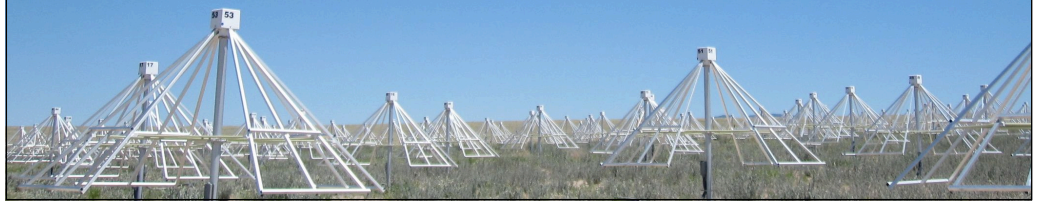
The Prototype All-Sky Imager

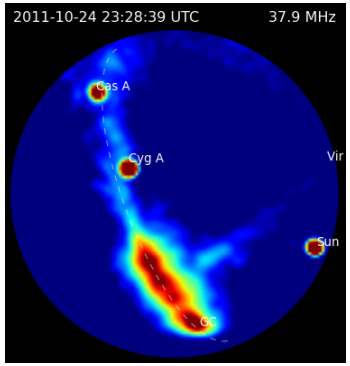
Jake Hartman (JPL)



- **The PASI system**
- Lightning
- Transient monitoring
- Results
- Next steps

The Prototype All-Sky Imager (PASI)

- Software correlator and imager in the LWA1's RFI shelter
- Receives a continuous 100 kSPS stream from all the dipoles
- Near-live imaging of the sky with up to 1 s cadence at 100% duty cycle, typically running 10−20 hr/day, covering 3π sr



LWA
Long Wavelength Array

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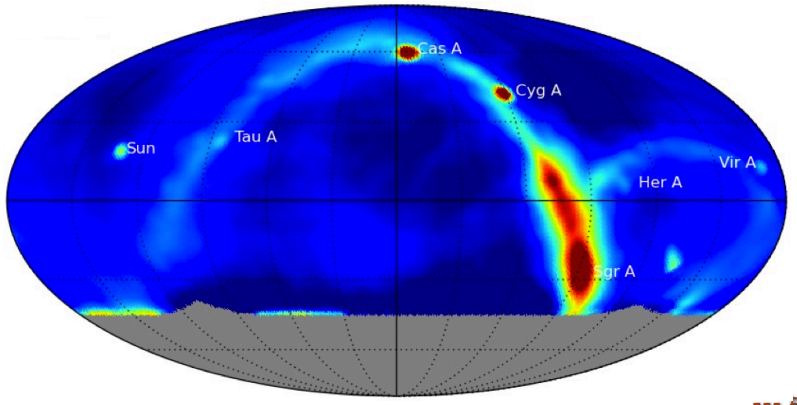
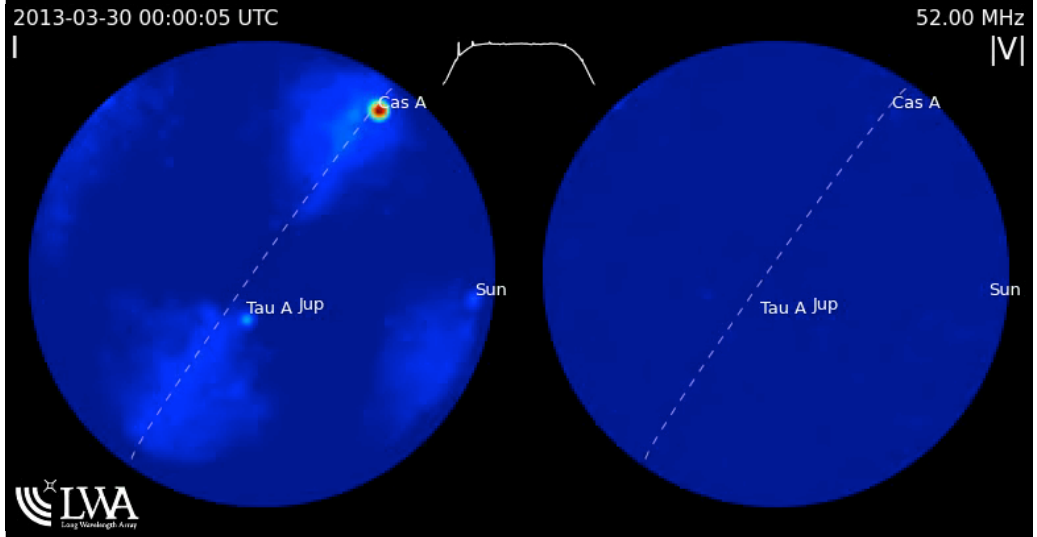


