

Excision of broadband arcing power-line RFI

Ryan Monroe

rmonroe@caltech.edu

The Owens Valley Radio Observatory Long Wavelength Array (OVRO-LWA)

- 288 Dual-pol Antennas
- Full sky viewing
@ ~25-85 MHz



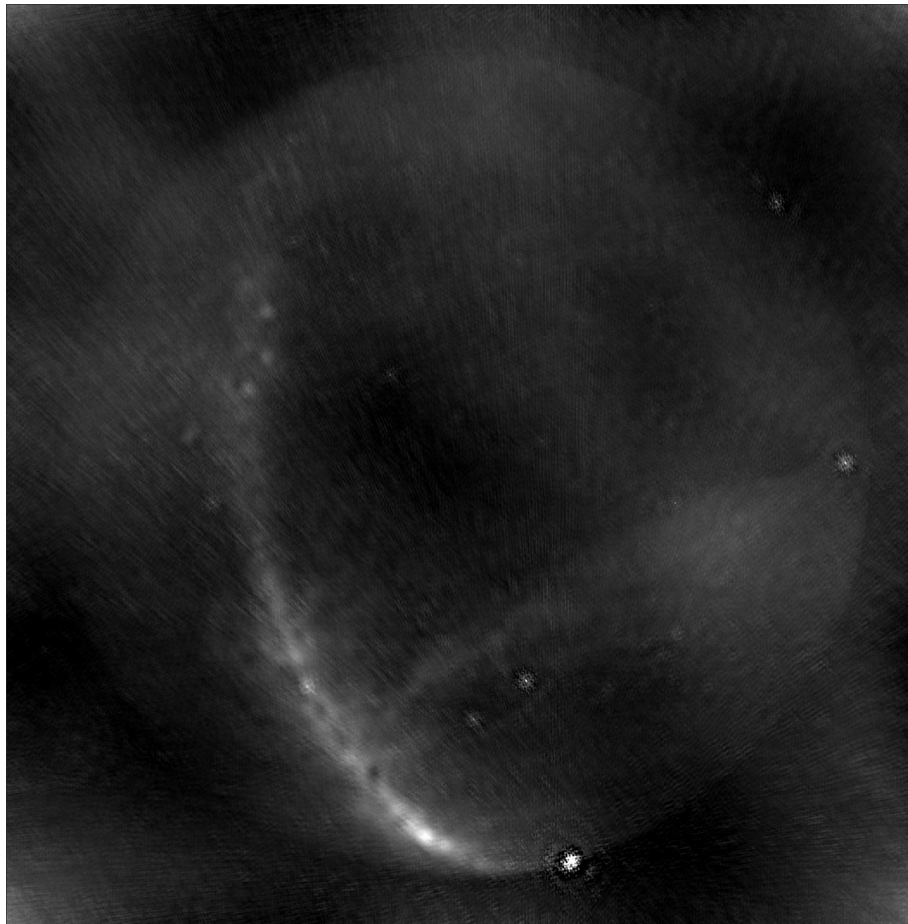
The Owens Valley Radio Observatory Long Wavelength Array (OVRO-LWA)

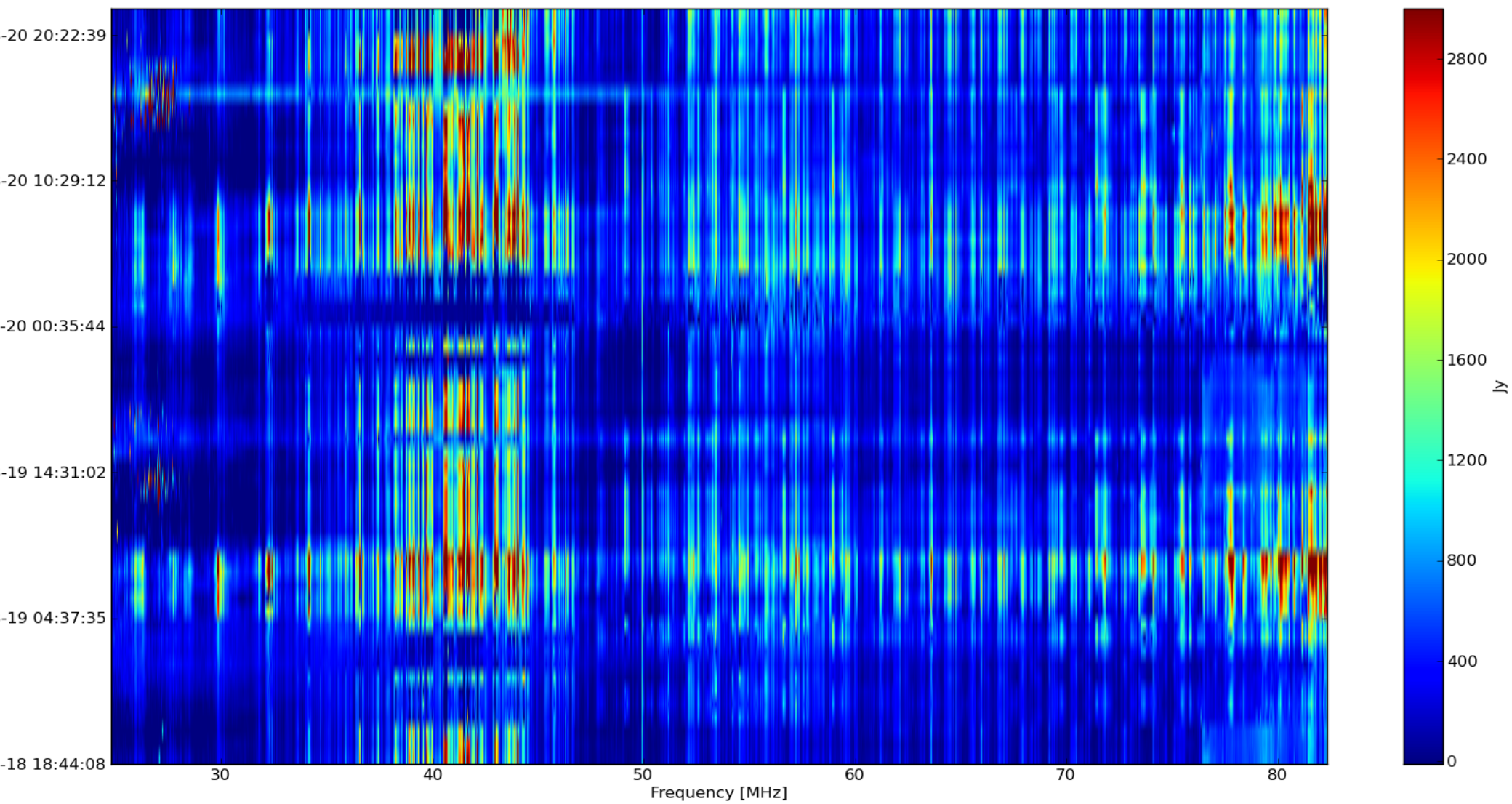
- $4 \text{ pols} * 2400 \text{ channels} * 33000 \text{ baselines} = 1.2558\text{e}+09$ visibility measurements per integration!
- Flagging of RFI and bad data
 - {antenna, channel, visibility}



