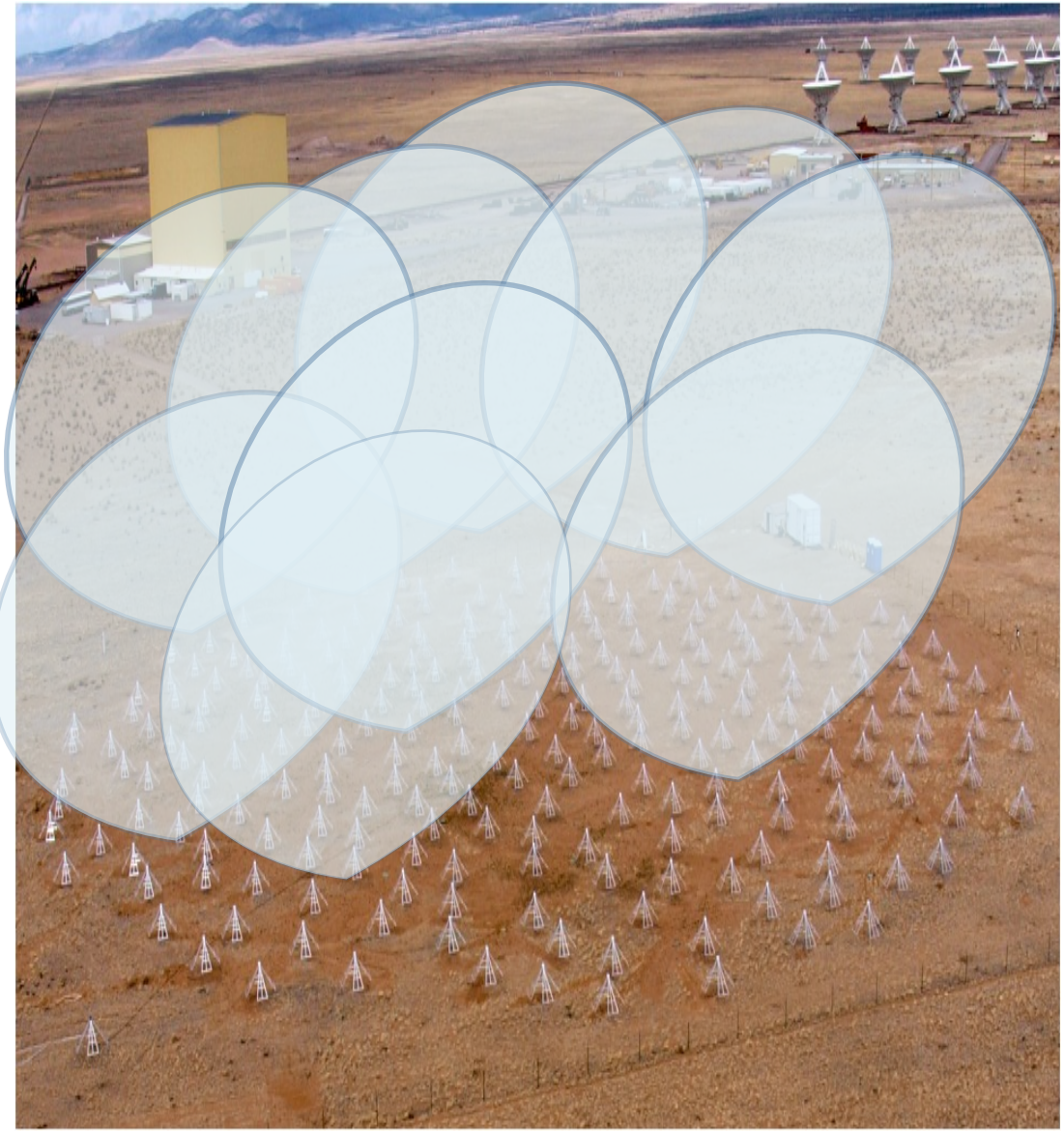
The first station of Long Wavelength Array (LWA 1)

- Operating frequency 10 – 88 MHz
- 256 dual- polarization dipole antennas
- Distributed within a 100 × 110m ellipse
- Co-located with the Very Large Array (VLA)
- Two operating modes: Digital beamforming and Transient Buffer



