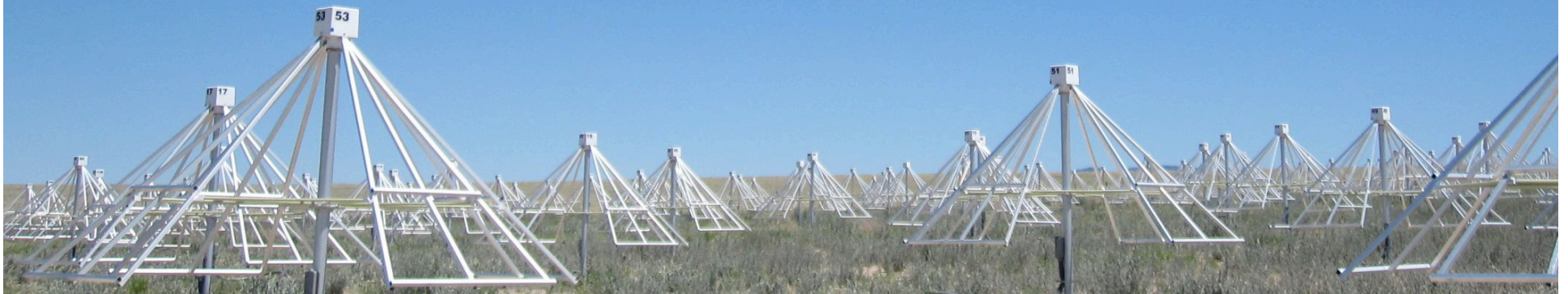


The Long Wavelength Array: A Dynamic Observatory for Radio Astronomy Education

Jake Hartman (JPL)
on behalf of the LWA collaboration



- Status of the Long Wavelength Array
- Data available to students
- Current and planned use of LWA data in the classroom
- How can your class get involved?



The first LWA station (LWA1)

- 256 dual-pol antennas within 110 m diameter
- 10–88 MHz; $> 4:1$ sky:noise dominance for 25–87 MHz
- Complete and operating



The first LWA station (LWA1)



Observing modes

- Phased-array
 - + Four simultaneous, independently steerable beams
 - + Two ~16 MHz BW tunings per beam; full Stokes
- Interferometer
 - + Simultaneous all-sky imaging
 - + 75 kHz BW; full Stokes



More details / shameless advertising

J2: Today at 14:00 & 14:20

Commissioning, Operations, and Early Results for the Long Wavelength Array
Joe Craig (UNM)

Results from LWA1 Commissioning:
Sensitivity, Beam Characteristics, and Calibration

Steve Ellingson (VA Tech)

J4: Friday at 10:20 & 10:40

Observing Cosmic Dawn with the Long Wavelength Array
Jake Hartman (JPL)

Detecting the Universe beyond Redshift 20

Lincoln Greenhill (CfA)



Data available to student researchers



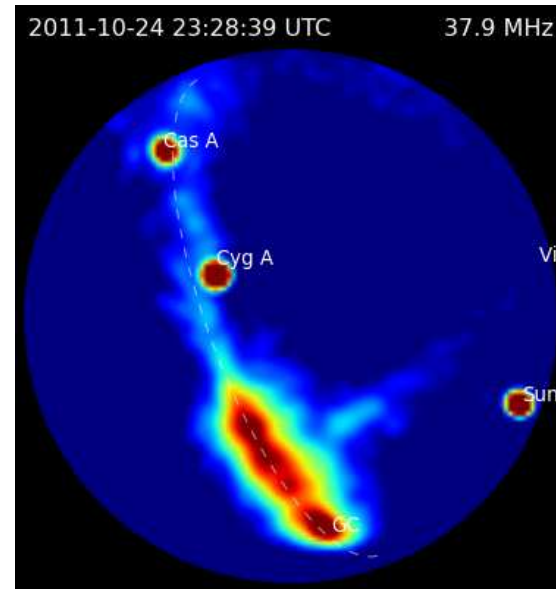
Allocated cycle 1 & 2 time

- An “open skies” instrument:
 - + Cycle 1 observations commencing now
 - + Cycle 2 proposals call will be soon
- Typical student projects will use ~6 beam hours each
- Cooperate with a “friend of the telescope”
- Use the Python-based LWA Software Library for analysis

- Project examples:
 - measure fringes,
 - detect the galactic plane,
 - measure the spectral slope of galactic synchrotron emission,
 - observe solar or Jovian bursts, ...