RFI seen from OVRO

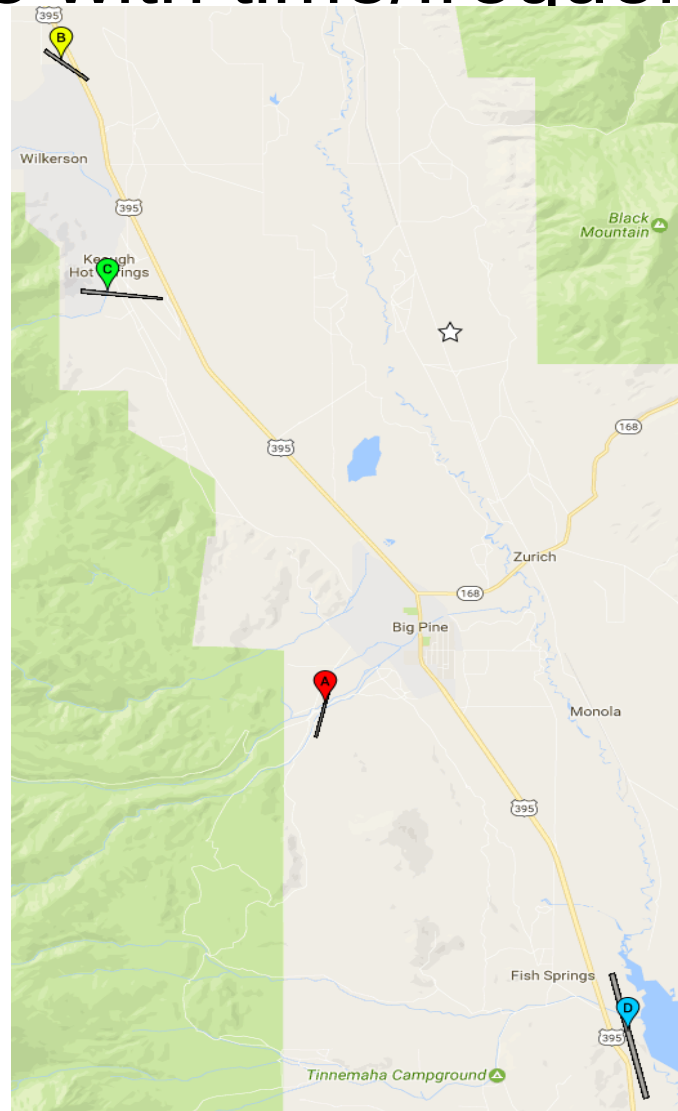
- Minimal RFI from intentional broadcasters - easily flagged
- However, power-line arcing produces broadband, time-variable RFI
- Fitting for near-field emitters produces candidate sources.