Dowell et al., TBW sky survey

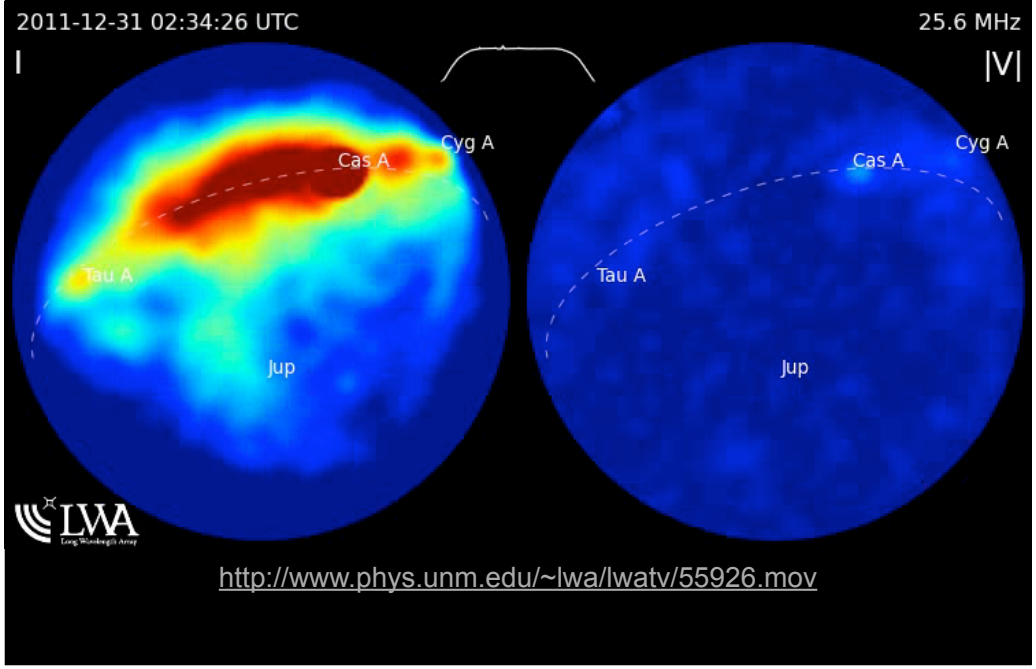
LWA
Long Wavelength Array

The Prototype All-Sky Imager (PASI)



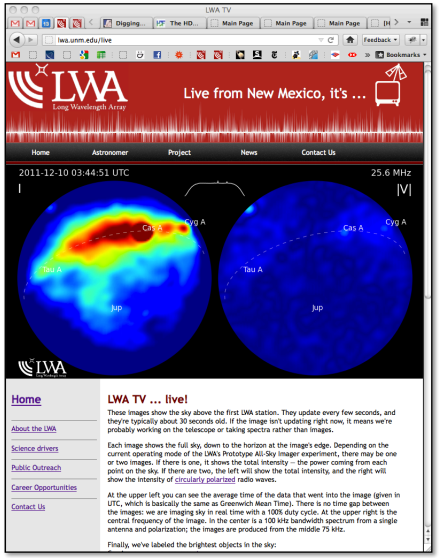
http://www.phys.unm.edu/~lwa/lwatv/56381.mov

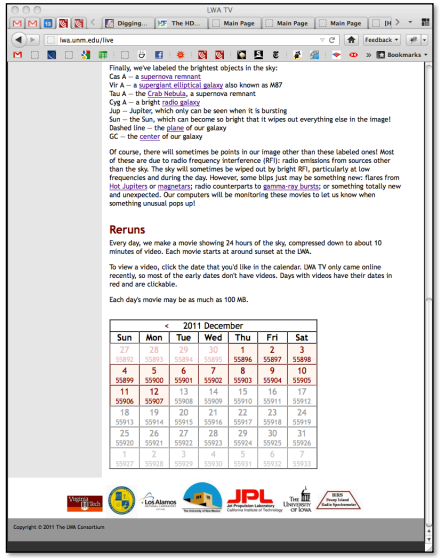
The Prototype All-Sky Imager (PASI)



