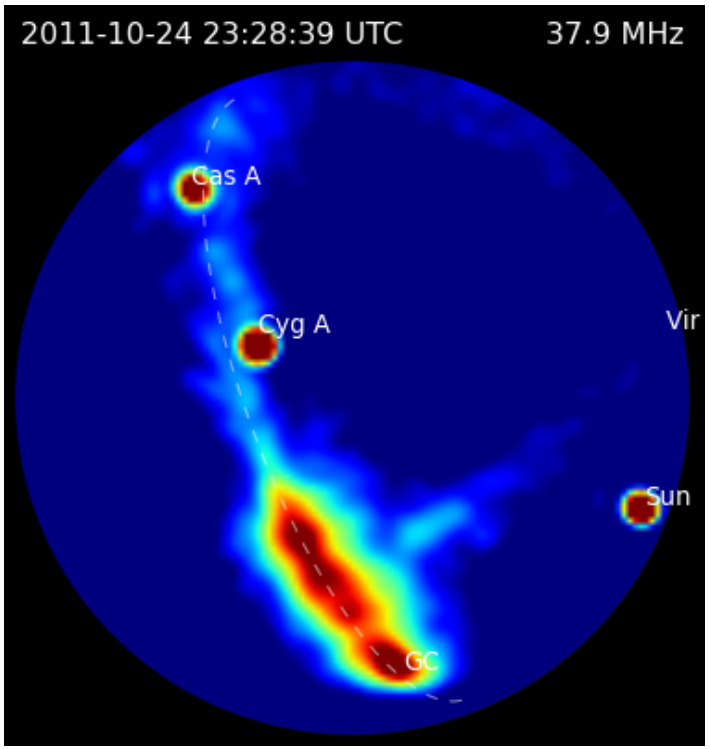
The Prototype All-Sky Imager

Jake Hartman (JPL)

- **The PASI system**
  - Movies!
  - Transient monitoring
  - That damn shimmering
  - Data products

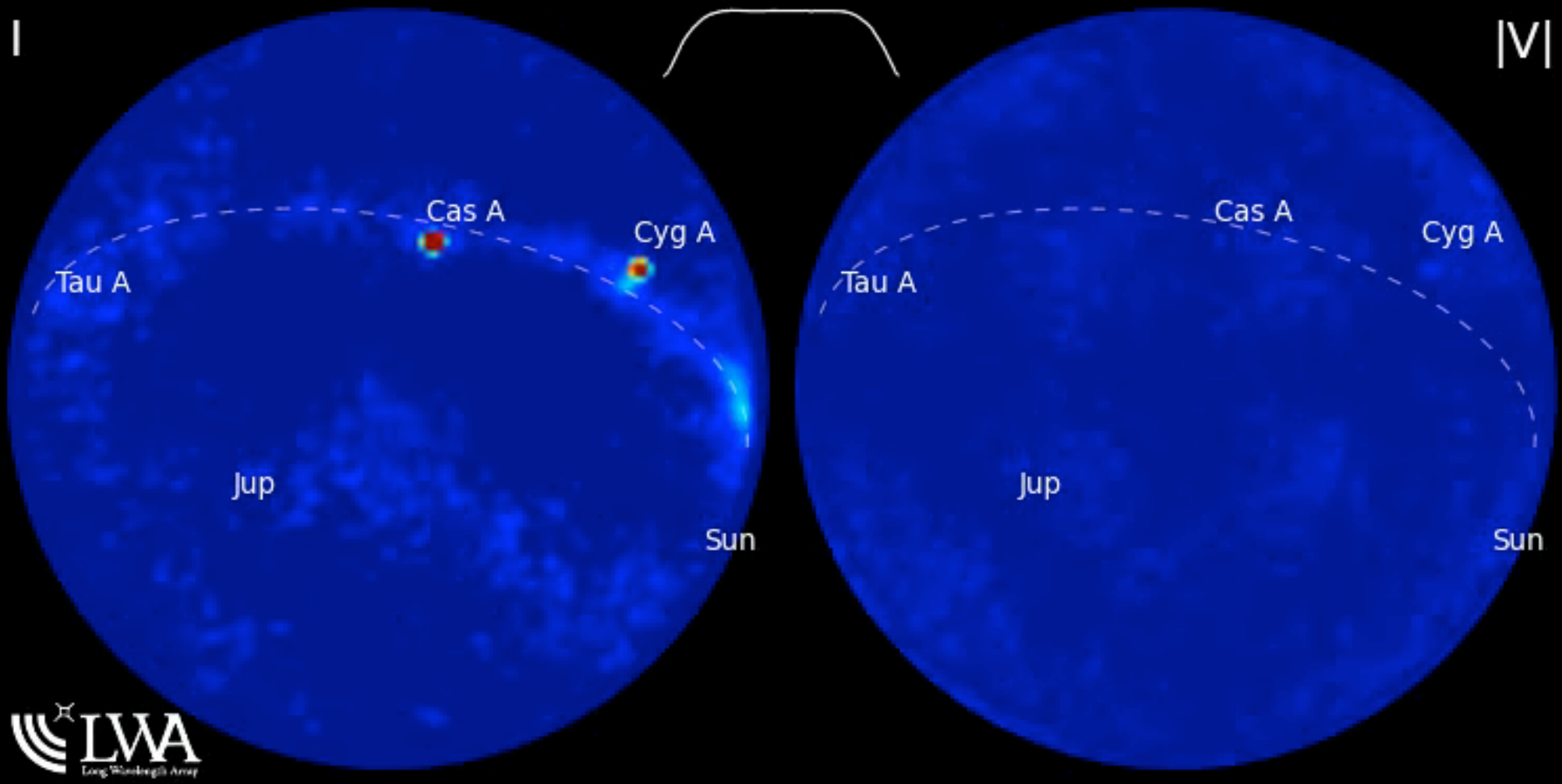
The Prototype All-Sky Imager (PASI)

- Software correlator located in the LWA1's RFI shelter
- Receives a continuous 100 kSPS stream from all the dipoles
- Images the full sky with a ~5 s cadence at 100% duty cycle and (potentially) 99% uptime, covering ≈ 3π sr every day



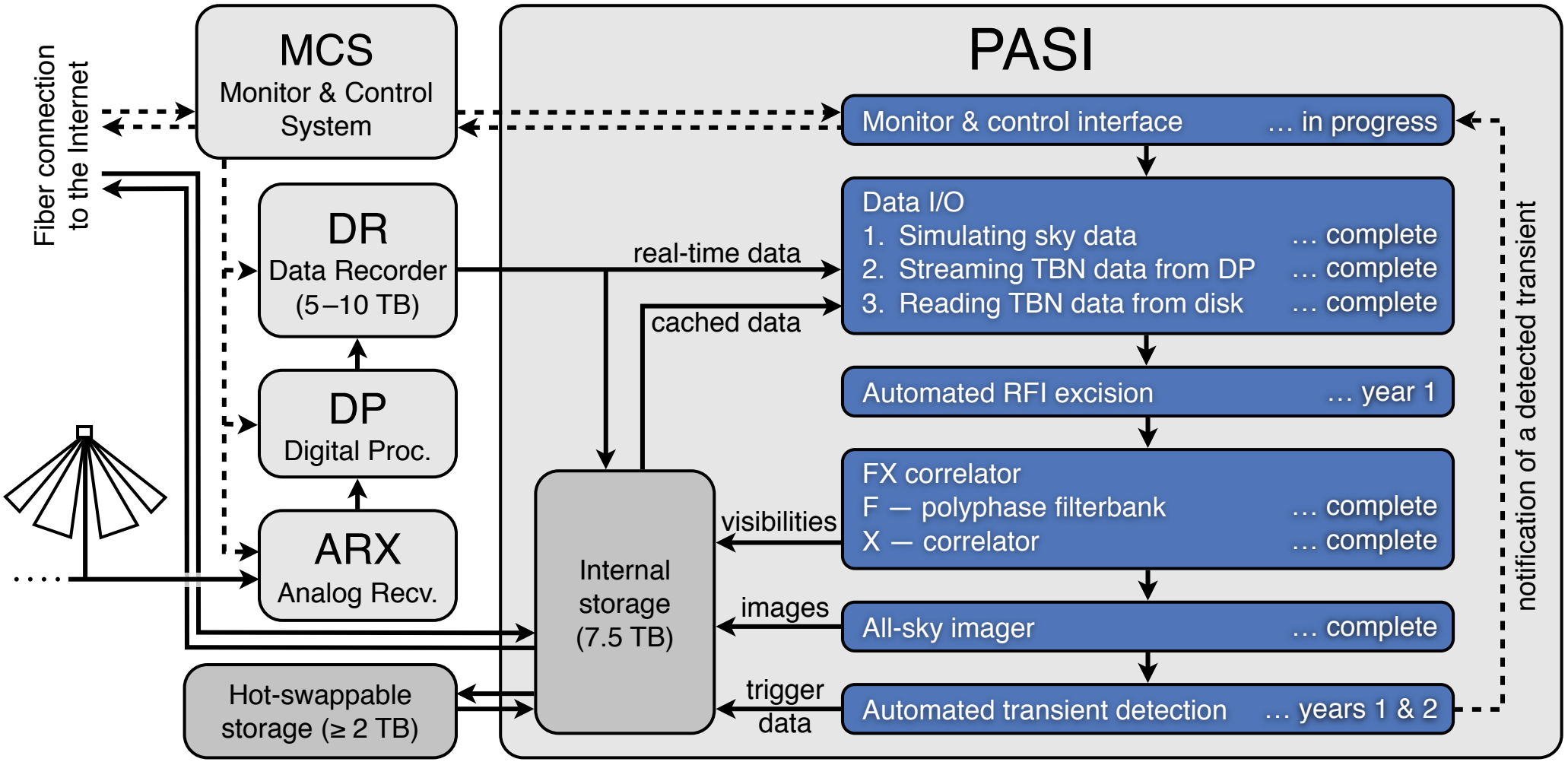
LWA
Long Wavelength Array

The Prototype All-Sky Imager (PASI)