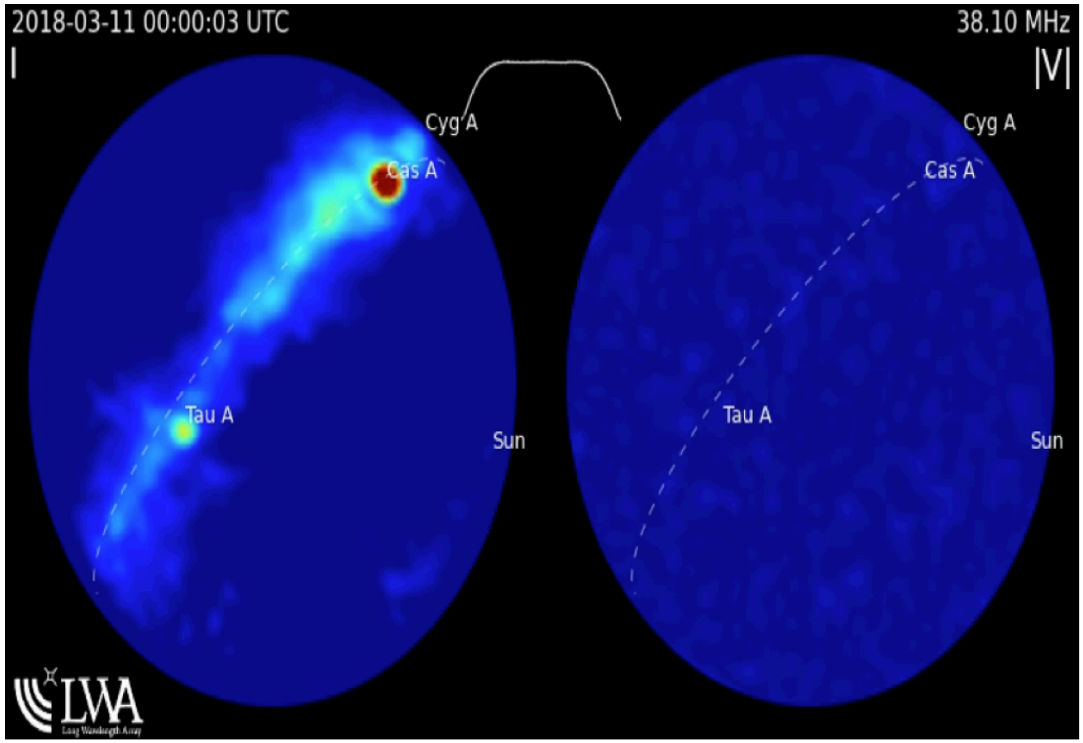
All sky mode –TBN & TBW

- Primary beam of single dipole is sensitive to whole sky
- Wideband (TBW) collects entire 78 MHz bandwidth output for 61ms burst every 5min
- Transient Buffer Narrow (TBN)- continuous collection of linearly polarized voltage time series
- 75 kHz bandwidth with 6 channels



LWA All Sky Imager (LASI)

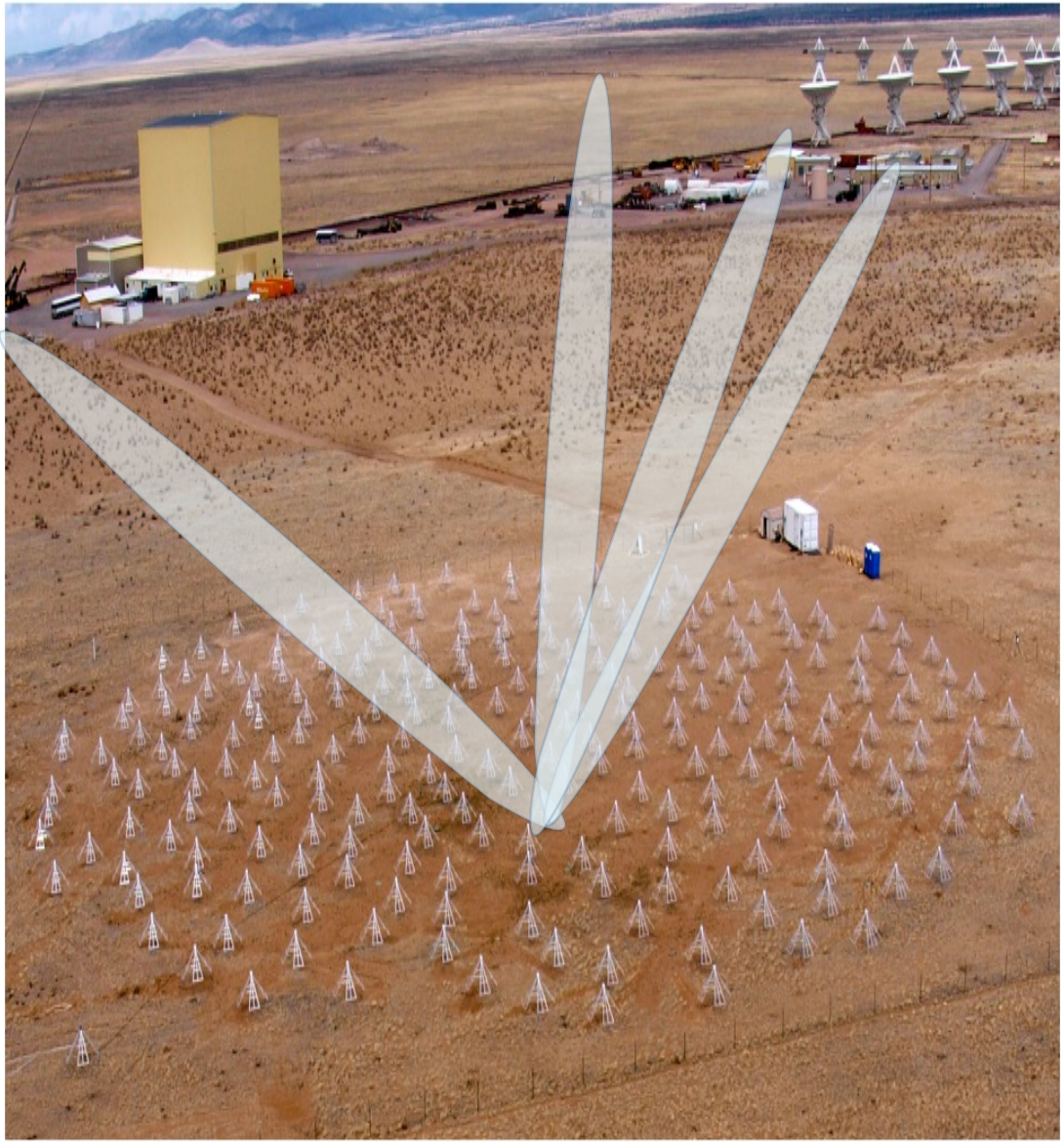
- Back end correlator/ imager
- Fourier transform and correlates the TBN voltage series in real time to get visibilities every 5 s
- Visibilities are converted to dirty images of the sky
- The images are uploaded to LWA TV and stored in the archive