http://www.phys.unm.edu/~lwa/lwatv/55926.mov

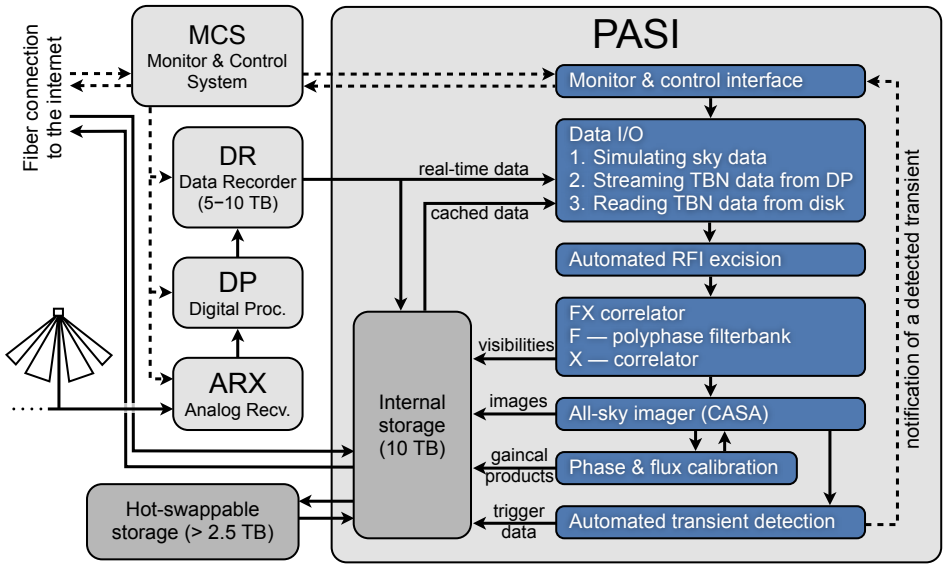
http://lwa.unm.edu/live





LWA
Long Wavelength Array

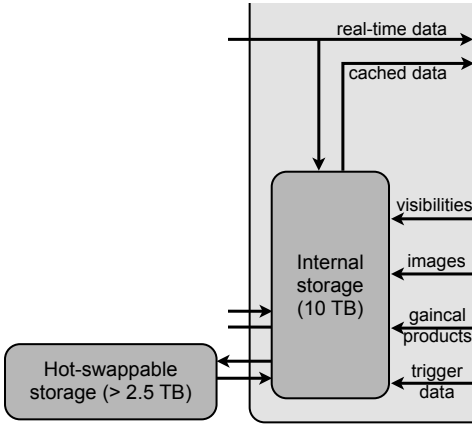
The Prototype All-Sky Imager (PASI)



LWA
Long Wavelength Array

The Prototype All-Sky Imager (PASI)

Internal storage provides look-back time for all levels of data products

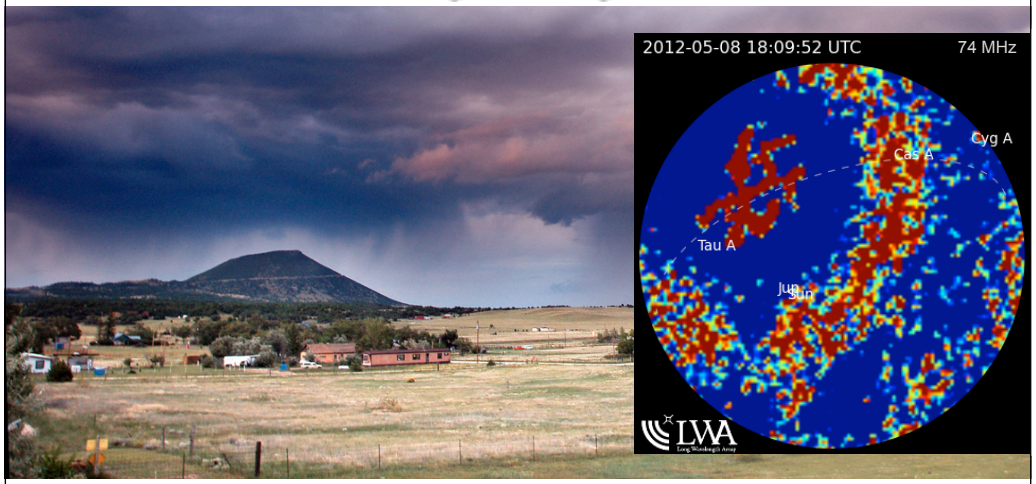


- 10−20 hours for raw data — not yet implemented
- > 30 days for visibilities with 1 s time resolution
- images kept forever
- detection candidates kept forever

LWA Long Wavelength Array


The PASI system
Lightning
Transient monitoring
Results
Next steps

Lightning!



