



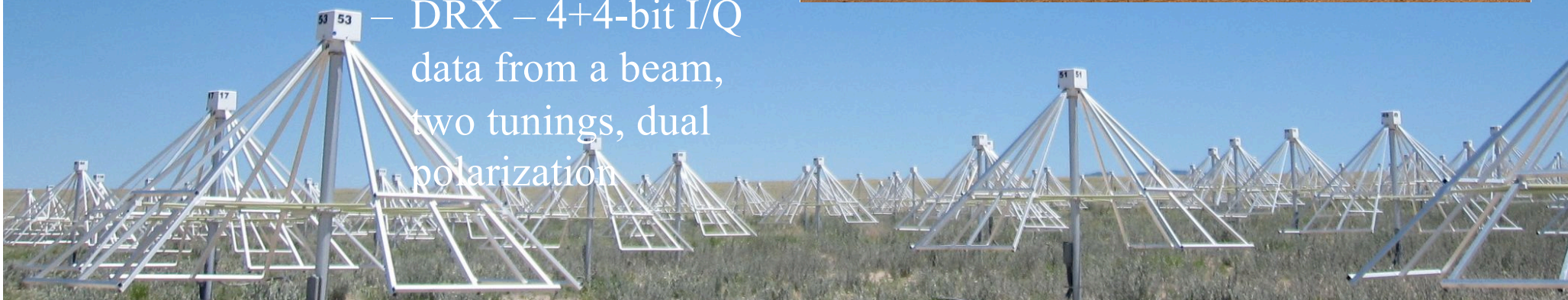
# LWA Technical Status

Jayce Dowell  
LWA Users Meeting  
August 1, 2019



# Current Status – LWA1

- DP used for the backend
- Three data products:
  - TBW – 12-bit digitizer samples for up to 61 ms from all dipoles
  - TBN – 8+8-bit I/Q data from all dipoles, 100 kHz bandwidth, 100% duty cycle
  - DRX – 4+4-bit I/Q data from a beam, two tunings, dual polarization



# Current Status – LWA1

- Up to 19.6 MHz bandwidth per DRX tuning
- Lost beam #1, strictly limited now to only three beams
  - Not clear what happened
  - Unlikely to get back to four beams in the near term
- LASI all-sky imager running when beams are not



# Current Status – LWA-SV



- ADP used for the backend – hybrid FPGA/GPU architecture
  - FPGAs used for digitization and conversion to the frequency domain
  - GPUs used for all subsequent processing to form data products
  - Developed using Bifrost
- Four data products:
  - TBF – 4+4-bit complex spectra, two tunings, up to a few seconds
  - TBN – same as LWA1
  - DRX – same as LWA1
  - COR – correlator visibility output with full polarization, one tuning



# Current Status – LWA-SV



- Up to 9.8 MHz per tuning
  - TBF and wide band correlator running at 10.8 MHz
- Two beams
  - Not fully independent; tunings are tied together
- LASI-SV running even when beams are running