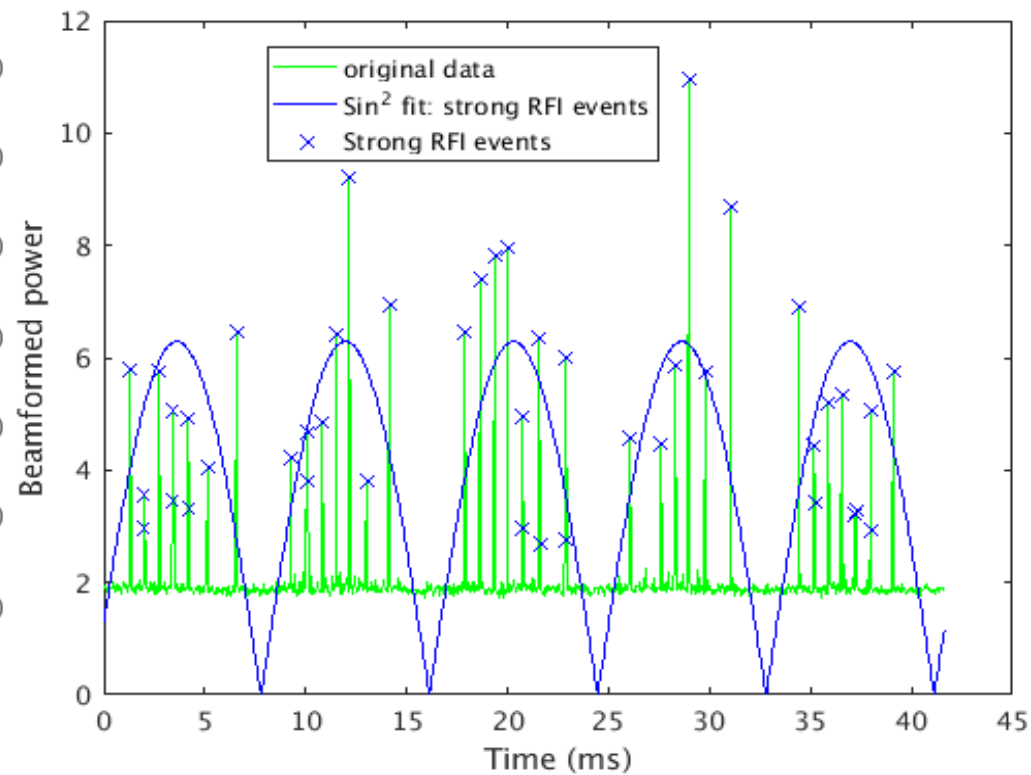
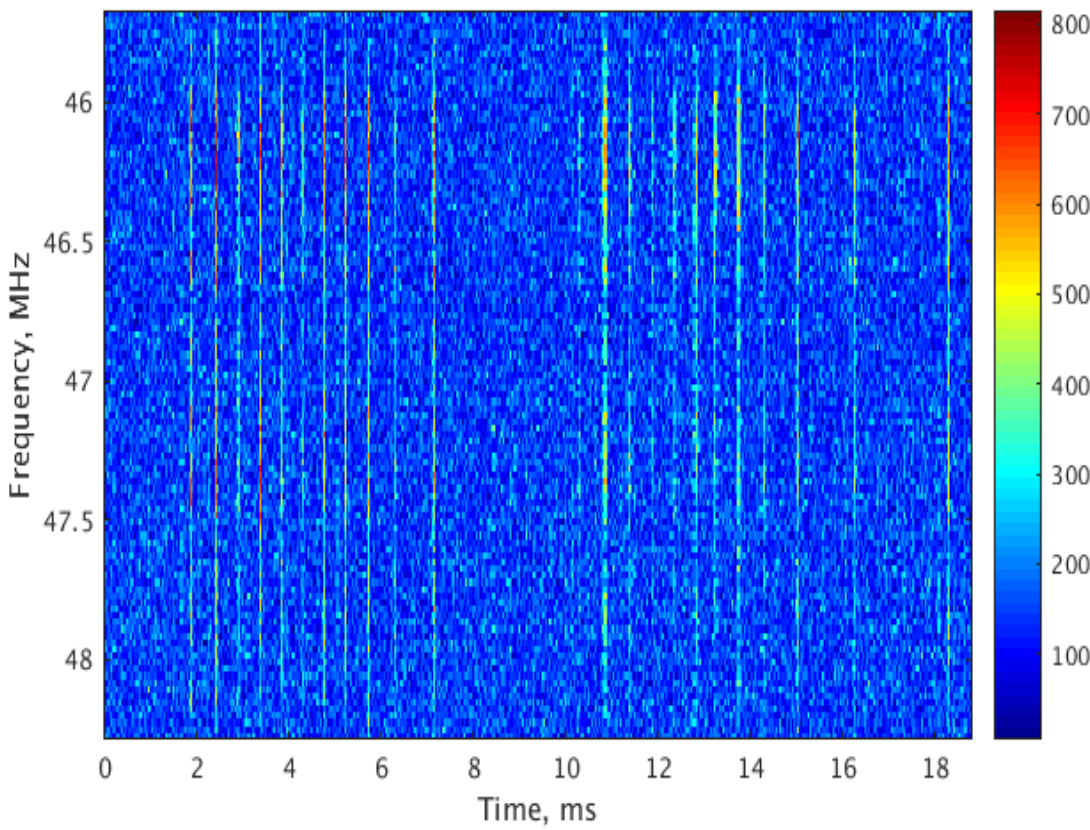
RFI seen from OVRO

- Unlike most RFI, this is on often and broadband – hard to remove with time/frequency flagging



