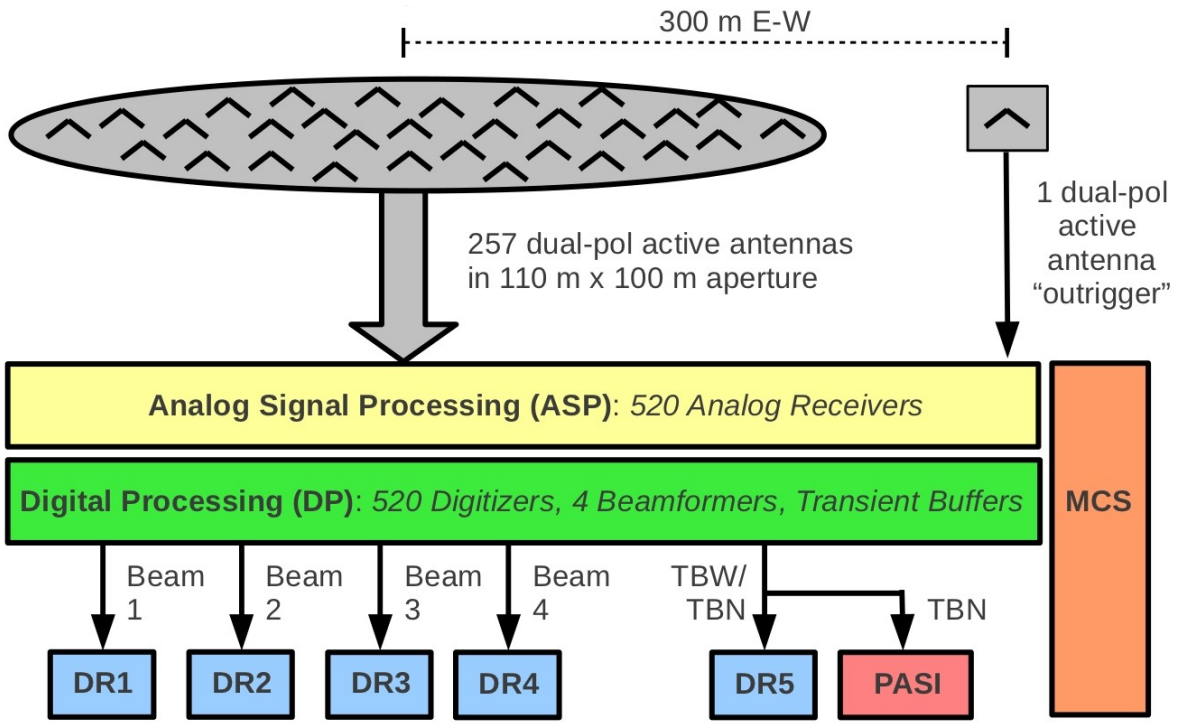
Commissioning the First Station of the Long Wavelength Array

Jayce Dowell (UNM)
On behalf of the LWA Collaboration

Beamforming



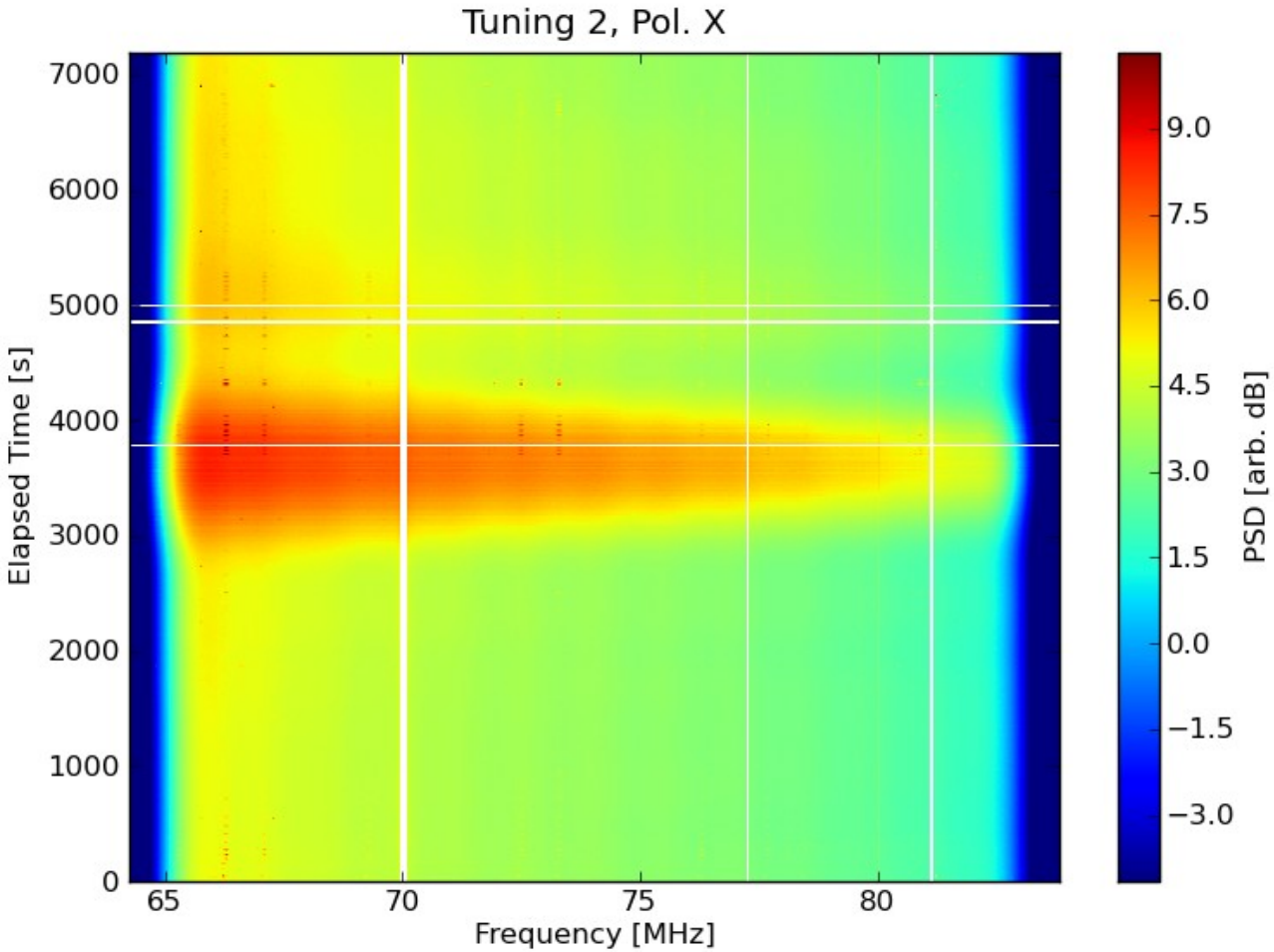
Goal is to phase or delay the various antenna signals so they the add coherently in a particular direction on the sky