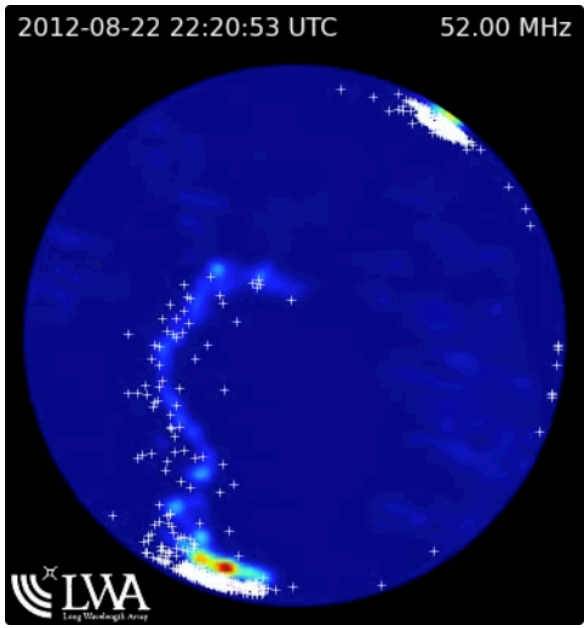
LWA
Long Wavelength Array

LWA1 lightning observation mode

When lightning is present near the LWA1:

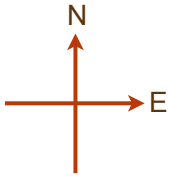
- Set TBN to 85 MHz and reduce the gain
- Record the raw data to disk on DR5
- Post-process with 5 ms (current) to 50 μs (anticipated) time resolution
- Compare results from NMT / Langmuir Lab's instrumentation, especially the Lightning Mapping Array

Fast imaging of lightning



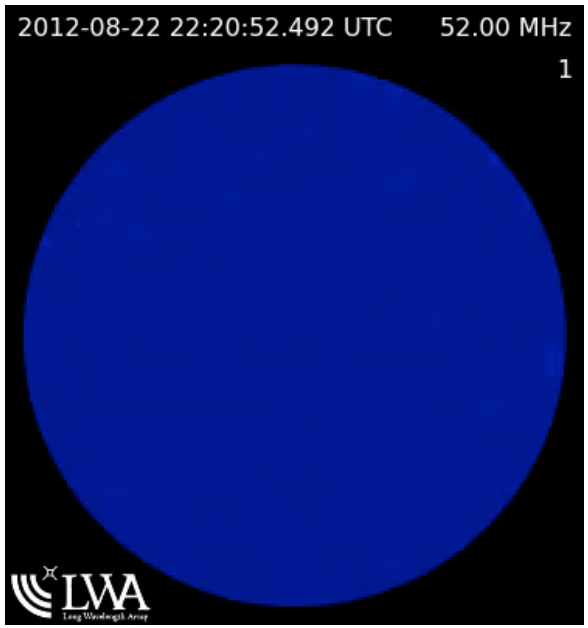
Intra-cloud discharge, traveling from SSW horizon to overhead

5 s integration



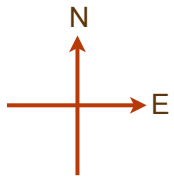
LWA
Long Wavelength Array

Fast imaging of lightning



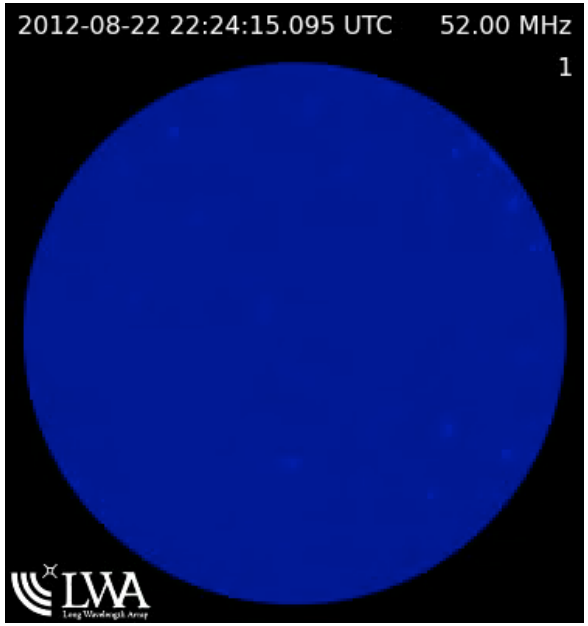
Intra-cloud discharge, traveling from SSW horizon to overhead