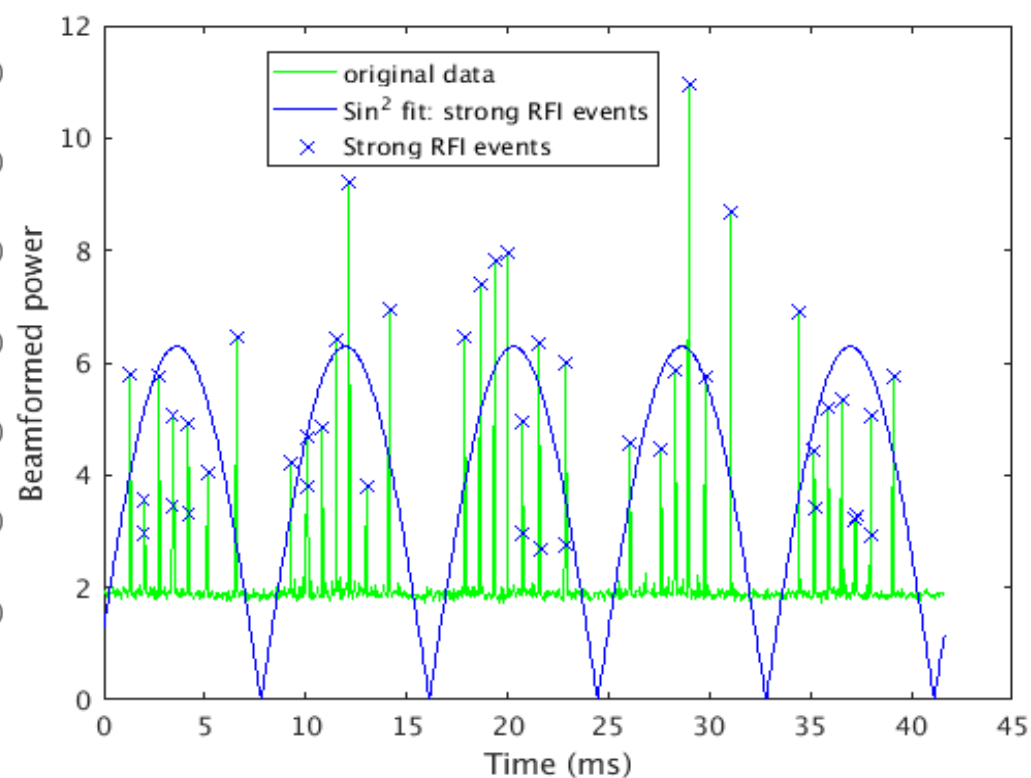
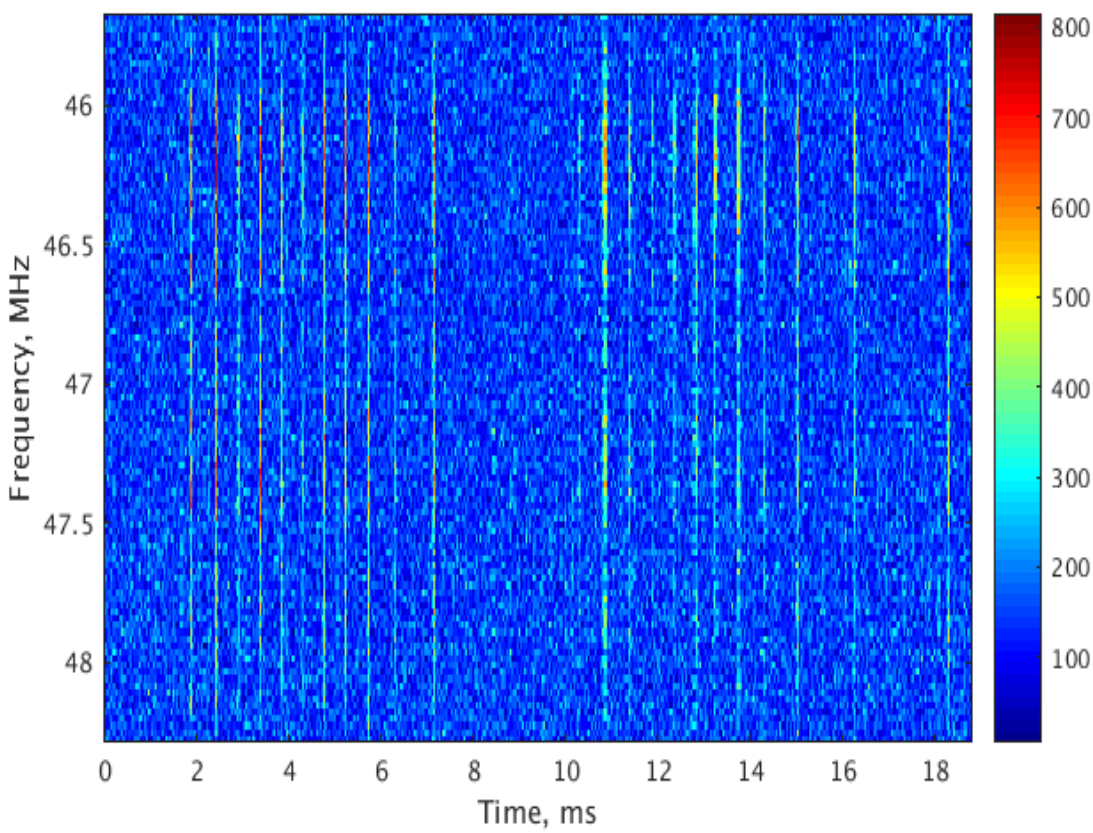
Beamformed detection