Two basic methods:
1) phase-and-sum
2) delay-and-sum

Good delay calibration is key

LWA
Long Wavelength Array

Cygnus A Drift Scan

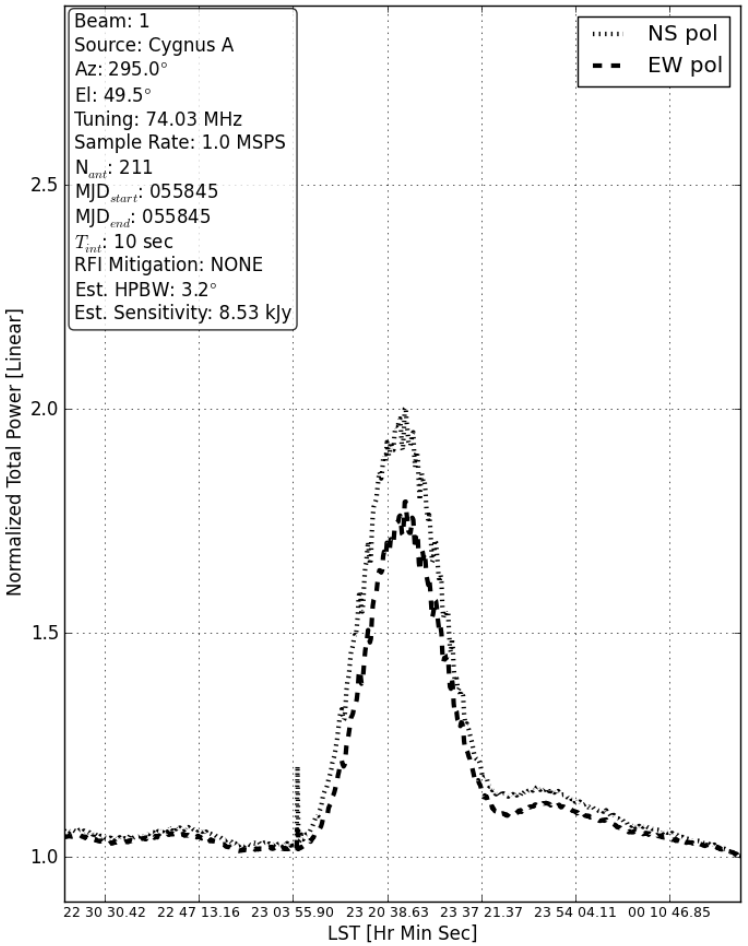


Cygnus A drifts through a beam at 74 MHz

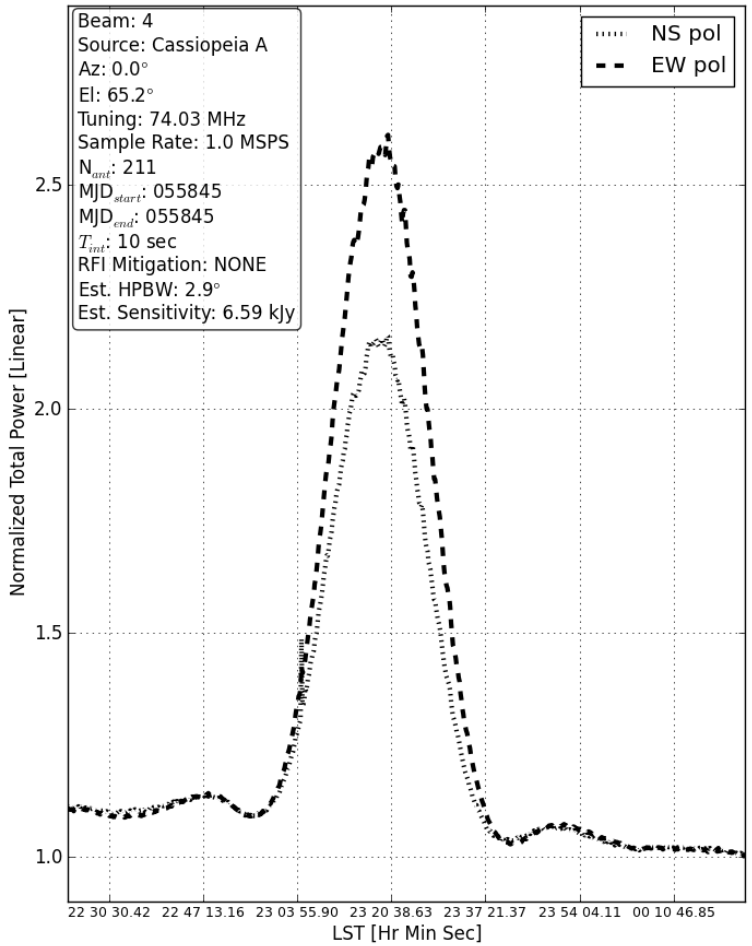
- 12/2/2011
- 19.6 MS/s (~16 MHz usable bandwidth)
- 175 dipoles
- Minimal RFI excision
- No bandpass cal.

