The VLA 4m band system and the Expanded LWA

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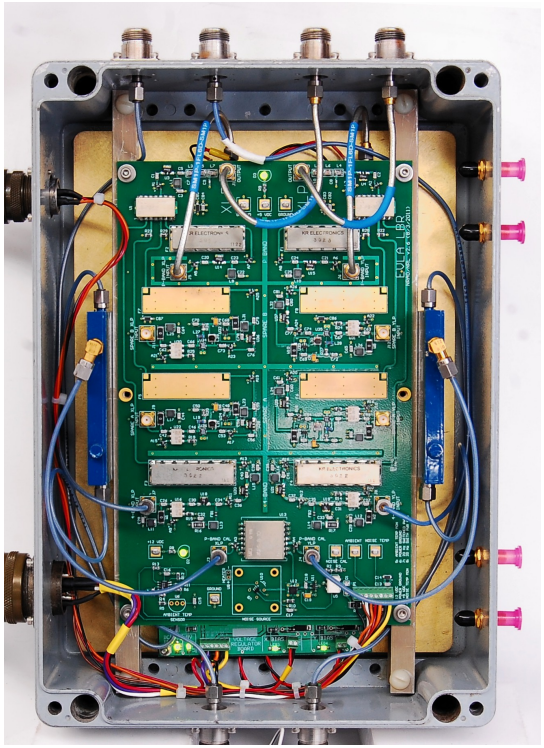
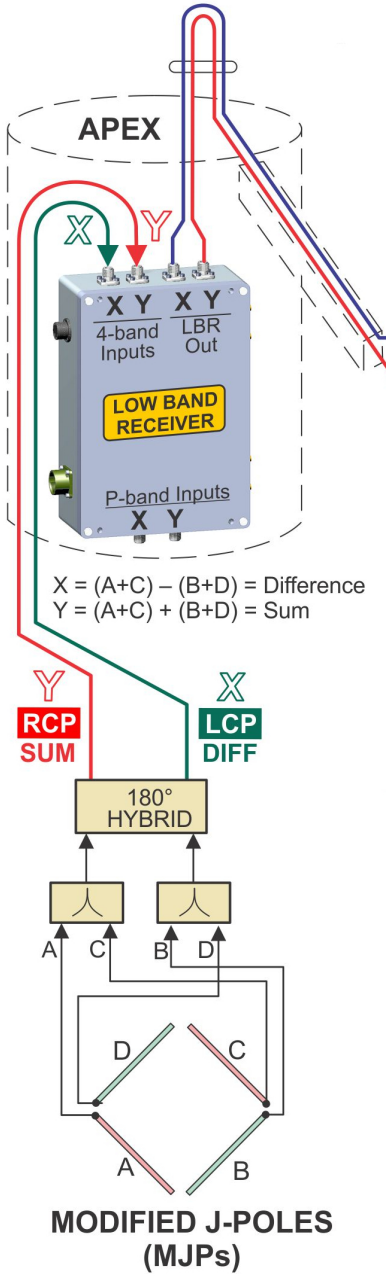
J. Dowell, G. Taylor (UNM)

VLA-MJP (50-86 MHz)





MODIFIED J-POLES (MJPs)

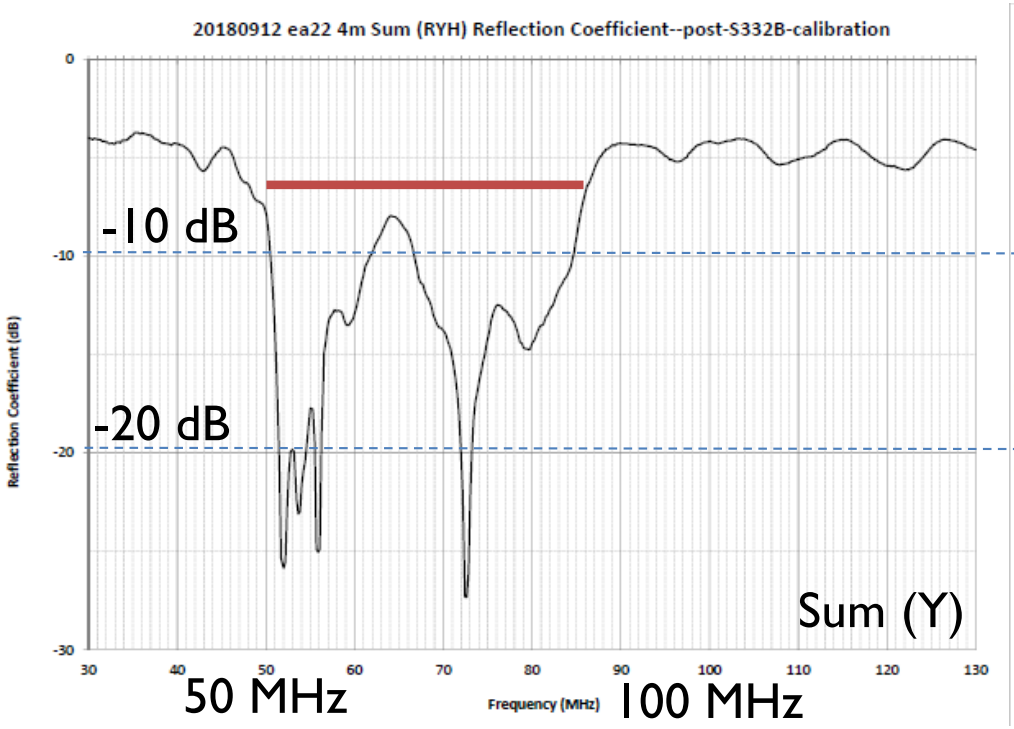
Ellingson, Coffey, Mertely (2013; EVLA Memo #172)

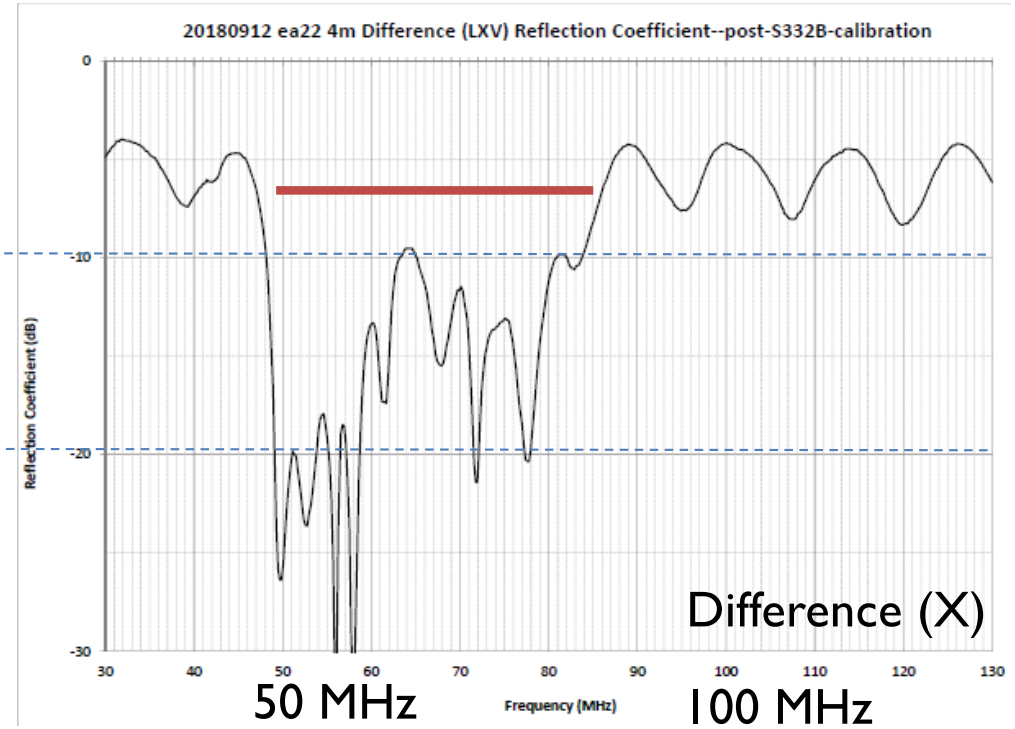
All 28 VLA antennas equipped as of 12/14/2018!

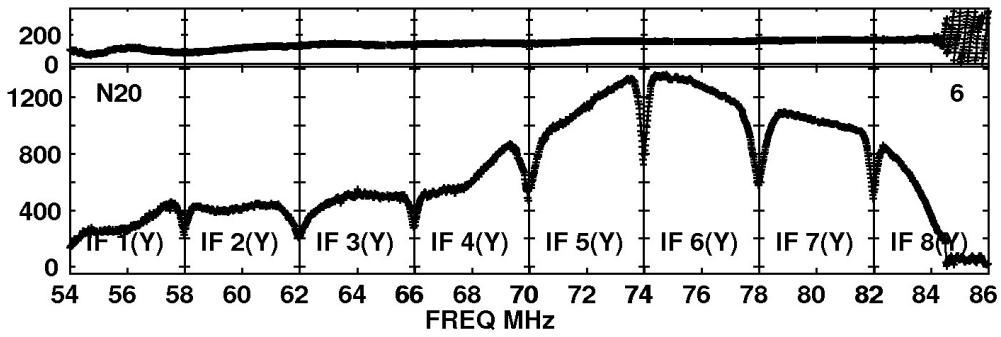
big thanks to Dan Mertely and his helpers