- Beamform in the direction of source for detection and analysis
- Easy to see RFI events with integrated power detector



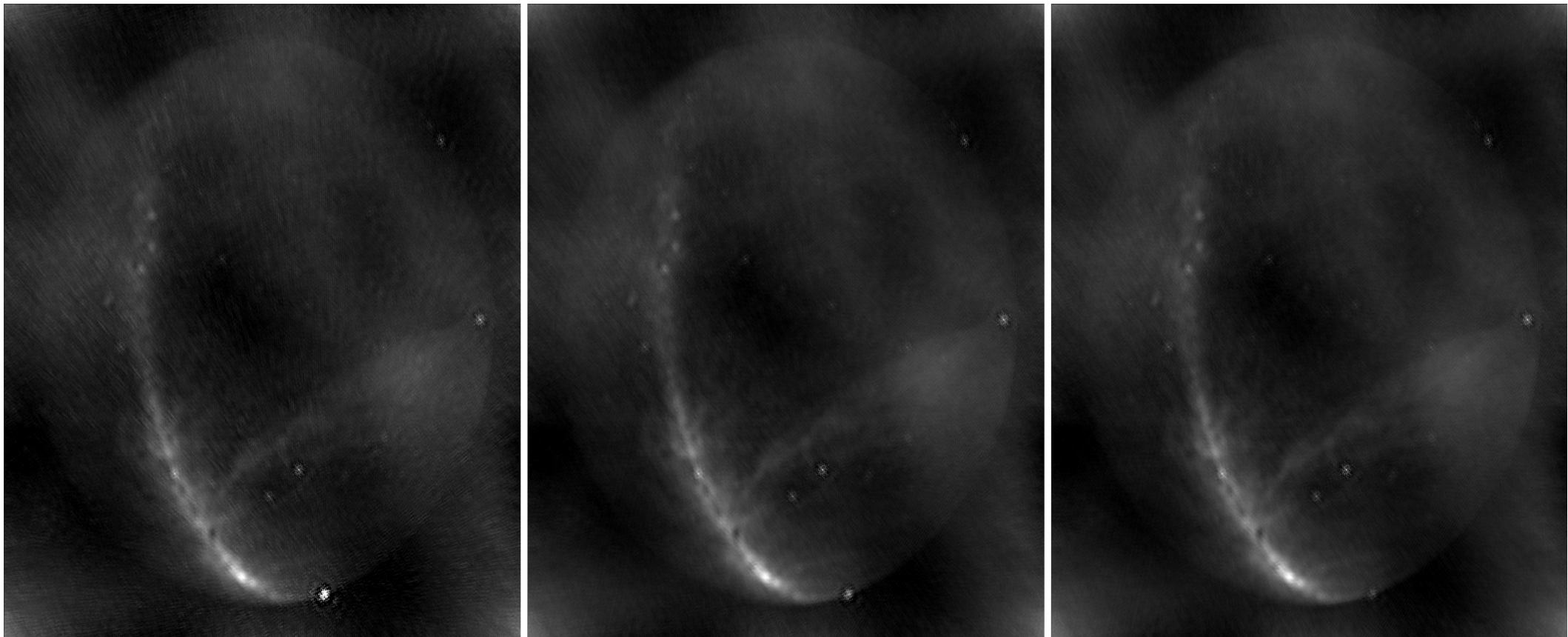
Beamformed detection

- Pulses unresolved at 41.6 microseconds
- Clear 60 Hz trend to pulse groupings



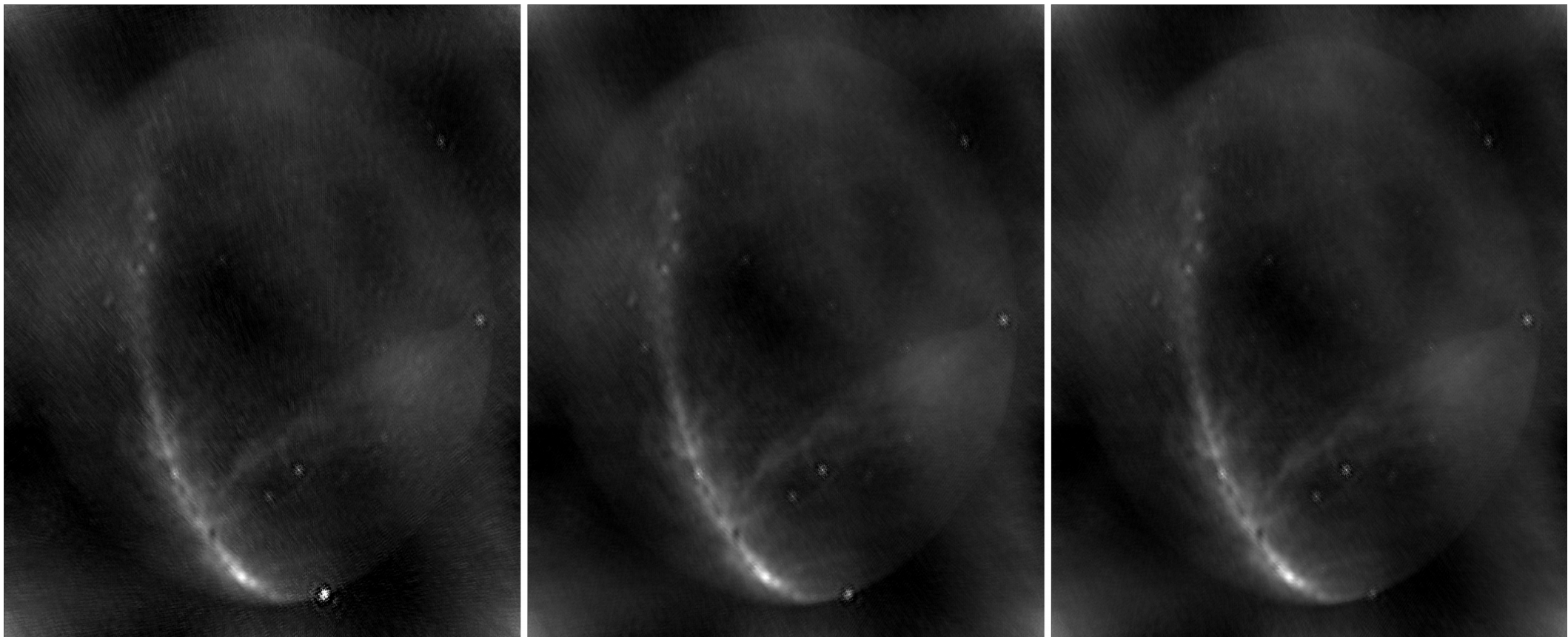
Results

- Flag in time @ 41.6 us, correlate in software