http://www.phys.unm.edu/~lwa/lwatv.html

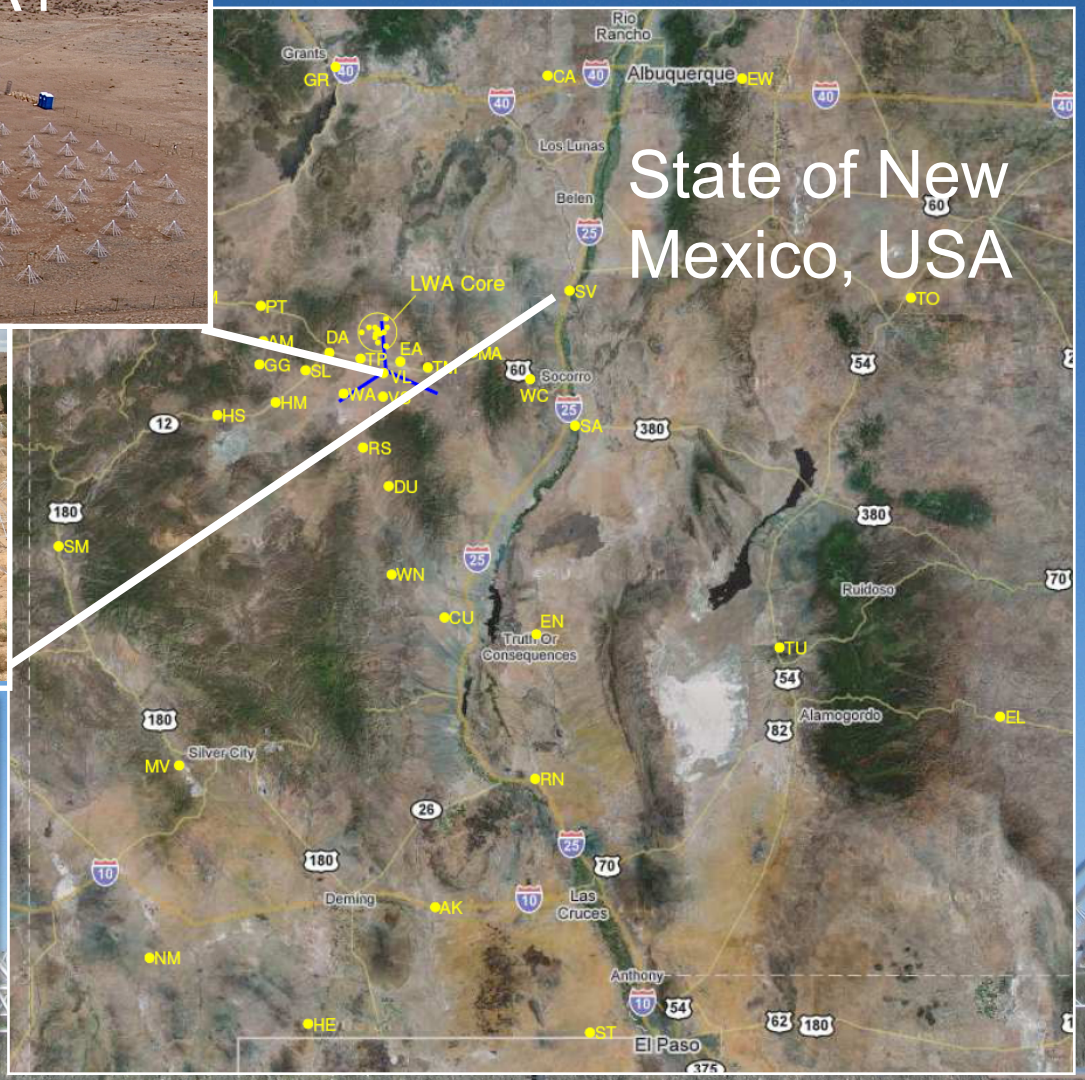
Beamforming - DRX

- Delay and sum beamforming
- Up to 4 beams
- 2 tunings of 20 MHz, dual pol
- Raw voltage time series or spectrometer mode