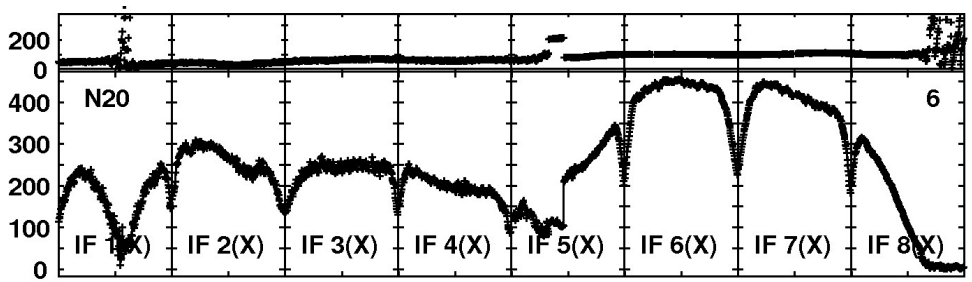
U.S. NAVAL RESEARCH LABORATORY

VLA (50-86 MHz) – S11/bandpasses



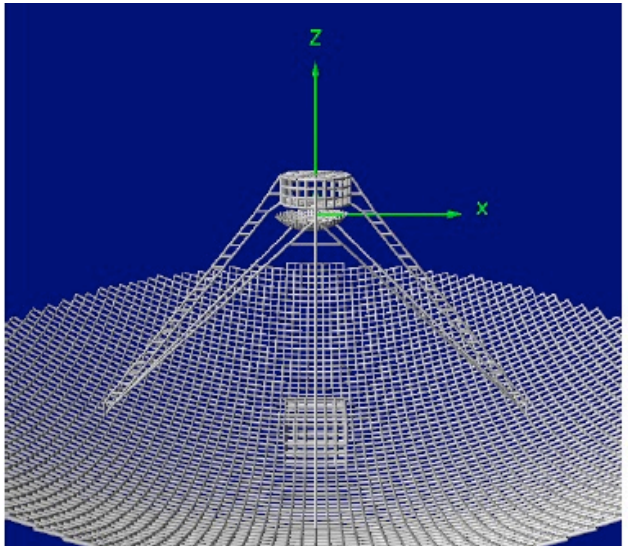


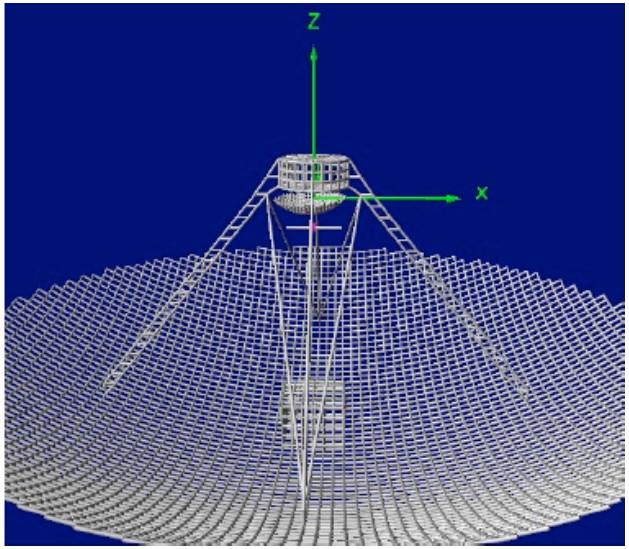


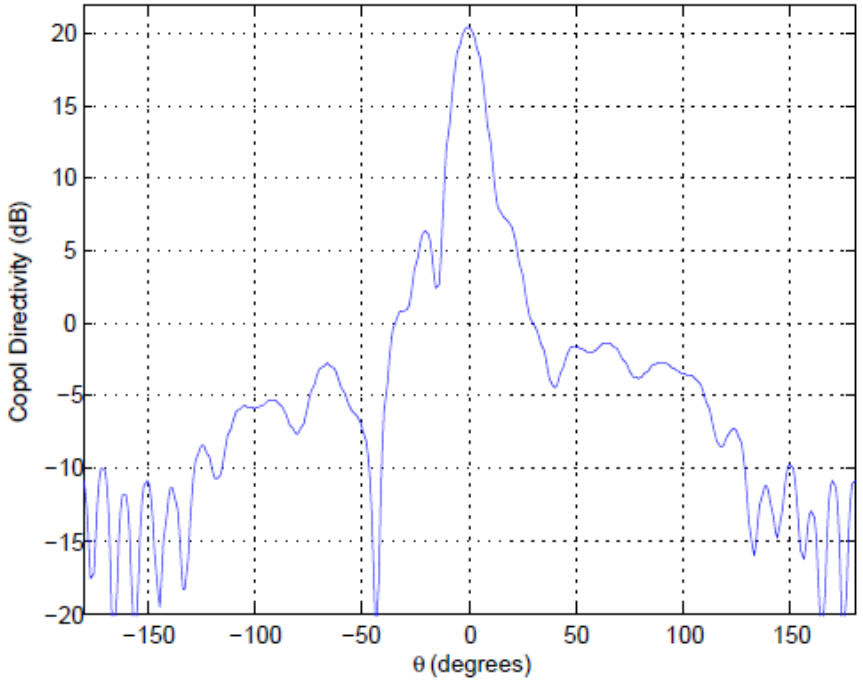


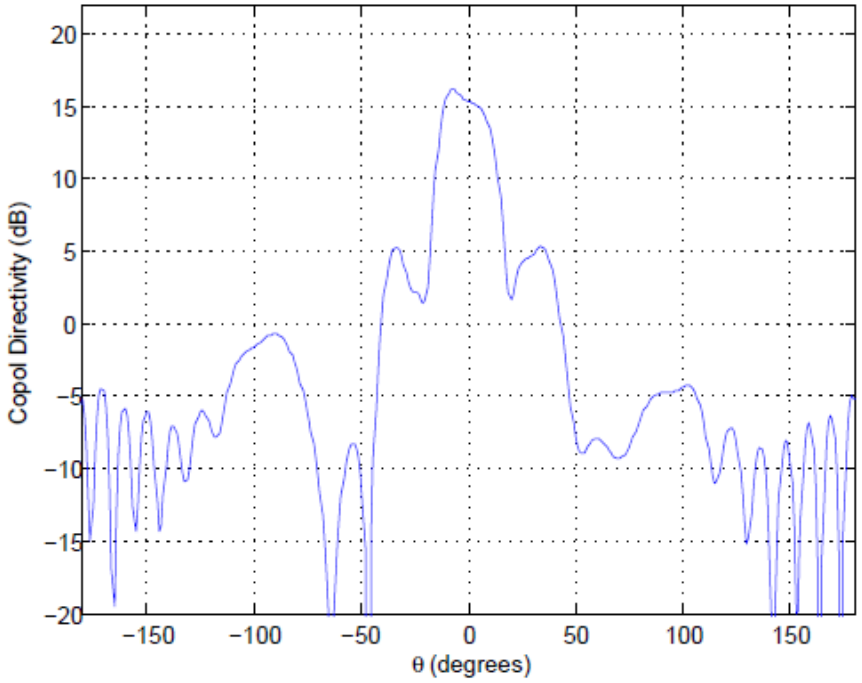
E-plane directivity

Simulations of interaction of support wires with dipole directivity.









Harun (2011,VT PhD thesis)

LWA (10-88 MHz)


LWA1

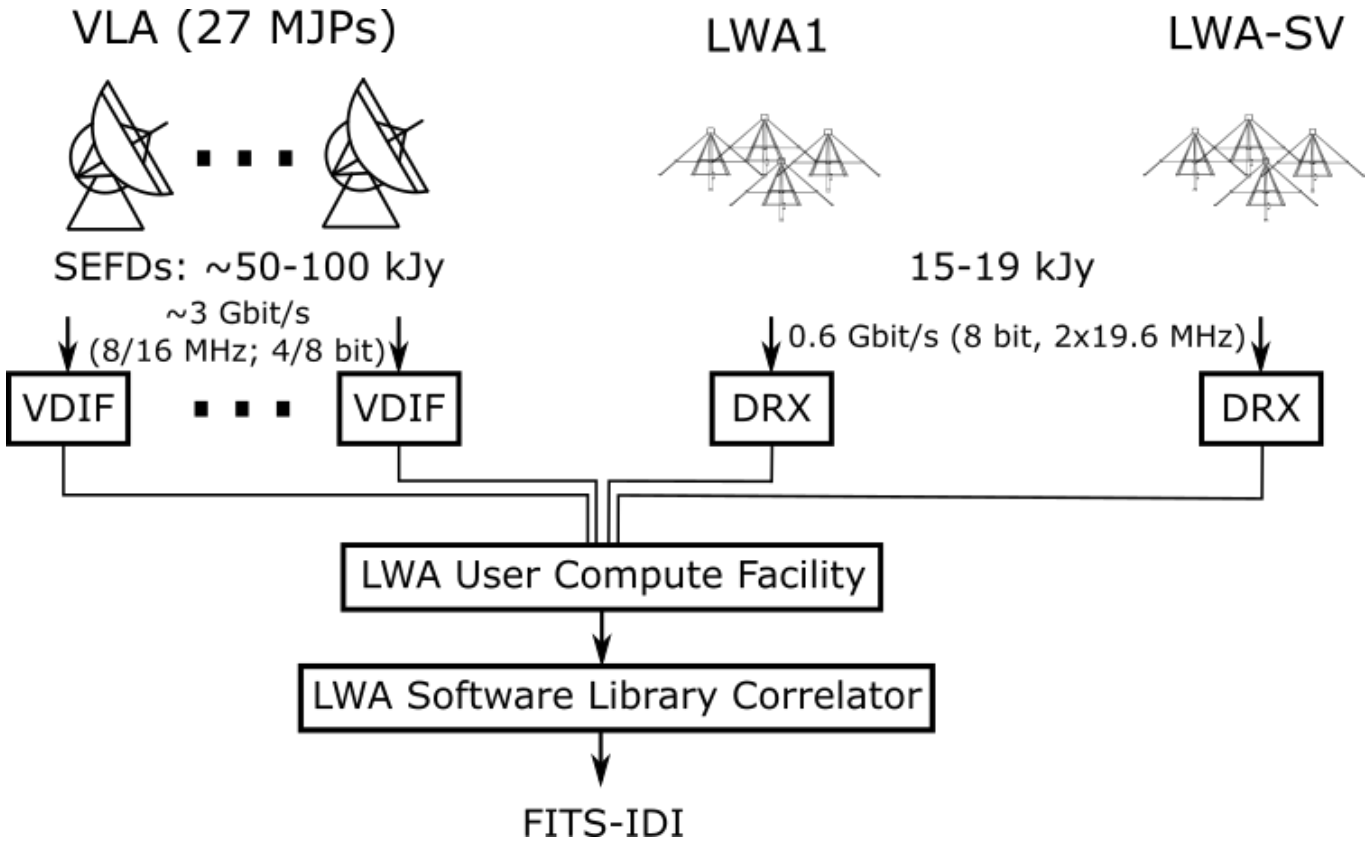

LWA-SV


State of New Mexico, USA
LWA Core
Rio Rancho
Albuquerque
Grants
Los Lunas
Belen
Socorro
Truth Or Consequences
Ruidoso
Alamogordo
Silver City
GR
CA
EW
SV
TO
PT
DA
EA
MA
GG
SL
HM
HS
WC
SA
RS
DU
SM
WN
CU
EN
TU
EL
MV
RN

ELWA

Provides maximum baseline length of 80 km/10” resolution.

Increases sensitivity of VLA by about a factor of two (mJy sensitivity)



LWA I /LWA-SV record in beam-forming mode with pointings following VLA issued commands

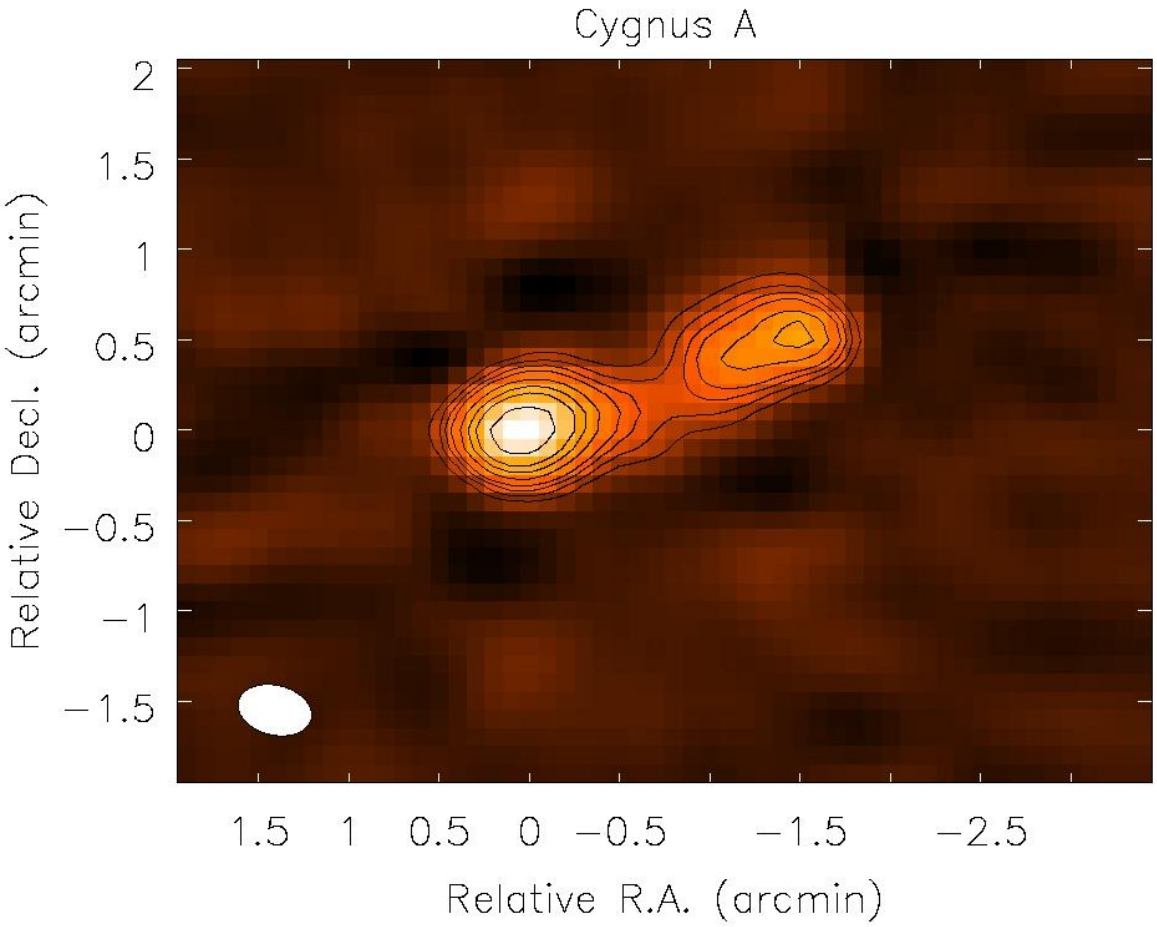
Observations – VLA resident-shared risk
(8 MHz/4bit; center frequency 76 MHz)