5 ms integrations



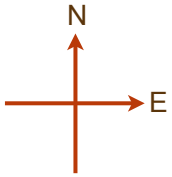
LWA
Long Wavelength Array

Fast imaging of lightning



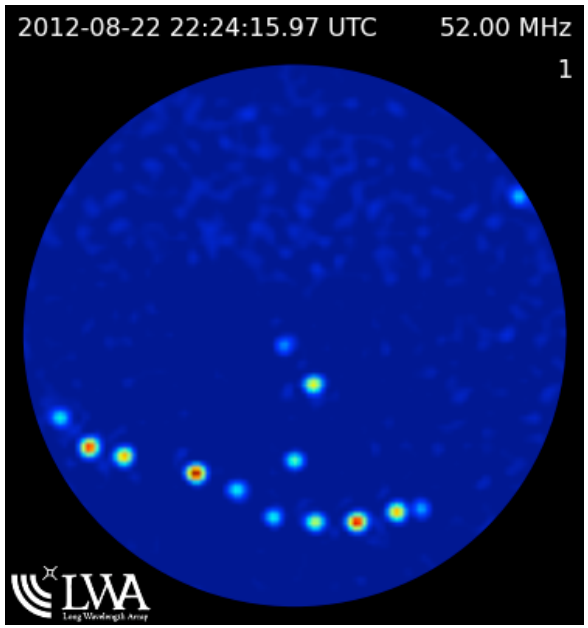
Intra-cloud discharge, initiating overhead, branching, then traveling to the horizons

5 ms integrations



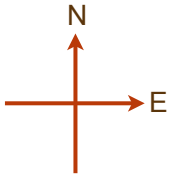
LWA
Long Wavelength Array

Fast imaging of lightning



Intra-cloud discharge, initiating overhead, branching, then traveling to the horizons

30 ms integration



LWA
Long Wavelength Array

The PASI system

Lightning

➤ **Transient monitoring**

Results

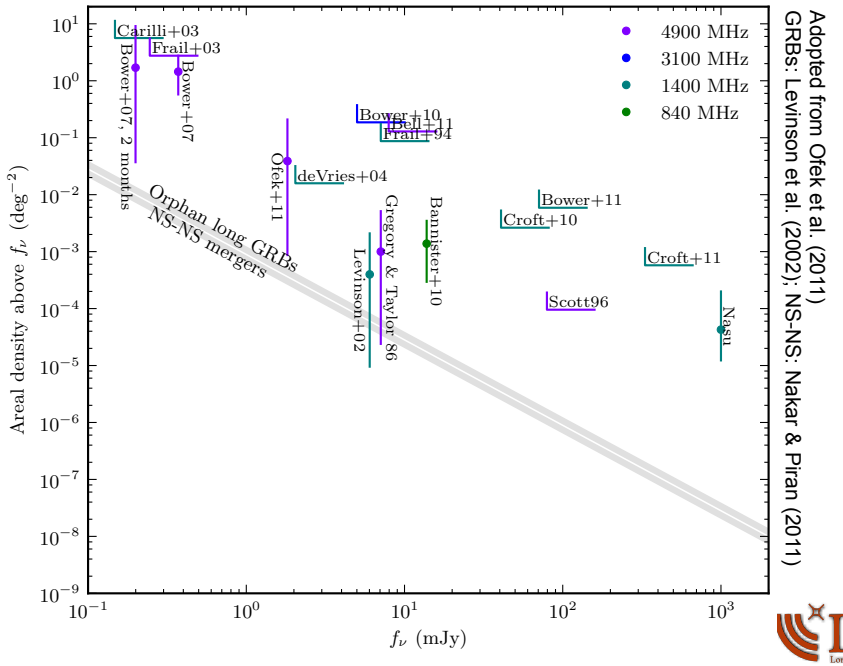
Next steps

Exploring new transient phase space

- Low frequency, full Stokes
- Large field of view: 10,000 deg^2 per image
- Cadence: 1–5 s integrations, 100% duty cycle
- Uptime: ~12 hr good data per day
  (currently limited by TBN / beamformer conflicts)
- Duration: ~6000 hr data and counting
- Noise limit from image differencing: ~100 Jy rms