LWA Long Wavelength Array

Multi-Beaming



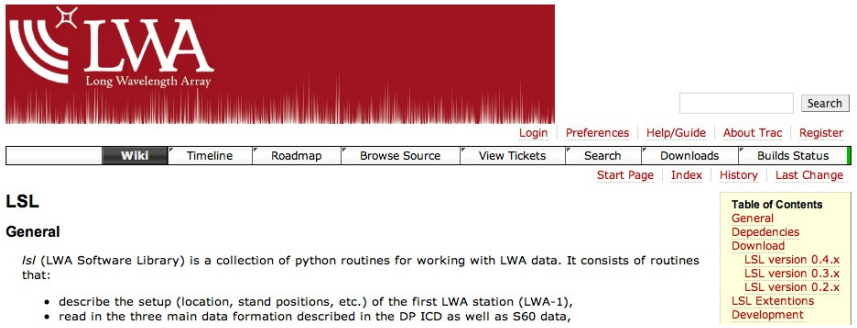
Cyg A: 295.0 az., 49.5 el.



Cas A: 0.0 az., 65.2 el.

LWA Long Wavelength Array

LWA Software Library

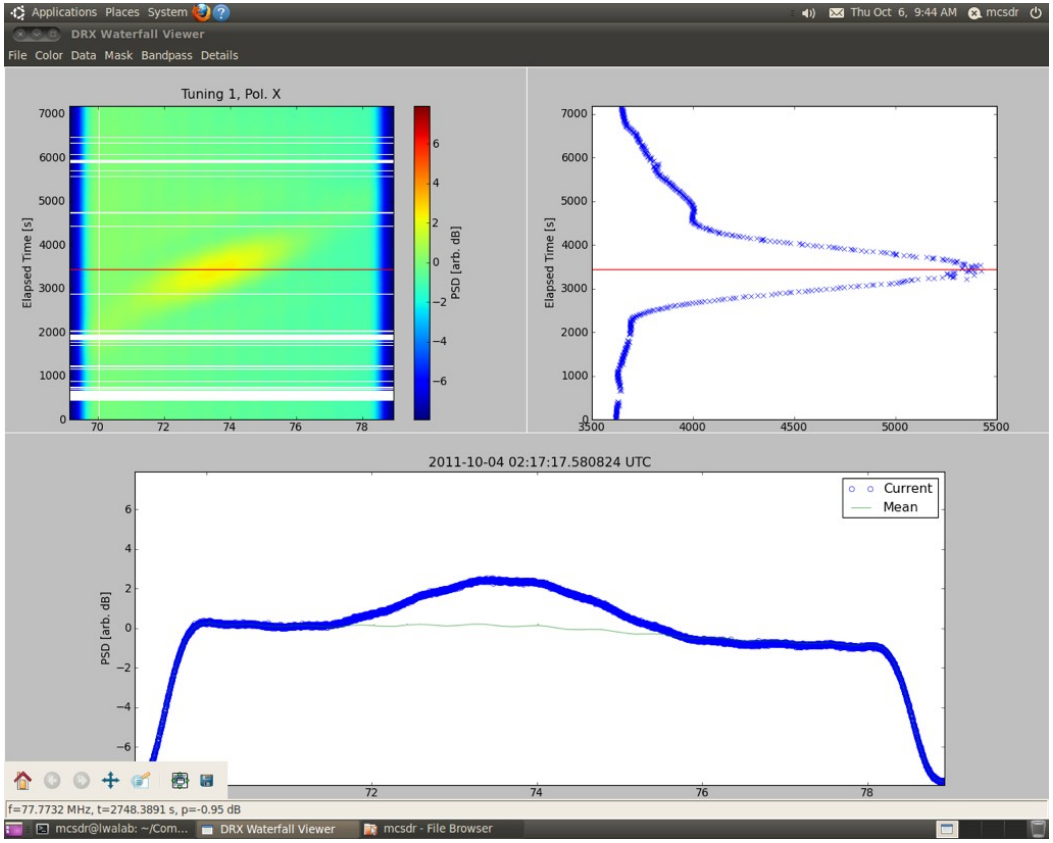


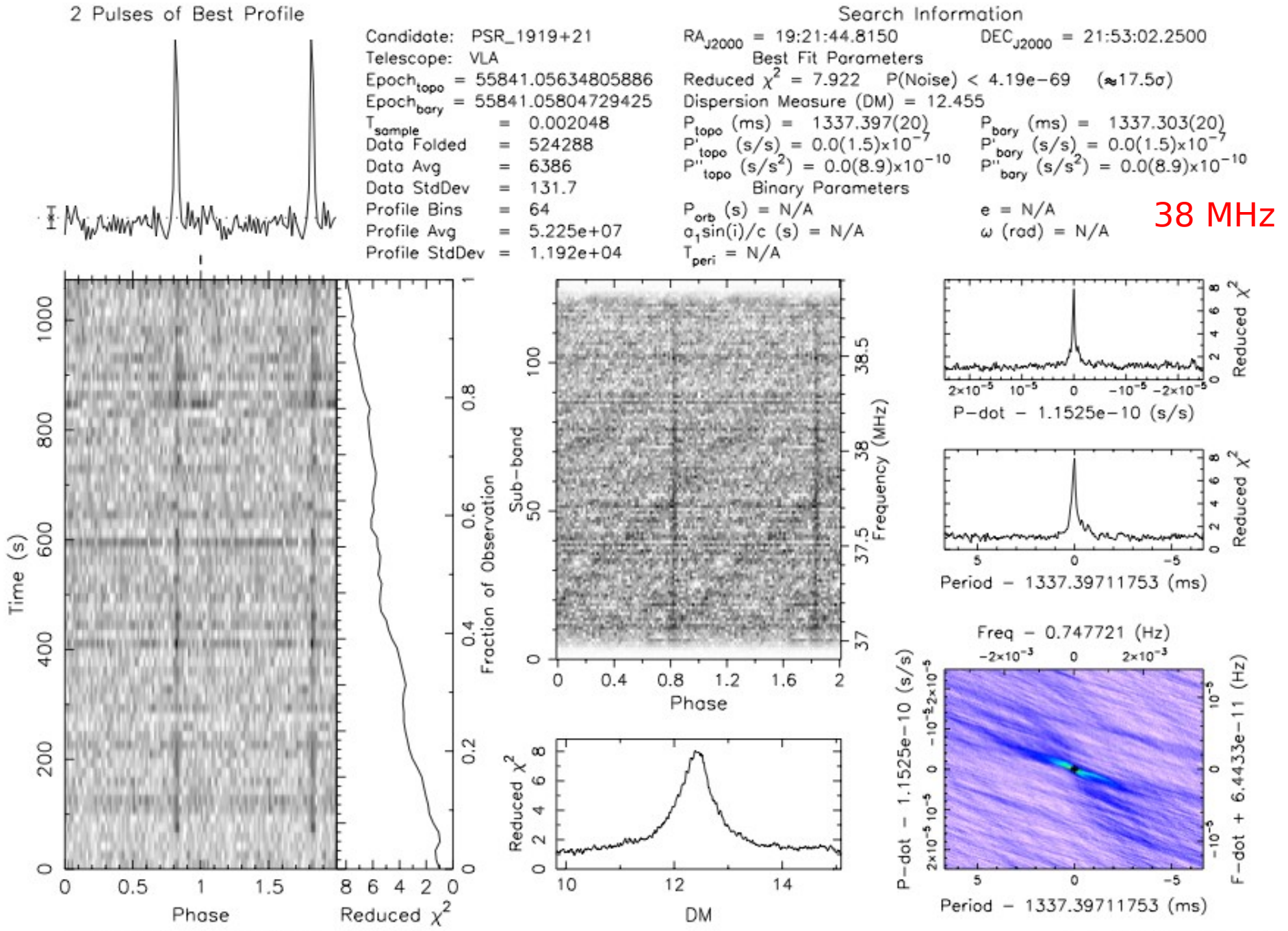
Python module for dealing with LWA data