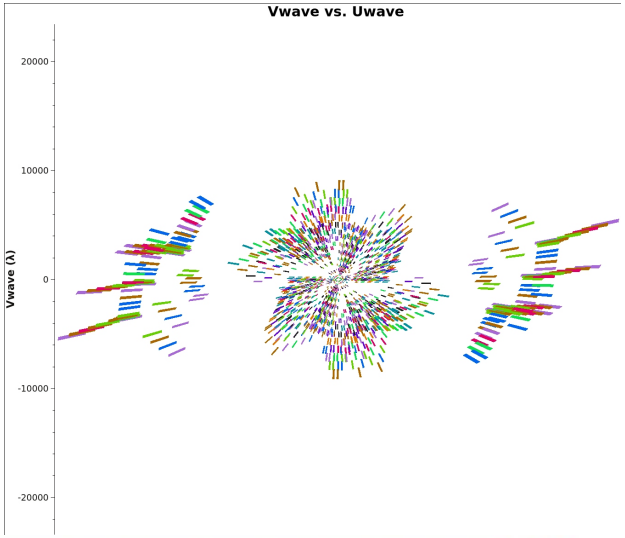
- April 20th, 2018: Virgo A (Tau A, 3C286) 6 hours, 22 Y + 2 LWA
- April 21st, 2018: 3C84, 7 hours, 23 Y + 2 LWA
- April 24th, 2018: Hydra A (Vir A), 6 hours, 21 Y+2 LWA
- May 16th, 2018: PSR B1832-06 (Cyg A), 3 hours, 22 Y + 2 LWA
- May 18th, 2018: PSR B1848-01 (Cyg A), 3 hours, 22 Y + 2 LWA
- May 26th, 2018: Tau A (Cas A), 6 hours, 24 Y + 2 LWA

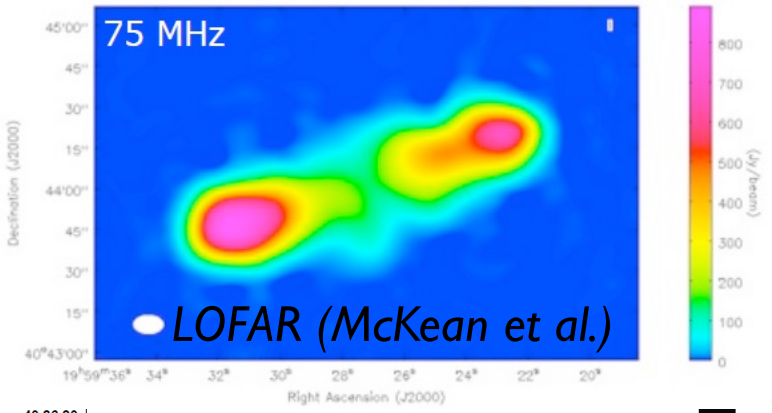
Calibration: AIPS

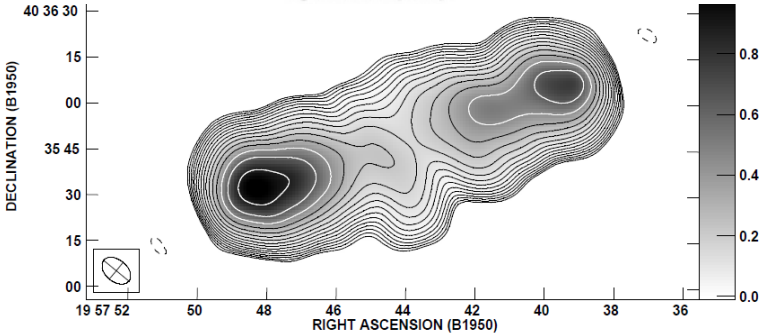
Imaging: difmap & CASA 5.4.0 using tclean (w-projection, multiscale)
including self-calibration

Cygnus A



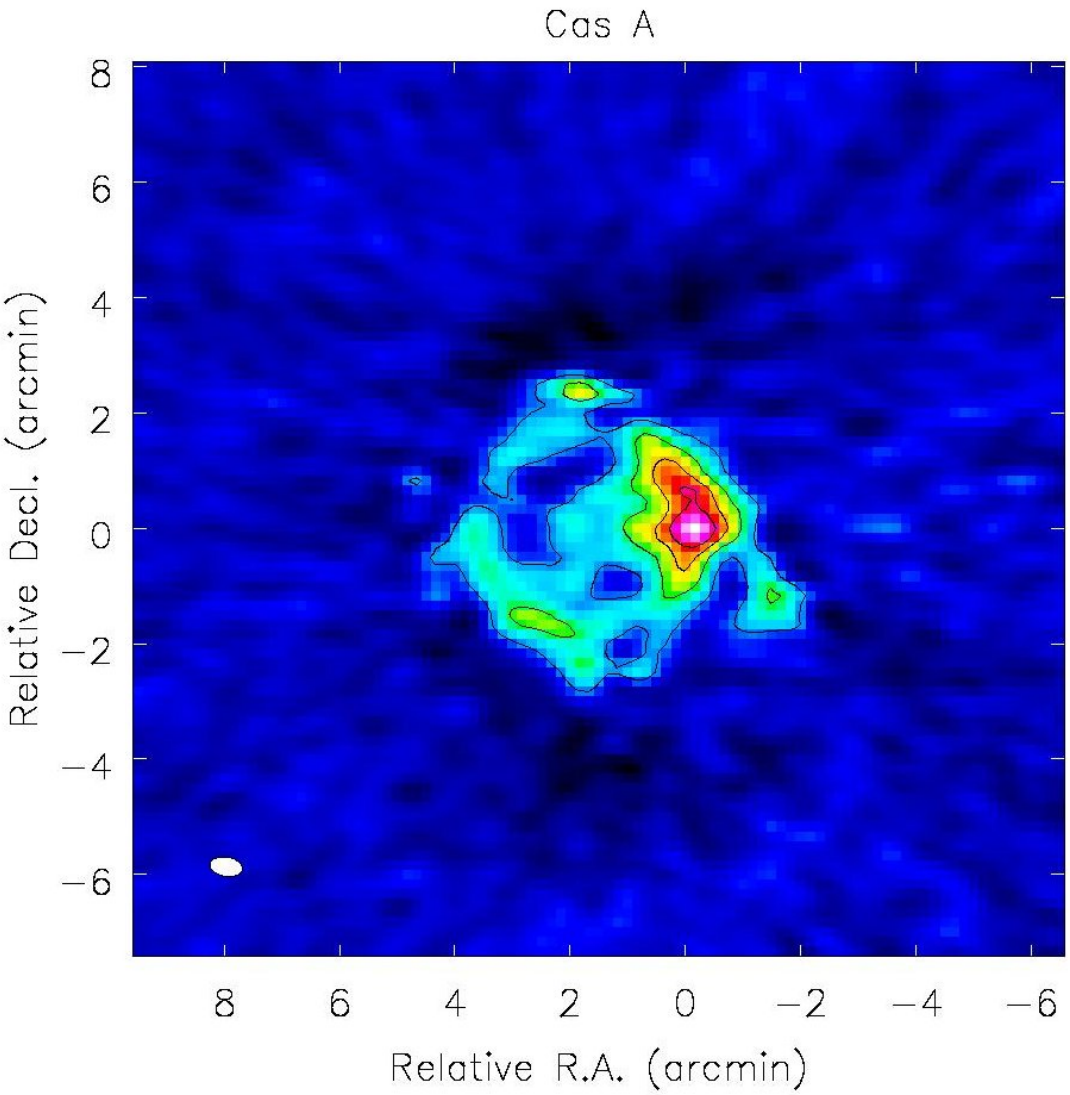


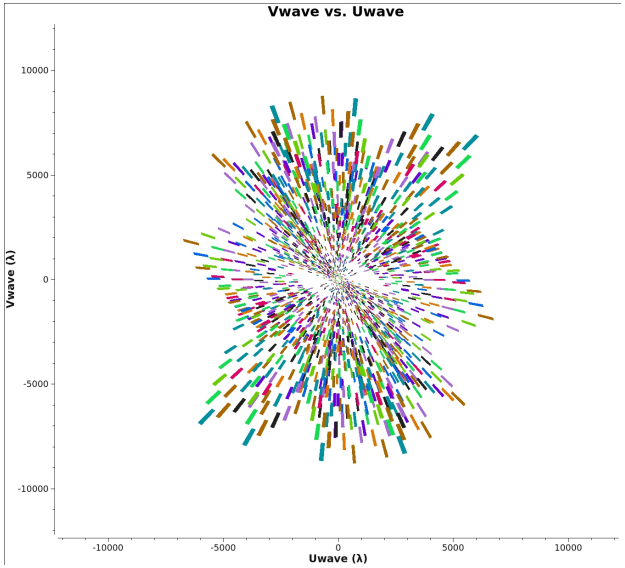


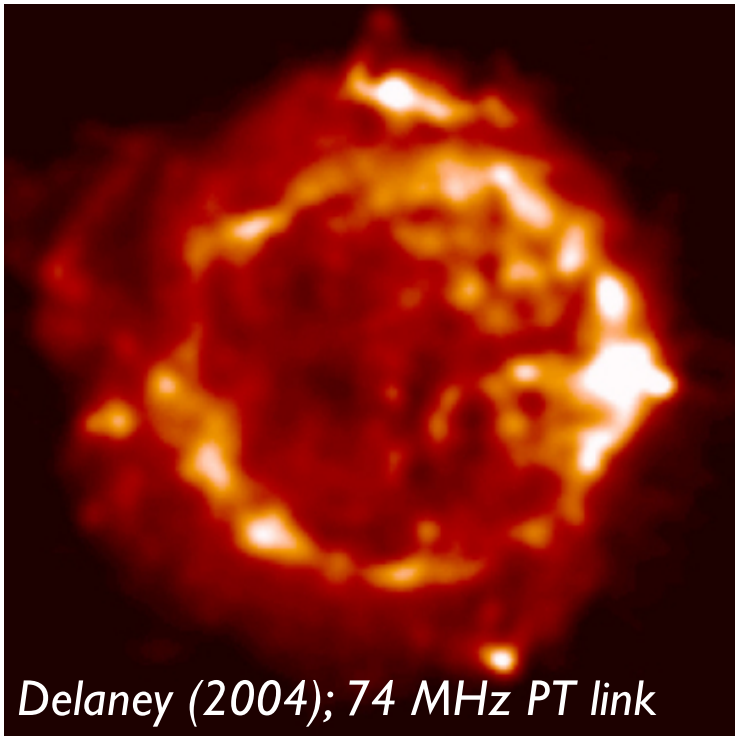


Lazio et al. 2006 (VLA+PT 74 MHz)

