# NAIC/NRAO Single Dish Summer School

July 10-16, 2011

## RFI Excision Techniques

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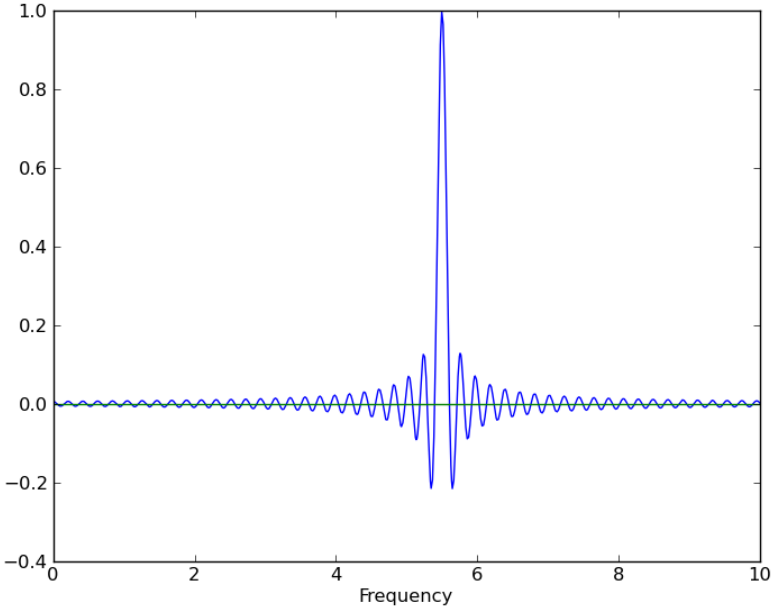
Atacama Large Millimeter/submillimeter Array
Expanded Very Large Array
Robert C. Byrd Green Bank Telescope
Very Long Baseline Array