- Functions for dealing with raw data, basic data analysis, and exporting to standard formats

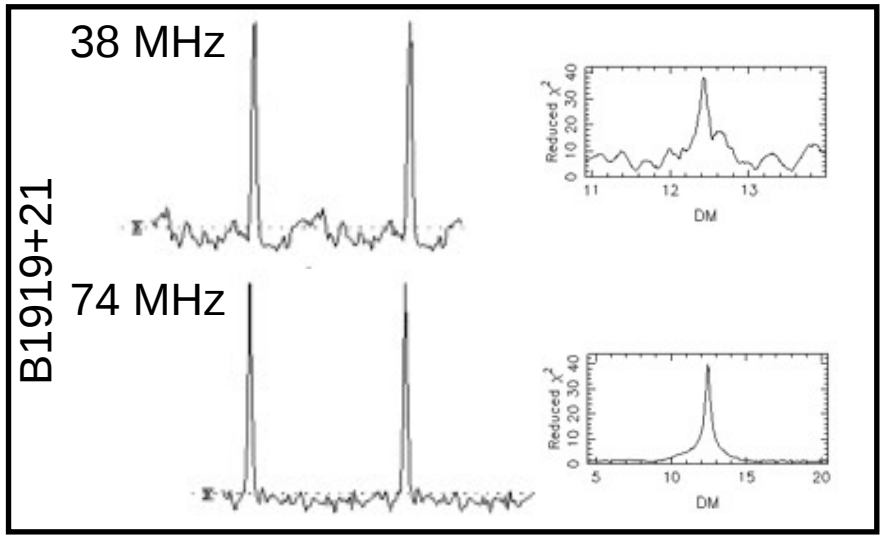
- Several example scripts for how to use LSL

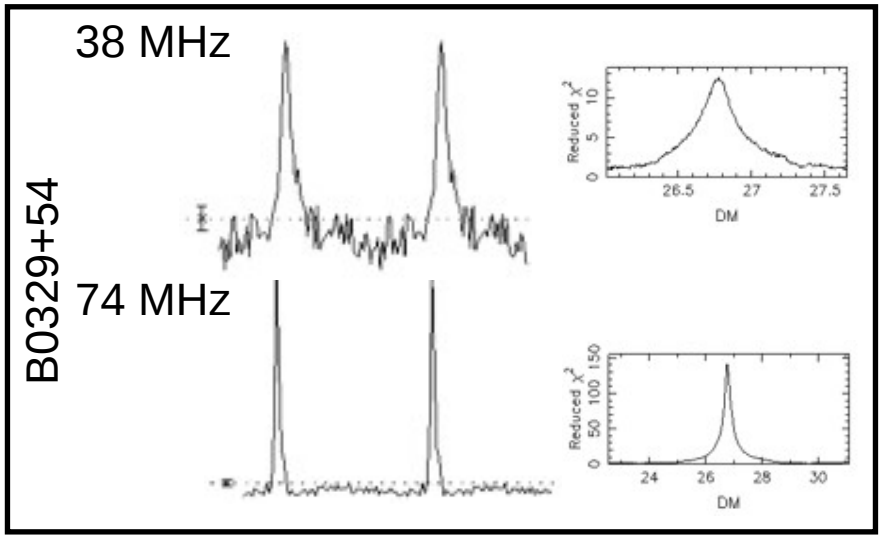
- Extensions to accomplish specified task, e.g. scheduling observations, that build off the core routines