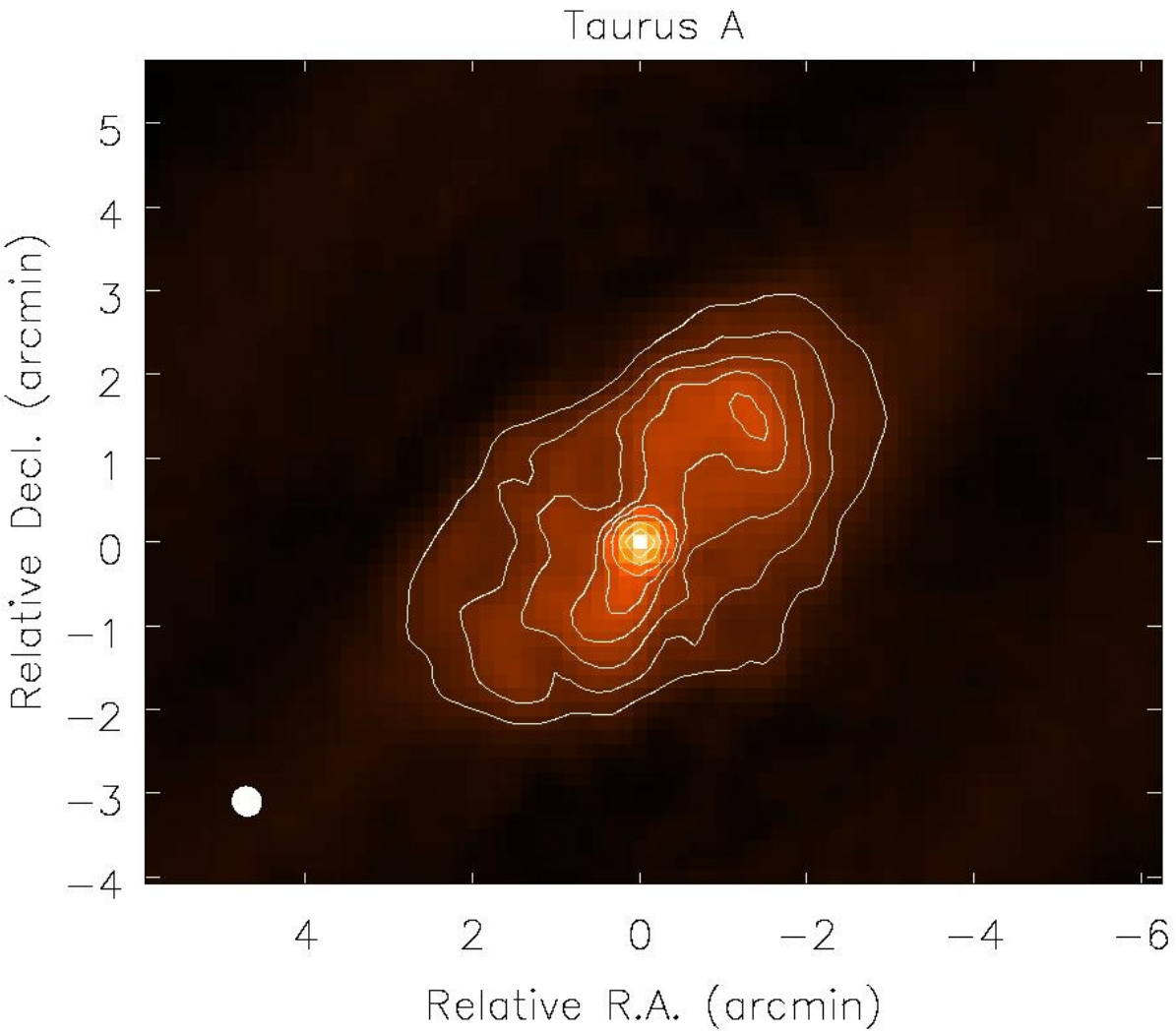
Cassiopeia A (w/o LWA-SV)

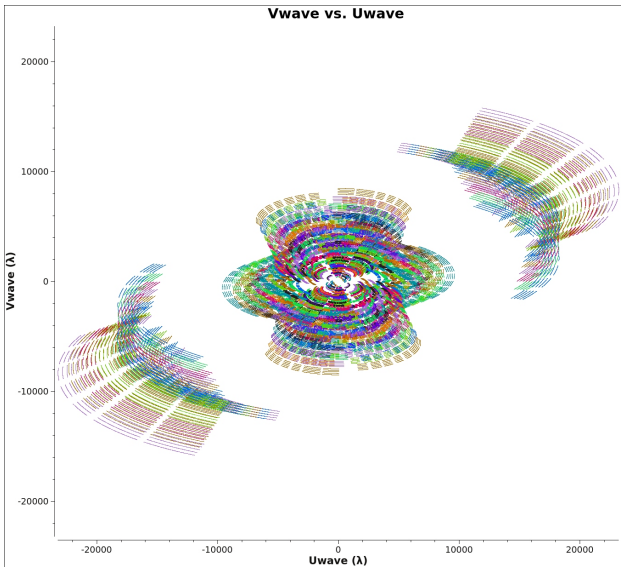


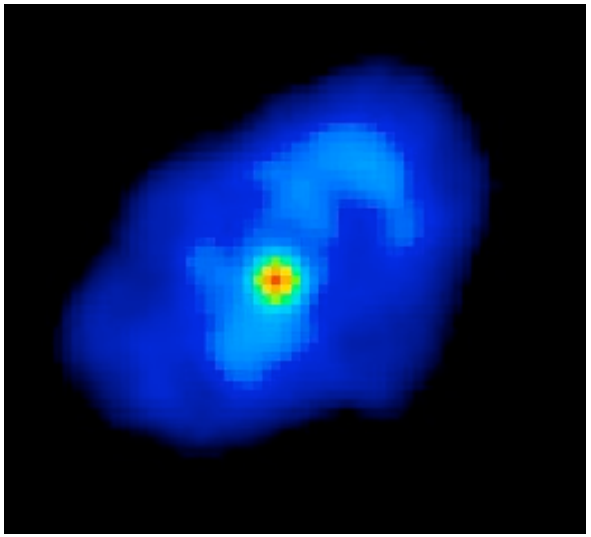




Taurus A / Crab

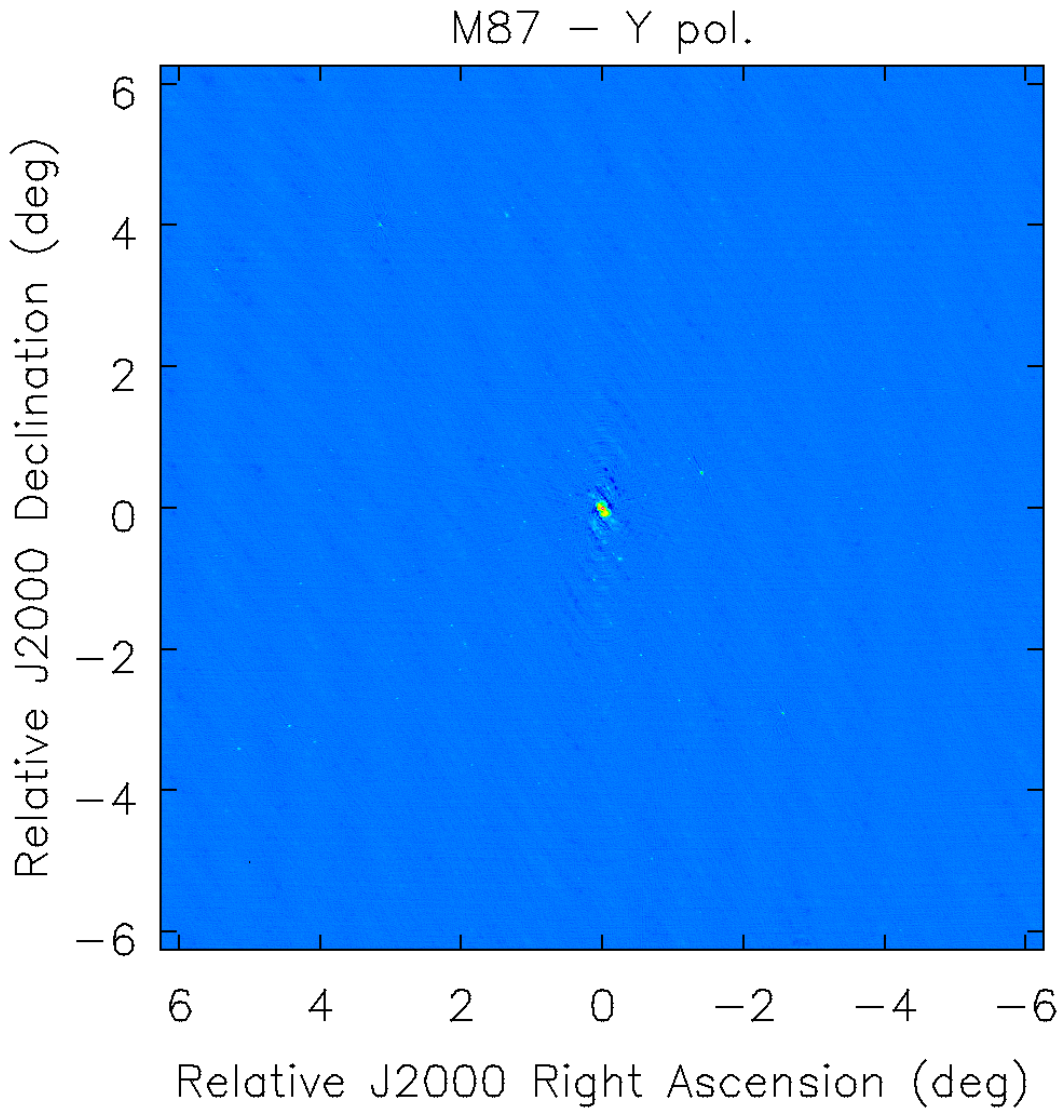






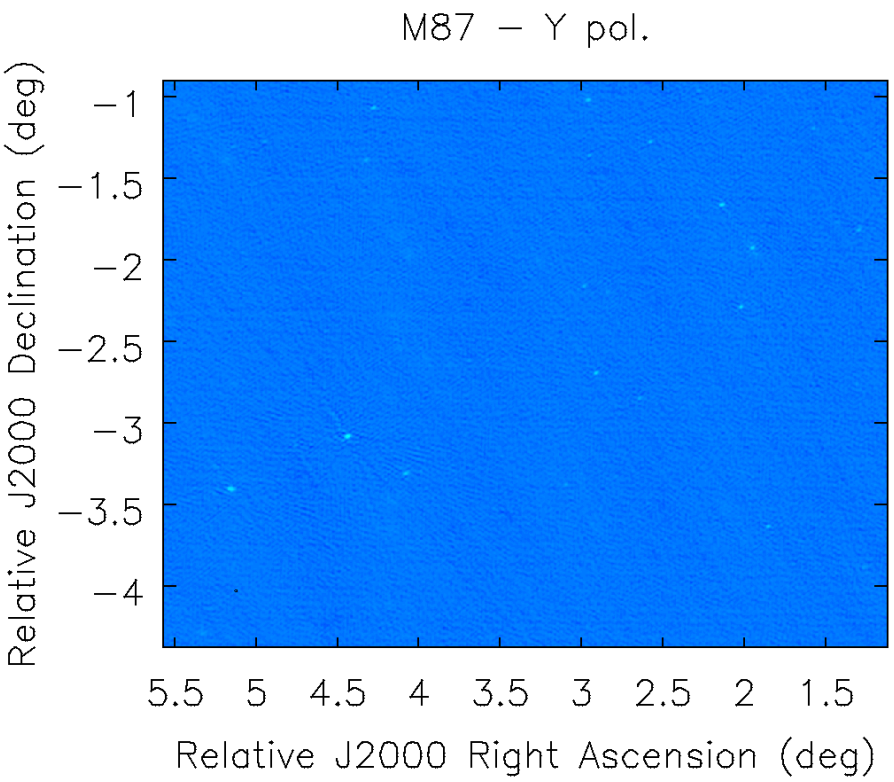
Bietenholz et al. (1997)