http://www.phys.unm.edu/~lwa/lwatv/55938.mov

PASI system design



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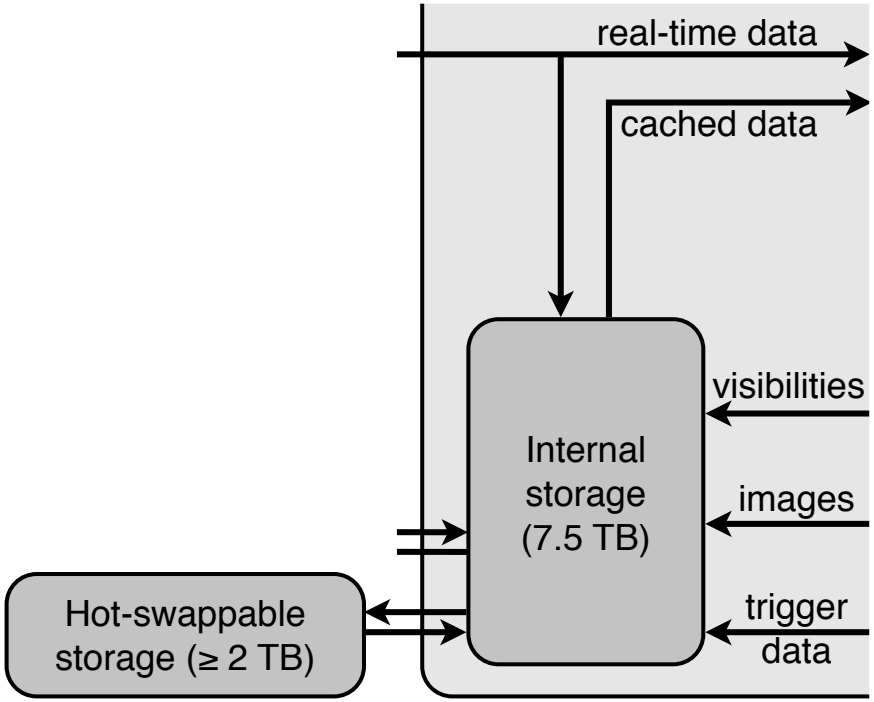
PASI system design

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



- 10–20 hours for raw data
- 30 days for visibilities
- images kept forever
- detection candidates kept forever

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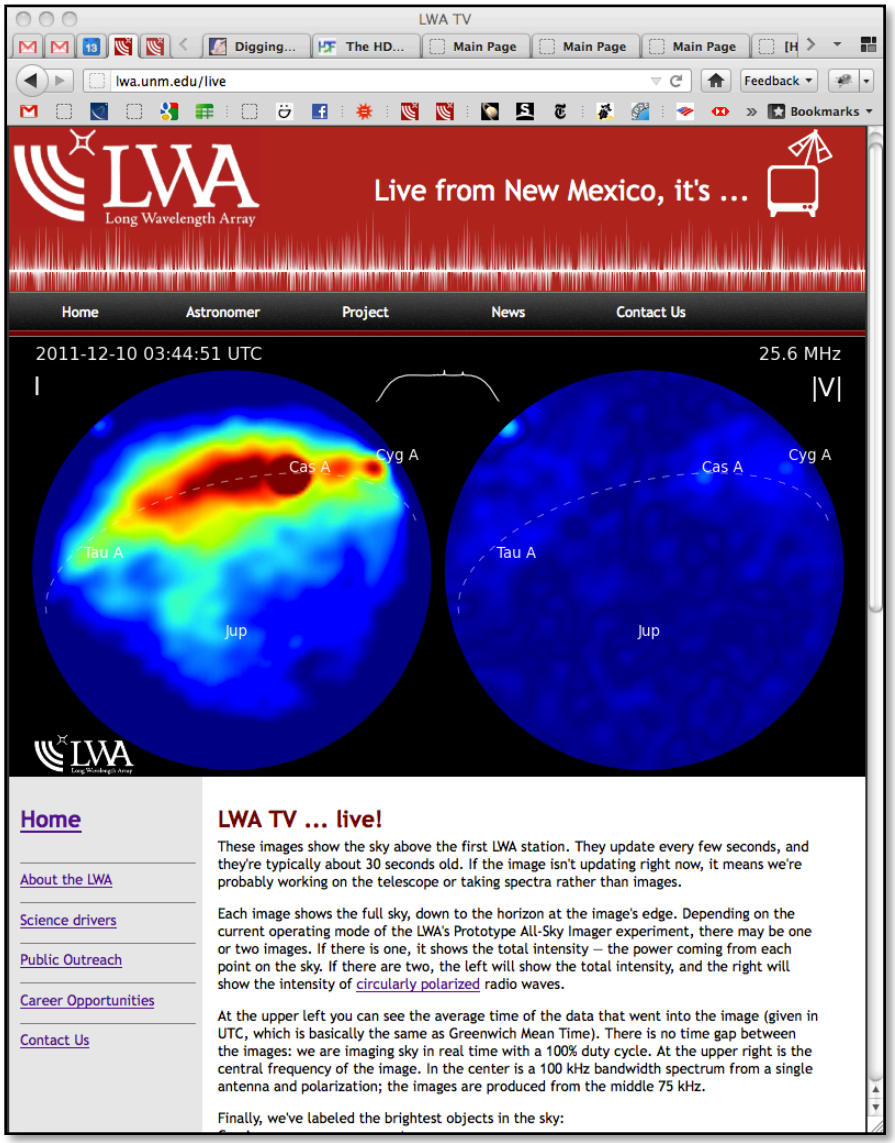
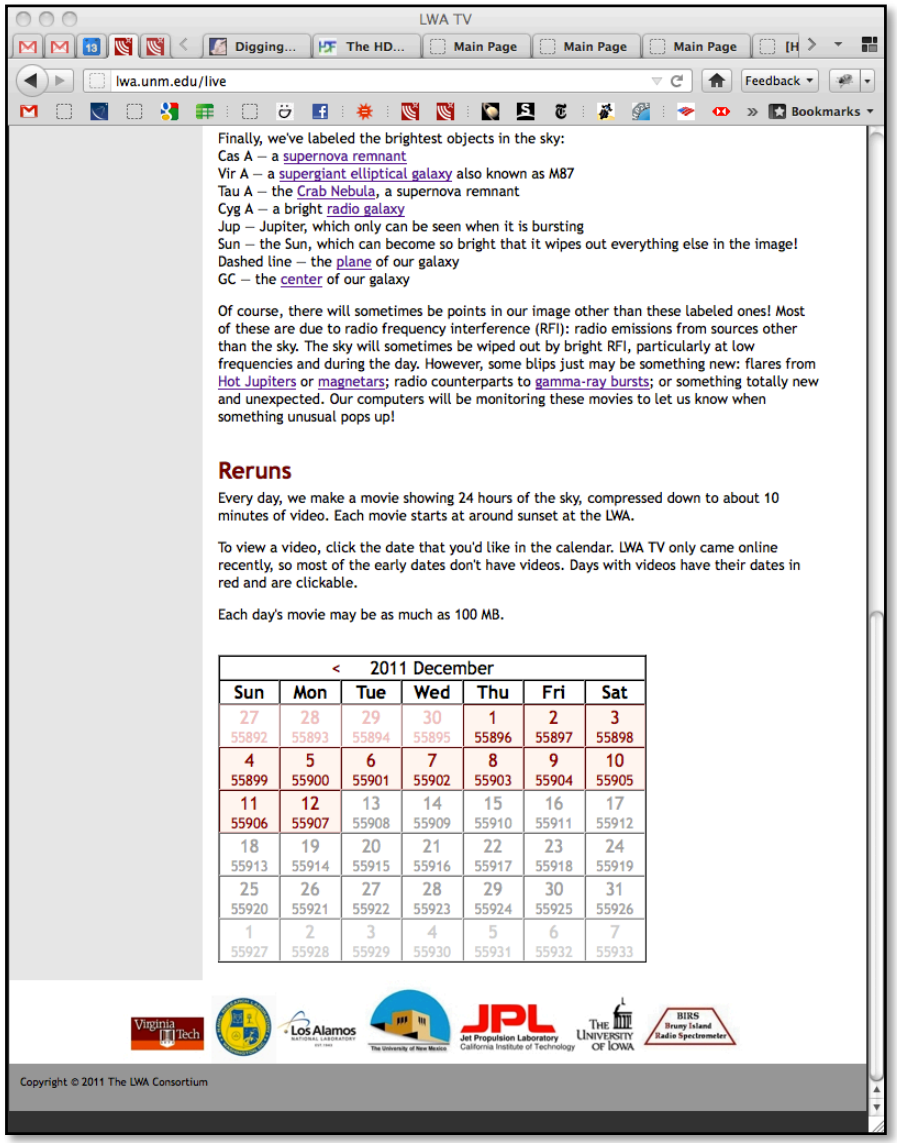
http://lwa.unm.edu/live