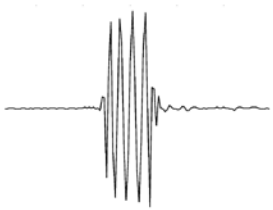
NRAO

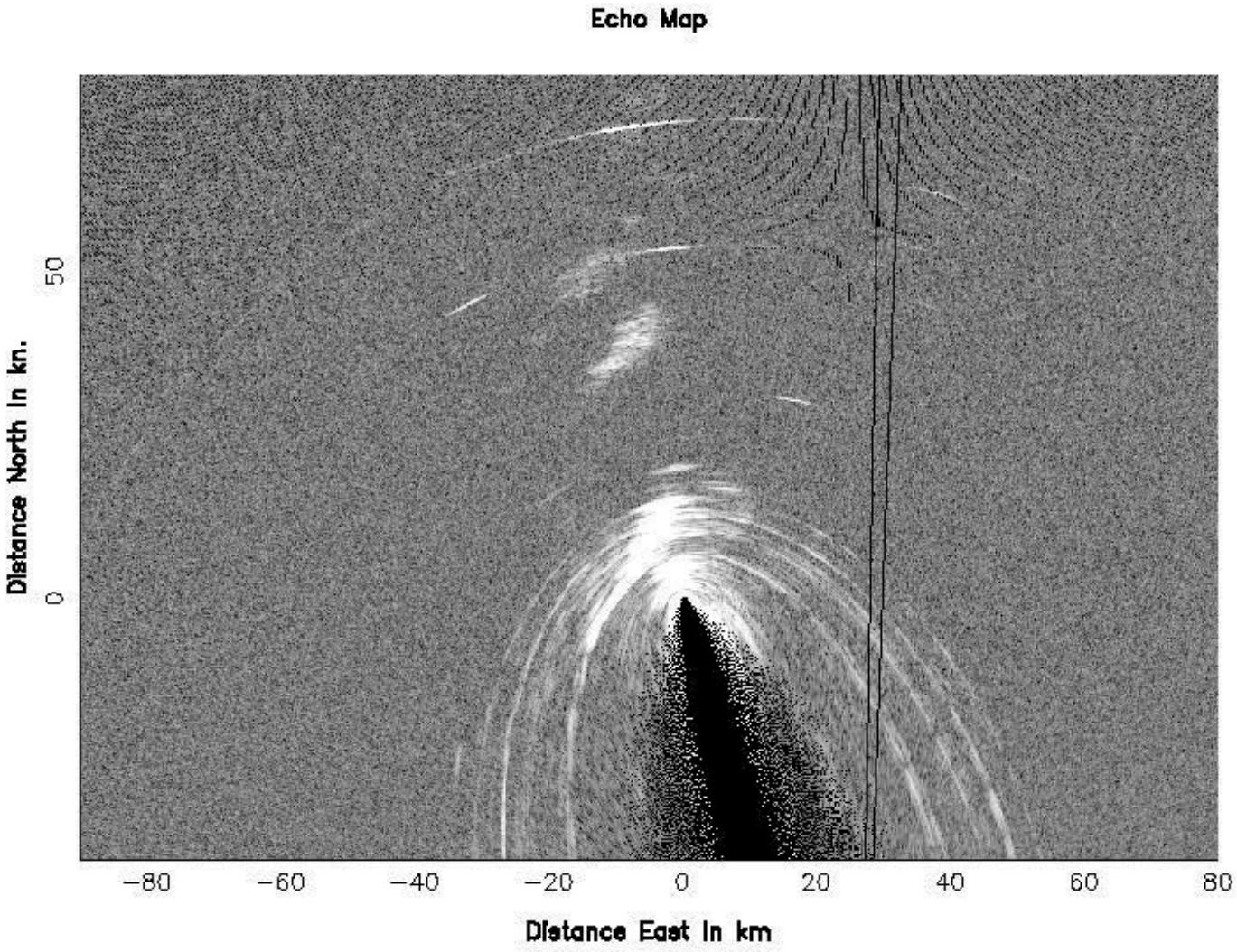
# Isolation of RFI from Science

- Frequency
  - Resolution
  - Spectral Isolation
    - "Window" taper $10^{-2}$
    - Polyphase Filter $<10^{-4}$
- Time
  - Editing
  - Blanking
    - Sub-second
    - Radar, Aircraft distance measuring, etc.
- Direction of Arrival
  - Low Sidelobes – GBT $\leq 10^{-1}$
  - Adaptive Cancellation