Virgo A – B array (VLA only Y-pol. – WIDAR 05/19/19)

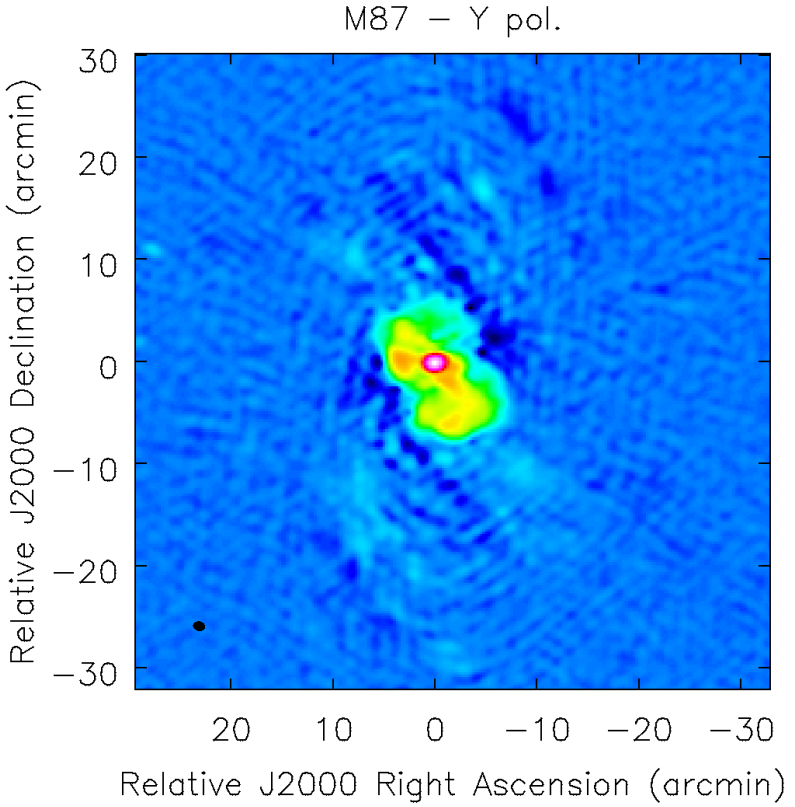


1:6000 dynamic range
some residual errors
Standard imaging & selfcal.
credit: F. Owen

Virgo A – B array (VLA only Y-pol. – WIDAR 05/19/19)

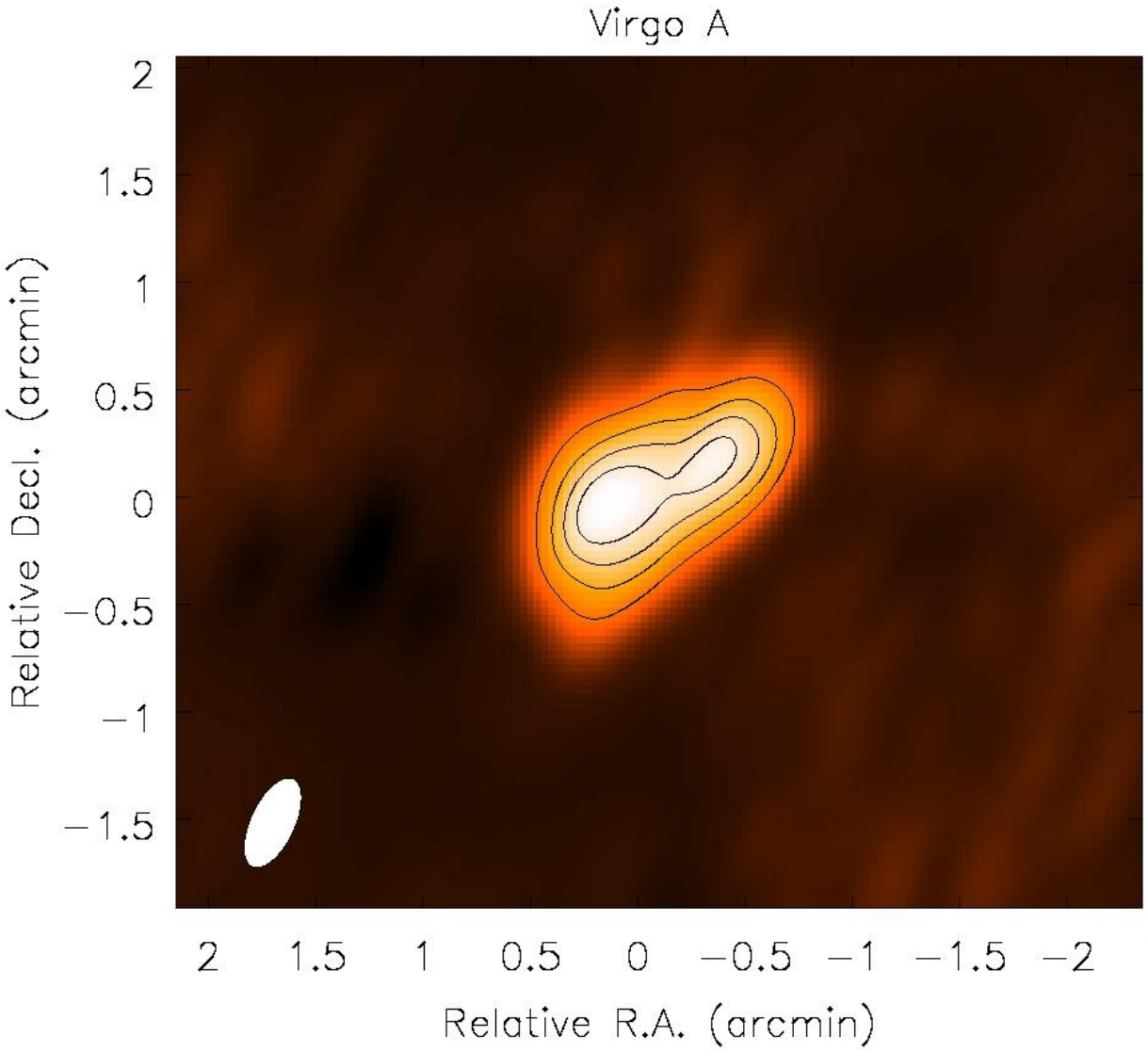


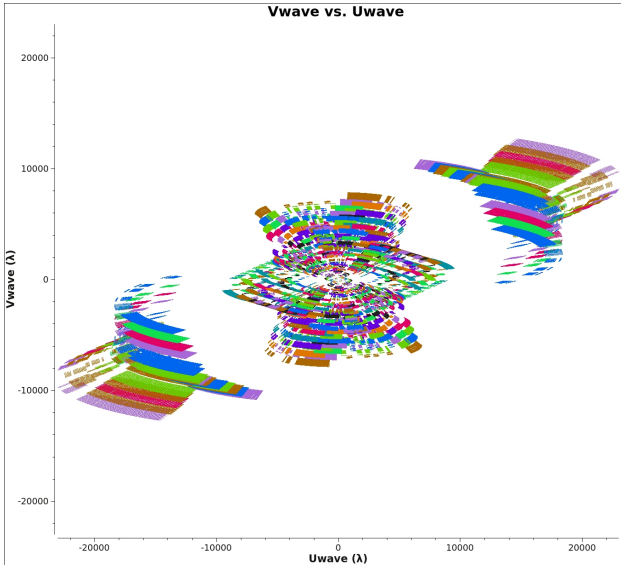
1-0.5 Jy sources 2-5 deg. from pointing center, some of them were missed by VLSSr

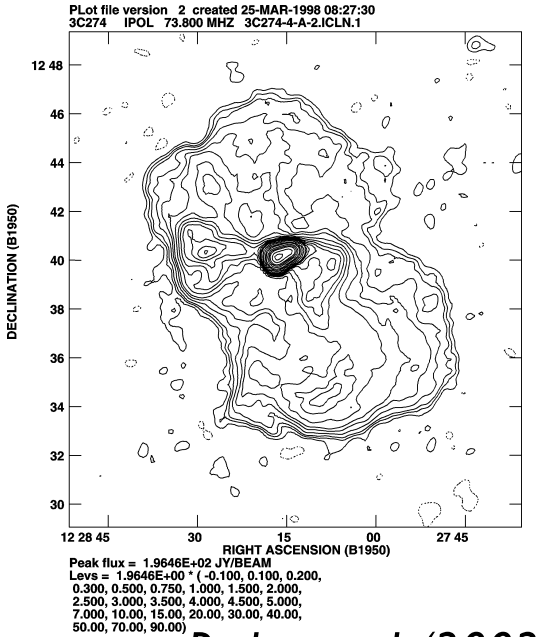


First B array image of M87 with new MJP 4-band system on all antennas. Some errors lingering …