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The PASI system

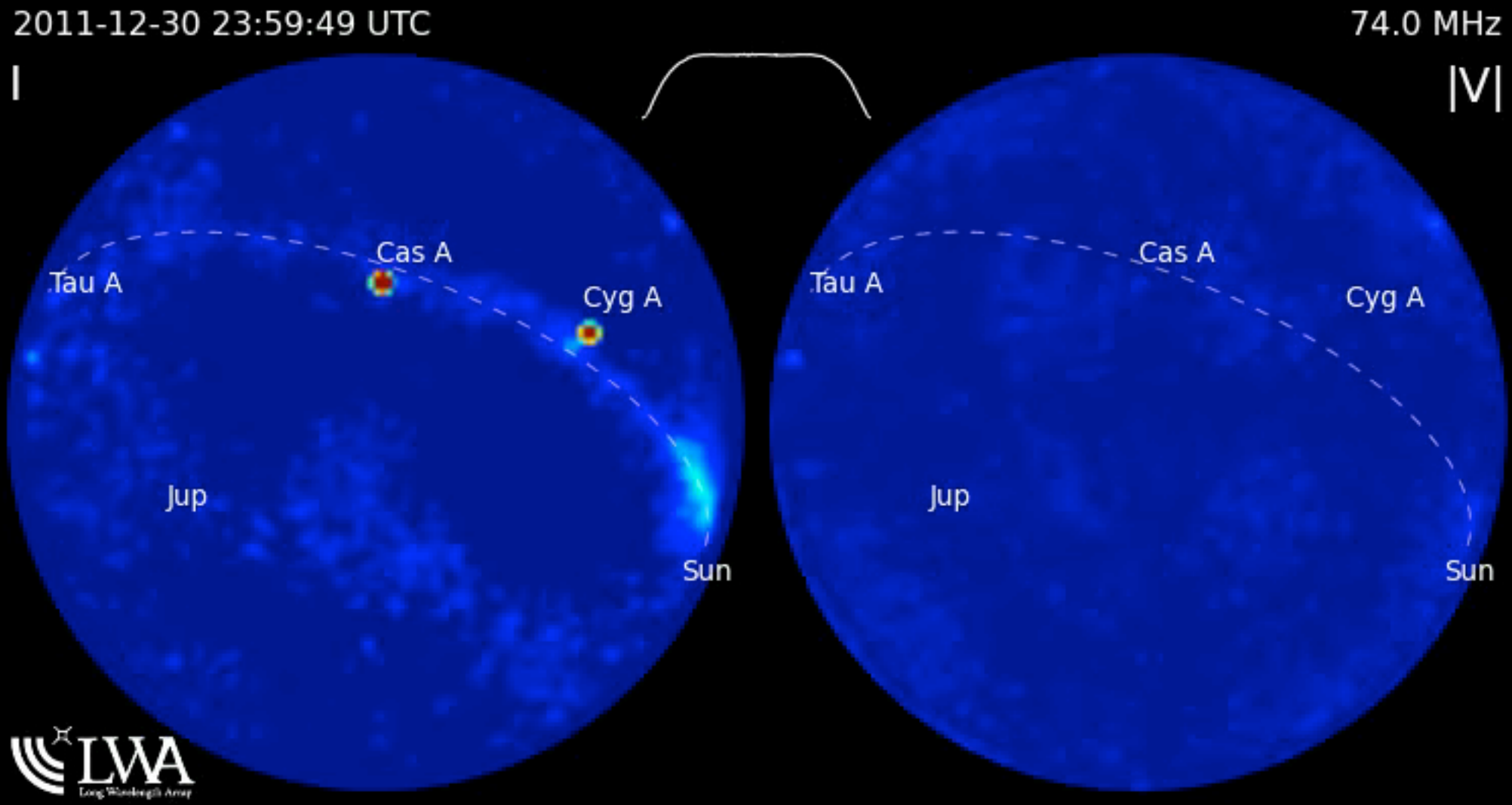
➤ **Movies!**

Transient monitoring

That damn shimmering

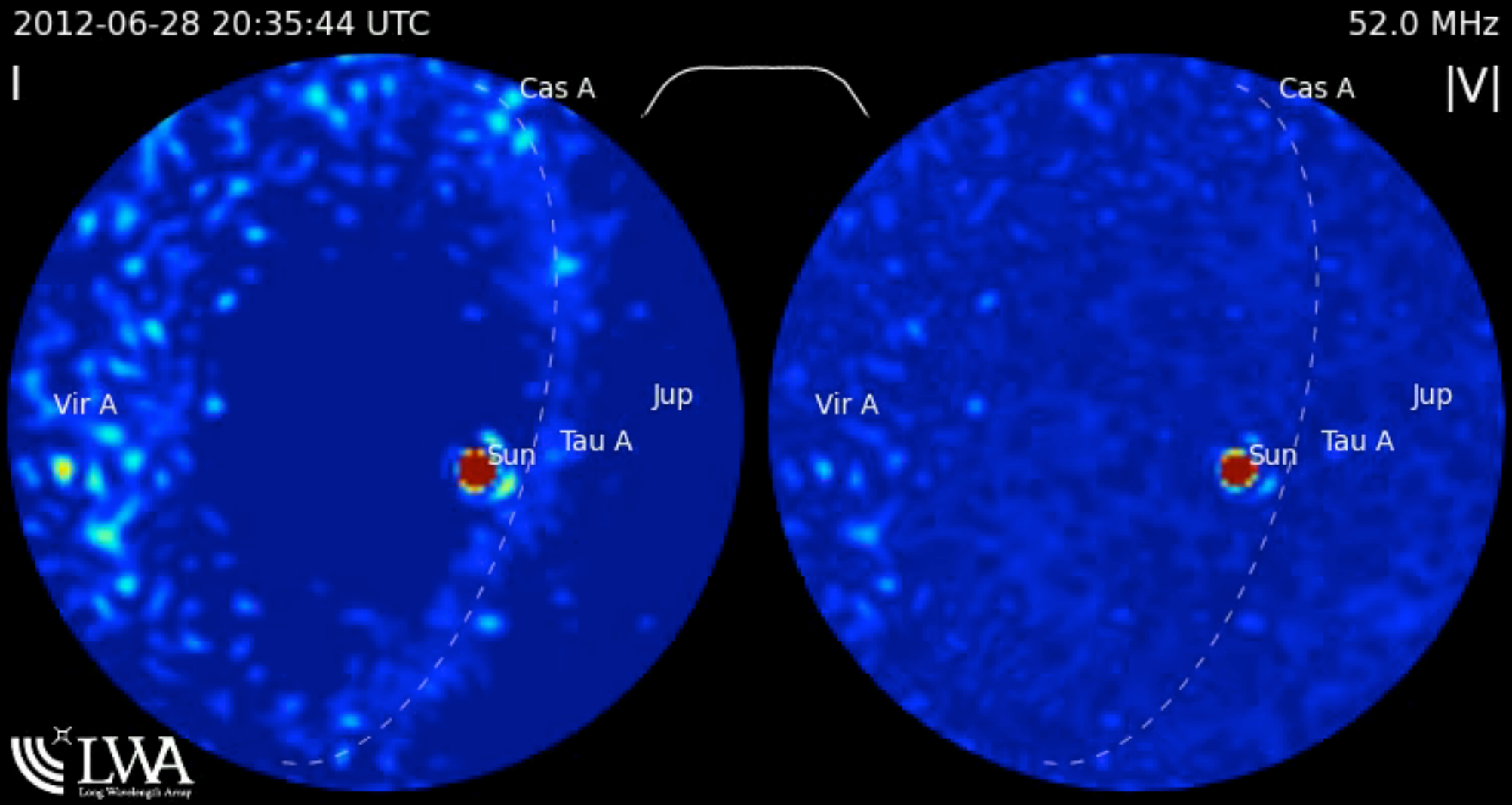
Data products

Jovian bursts … and shimmering



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