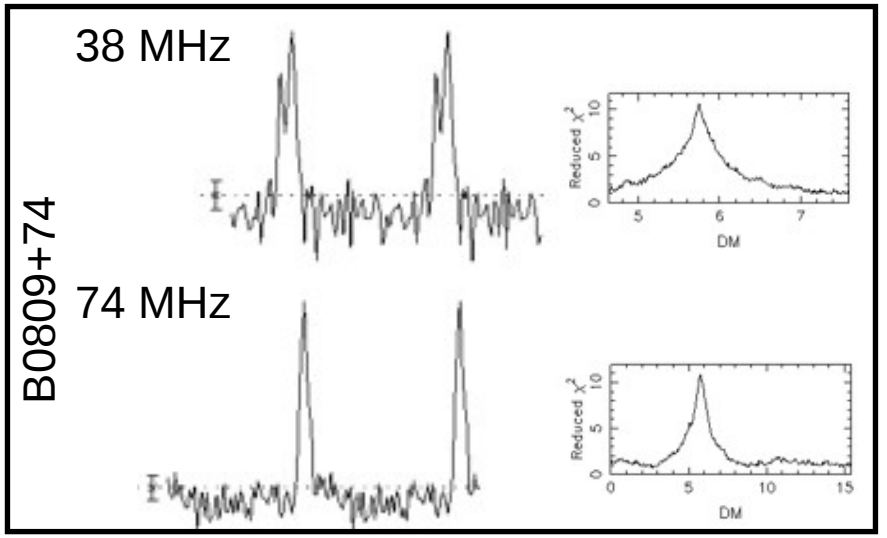



2 Pulses of Best Profile
Search Information
Candidate: PSR_1919+21
Telescope: VLA
Epoch_topo = 55841.05634805886
Epoch_bary = 55841.05804729425
T_sample = 0.002048
Data Folded = 524288
Data Avg = 6386
Data StdDev = 131.7
Profile Bins = 64
Profile Avg = 5.225e+07
Profile StdDev = 1.192e+04
RA_J2000 = 19:21:44.8150
DEC_J2000 = 21:53:02.2500
Best Fit Parameters
Reduced χ^2 = 7.922 P(Noise) < 4.19e-69 (≈17.5σ)
Dispersion Measure (DM) = 12.455
P_topo (ms) = 1337.397(20)
P'_topo (s/s) = 0.0(1.5)x10^-7
P''_topo (s/s^2) = 0.0(8.9)x10^-10
P_bary (ms) = 1337.303(20)
P'_bary (s/s) = 0.0(1.5)x10^-7
P''_bary (s/s^2) = 0.0(8.9)x10^-10
Binary Parameters
P_orb (s) = N/A
a_1sin(i)/c (s) = N/A
T_peri = N/A
e = N/A
ω (rad) = N/A
38 MHz
Time (s)
Phase
Reduced χ^2
Fraction of Observation
Sub-band
Frequency (MHz)
DM
P-dot - 1.1525e-10 (s/s)
Period - 1337.39711753 (ms)
Freq - 0.747721 (Hz)
F-dot + 6.4433e-11 (Hz)
drx_55841_04868_b4t1p0_0001.fits
kstovall 7-Oct-2011 21:00