Virgo A – LWA + VLA A-array

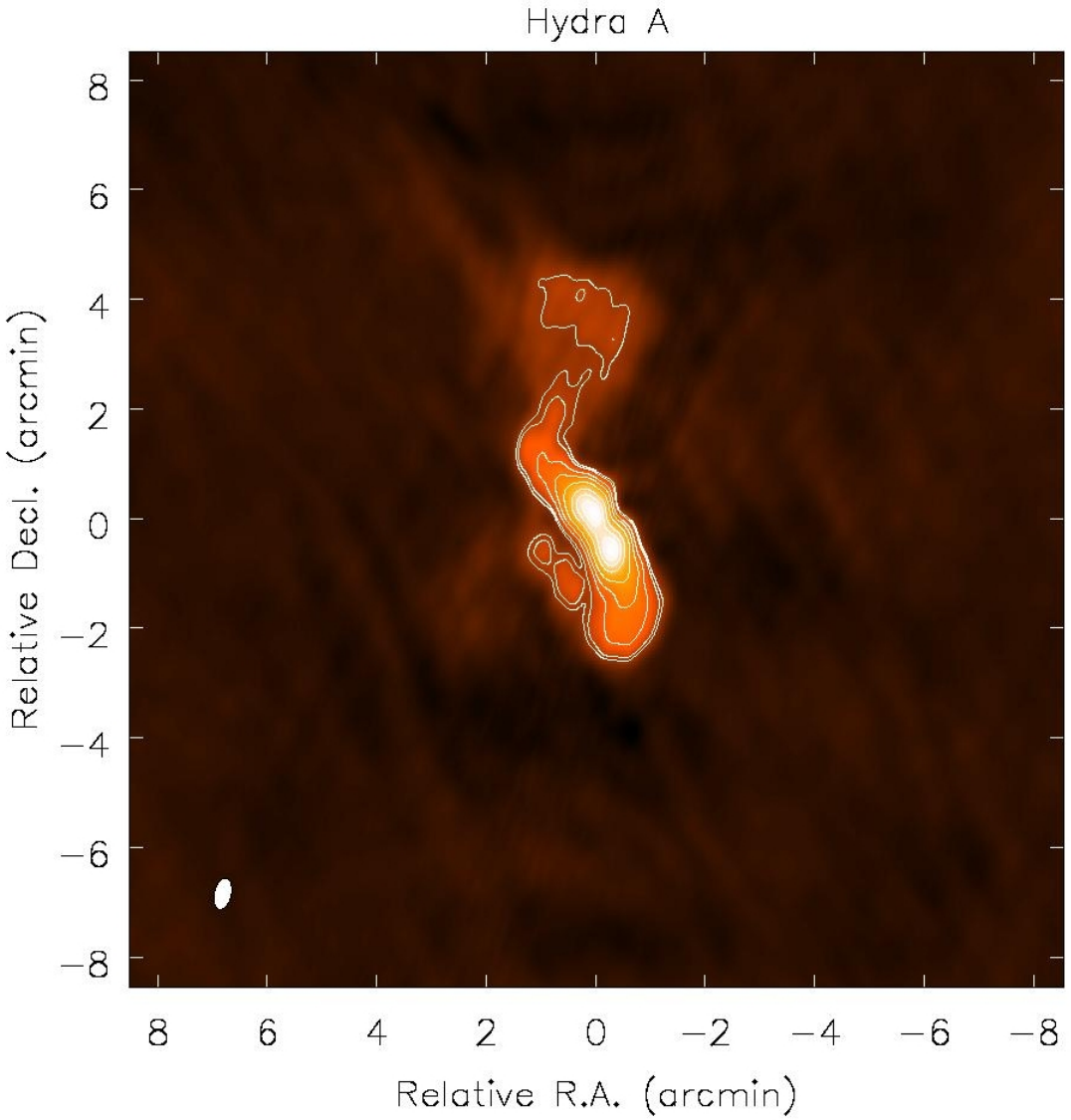


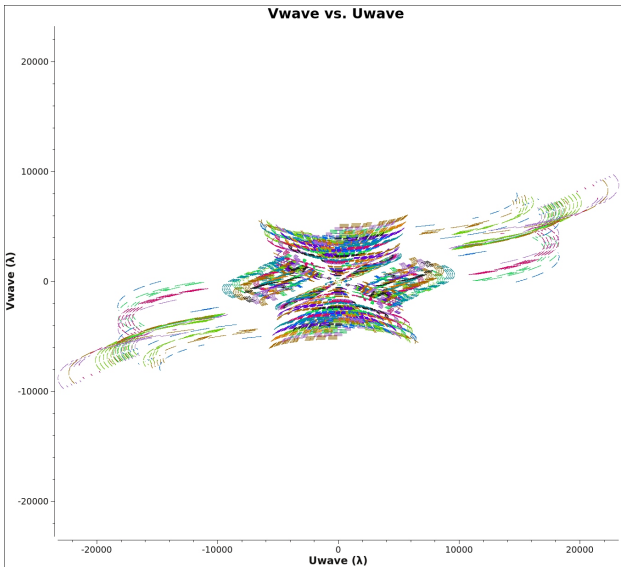


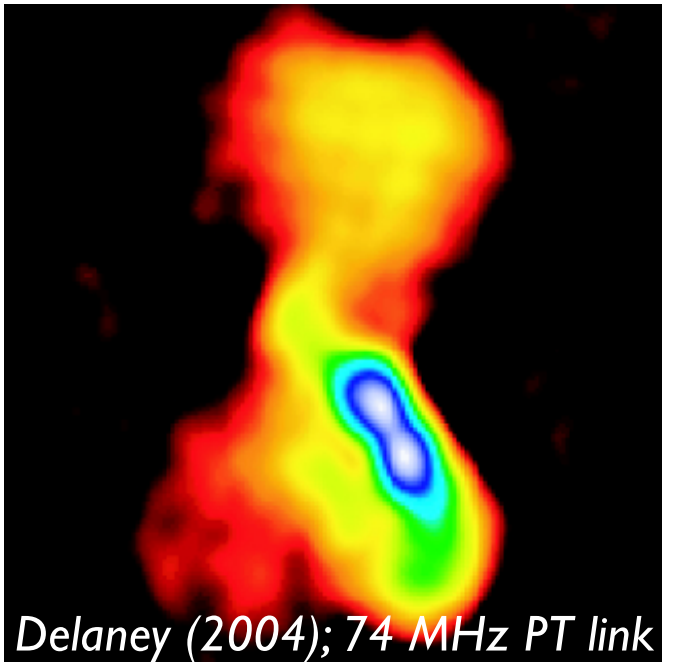


Perley et al. (2002)