LWA Plan

- 10-88 MHz Aperture Synthesis Telescope
- 4 beams x 2 pol. x 2 tunings x 16 MHz
- 2 all-sky transient obs. modes



- Goal of 53 LWA stations, baselines up to 400 km for resolution 2” at 80 MHz with mJy sensitivity
- Cost is ~$1M/station

NATIONAL RADIO ASTRONOMY OBSERVATORY

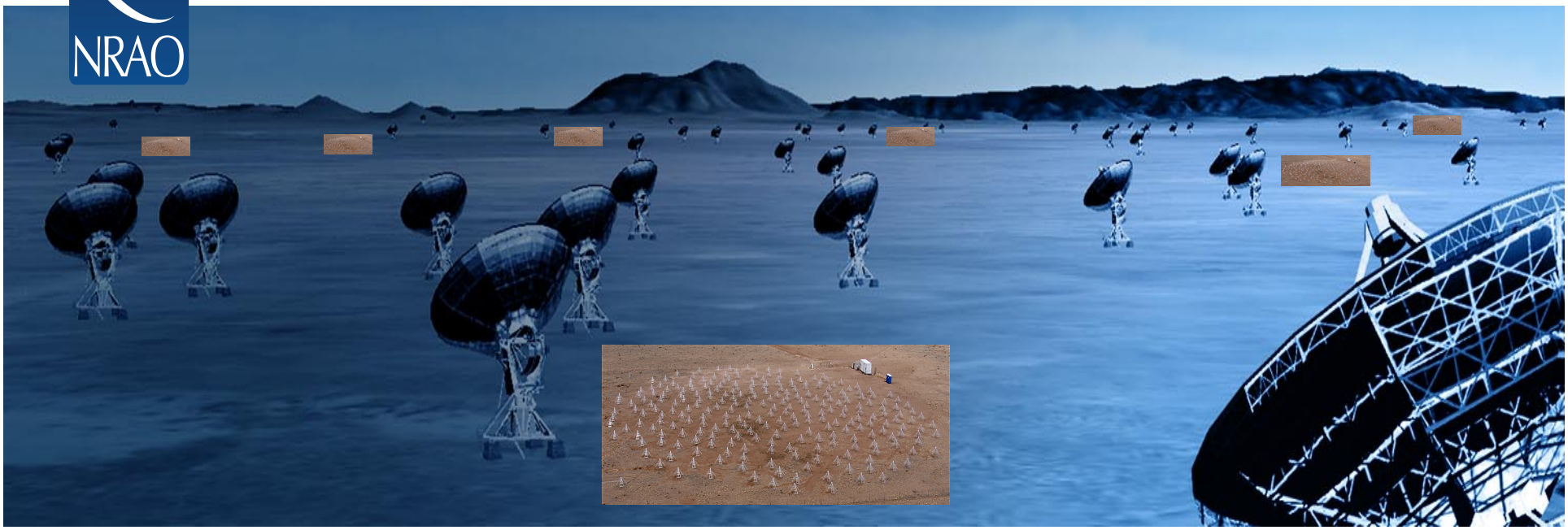
Next Generation Very Large Array (ngVLA)

NSF · Associated Universities, Inc. · LWA Long Wavelength Array · U.S. Naval Research Laboratory · Lobos New Mexico