LWA
Long Wavelength Array

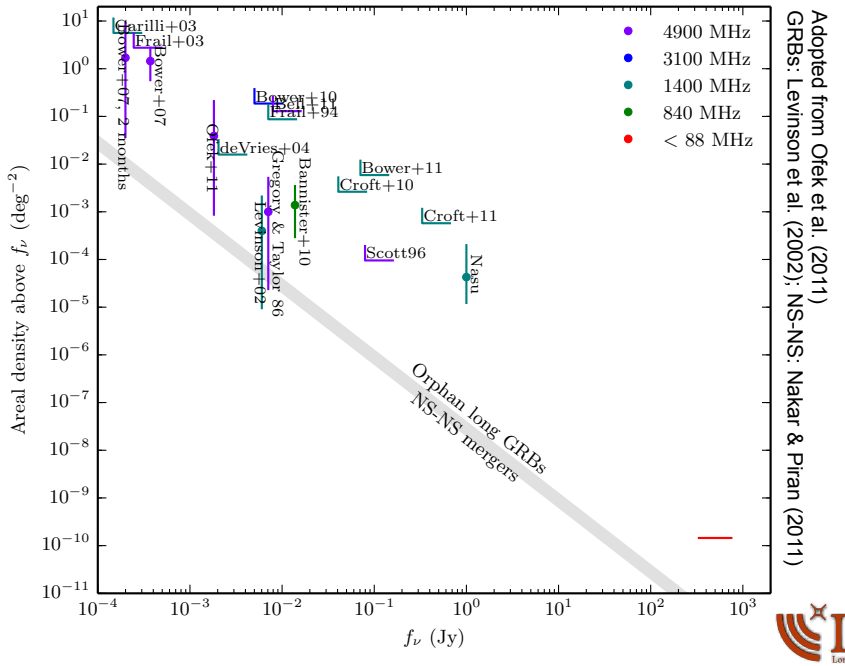
Exploring new transient phase space



Adopted from Ofek et al. (2011)
GRBs: Levinson et al. (2002); NS-NS: Nakar & Piran (2011)

LWA
Long Wavelength Array

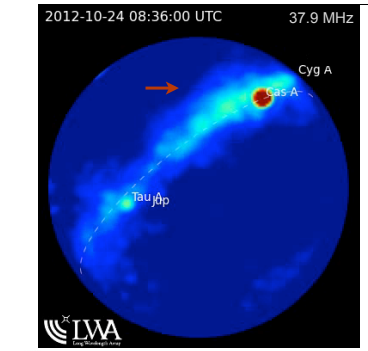
Exploring new transient phase space

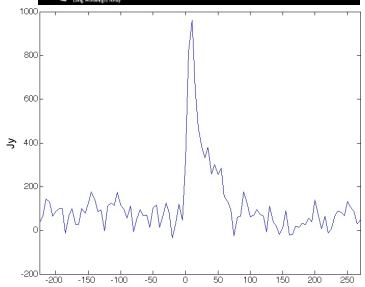


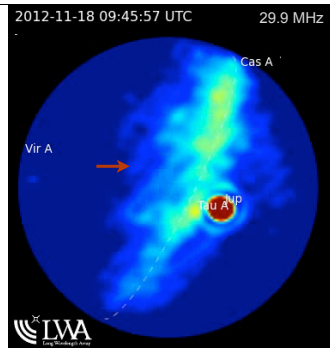
Adopted from Ofek et al. (2011)
GRBs: Levinson et al. (2002); NS-NS: Nakar & Piran (2011)

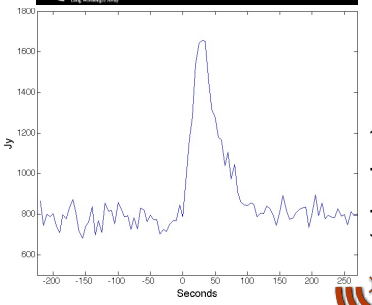
LWA
Long Wavelength Array

Unidentified FRED transients







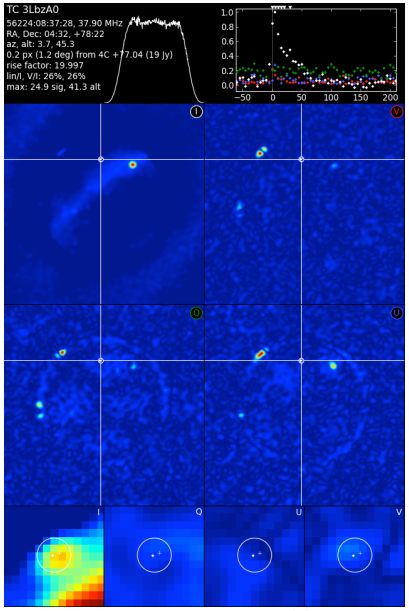


Obenberger, Hartman, Taylor, et al. (in prep.)