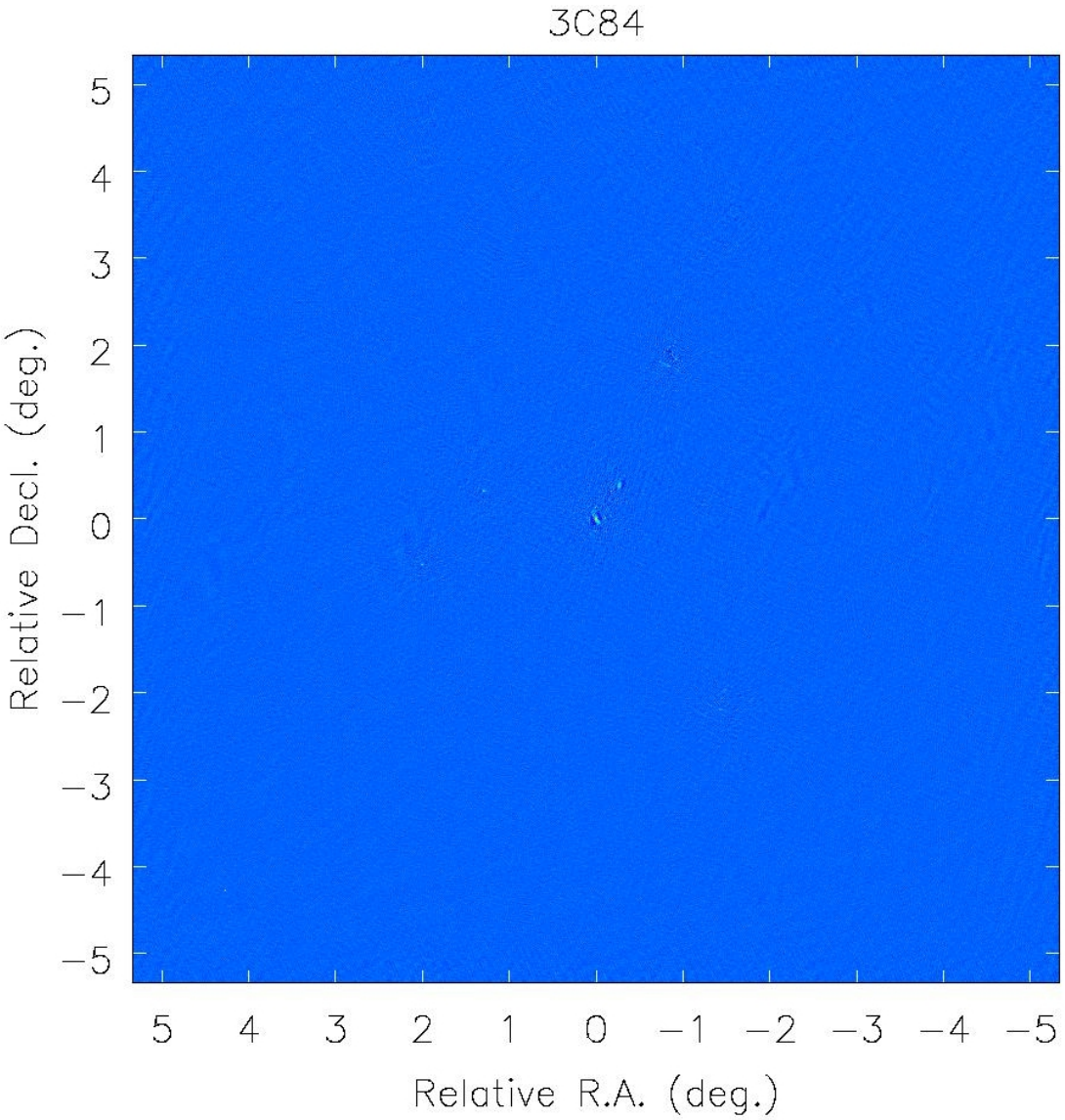
Hydra A

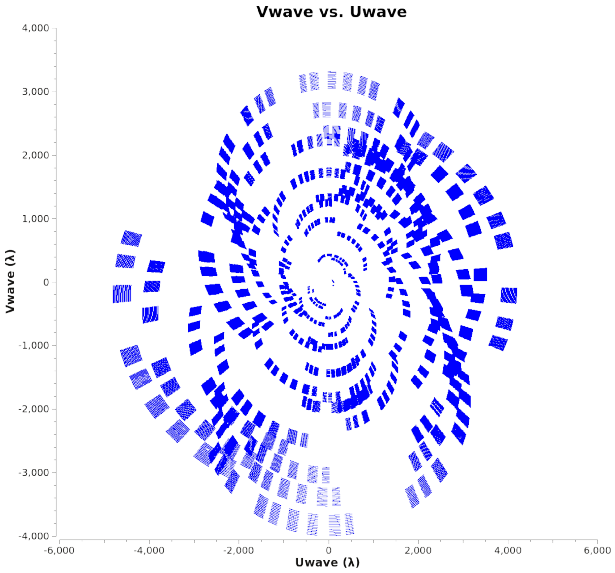

Hydra A
Relative Decl. (arcmin)
Relative R.A. (arcmin)
8
6
4
2
0
−2
−4
−6
−8


Vwave vs. Uwave
Vwave (λ)
Uwave (λ)
20000
10000
0
-10000
-20000

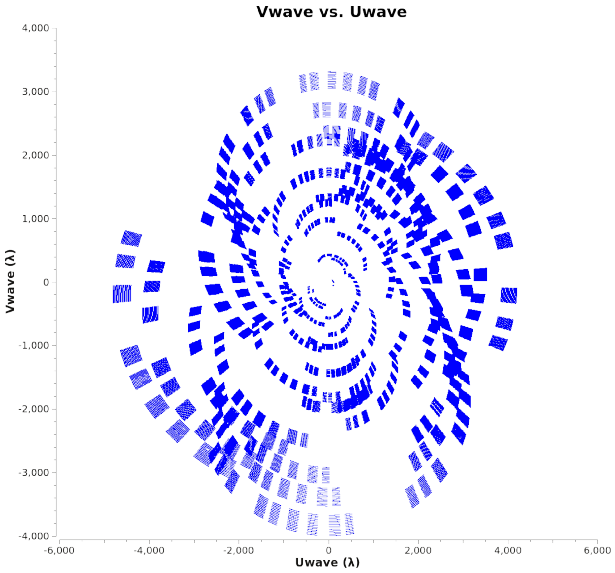

Delaney (2004); 74 MHz PT link

Perseus A / 3C 84



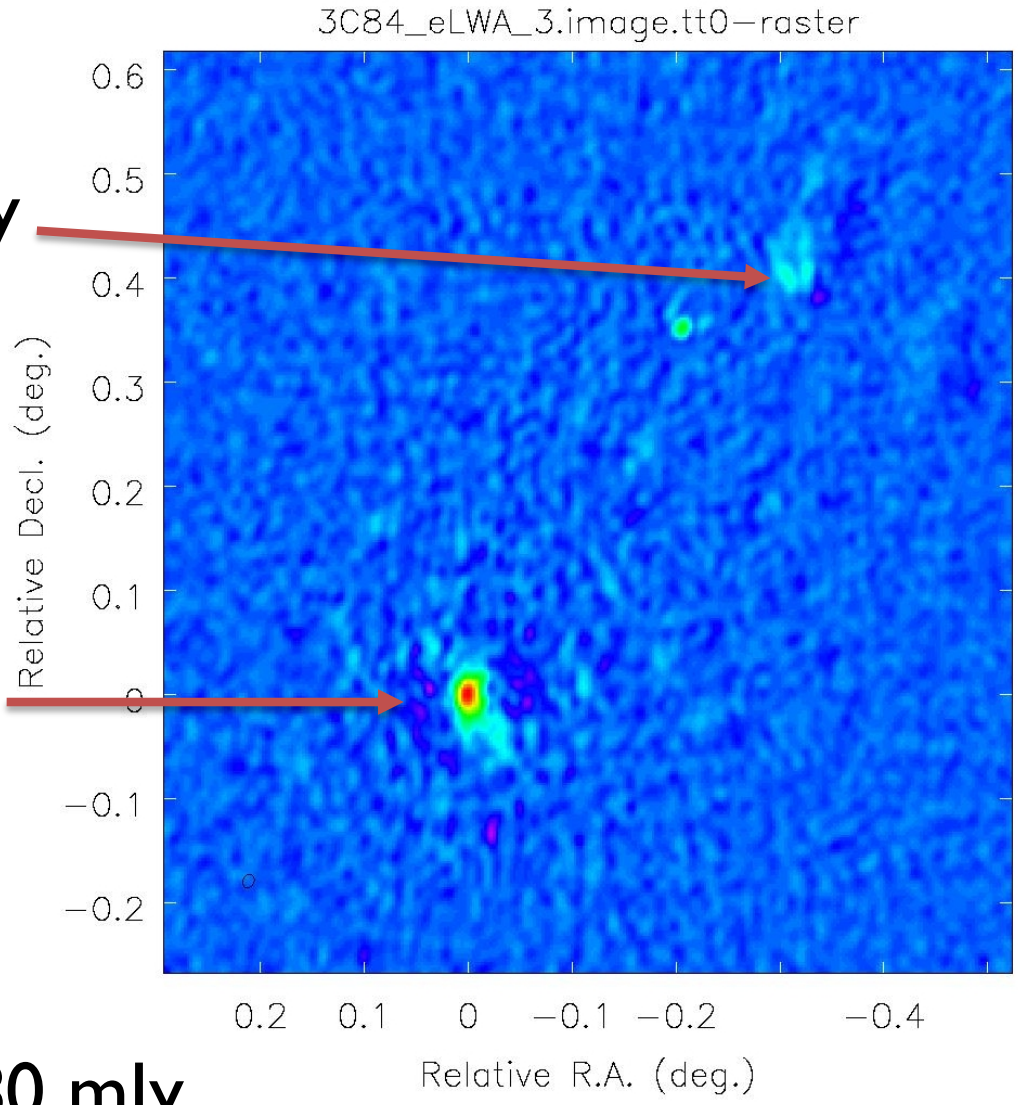


Perseus A / 3C 84

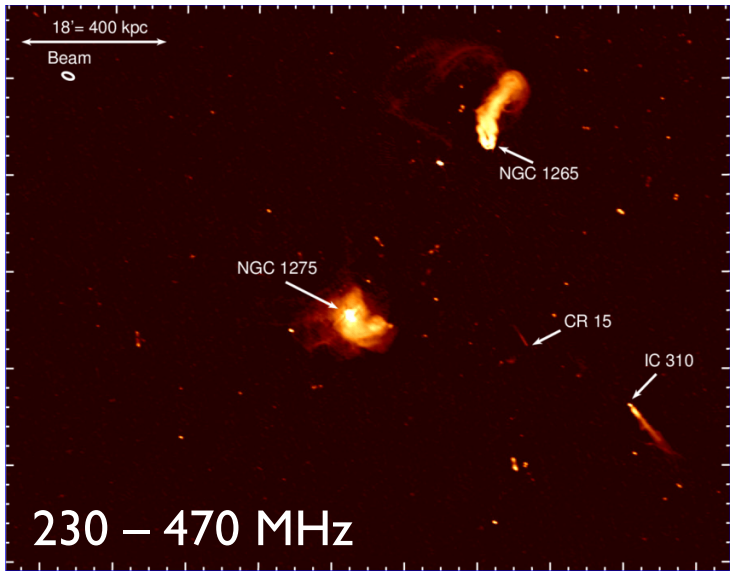


~0.8 Jy

~27 Jy



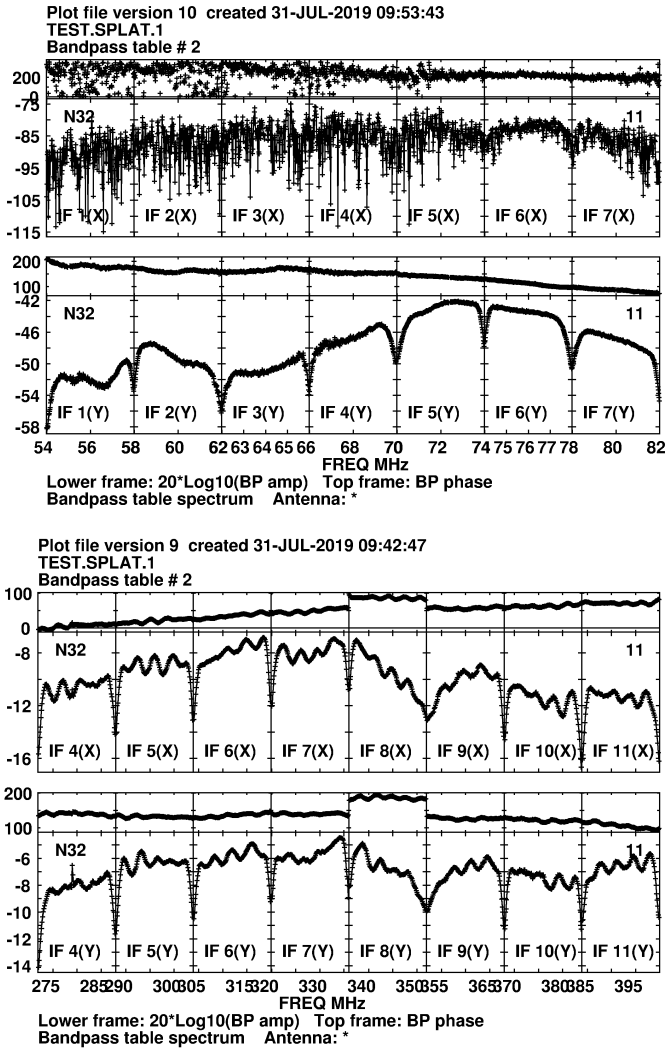
rms ~80 mJy



Gendron-Marsolais et al. (2017)

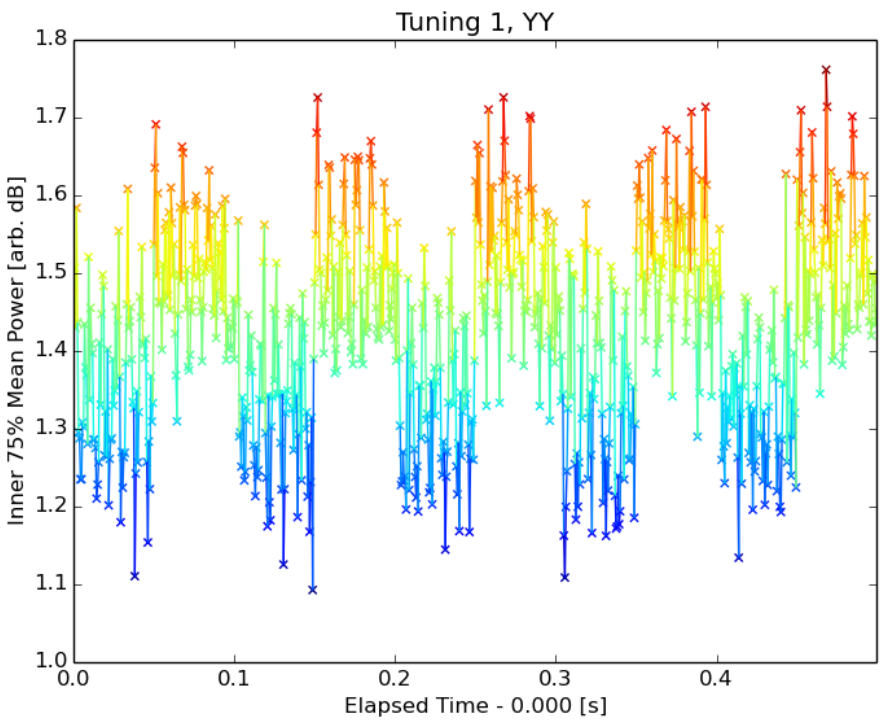
Some Technical Challenges - Mechanics

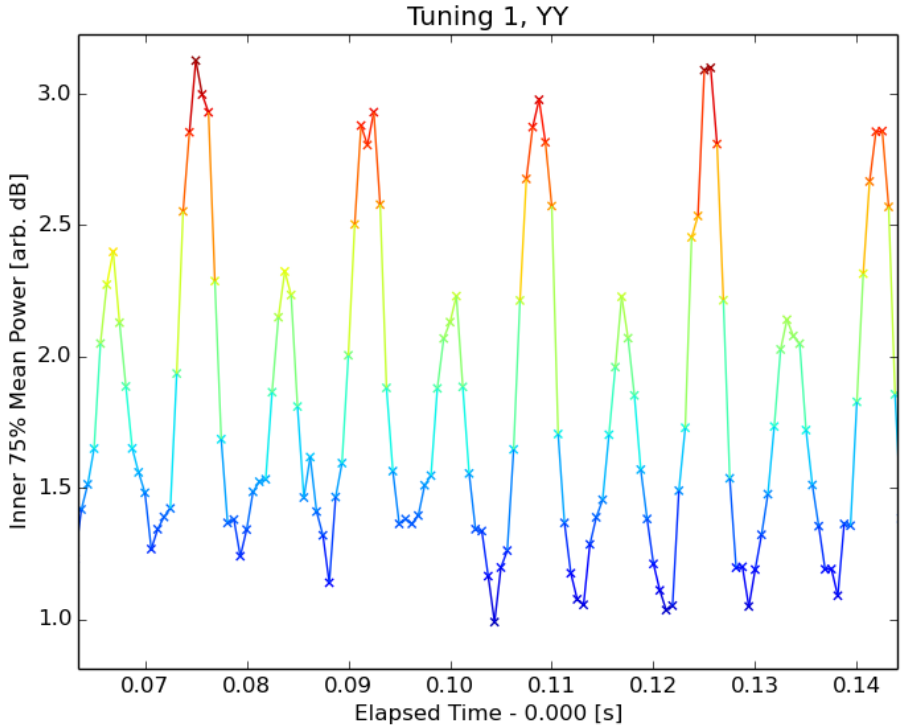
Replace cables on VLA & retrofit P-band dipole bearings