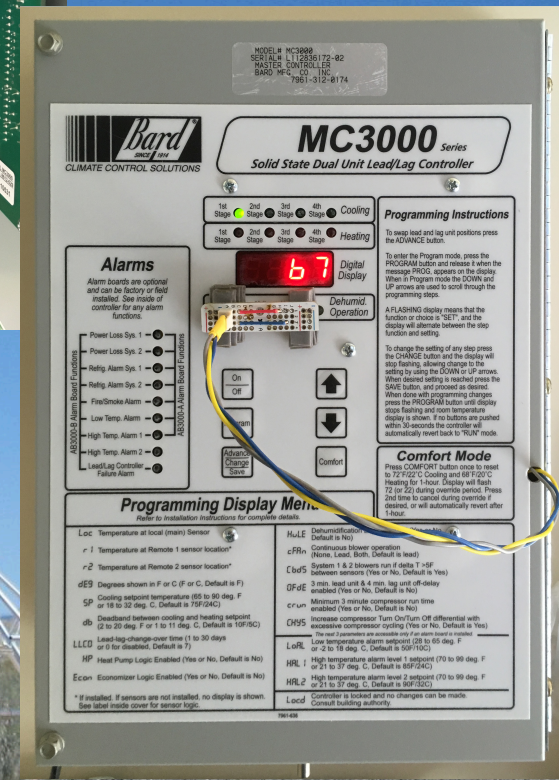
# Recent Changes at the Stations

- Overhaul of data recording out at the sites
  - Replaced all DRSUs with single 12 TB hard drives
  - Replaced 3 of the 5 DRs at LWA1 with 1U servers similar to what is installed at LWA-SV
    - Take up less space and use less power, reduces cable clutter
    - “DRSU” drives are now internal via hot-swappable slots
- Active power monitoring at both sites
  - Used to identify brownouts, outages, and other power problems
  - Currently done with cheap DMMs, replacing with dedicated monitors soon



# Recent Changes at the Stations (cont'd)

- Designed and built HVAC interface boards for both stations
  - Allow for remote reset of the controller and for disabling the compressors
  - Helps deal with icing at both stations and “run away overheating” at LWA-SV



# Recent Changes at the Stations (cont'd)

- Various changes to the HAL systems to improve ease of operation
  - Automated control of the station and observations
  - Power monitoring and automatic recovery from power problems
  - Improvements to triggering, including new modes for solar observations and targets of opportunity
  - Automatic pulsar observations for the pulsar archive
- Continued battles against RFI
  - Not really a change, more like the status quo
  - Powerlines, self-generated RFI, lights, etc.





# Computing – Status and Changes



- LWA Users Computing Facility
  - Six nodes with hexacore processors and Ubuntu 14.04
    - 32 to 64 GB of memory
    - 4 to 6 TB of scratch storage
    - Recently upgraded to have at least one Nvidia GTX 980 GPU per node
  - Pooled storage of 138 TB for raw data
  - Also serves as a software correlator



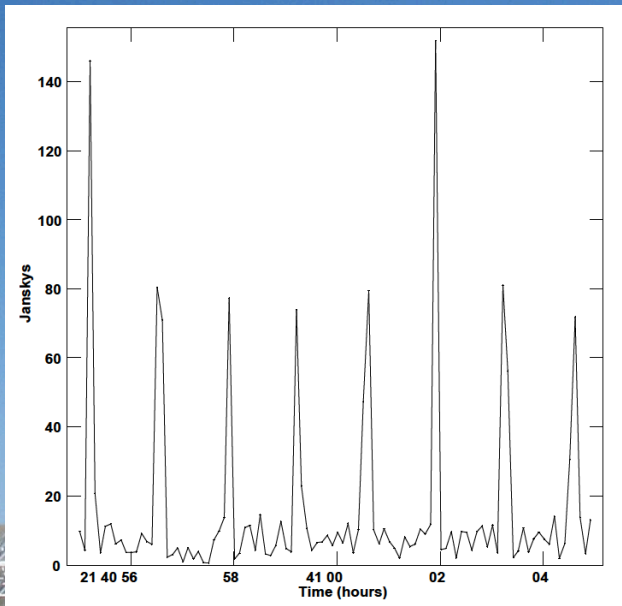
# Computing – Status and Changes

- LWA Data Archive
  - Stores various data products:
    - Spectrometer data
    - Interferometer data
    - LASI and LASI-SV images
    - LWA Pulsar Archive
  - Recently upgraded to a 270 TB ZFS system
    - Expandable up to 750 TB with current chassis



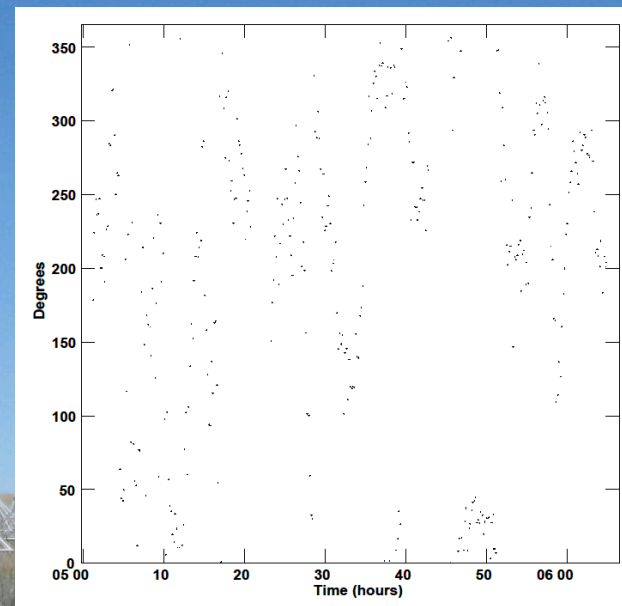
# The LWA Single-Baseline Interferometer