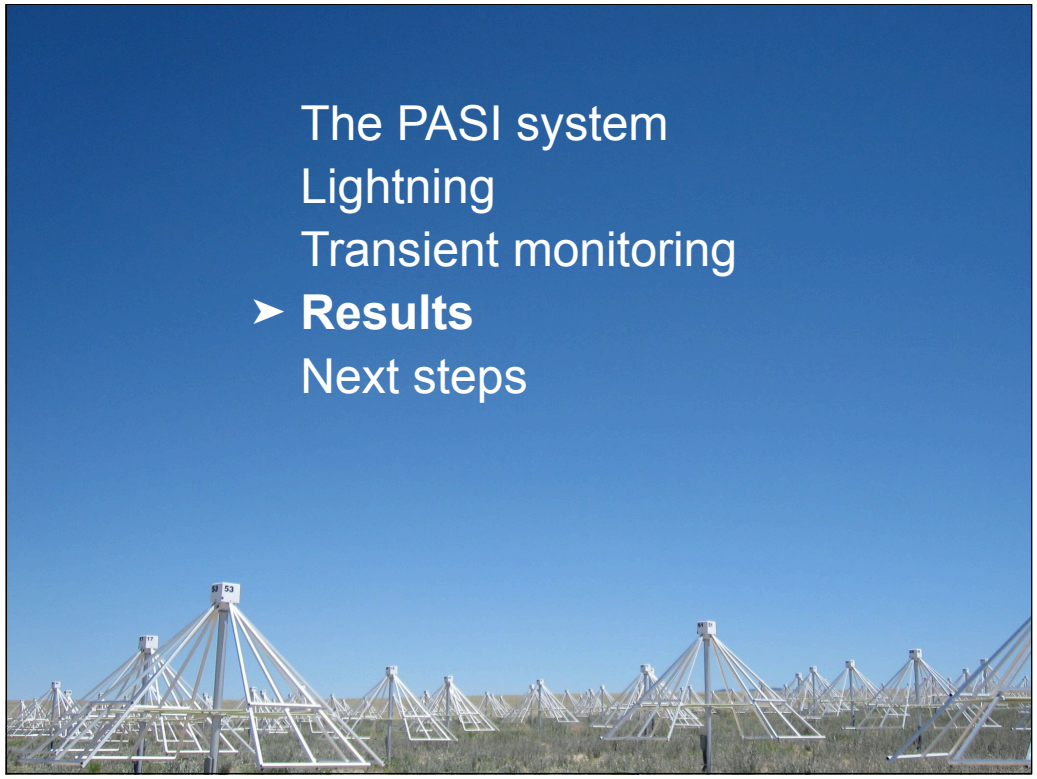
LWA
Long Wavelength Array

Detection strategy

- Confusion: 100 Jy/beam at 38 MHz
- Image differencing in Stokes I and V
- Detect large rises
  (> 5 σ off G. plane; > 7 σ on it)
- Remove transient candidate if:
  - below 20º–25º altitude
  - obvious RFI in the spectrum
  - *any* associated linear polarization
  - close to >30 Jy VLSS sources
  - vis data reveal it's not broadband
  - moving across the sky!
- 300 days searched,
  200 days remaining