ngVLA

The Next Generation Very Large Array

NATIONAL RADIO ASTRONOMY OBSERVATORY

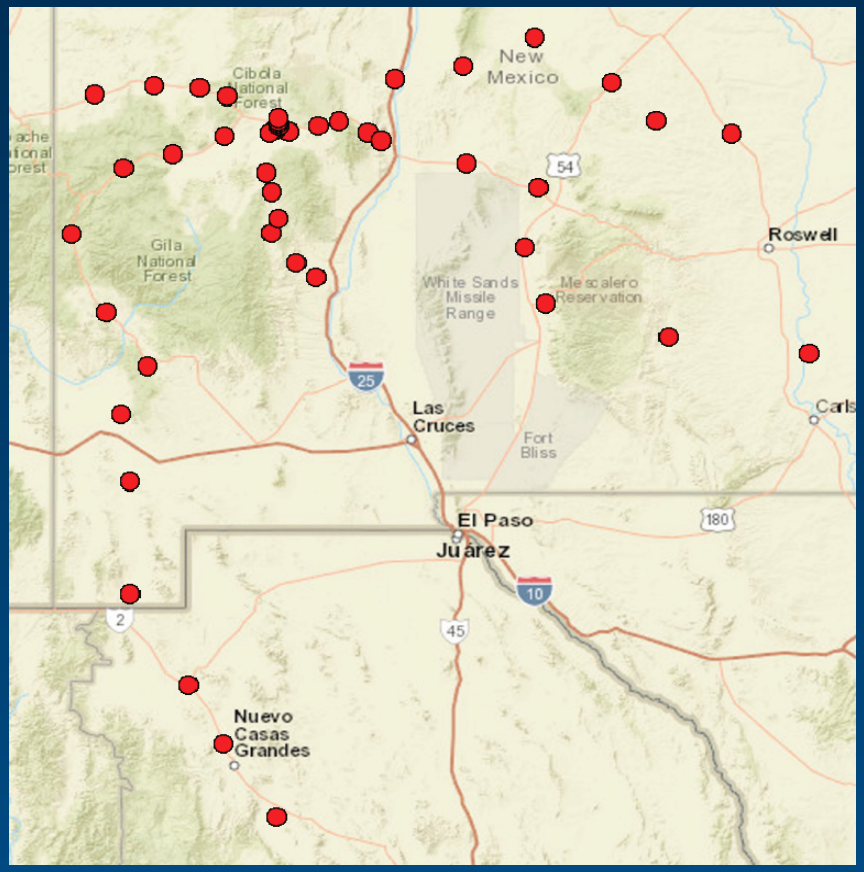


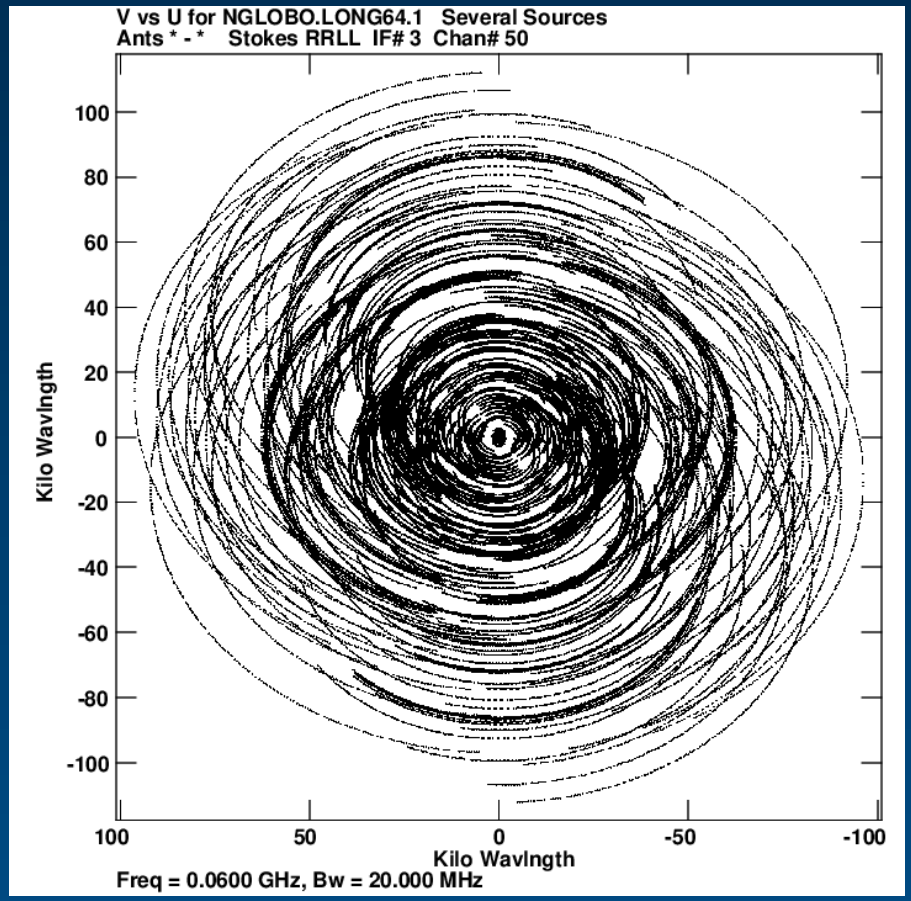
Major Option: US Low Frequency Expansion

NSF · Associated Universities, Inc. · LWA Long Wavelength Array · U.S. Naval Research Laboratory · Lobos New Mexico

ngVLA
The Next Generation Very Large Array

A Next Generation Low Band Array (ngLOBO)