Prototype all-sky imager (PASI)

- Correlator backend for the LWA1
- Receives a continuous 100 kSPS stream from all the dipoles
- Images the hemisphere many times per minute at 100% duty cycle and $\gtrsim 90\%$ uptime, covering $\approx 3 \pi$ sr every day
- This is a virtually unexplored region of transient phase space! (radio frequency, sky coverage, imaging cadence, uptime)

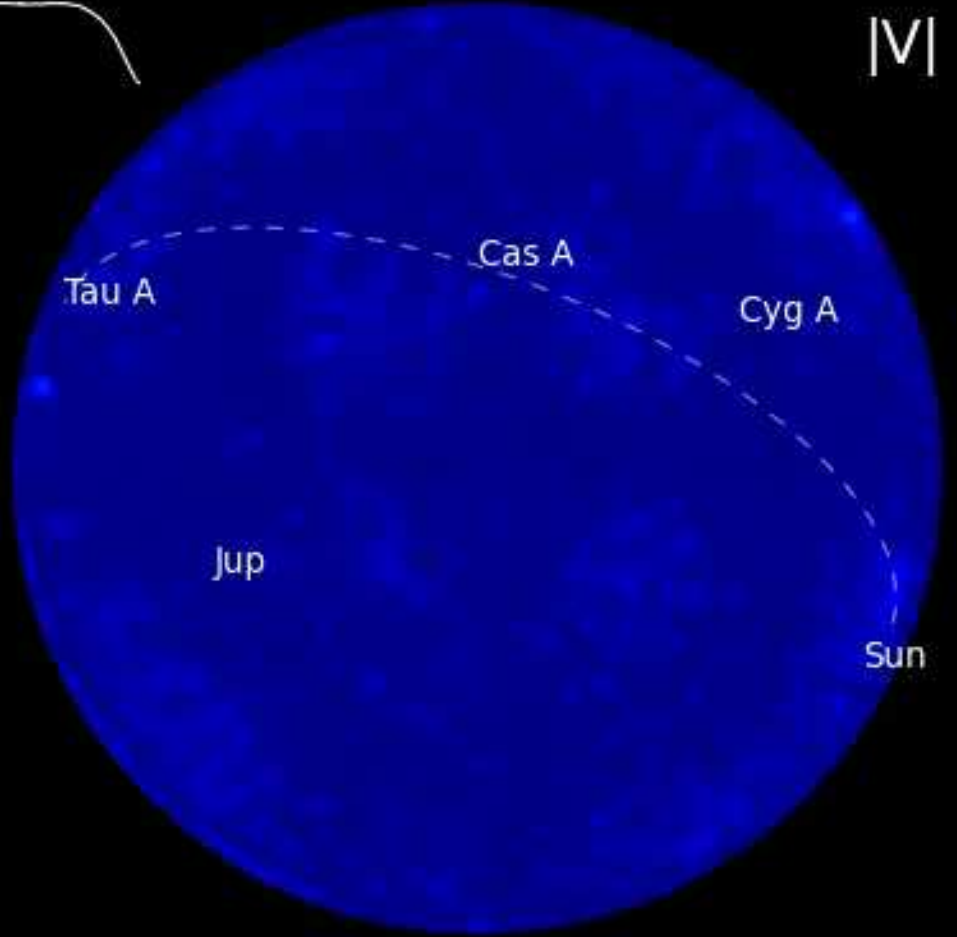
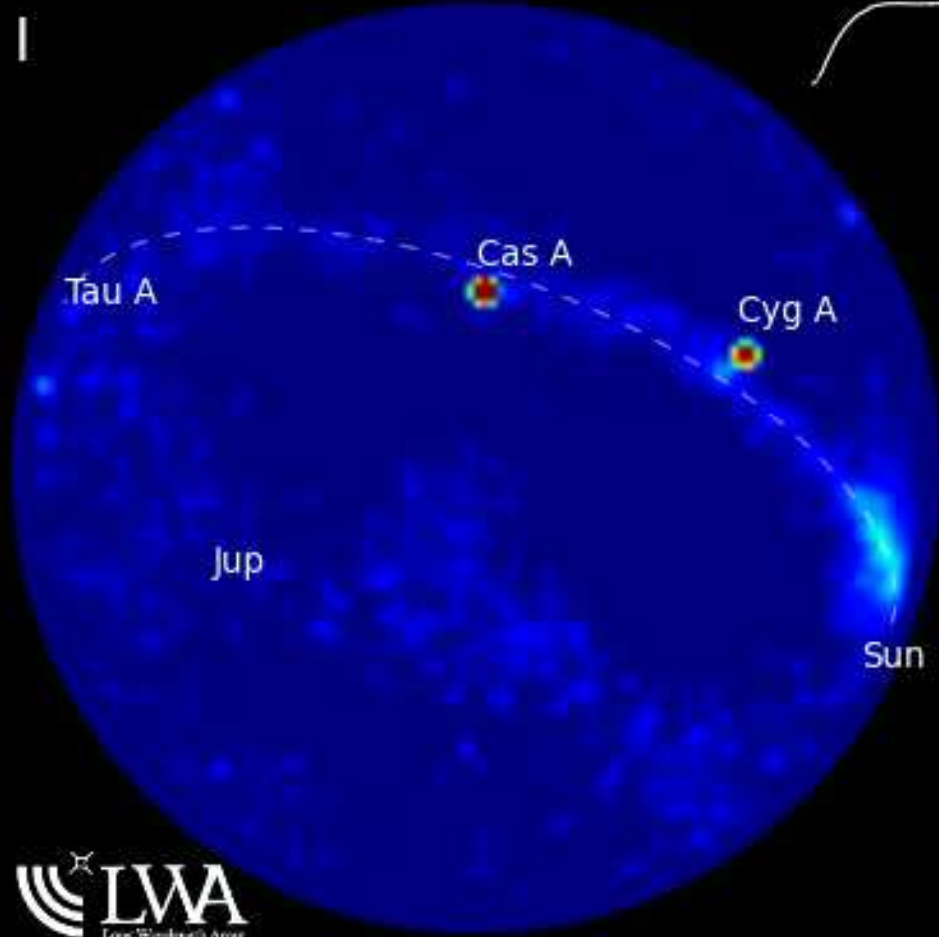