Results

- Easy to implement on GPU correlator; for large arrays is often computationally efficient = real-time processing
- OVRO-LWA will use this for final 352-antenna array



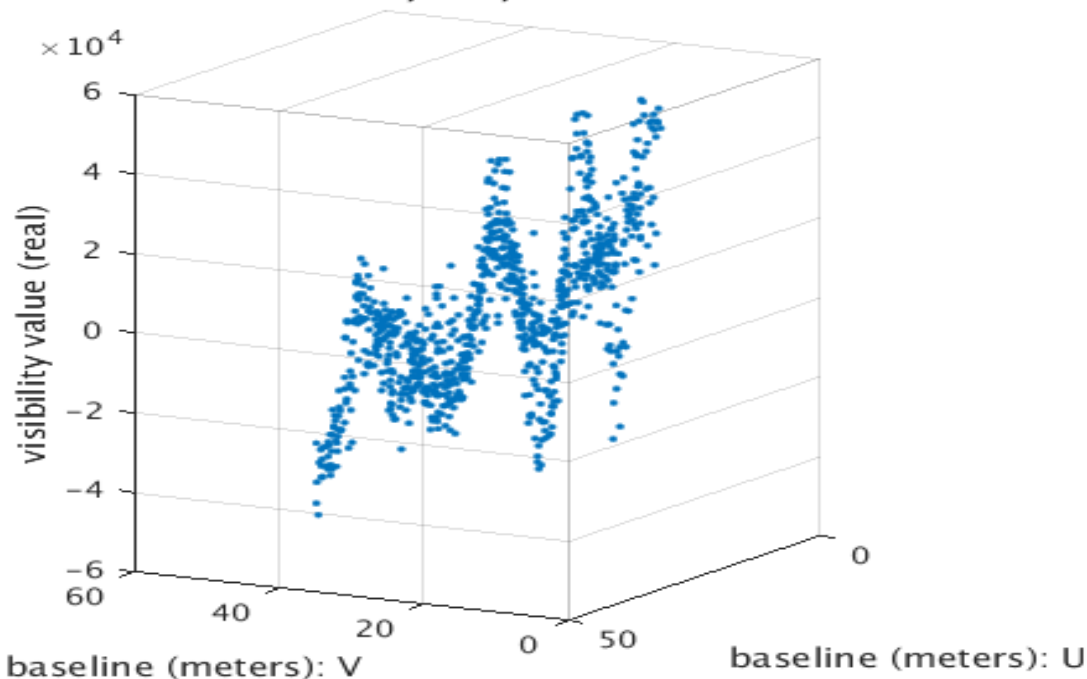
Flagging Bad Data

- Antennas: 288 (easy)
- Frequencies: 2398 (easy)
- Baselines: 165600 (much harder!)
 - Most baseline-driven issues are stable in time