LWA
Long Wavelength Array


The PASI system
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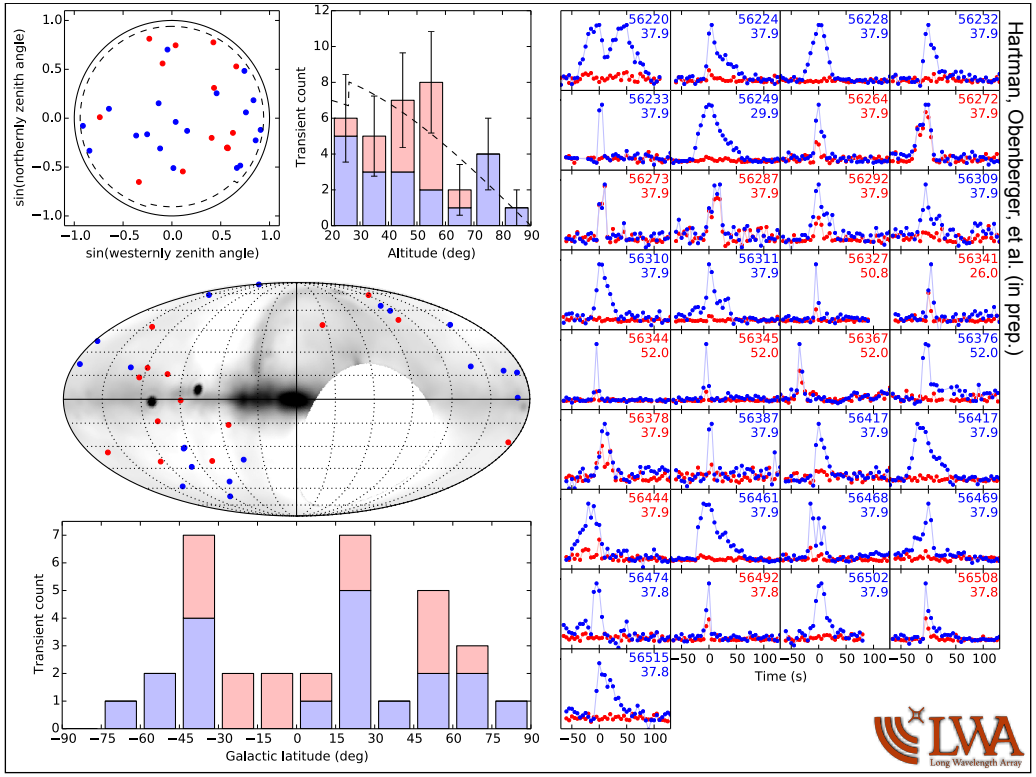
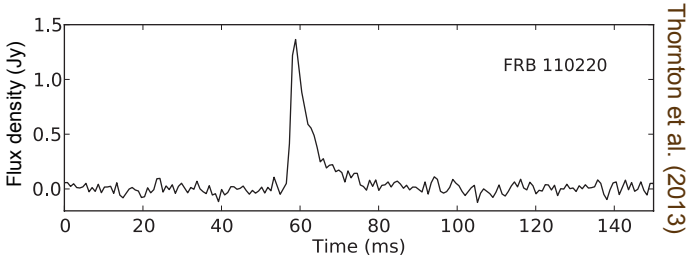

sin(northernly zenith angle)
sin(westernly zenith angle)
Transient count
Altitude (deg)
Transient count
Galactic latitude (deg)
56220 37.9
56224 37.9
56228 37.9
56232 37.9
56233 37.9
56249 29.9
56264 37.9
56272 37.9
56273 37.9
56287 37.9
56292 37.9
56309 37.9
56310 37.9
56311 37.9
56327 50.8
56341 26.0
56344 52.0
56345 52.0
56367 52.0
56376 52.0
56378 37.9
56387 37.9
56417 37.9
56417 37.9
56444 37.9
56461 37.9
56468 37.9
56469 37.9
56474 37.8
56492 37.8
56502 37.9
56508 37.8
56515 37.8
Time (s)
Hartman, Obenberger, et al. (in prep.)
LWA
Long Wavelength Array

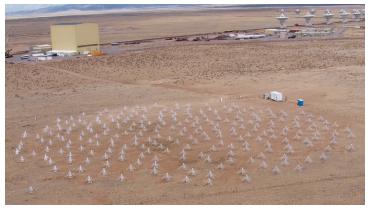
Fast Radio Bursts?

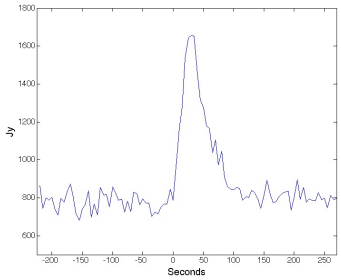
Parkes Radio Telescope



Thornton et al. (2013)

LWA1





LWA1 / Parkes:
$10^{-1.5}$ in frequency
10^{4} in time
10^{3} in flux density

LWA
Long Wavelength Array

Next steps

Soon:

- Process 200 days of more data
- Further verification that these are real
- Measure or limit DMs from visibility data
- Flux calibration, self-calibration
- Check associations with nearby stars

Over the next ~year:

- Search beamformed data:
  detectable in Steve's SDP project?
- Trigger beamformed observations
- More / better data: OVRO and Sevilleta

LWA
Long Wavelength Array