Sporadic E event and solar bursts



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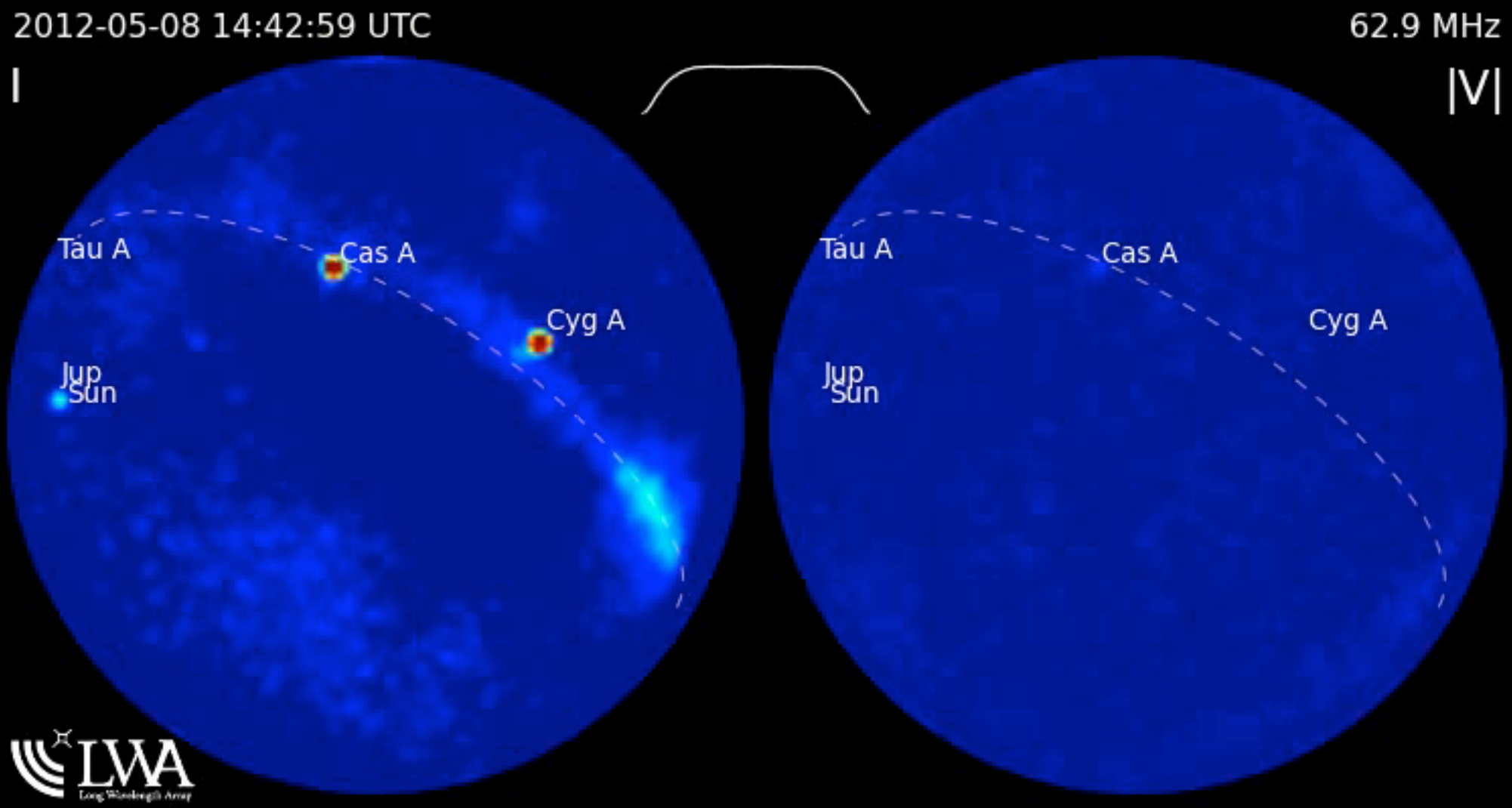
Lightning!



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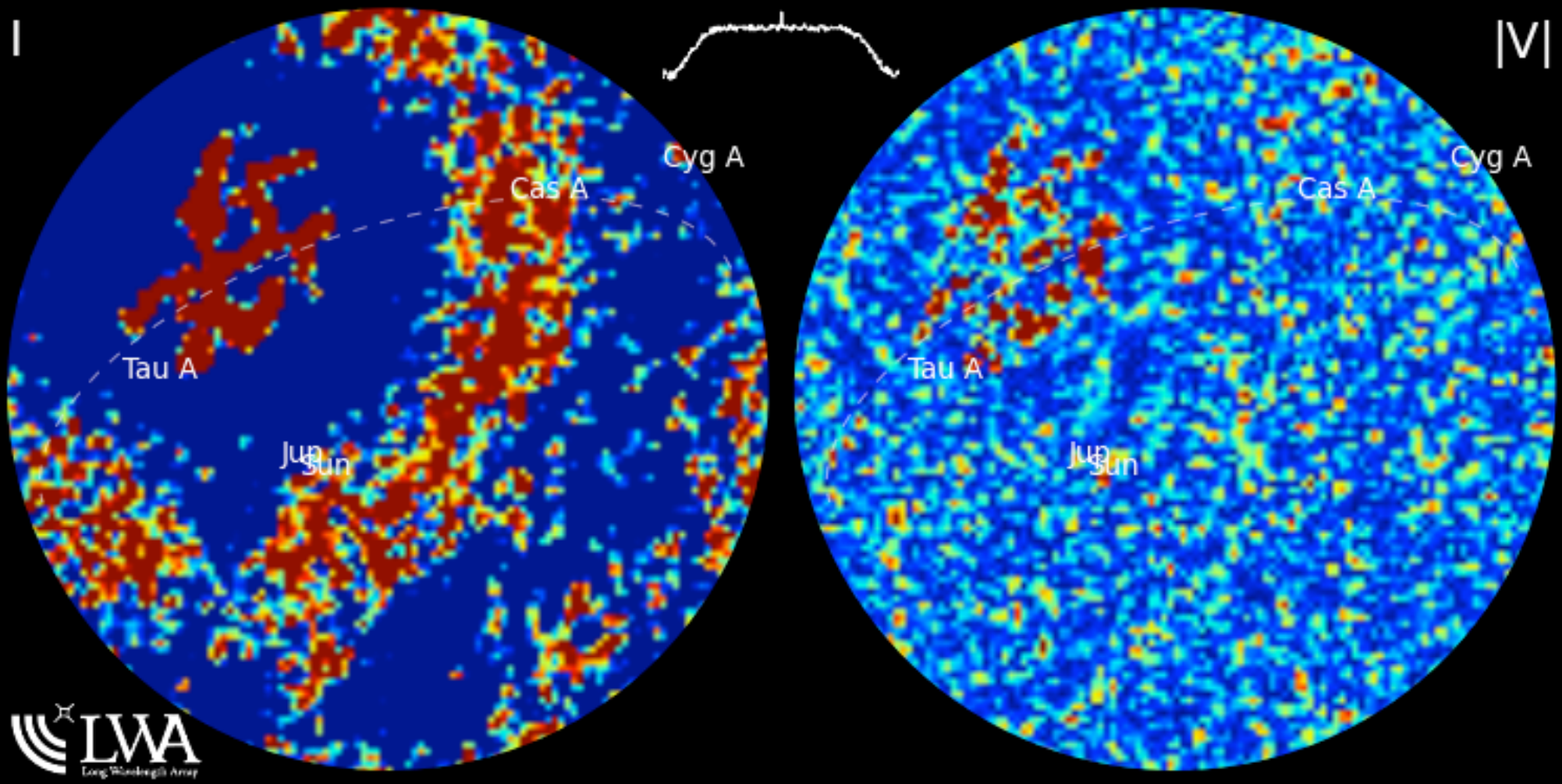
Lightning!



http://www.phys.unm.edu/~lwa/lwatv/56055.mov

The PASI system

Movies!