High SNR Pulsars





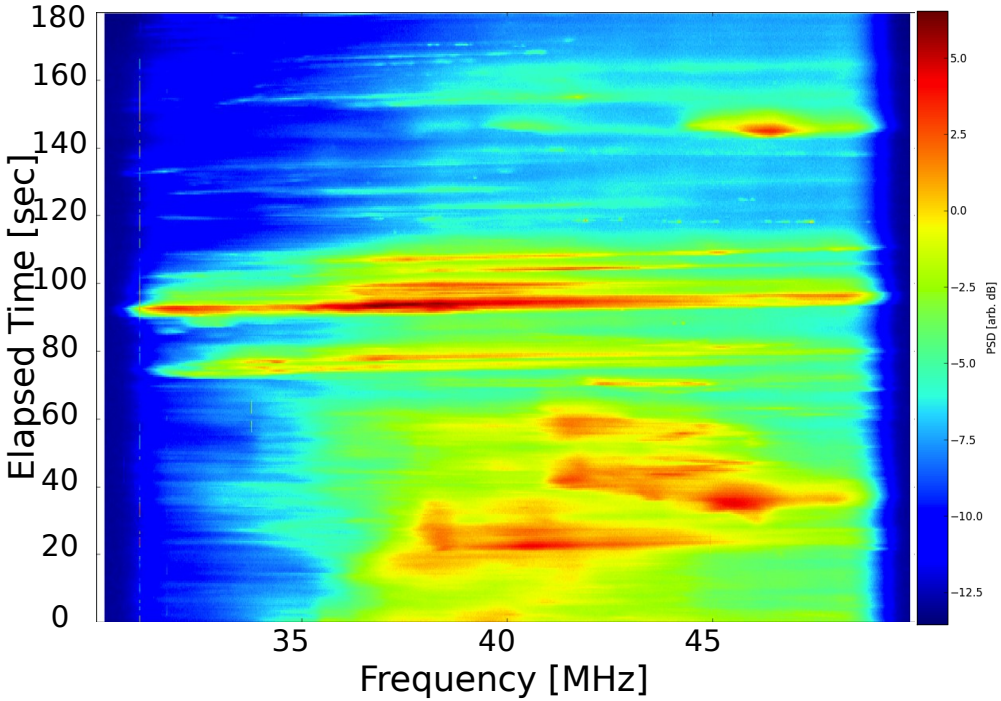


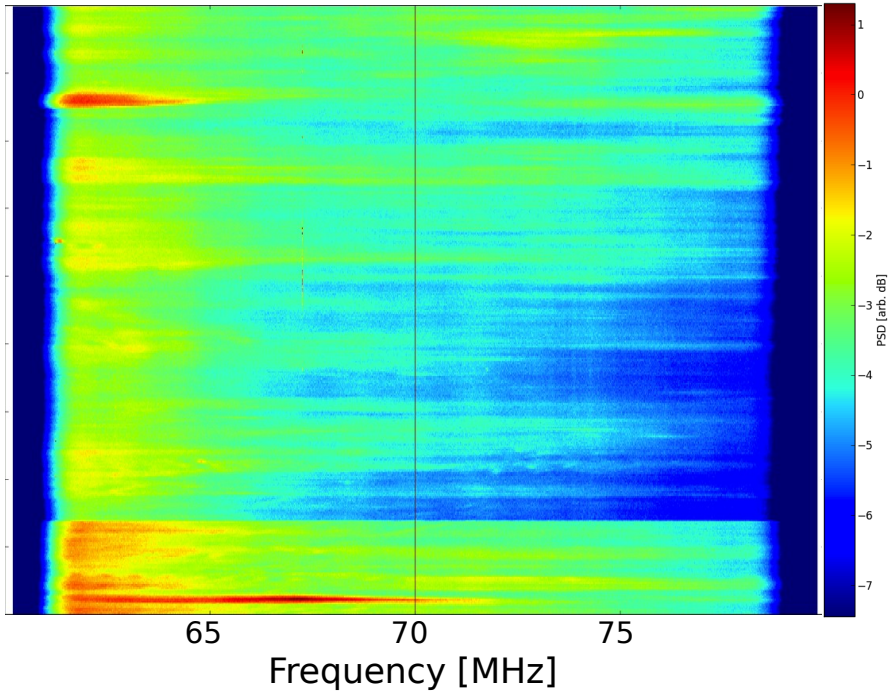
Observation Parameters

- 20 min, 19.6 MS/s (~16 MHz of usable BW) at each tuning
- Tunings at 38 MHz & 74 MHz
- Folding, de-dispersion, averaging with PRESTO-prepfold
- No RFI excision

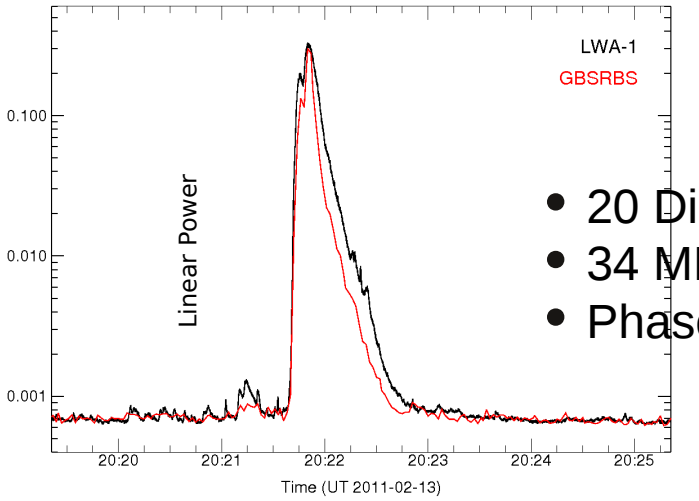
Pulsars with LWA-1 courtesy Kevin Stovall (UTB)