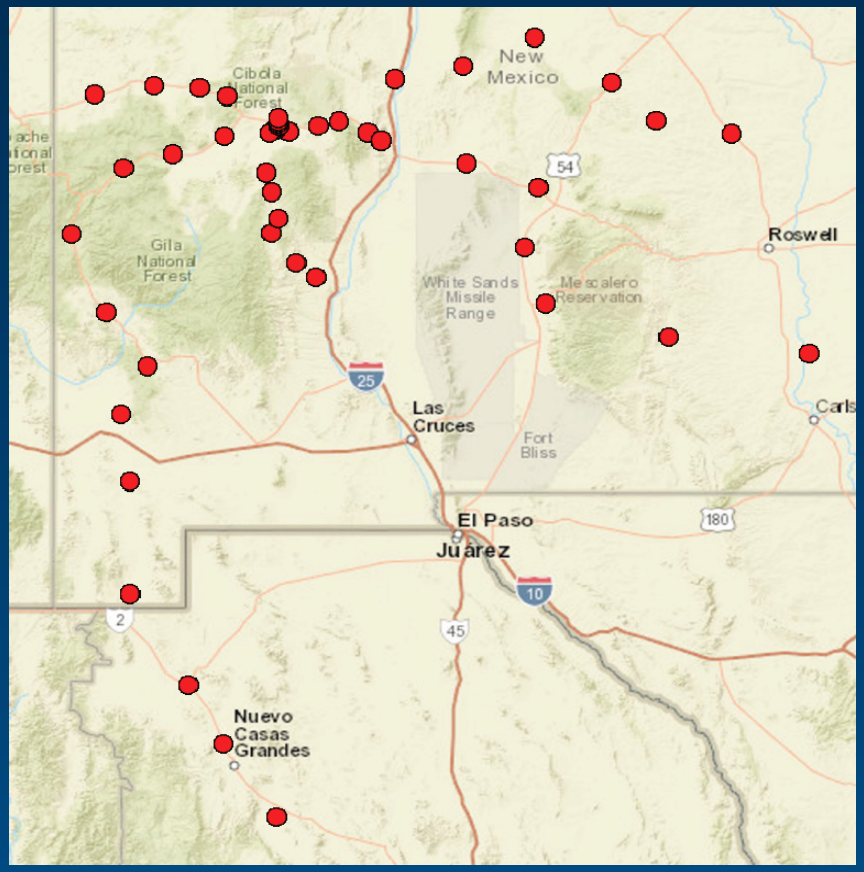


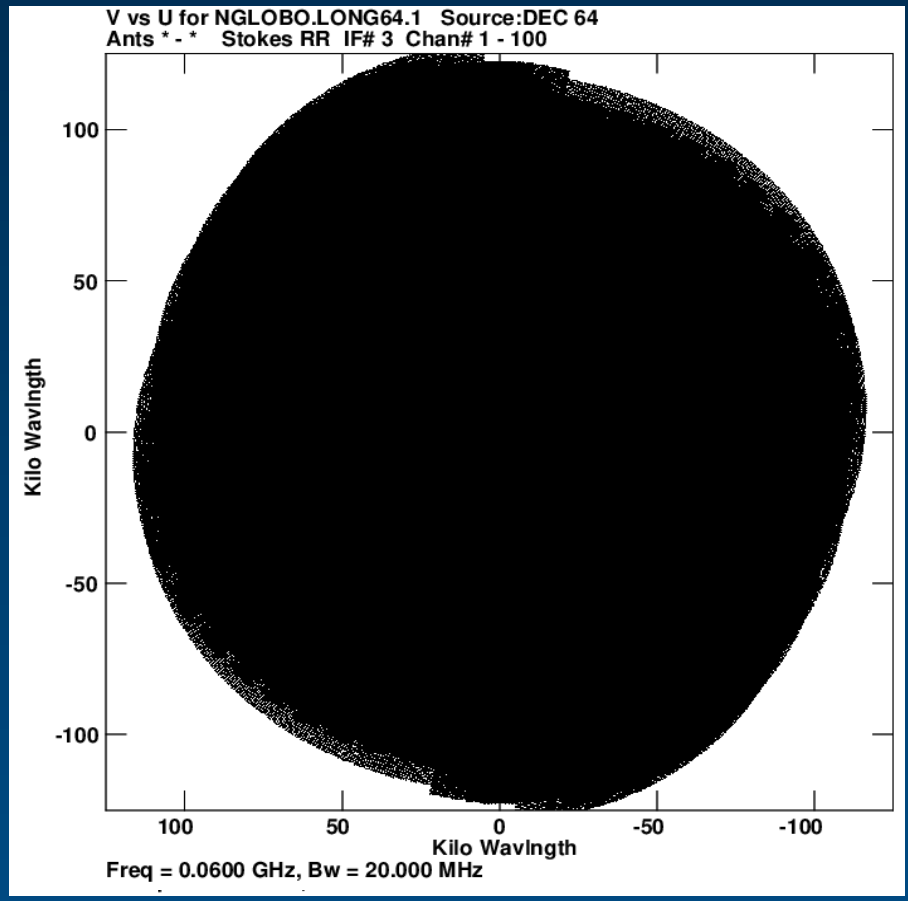


- 5-150 MHz Aperture Array
- 50 stations
- ~0.1 mJy in 1 hour

Multi-frequency synthesis OFF

A Next Generation Low Band Array (ngLOBO)