- New interferometry mode first available in CFP7
- Single baseline of  $\sim 70$  km with up to  $\sim 20$  MHz of bandwidth
- Observing strategy uses two beams
  - one on source and another on a nearby ( $< 5^\circ$ ) phase calibrator
  - $\sim 100$  s coherence time



Pulses from  
B1919+21

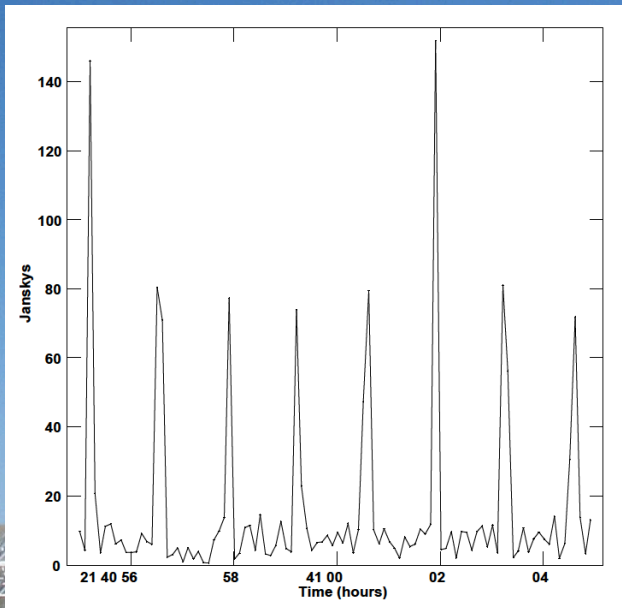
Davis et al., in prep.



Phase for  
4C 55.28  
(4.5 Jy)