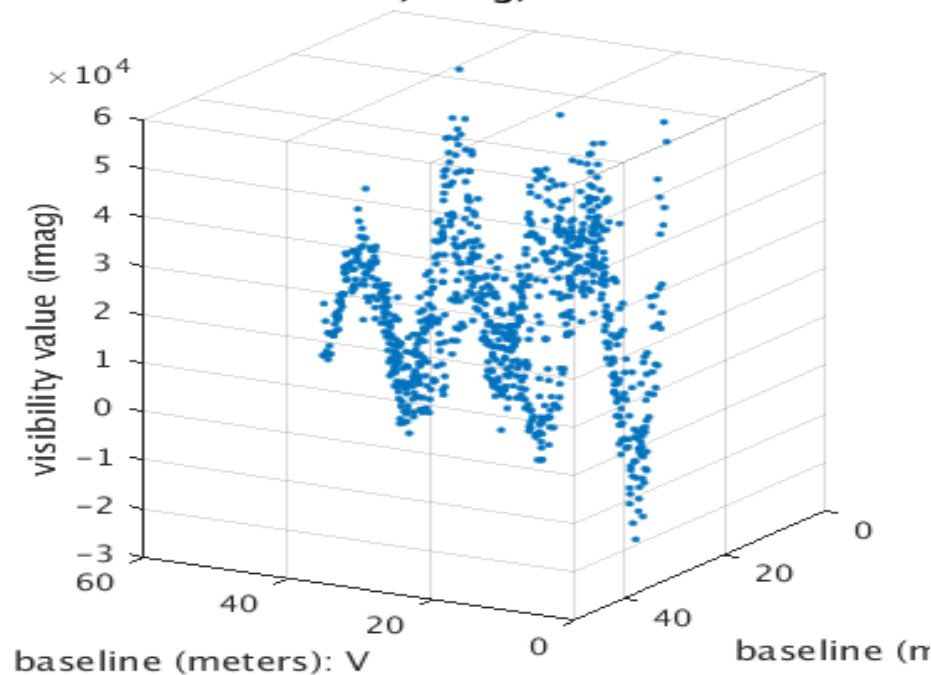
Baseline flagging

- Insight: visibilities smooth in $\{u, v, w, \text{time}, \text{frequency}\}$
- Instrumental effects violate this