Some Technical Challenges - Electronics

Ground Loop

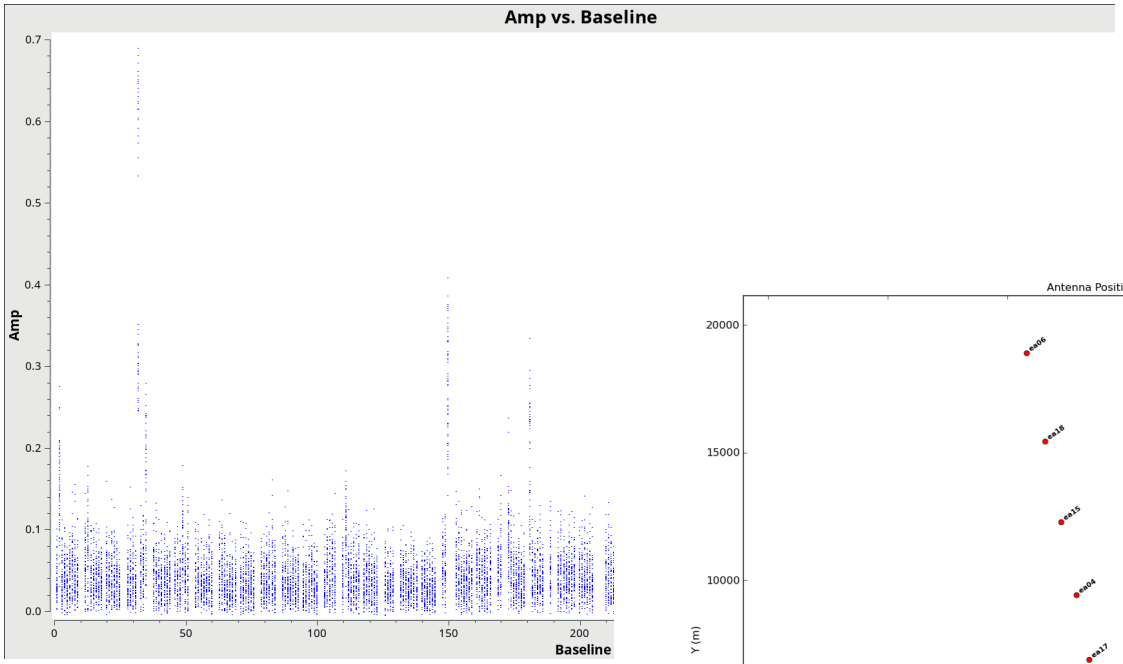


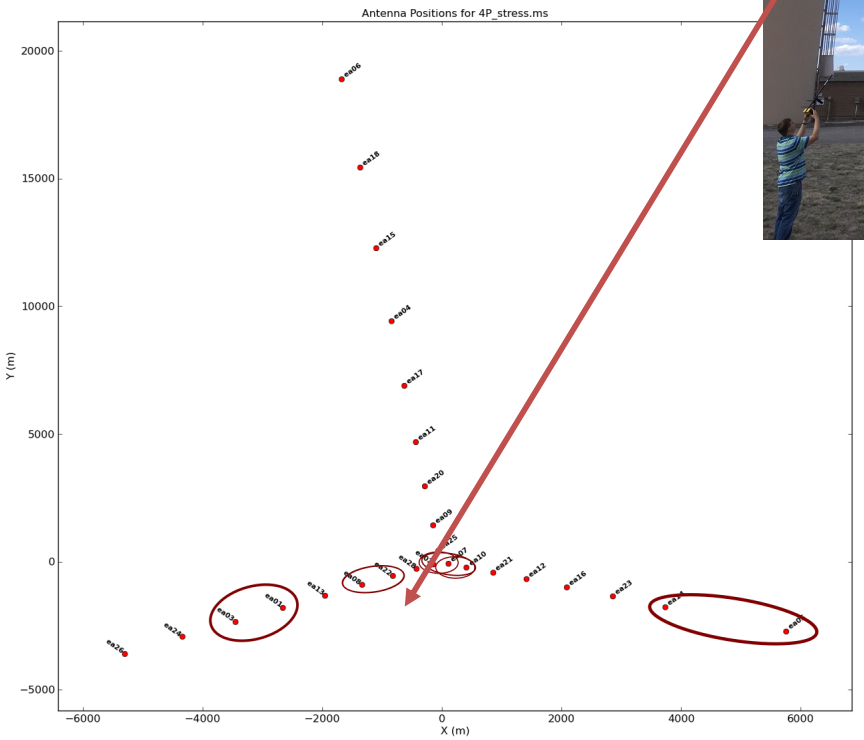


Gain oscillations at 60/120 Hz – need to find & break the loop
could cause spurious correlations; otherwise averages out

Some Technical Challenges - External

Powerline RFI





Spurious cross-correlations most likely due to powerline interference.

Near-term Developments

- ELWA efforts funded for the next three years through NSF MSIP and in-kind contributions by NRAO.
- Characterize and document performance of the full system.
- Fully automate joint operations between LWA and VLA, including operations of the software correlator.
- Make VLA only 4 m band available for shared-risk observing for semester 2020B (Feb 1st, 2020 deadline), allowing simultaneous 4- and P-band observations.
- ELWA observations are anticipated to be made available through the regular NRAO proposal process, where time awarded by NRAO on the VLA will automatically award time on LWA.
- Improve support of lowband calibration/imaging through CASA

Summary

- The VLA has a fully operational 74 MHz system again!
  permanently installed and non-interfering with cm-wavelengths
- ELWA: combines the VLA and LWA stations in NM
  replicates and surpasses the former Pie Town link of the pre-EVLA era.
- ELWA will be a great tool to develop science at <100 MHz and to develop and test imaging algorithms needed for wide fields.
- Preliminary observations of prominent A-team objects are promising:
  a) performance at least at the level of pre-EVLA with indicationsto be a factor of 2-4 better,
  b) simple calibration and imaging already gives decent results
- The success of lowband observing with the VLA as pathfinder for a possible next generation low-frequency observatory depends on **you**!

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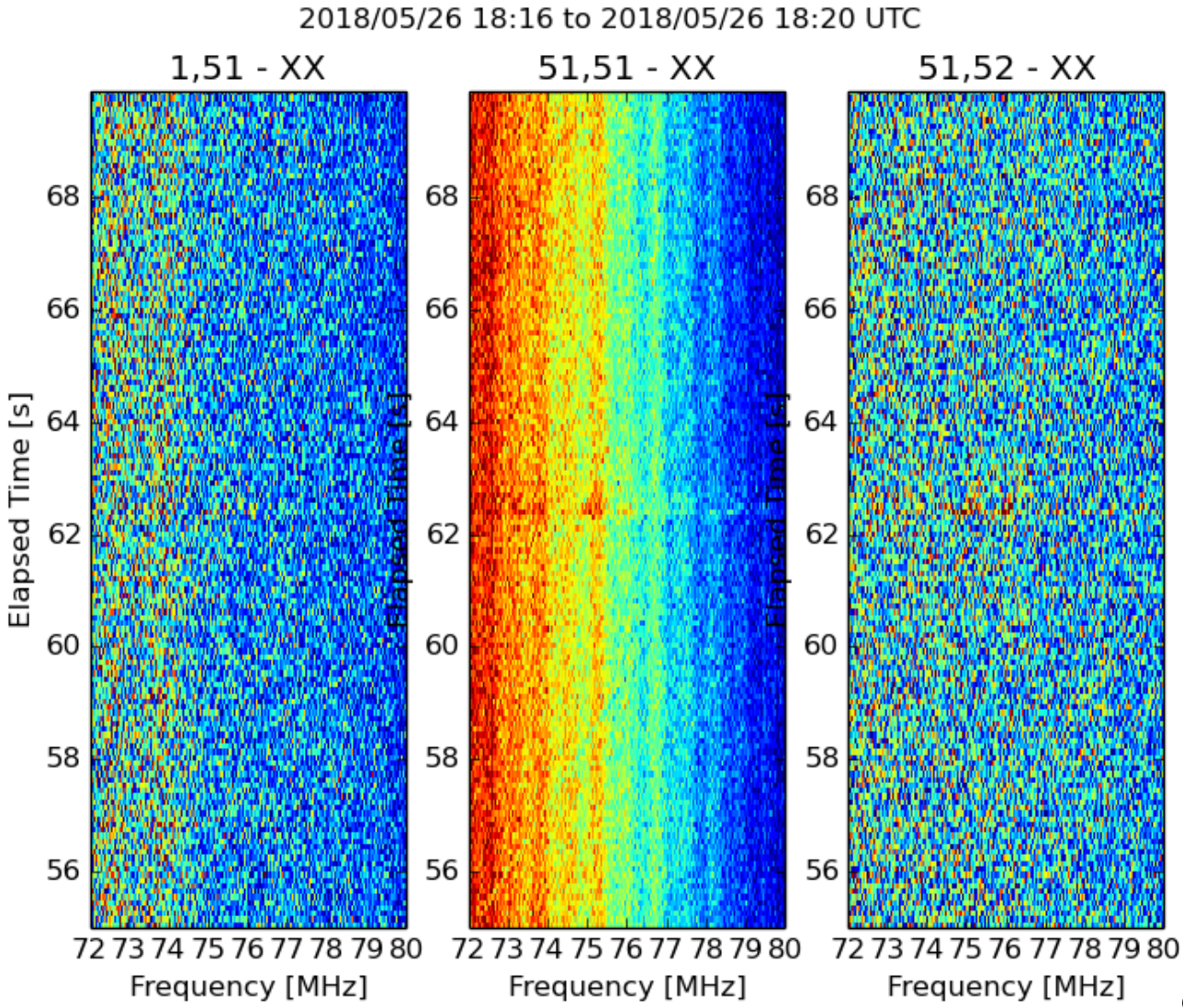
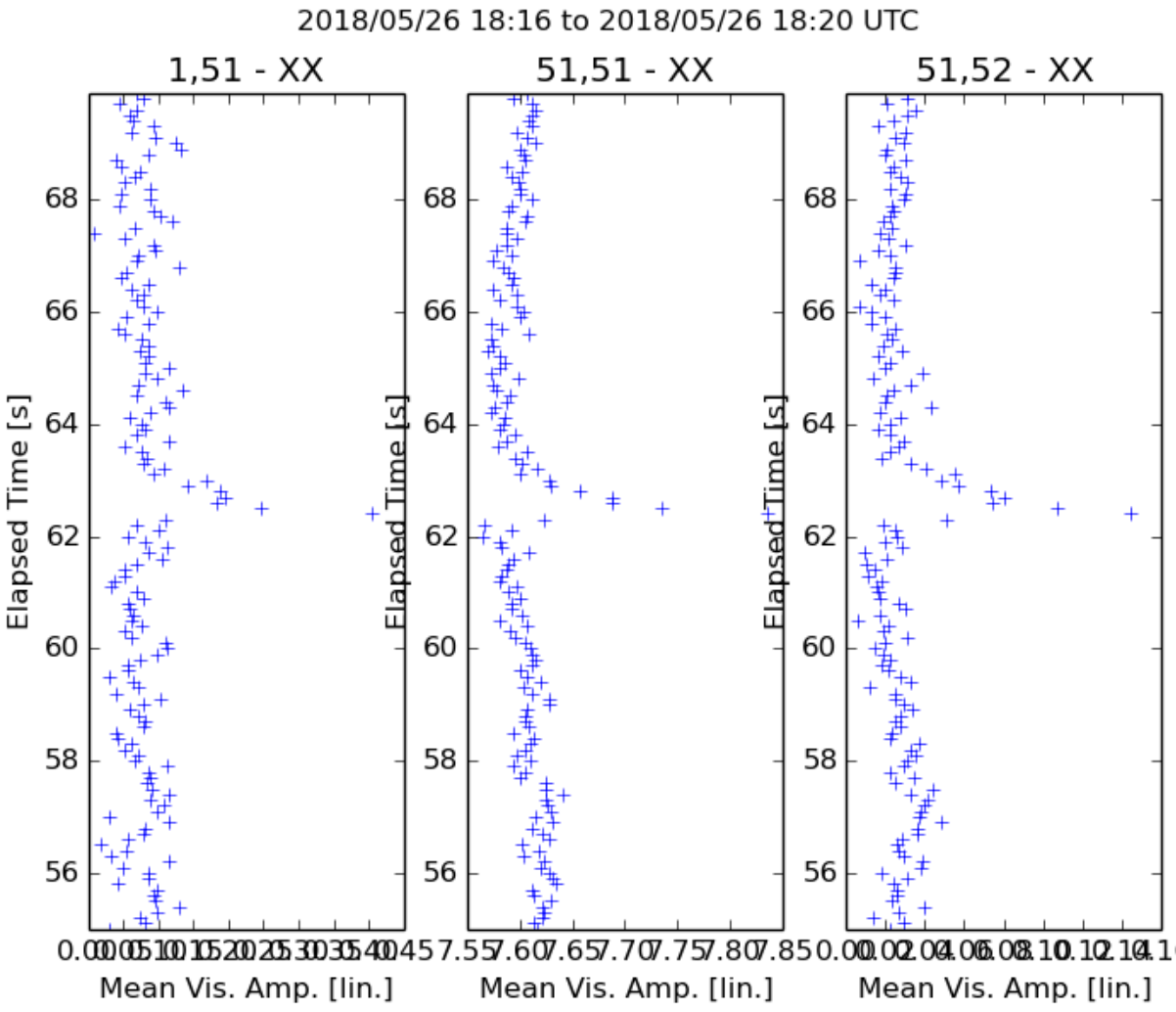
Giant Pulses



credit: Pratik Kumar

Giant Pulses



credit: Pratik Kumar

Captured Crab Giant pulses during ELWA imaging observation

Tau A – CGP (4s snapshots movie)