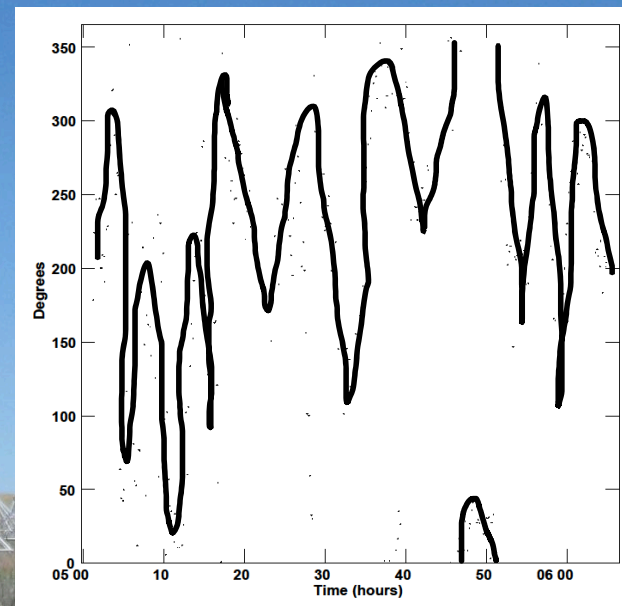
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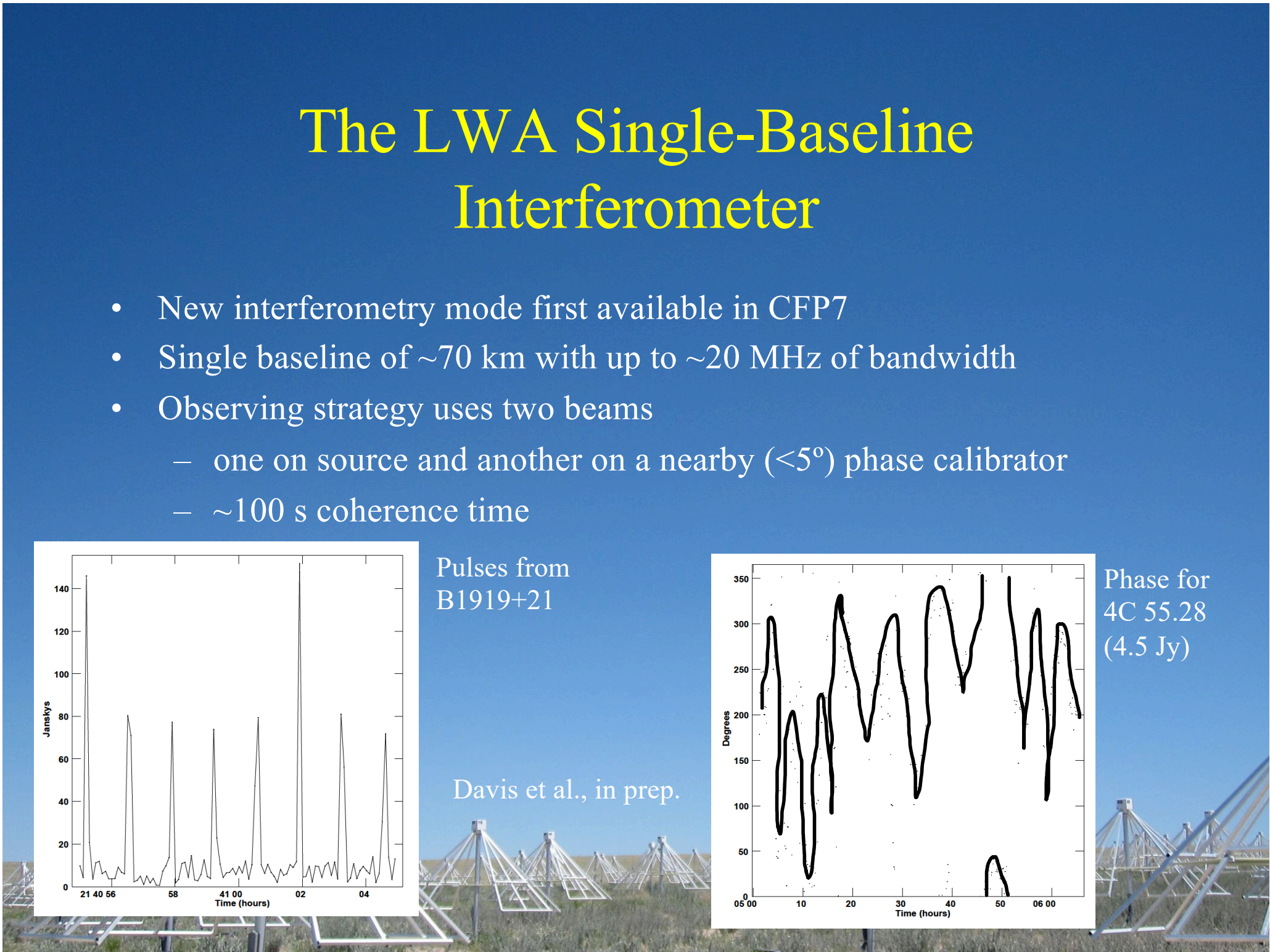


Pulses from  
B1919+21

Davis et al., in prep.

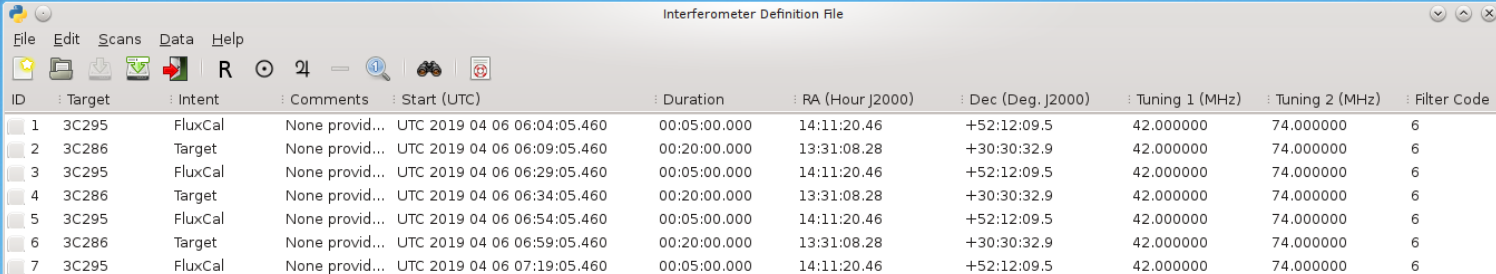


Phase for  
4C 55.28  
(4.5 Jy)