➤ **Transient monitoring**

That damn shimmering

Data products

Exploring new transient phase space

- Frequency: 10–87 MHz CF, with full Stokes
- FOV: full sky with each image; ≈ 3π sr every day
- Cadence: current max is 20 images per minute, live; could be as fast as 40 images/min with minor changes
- Uptime: 24 hrs/day with ~90% duty cycle demonstrated, but currently limited by TBN / BAM conflicts
- Noise limits for 74 MHz integrations:
  10 s integration: 2 Jy/beam
  2 hr integration: 0.1 Jy/beam

➤ Result is ~10^7 images per year, if TBN issue is resolved

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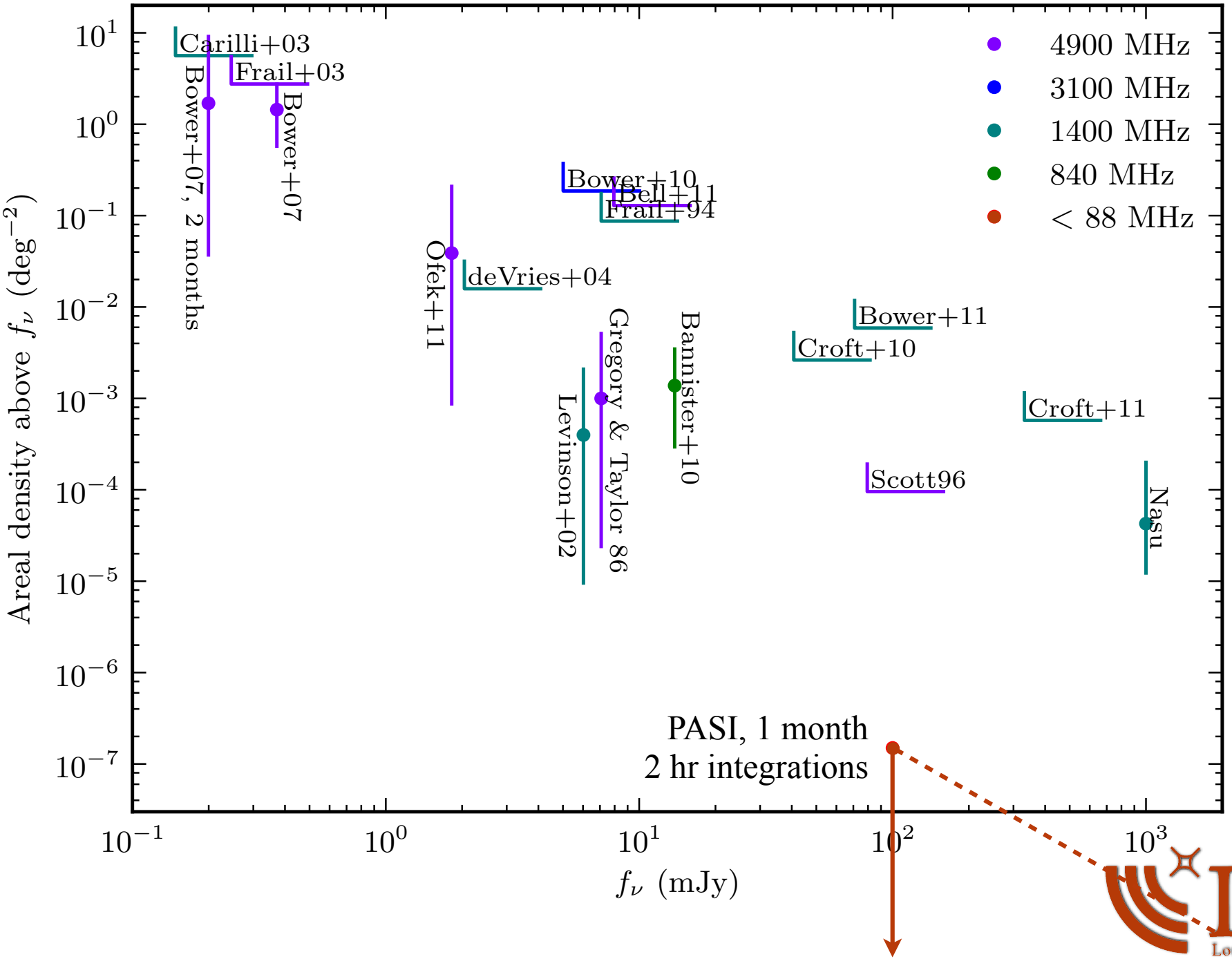
Exploring new transient phase space



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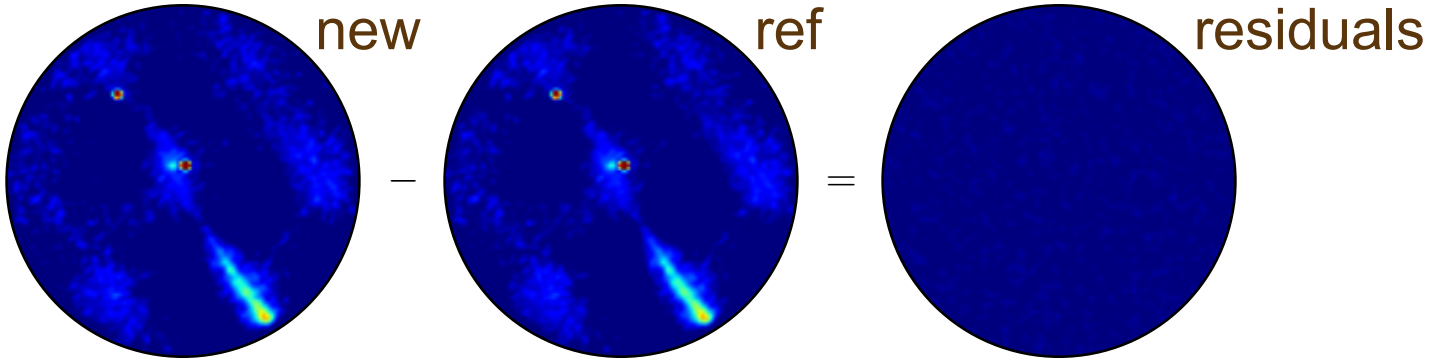
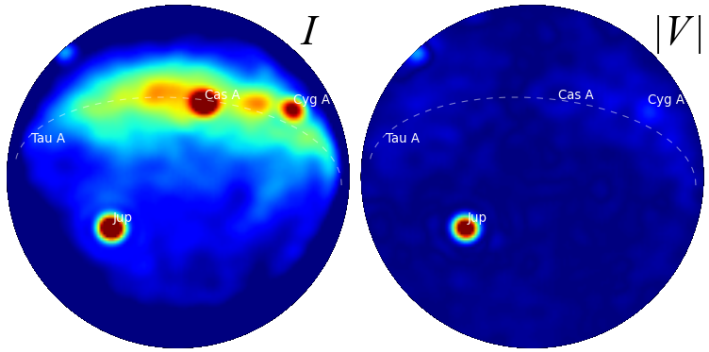
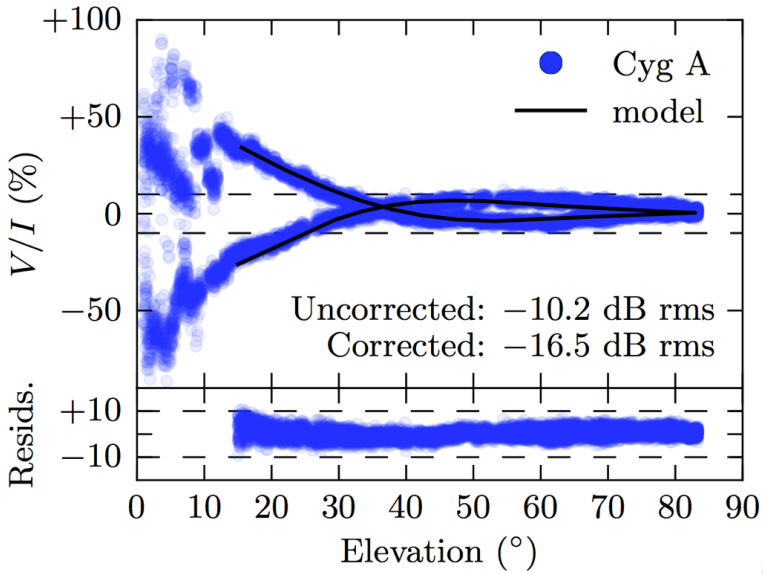
Strategy to reach noise limit

- Confusion limit is 25 Jy/beam at 74 MHz, but this limit is dominated by constant, unpolarized emission
- Image differencing



- Polarization filtering





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The PASI system

Movies!