Solar Activity in a Beam



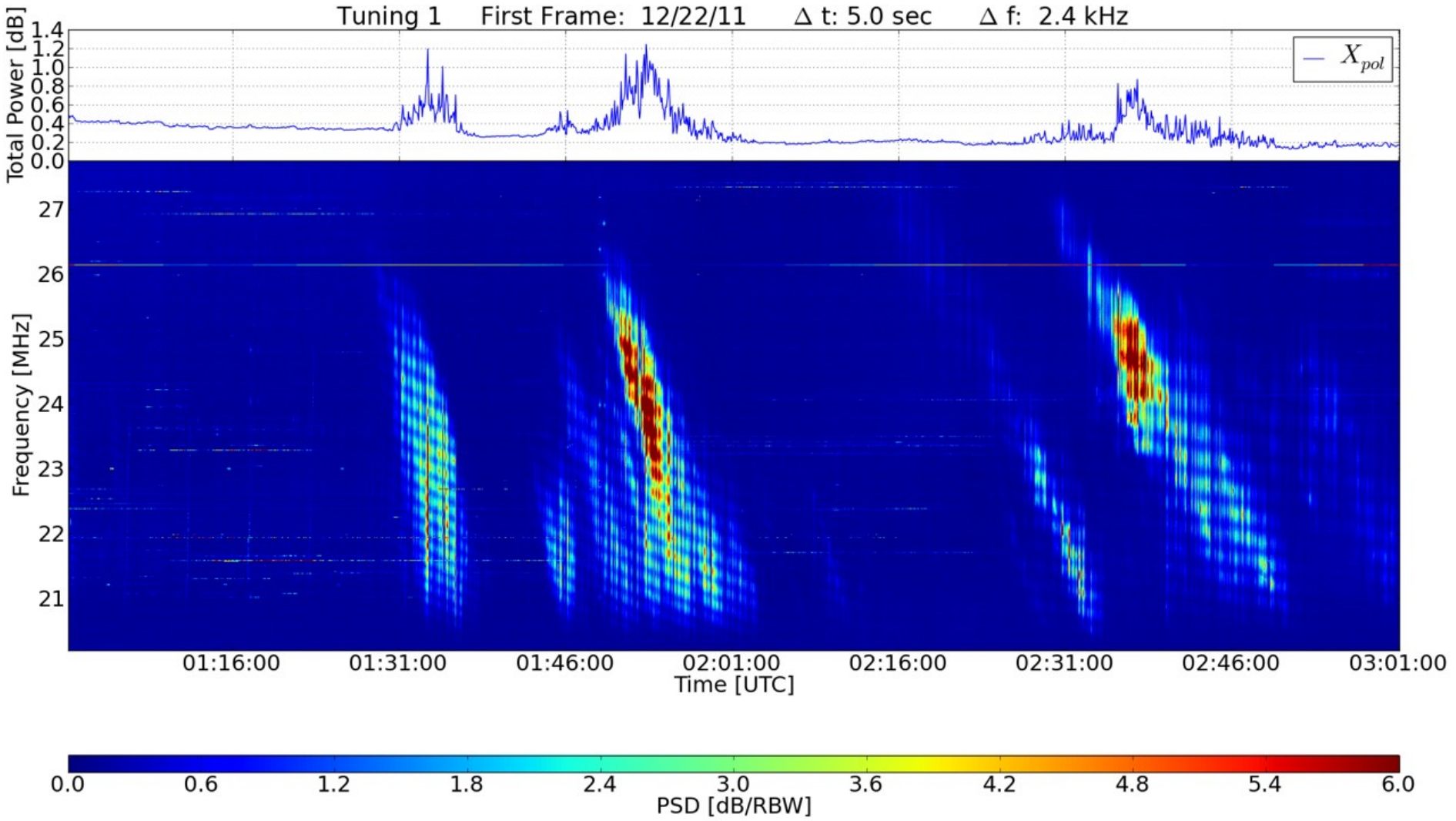


- Shown ~13:00 (local) on 12/25/2011
- Temporal Res. ~ 0.5 sec
- Freq. Res. ~ 2.4 kHz
- Beam repointed every 4 min
- No Bandpass Cal. or RFI excision