# The LWA Single-Baseline Interferometer

- Observations defined with Interferometer Definition Files (IDFs)
  - Submitted through the validator, similar to SDFs
  - Supported in LSL starting with version 1.2.4
- Suite of tools to help setup observations
  - `swarmGUI.py` – IDF builder
  - `calibratorSearch.py` – Phase calibrator search tool



The screenshot shows a software window titled "Interferometer Definition File" with a menu bar (File, Edit, Scans, Data, Help) and a toolbar. Below the toolbar is a table with 11 columns: ID, Target, Intent, Comments, Start (UTC), Duration, RA (Hour, J2000), Dec (Deg, J2000), Tuning 1 (MHz), Tuning 2 (MHz), and Filter Code. The table contains 7 rows of observation data.

ID	Target	Intent	Comments	Start (UTC)	Duration	RA (Hour, J2000)	Dec (Deg, J2000)	Tuning 1 (MHz)	Tuning 2 (MHz)	Filter Code
1	3C295	FluxCal	None provid...	UTC 2019 04 06 06:04:05.460	00:05:00.000	14:11:20.46	+52:12:09.5	42.000000	74.000000	6
2	3C286	Target	None provid...	UTC 2019 04 06 06:09:05.460	00:20:00.000	13:31:08.28	+30:30:32.9	42.000000	74.000000	6
3	3C295	FluxCal	None provid...	UTC 2019 04 06 06:29:05.460	00:05:00.000	14:11:20.46	+52:12:09.5	42.000000	74.000000	6
4	3C286	Target	None provid...	UTC 2019 04 06 06:34:05.460	00:20:00.000	13:31:08.28	+30:30:32.9	42.000000	74.000000	6
5	3C295	FluxCal	None provid...	UTC 2019 04 06 06:54:05.460	00:05:00.000	14:11:20.46	+52:12:09.5	42.000000	74.000000	6
6	3C286	Target	None provid...	UTC 2019 04 06 06:59:05.460	00:20:00.000	13:31:08.28	+30:30:32.9	42.000000	74.000000	6
7	3C295	FluxCal	None provid...	UTC 2019 04 06 07:19:05.460	00:05:00.000	14:11:20.46	+52:12:09.5	42.000000	74.000000	6



# The LWA Single-Baseline Interferometer

**Observer Information**

Data Products

ID Number: 99

First Name: jayce

Last Name: Dowell

**Project Information**

ID Code: COMJD

Title: Commissioning data

Comments: None provided

**Run Information**

ID Number: 1

Title: Test Run of the LWA Single Baseline Intererometer

Comments:

Correlator Setup: Channels: 256 Int. Time: 1.0

Linear  Circular  Stokes

Data Return Method:  DRSU  USB Harddrive (4 max)  Copy to UCF

UCF Username:

Ok Cancel

**Advanced Settings**

**Interferometer Information**

Stations:  LWA1  LWASV  LWANA  OVLWA

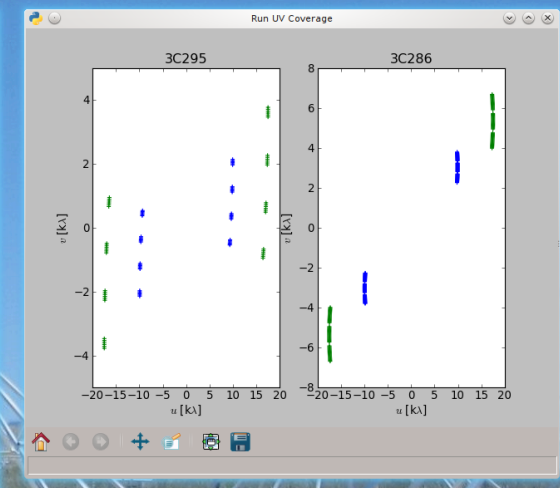
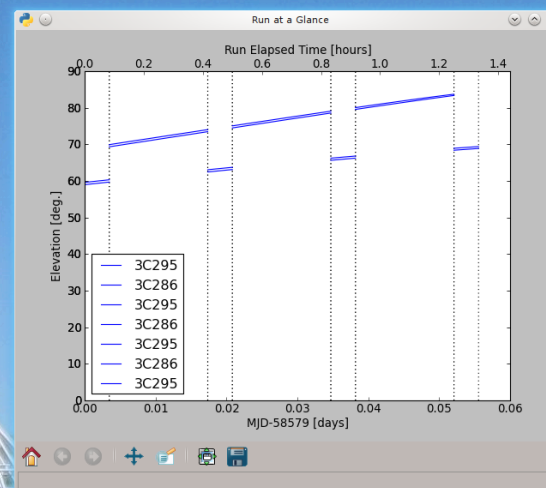
**ASP-Specific Information**

Filter Mode Setting: Split for all inputs

**DRX-Specific Information**

Gain: 6

Ok Cancel



# The LWA Single-Baseline Interferometer

VLSSr Calibrator Search

File Help

Target Parameters

Name:  - or - RA:

Dec:

VLSSr Search Parameters

Search Radius Min:  deg Max:  deg

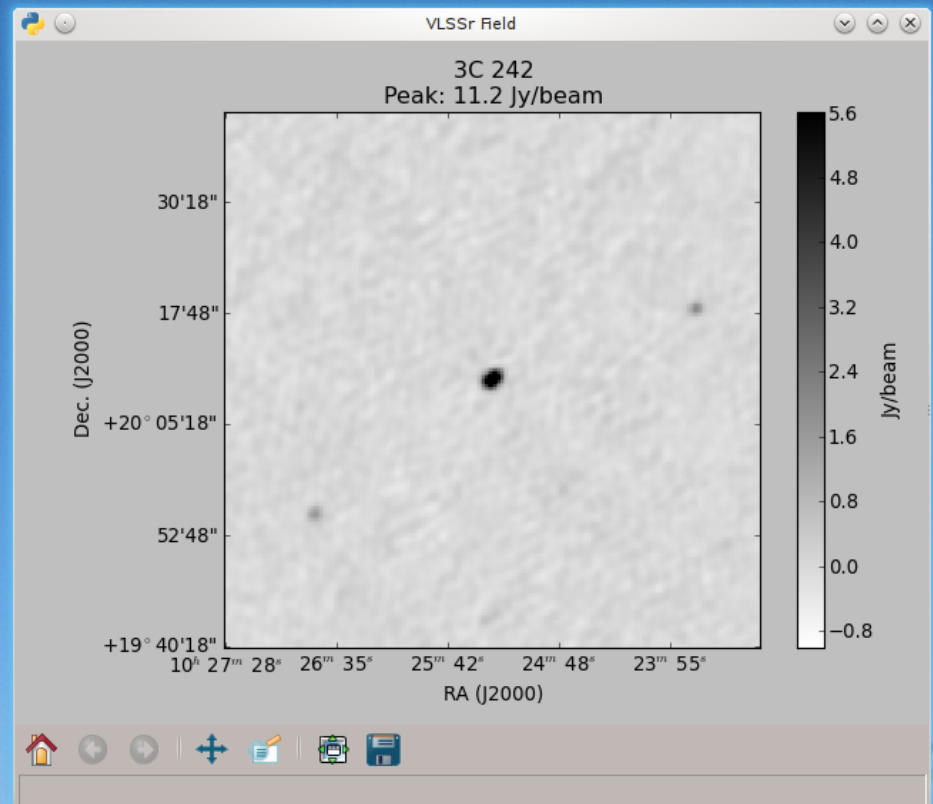
Flux Density Min:  Jy

Candidates

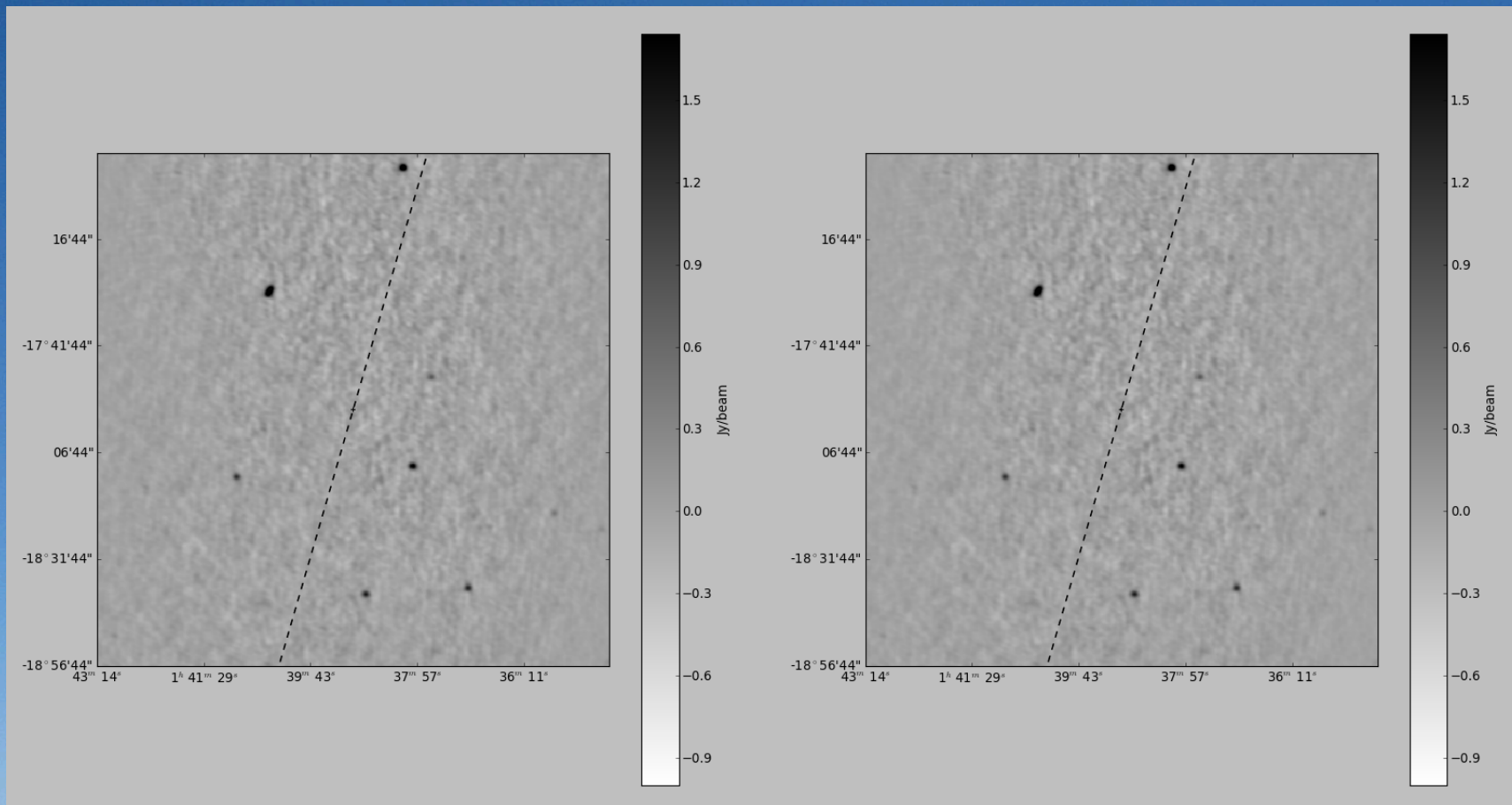
Name	RA (J2000)	Dec (J2000)	Dist. (deg)	Flux (Jy)	Size
<b>3C 242</b>	<b>10:25:20.79</b>	<b>+20:10:21.0</b>	<b>1.4</b>	<b>15.8</b>	<b>68.9" by &lt;30.5" @ -50.7</b>
3C 241	10:21:54.39	+21:59:33.4	2.2	17.0	27.2" by <23.9" @ -87.2
4C 21.27	10:11:9.17	+21:12:55.8	2.4	11.8	<29.3" by <24.2" @ -62.3