2011-12-30 23:59:49 UTC

74.0 MHz

I

IV



http://lwa.unm.edu/live/

LWA TV

lwa.unm.edu/live

LWA
Long Wavelength Array

Live from New Mexico, it's ...

Home Astronomer Project News Contact Us

2011-12-10 03:44:51 UTC 25.6 MHz

Home

LWA TV ... live!

These images show the sky above the first LWA station. They update every few seconds, and they're typically about 30 seconds old. If the image isn't updating right now, it means we're probably working on the telescope or taking spectra rather than images.

Each image shows the full sky, down to the horizon at the image's edge. Depending on the current operating mode of the LWA's Prototype All-Sky Imager experiment, there may be one or two images. If there is one, it shows the total intensity — the power coming from each point on the sky. If there are two, the left will show the total intensity, and the right will show the intensity of circularly polarized radio waves.

At the upper left you can see the average time of the data that went into the image (given in UTC, which is basically the same as Greenwich Mean Time). There is no time gap between the images: we are imaging sky in real time with a 100% duty cycle. At the upper right is the central frequency of the image. In the center is a 100 kHz bandwidth spectrum from a single antenna and polarization; the images are produced from the middle 75 kHz.

Finally, we've labeled the brightest objects in the sky:

LWA TV

lwa.unm.edu/live

Finally, we've labeled the brightest objects in the sky:

- Cas A — a supernova remnant
- Vir A — a supergiant elliptical galaxy also known as M87
- Tau A — the Crab Nebula, a supernova remnant
- Cyg A — a bright radio galaxy
- Jup — Jupiter, which only can be seen when it is bursting
- Sun — the Sun, which can become so bright that it wipes out everything else in the image!
- Dashed line — the plane of our galaxy
- GC — the center of our galaxy

Of course, there will sometimes be points in our image other than these labeled ones! Most of these are due to radio frequency interference (RFI): radio emissions from sources other than the sky. The sky will sometimes be wiped out by bright RFI, particularly at low frequencies and during the day. However, some blips just may be something new: flares from Hot Jupiters or magnetars; radio counterparts to gamma-ray bursts; or something totally new and unexpected. Our computers will be monitoring these movies to let us know when something unusual pops up!

Reruns

Every day, we make a movie showing 24 hours of the sky, compressed down to about 10 minutes of video. Each movie starts at around sunset at the LWA.

To view a video, click the date that you'd like in the calendar. LWA TV only came online recently, so most of the early dates don't have videos. Days with videos have their dates in red and are clickable.

Each day's movie may be as much as 100 MB.