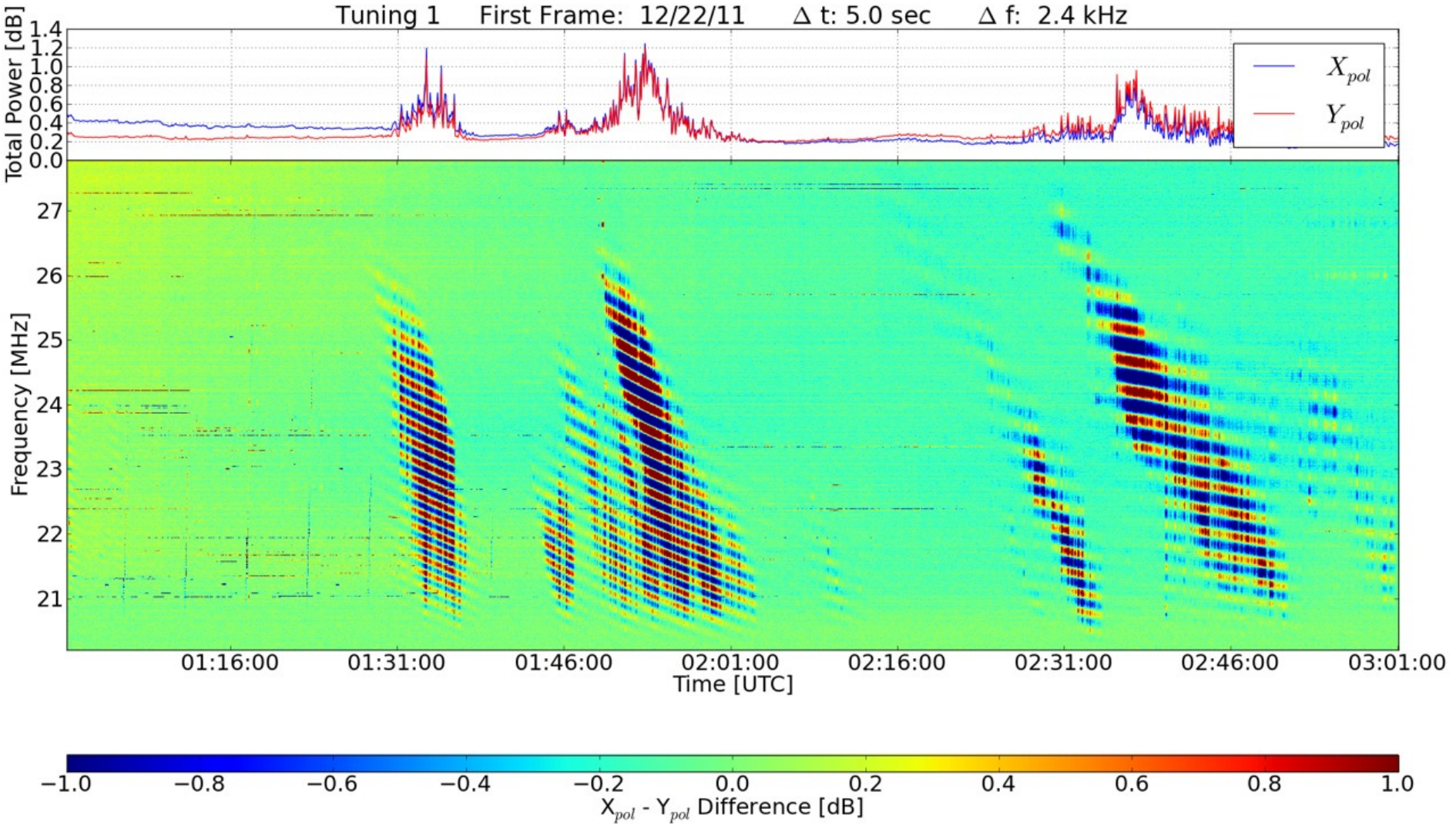


- 20 Dipoles
- 34 MHz TBN
- Phased beam

Decametric Jovian Emission



Decametric Jovian Emission



For more information:

S. Ellingson, “Sensitivity of Antenna Arrays for Long-Wavelength Radio Astronomy,” IEEE, Trans. Ant. & Prop. [LWA Memo 166]

P. Henning, et al. (2010), “The First Station of the Long Wavelength Array,” Proc. ISKAF2010 Science Meeting, 2010. [LWA Memo 171]

Project Web Site:
http://lwa.unm.edu

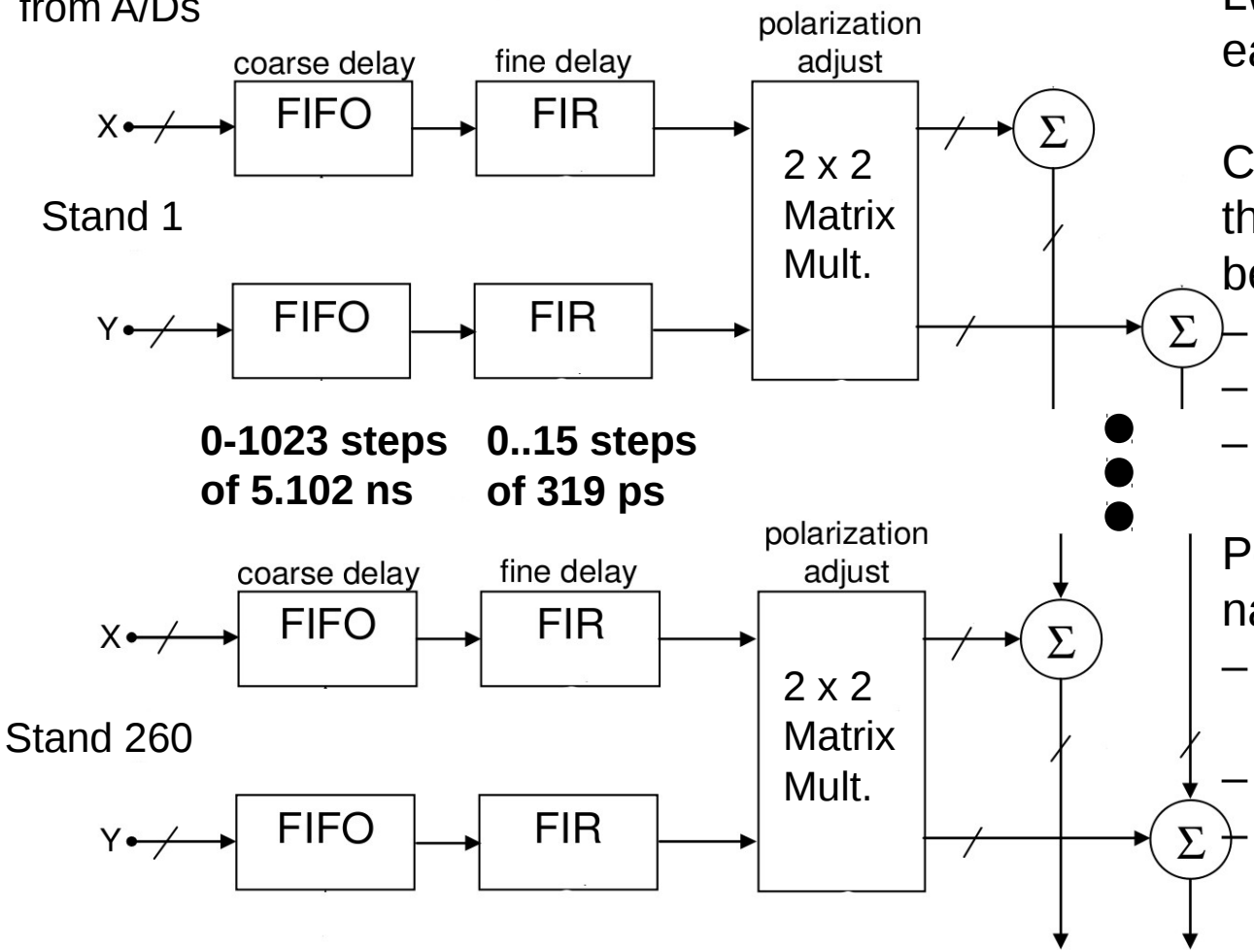
Memo Series:
http://www.phys.unm.edu/~lwa/memos

The LWA is on Facebook

Backup Slides

Beamformer Details

196 MSPS
x 12 bits
from A/Ds



LWA-1 has 4 of these, each independently-pointable

Course delay, fine delay, and the 4 polarization coeffs can be user-specified if desired
- Cable dedispersion
- Optimized beamforming
- Sector beams, nulls

Polarization adjustment is narrowband. Other uses:
- dipole-to-dipole gain equalization
- "turning off" dipoles
- Trading polarizations for additional beams

LWA Long Wavelength Array