Image Size:  deg

Found 3 candidates matching the search criteria



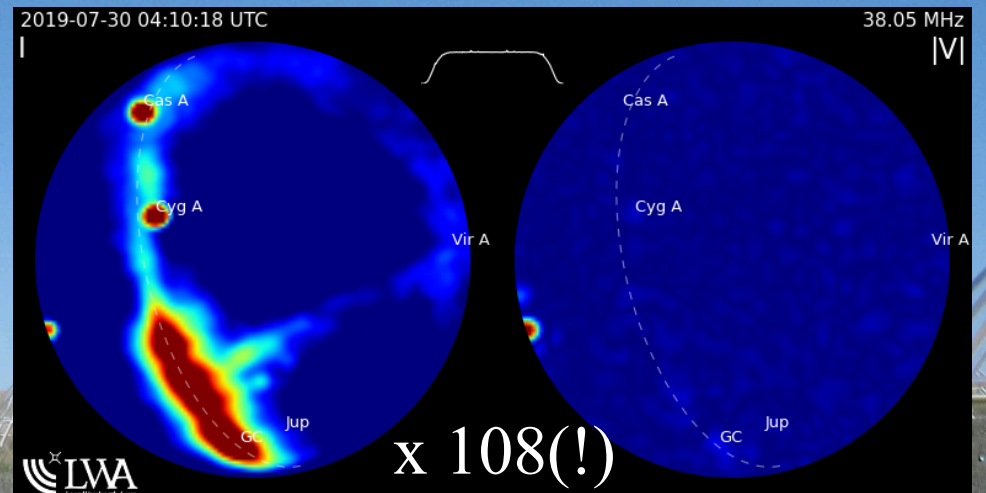
# The LWA Single-Baseline Interferometer





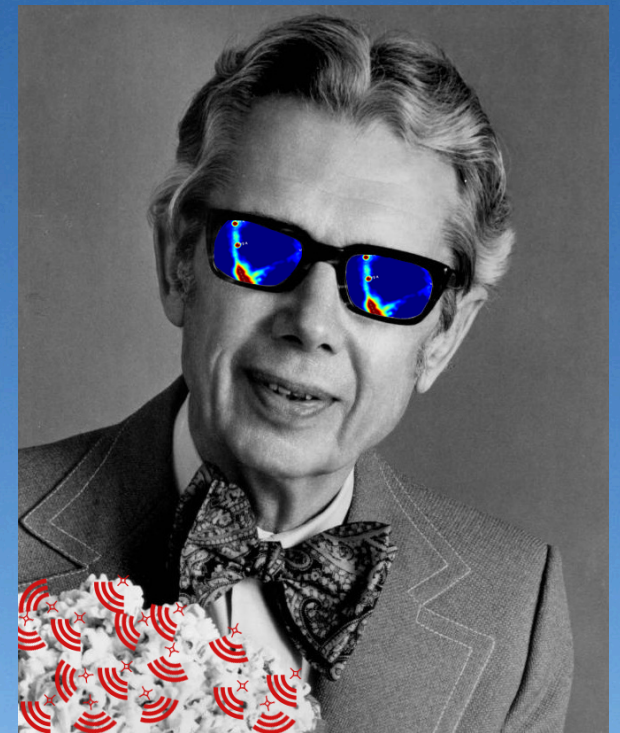
# The Prototype Wideband Imager

- New capability at LWA-SV that uses the wideband correlator output
- Realtime imaging of 10.8 MHz of bandwidth
  - Full Stokes images with a 10 s integration time
  - 100 times the bandwidth of LASI-SV
- Runs concurrently with LASI-SV
  - Storage for ~2 weeks of images in a circular buffer
    - Not currently archived



# The Future

- LWA-SV bandwidth expansion to 19.6 MHz
  - Enabled by new RTX2080 Ti GPUs and Bifrost “Project Orville”
  - Beam tunings still tied together
  - Needs new hardware to upgrade the wideband imager to support more bandwidth
  - Needs better network connectivity out to LWA-SV for data transport



# The Future



Fir0002/Flagstaffotos

- LWA Swarm
  - Array composed of LWA stations operated by different universities that work together
  - New approach for signal processing at the station with a goal of removing the limit of two tones
  - Greg will talk more about this tomorrow

Swarm!