visibilities, real; $f=36.7$ MHz

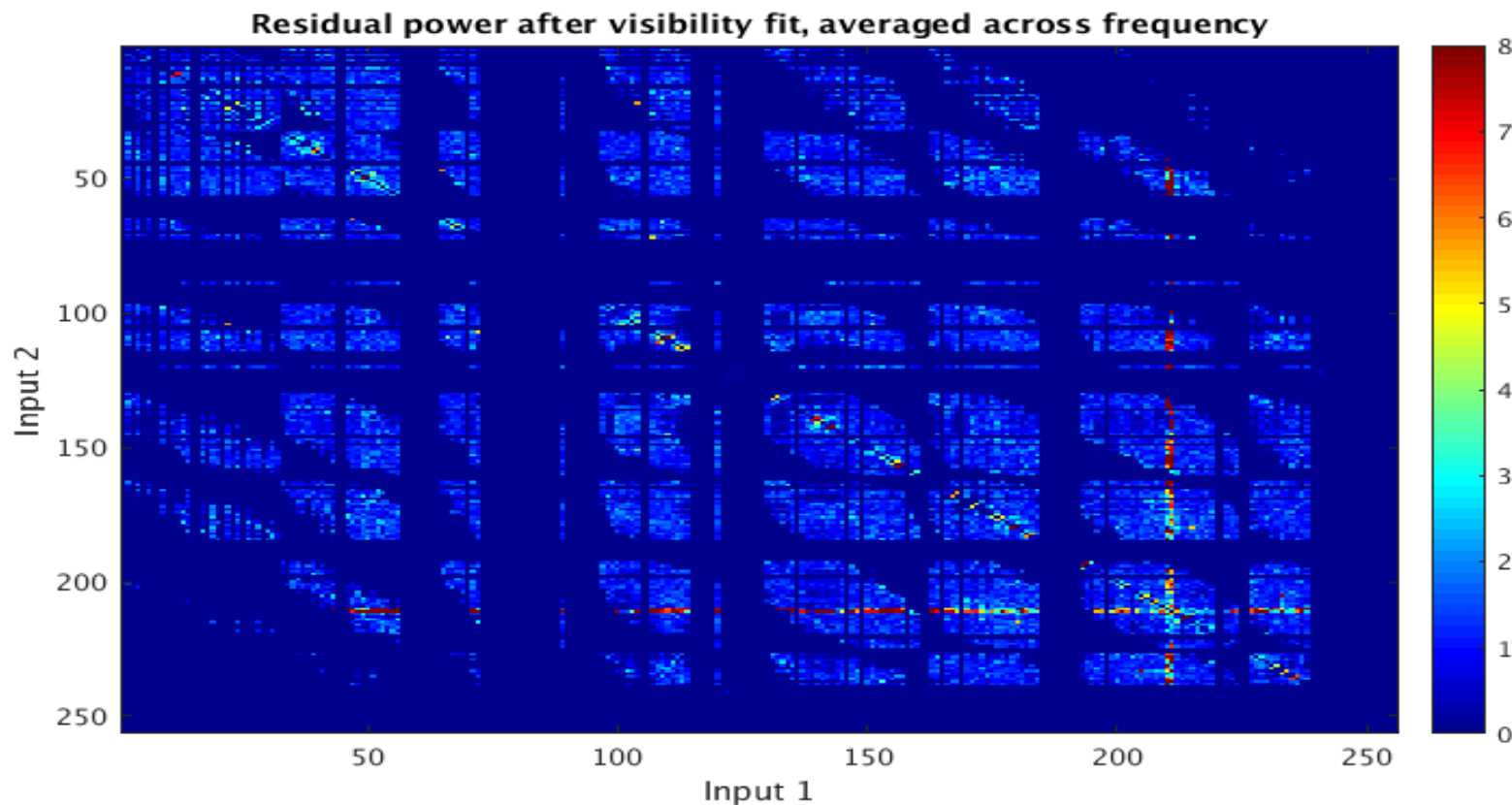


visibilities, imag; $f=36.7$ MHz



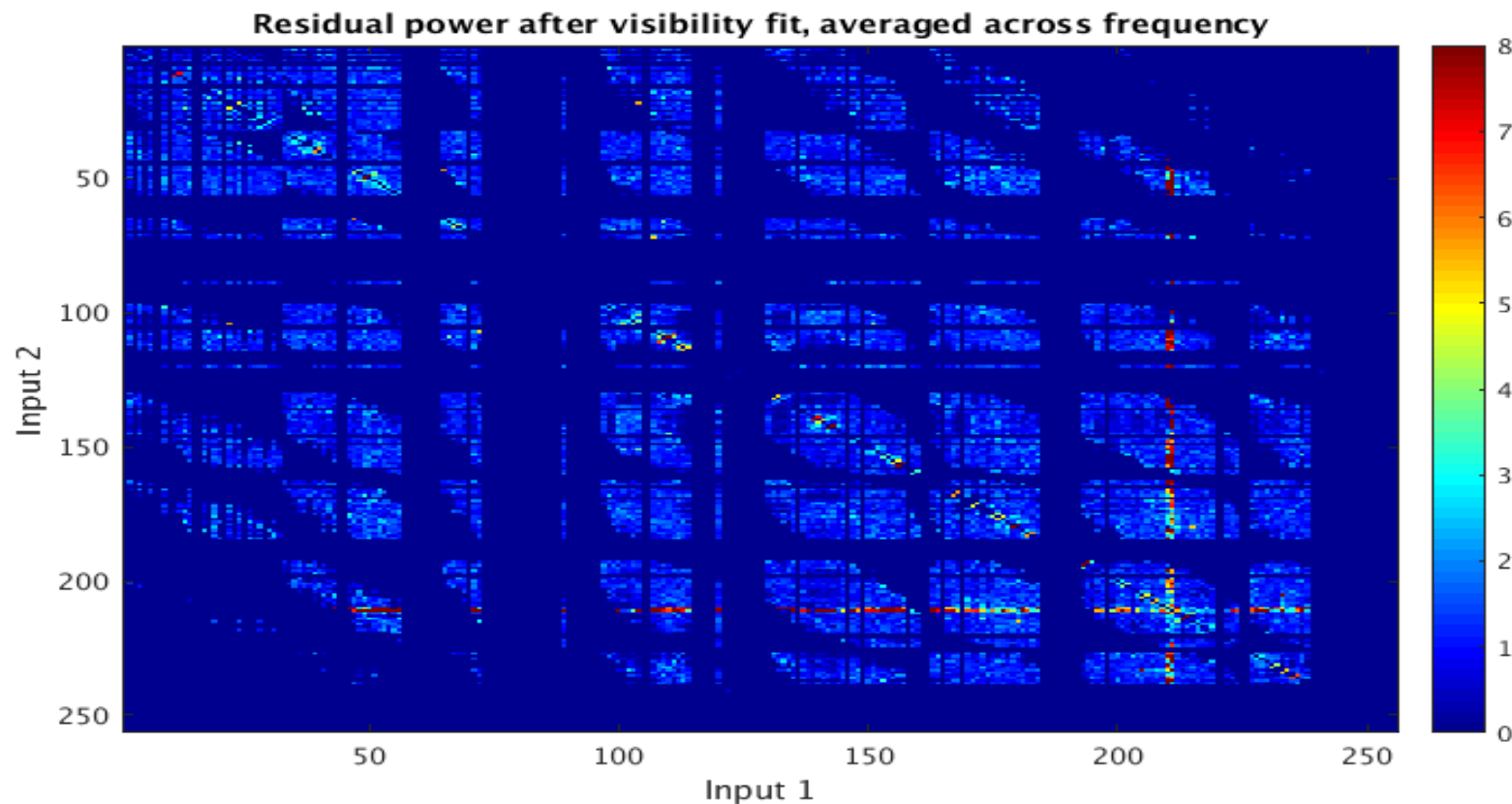
Baseline flagging

- Insight: visibilities smooth in $\{u,v,w,\text{time},\text{frequency}\}$
- Fit low-order polynomial to surface, look for large residuals



Baseline flagging

- Limitation: require sufficient visibility density
 - In our case, long baselines too sparse



Baseline flagging

- Discovered: a few bad antennas, frequencies
 - Also, adjacent ARX line leakage
 - (was already planning on designing improved ARX boards)

Conclusions

- You might need evidence to convince utilities companies to clean their power lines: look for something like this
- Created realtime RFI mitigator which is easy to implement in software
- Used smoothness assumption in visibility space to flag bad baselines
- Email me at rmonroe@caltech.edu