- ✧ 5-150 MHz Aperture Array
- ✧ 50 stations
- ✧ ~0.1 mJy in 1 hour

Multi-frequency synthesis ON

VLA 50-86 MHz

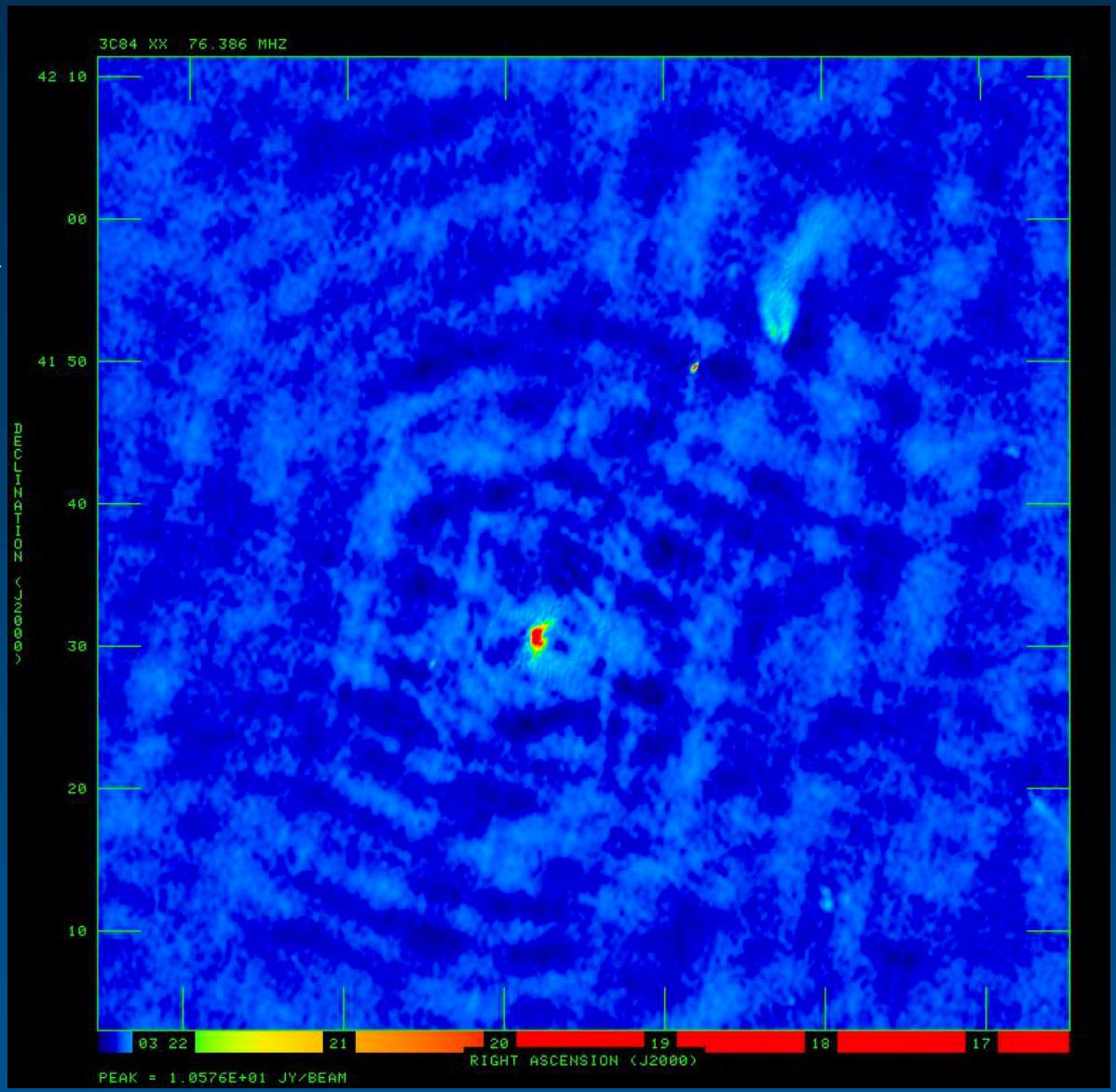
New 4 band feeds (MJP)
4 meter band: 50-86 MHz
21 installed

All 27 by end of 2018

ELWA - Demonstration

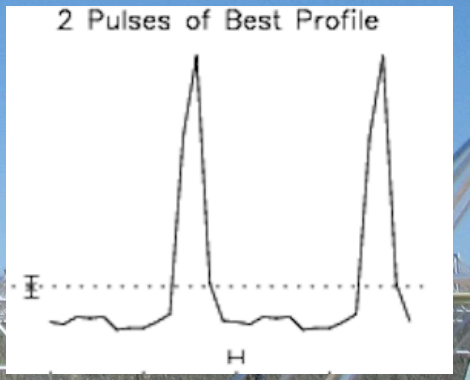
3C84 at 76 MHz
Apr 21, 2018
LWA1 + LWA-SV
+ 21 VLA

15 mJy noise



LWA-SV station

- New station as part of the Long Wavelength Array
- 257 dual polarization LWA dipoles
- 20 MHz bandwidth beamforming
- 20 MHz bandwidth all-sky imaging
- 75 km baseline provides 10” resolution in conjunction with LWA1



LWA Science

Astrophysics

- Cosmology
  Observing cosmic dawn through redshift 30 absorption of the 21 cm line. High redshift radio galaxies, containing the earliest black holes
- Acceleration, Propagation & Turbulence in the ISM
  Origin, spectrum & distribution of Galactic cosmic rays, Supernova remnants & Galactic evolution, Pulsars and their environments
- Solar Science & Space Weather
  Jupiter, Radio heliography of solar bursts & coronal mass ejections, Solar magnetic fields
- Exploration of the Transient Universe
  New coherent sources, GRB prompt emission, poorly explored parameters space …
- Meteors
  Self-emission and reflections of man-made signals

Iono- & Atmospheric Physics

- Unprecedented continuous spatial & temporal imaging of the ionosphere
- Test and improve global ionospheric models
- High-time-resolution Imaging of Lightning

Cosmic Ray Physics

Your ideas?
All of LWA time is open skies.
Your observing proposals are welcome!