< 2011 December						
Sun	Mon	Tue	Wed	Thu	Fri	Sat
27 55892	28 55893	29 55894	30 55895	1 55896	2 55897	3 55898
4 55899	5 55900	6 55901	7 55902	8 55903	9 55904	10 55905
11 55906	12 55907	13 55908	14 55909	15 55910	16 55911	17 55912
18 55913	19 55914	20 55915	21 55916	22 55917	23 55918	24 55919
25 55920	26 55921	27 55922	28 55923	29 55924	30 55925	31 55926
1 55927	2 55928	3 55929	4 55930	5 55931	6 55932	7 55933

Virginia Tech, Los Alamos National Laboratory, The University of New Mexico, JPL Jet Propulsion Laboratory, The University of California, BIRS Bruny Island Radio Spectrometer

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LWA in the classroom



UNM Astro 101

Prof. Greg Taylor

LWA TV: an introduction to the dynamic sky, from long wavelength radio to TeV gamma rays

Live images get student attention!



UNM Astro 423: Radio Astronomy

Prof. Greg Taylor

For advanced undergrads; offered every other spring
Students learn about radio telescopes, then ...

- Write proposals
- Review and rank proposals; come up with a shortlist
- Schedule top-rated proposals
- Tour local telescopes (VLA & LWA)
- Reduce data, including homework on calibration and imaging
- Write up and present their results

VT ECE 4984: senior “capstone” project

Prof. Steve Ellingson

Two-semester course for seniors,
from concept through demonstration

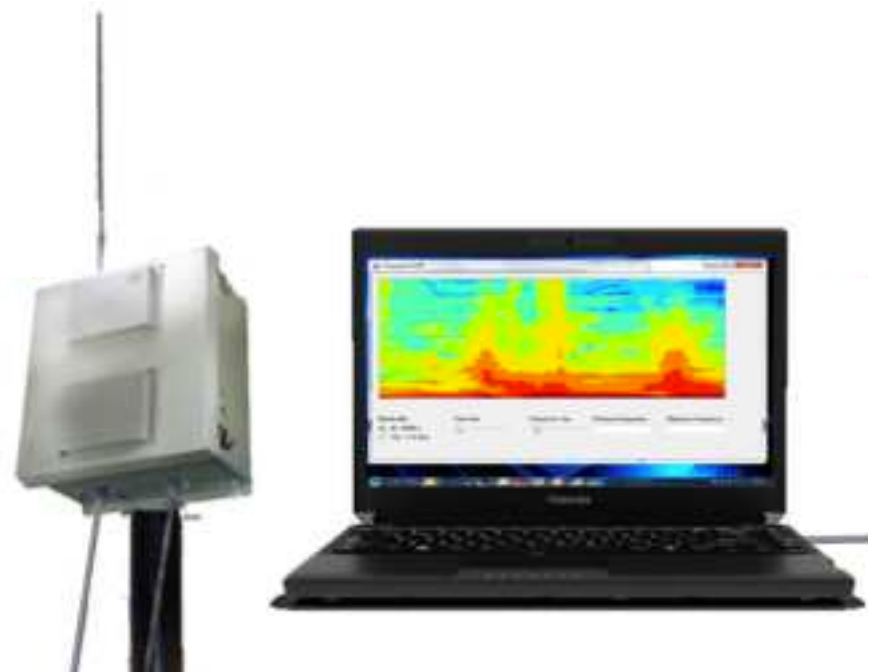
Fall: design, Spring: build

This year:

Radio Frequency Spectrum Sensor
25–80 MHz and 116–174 MHz

Next year:

Something more LWA-specific,
since URO funding was awarded



UT Brownsville's LoFASM project

Prof. Rick Jenet

- Low-Frequency All-Sky Monitor project (DoD funded)
- Uses LWA antennas: great for student construction!
- Arecibo Remote Command Center scholars will carry out construction and observation



Synthesis Imaging Summer School

- Offered every other summer in Socorro, NM (May 29 – June 15, 2012)
- 150 participant limit
- Lectures on low-frequency and large- N observing
- Data reduction workshops using canned LWA1 data



YOUR institution!

- Flexible — anywhere from Astro 101 to advanced work
- LWA provides a few hours of data, if needed, to US university
- Requirements if observations are required:
 - + Must be an integral part of the course (≥ 4 hours of class time)
 - + A sample student report must be sent to the LWA collaboration
 - + Cannot conflict with accepted observing programs
- Please contact us about details if you're interested!