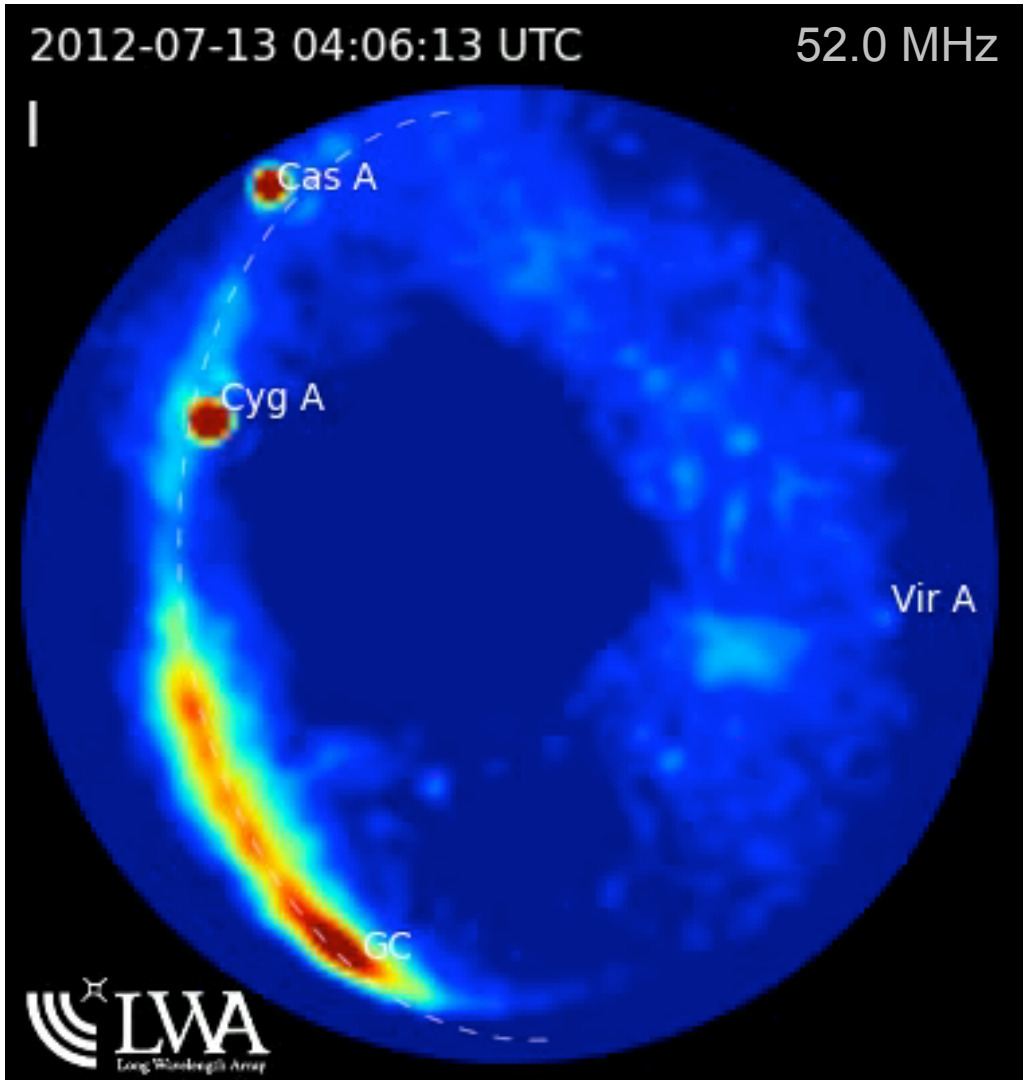
Transient monitoring

➤ **That damn shimmering**

Data products

Possible causes of shimmering

- Ionospheric scintillation
  - + stronger when ionospheric disturbances are present
  - + also seen in beam data
  - – ~50 Jy noise floor without elevation dependence
- Calibration issues
  - + phase cal could likely be improved; using bright Sun
  - – hard to explain 5 s variability
- Problem with DP?
- Bug in my code?
  - – hard to believe possible



http://www.phys.unm.edu/~lwa/lwatv/56121.mov

LWA Long Wavelength Array

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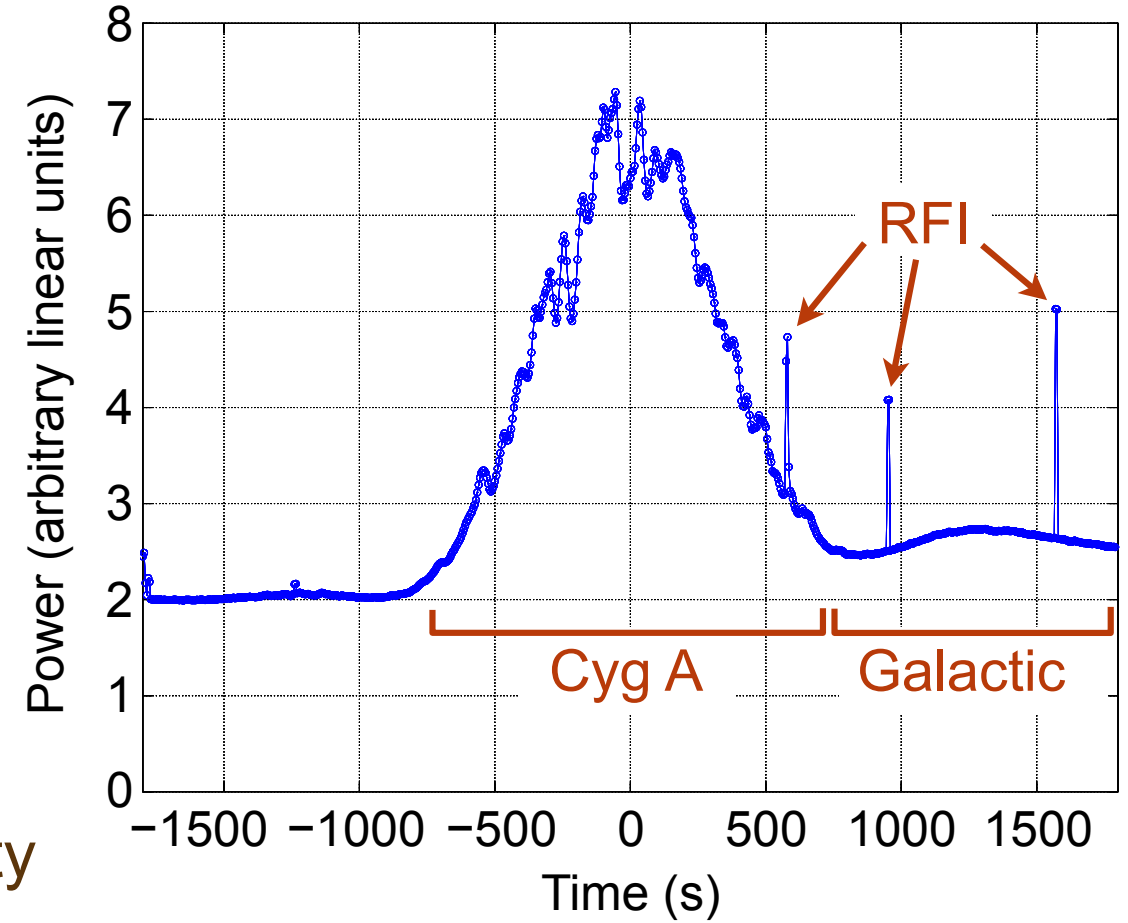

Drift scan observation using beamformed TBN data

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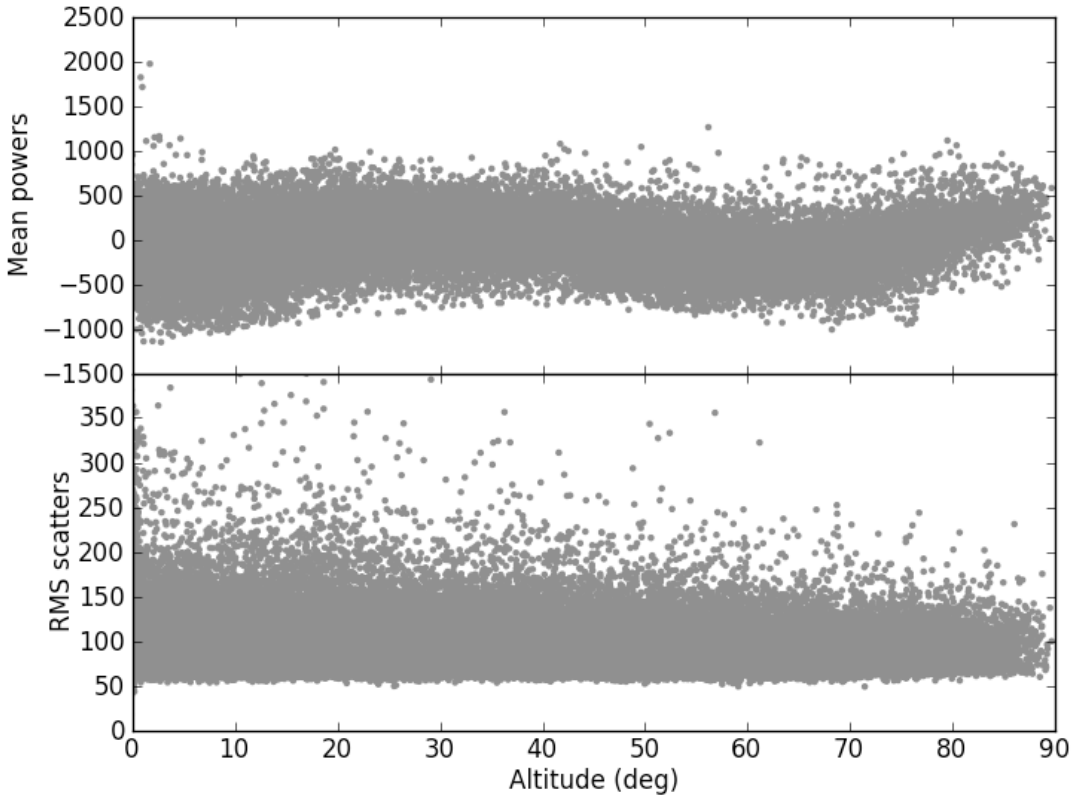
- Problem with DP?
- Bug in my code?
  - – inconceivable!