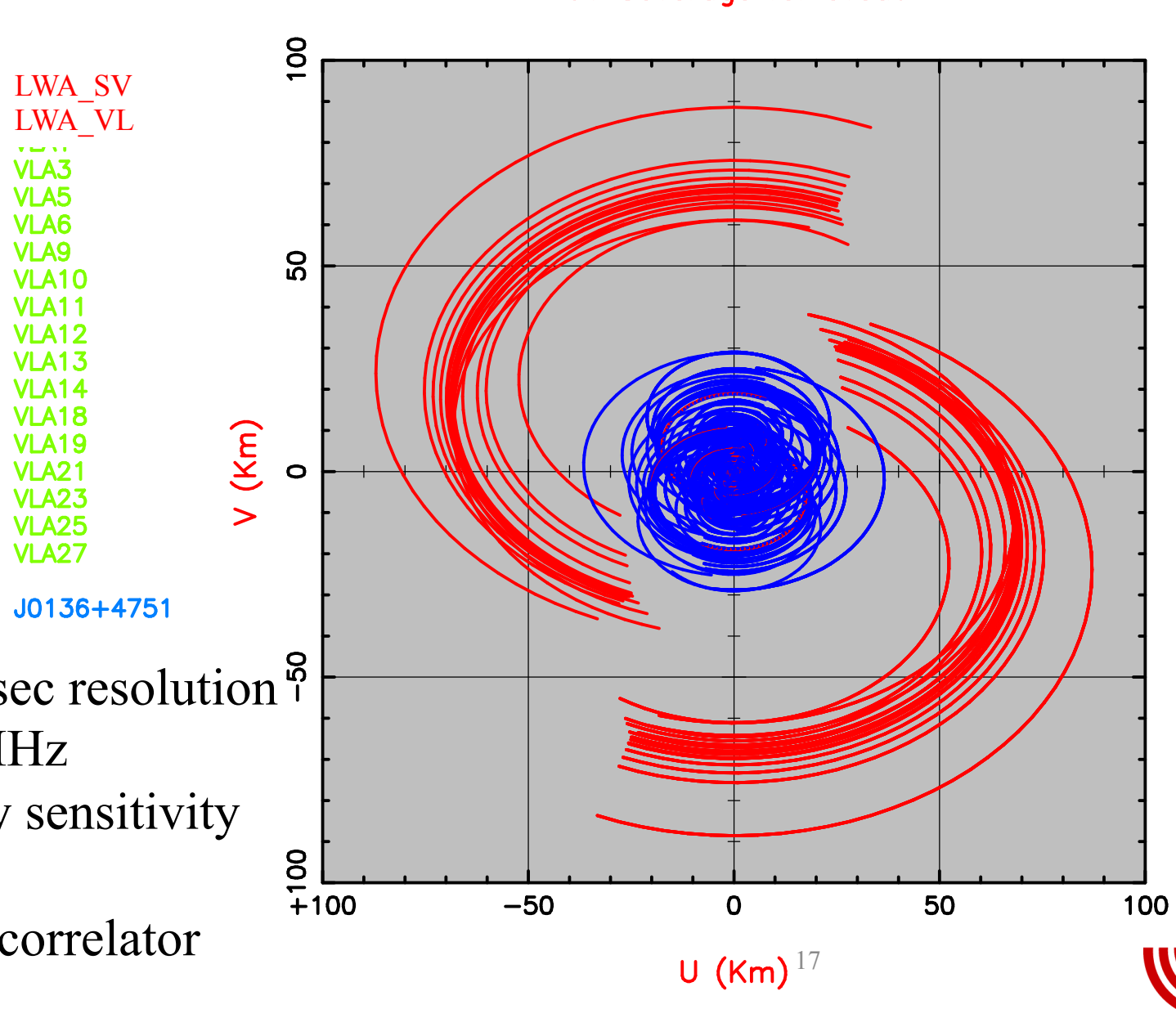
LWA User Compute Facility

- In the old VLA correlator room
- 10 Gbps link to LWA1
- 6 nodes each with 2+ GPUs

lwaucf1, lwaucf2, …

- 140 TB storage

16 VLA + LWA1 + LWA-SV



~10 arcsec resolution at 74 MHz

~20 mJy sensitivity

Cluster/correlator

LWA Long Wavelength Array

Science at Low Frequencies II, held in Albuquerque NM Dec 2-4, 2015. 105 attendees from around the world.

Follow-up from SLF I in Tempe (2014)