1000 random points on the sky with fixed RA & Dec measured over 24 hr

Uniform cutoff at ~50 Jy zenith: hard to explain with scintillation

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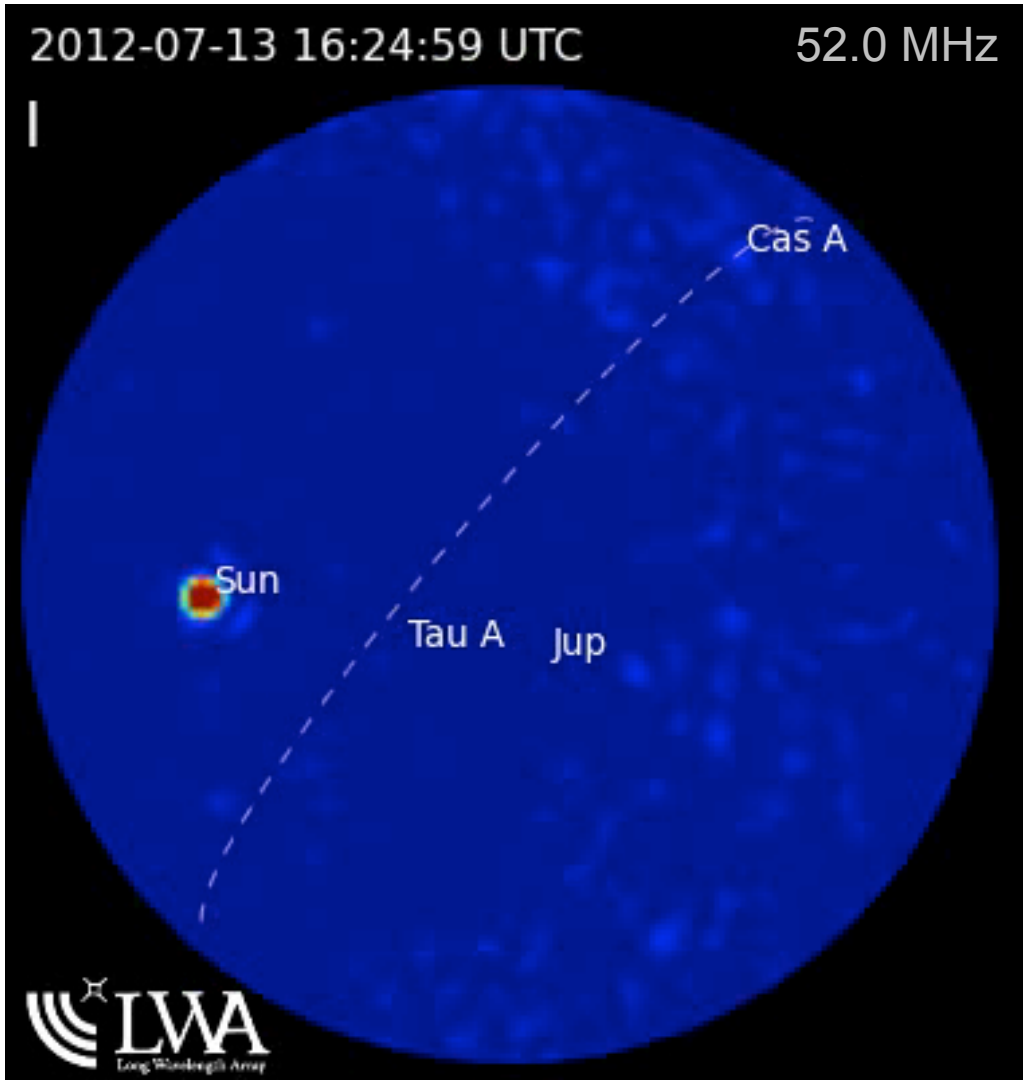

http://www.phys.unm.edu/~lwa/lwatv/56121.mov

LWA
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The PASI system

Movies!

Transient monitoring

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➤ **Data products**

Source fluxes

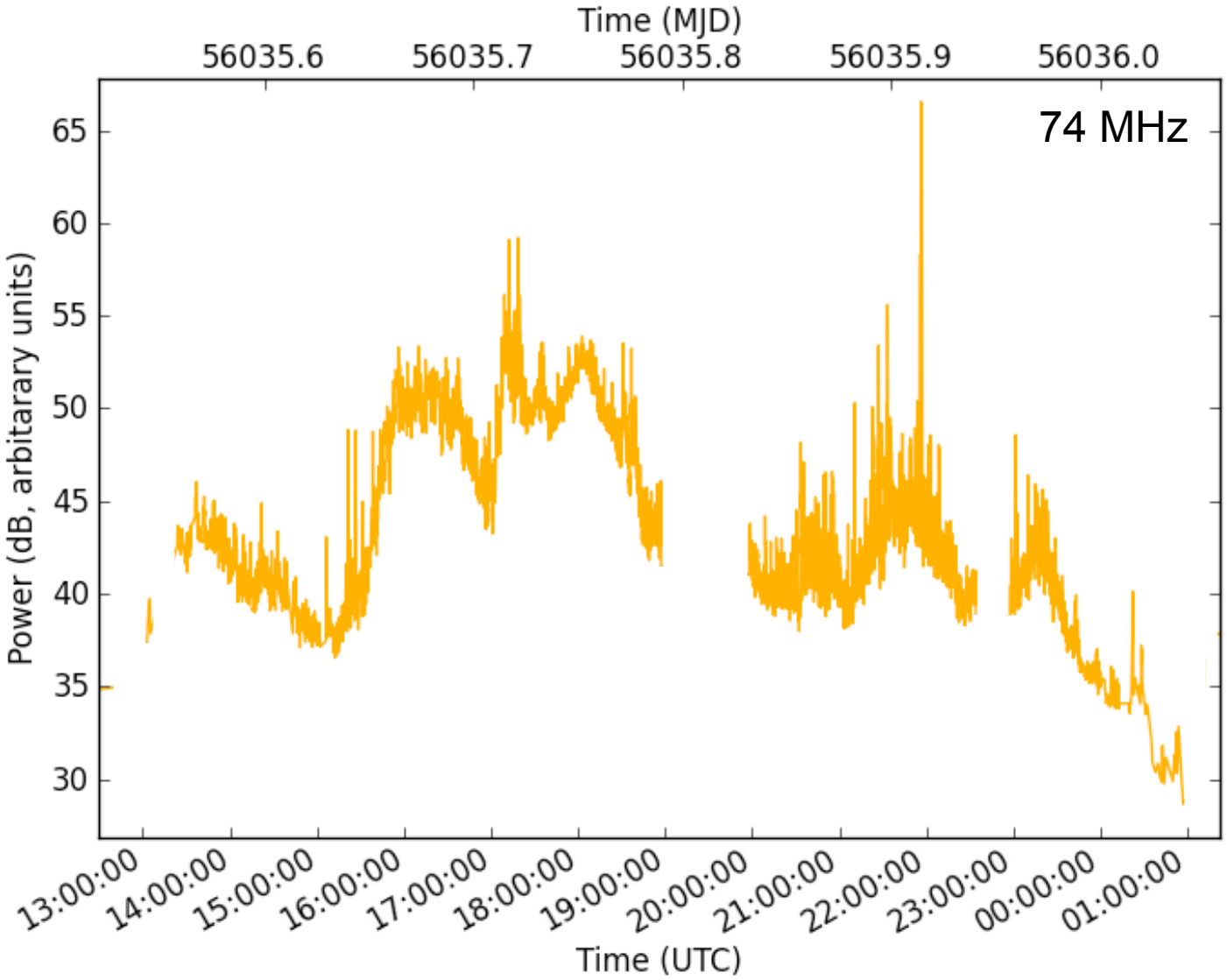
2D Gaussian is fit to each known source location. Gives:

- deviation from expected location
- PSF radius
- power

Targeted sources:

- The “A Team” of Cas, Cyg, Vir, Tau
- The Sun
- Jupiter (< 40 MHz)

Python interface will be available soon, with data stored in the UNM archive.



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Raw image data

- Images are stored in a proprietary binary format on PASI. (Should be transferred into the UNM archive.) Image DB files are never deleted.
- Each file is: 1 hr / 720 integrations / 360 MB.
- Four images (Stokes *I*, *Q*, *U*, *V*) per integration, stored as 4 × 180 × 180 floating point array, plus lots of metadata.
- Encapsulated in a Python class for simplified access (PasiImageDB).

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Visibility data

- Saved for at least two weeks in a rolling buffer on PASI.
- Each file is: one integration / 6.5 MB.
- Saved as gzipped CASA Measurement Set directories.
- I can provide UVFITS-format data upon request.

LWA
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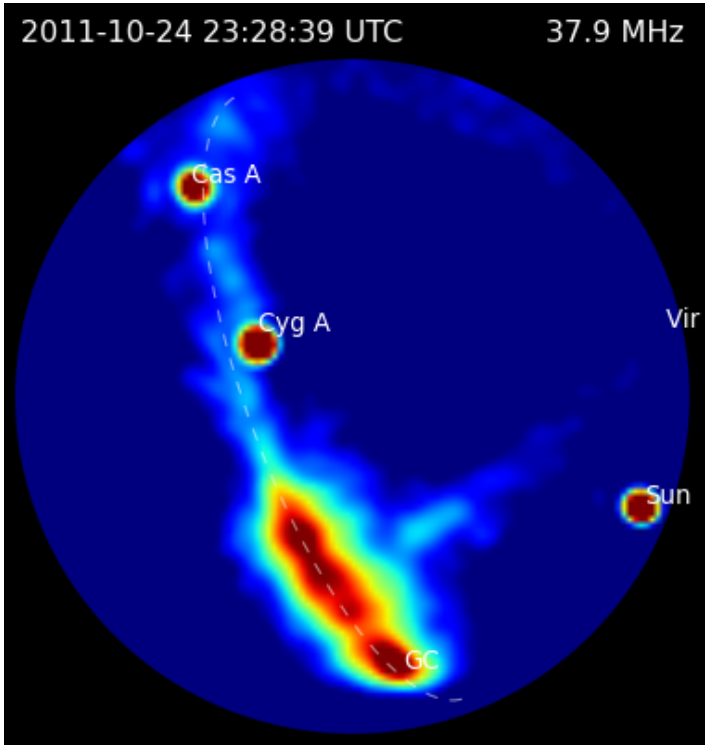
Summary

- Images the full sky many times per minute at 100% duty cycle and > 90% uptime, covering ≈ 3π sr every day
- This is a virtually unexplored region of transient phase space!
- Still much calibration work to be done before it realizes its full potential



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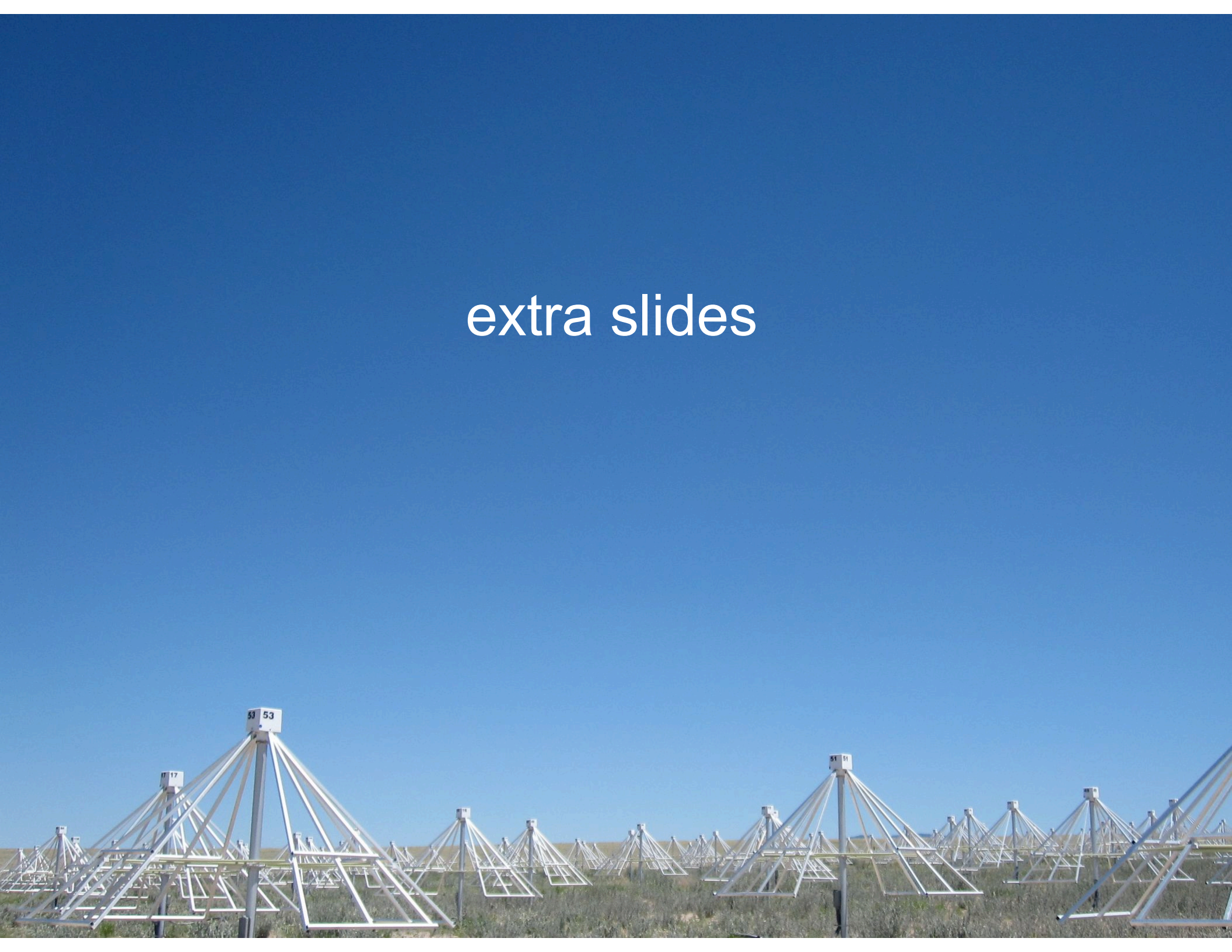
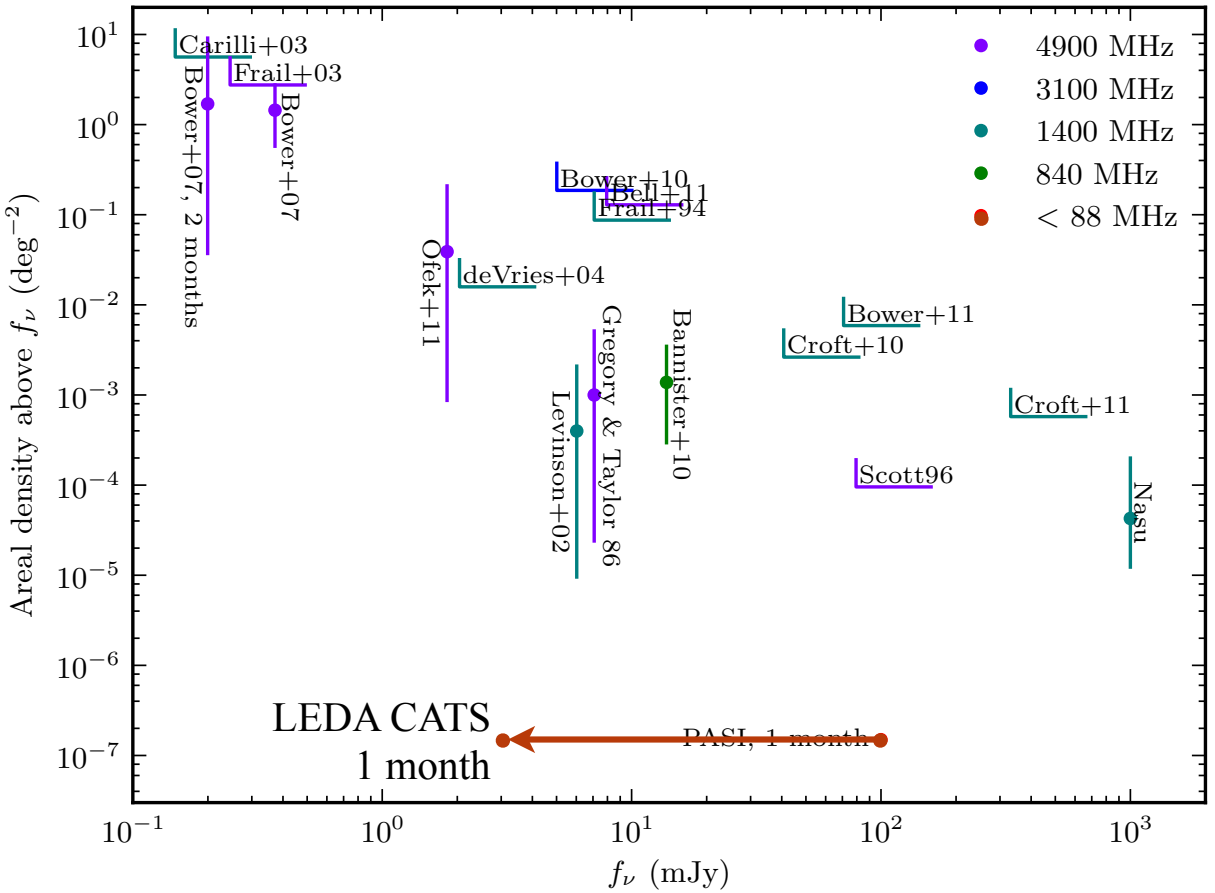
extra slides



LEDA Commensal All-sky Transients

- Large-aperture Experiment to detect the Dark Ages: approved and funded project to develop a 50 MHz BW correlator backend for the LWA
- LEDA CATs (Caltech PI: Gregg Hallinan)
  75 kHz BW → 50 MHz BW



Long Wavelength Array