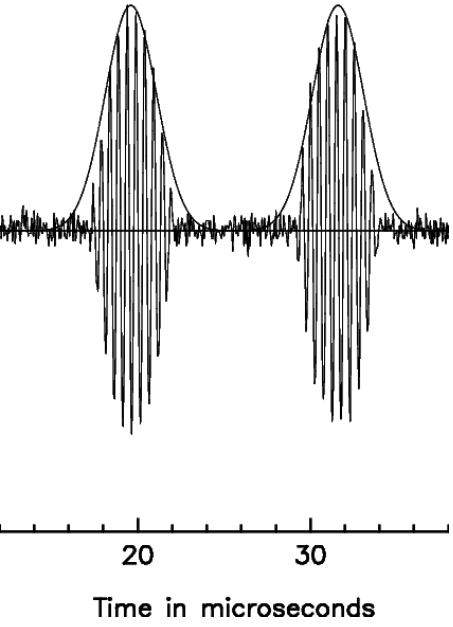


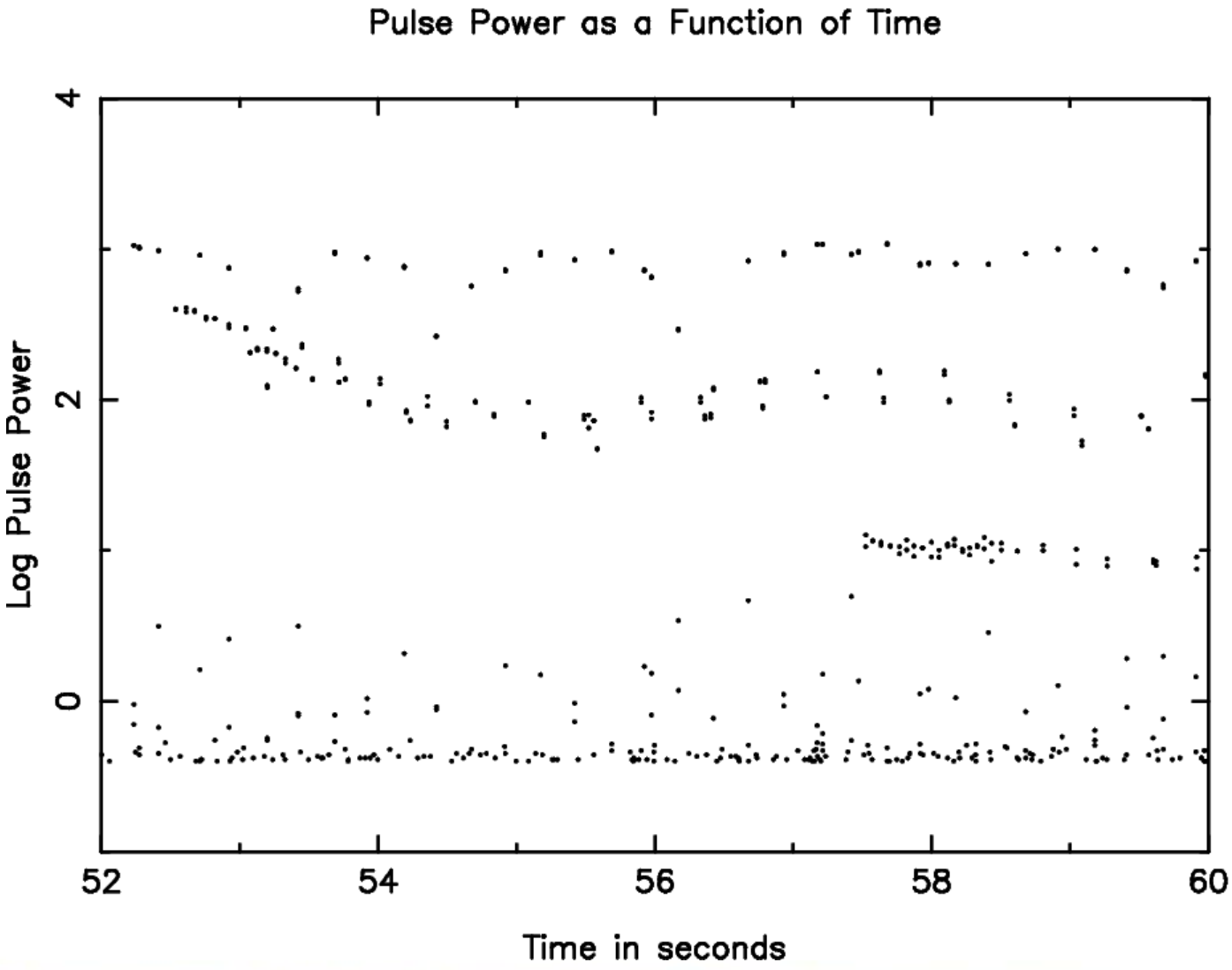
# Radar



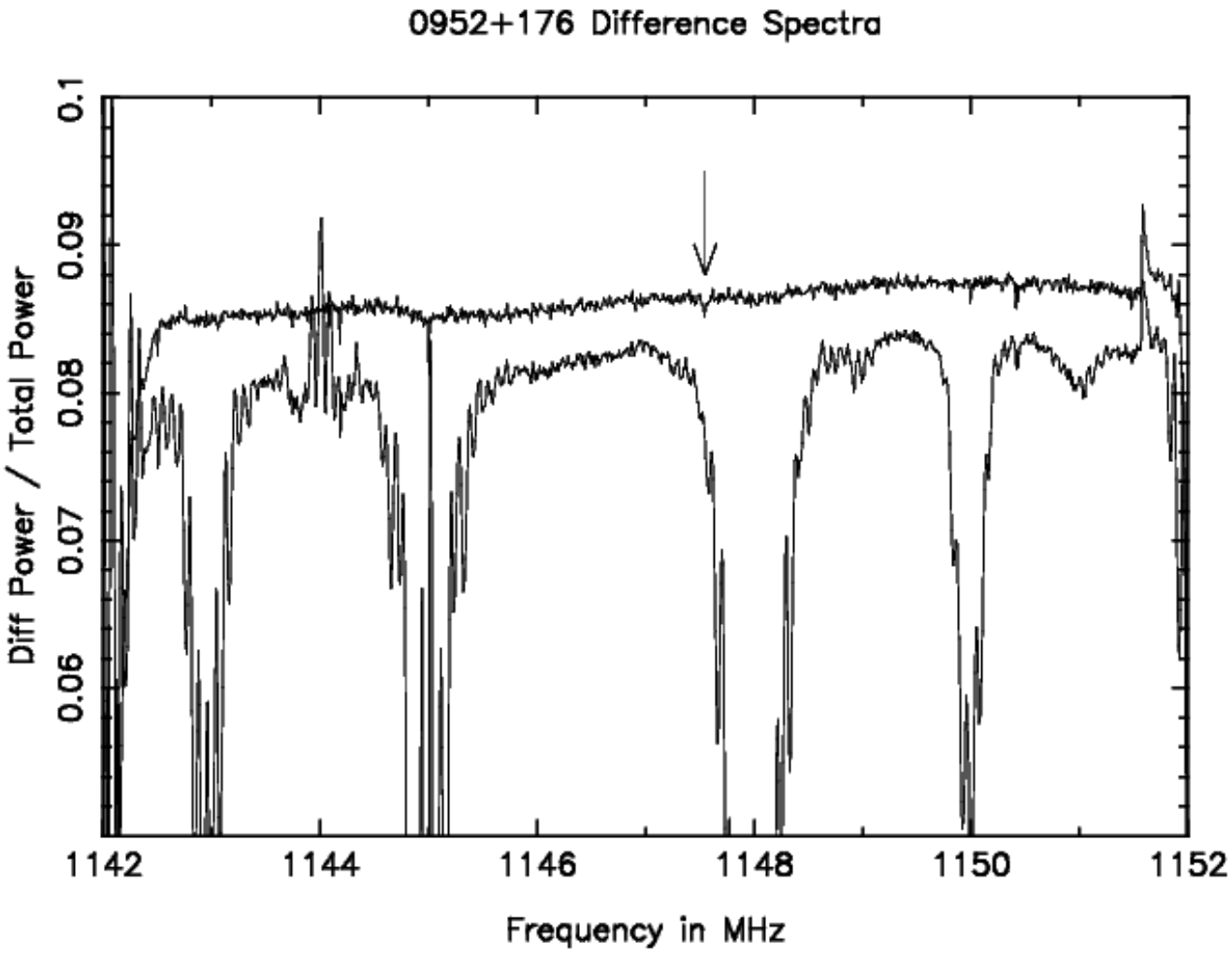

Echo Map
Distance North in kn.
0
50
−80
−60
−40
−20
0
20
40
60
80
Distance East in km

# Aircraft Distance Measuring Equipment

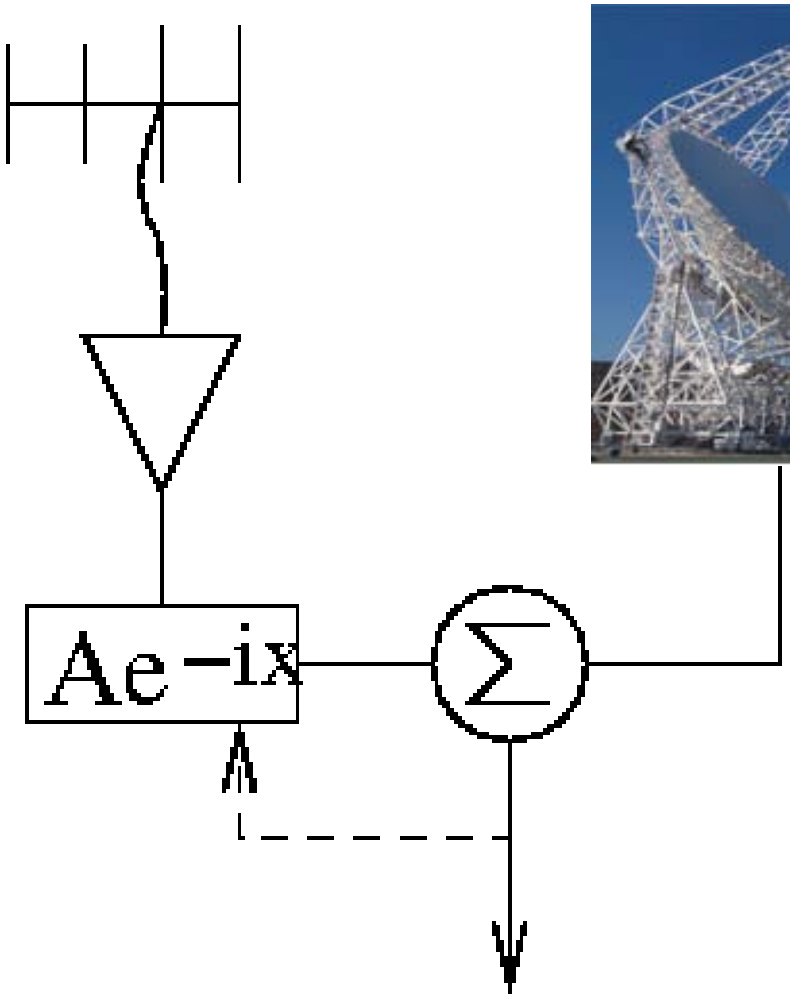


# DME pulse removal



# Adaptive Cancelling




# Adaptive Cancelling Challenges

- High interference-to-noise ratio in reference channel
  - Reference antenna gain, $G_{ref} \gg (T_{ref} / T_{GBT}) * G_{GBT\ sidelobes}$
- Rapid frequency dependence due to multi-path delays
  - $\Delta f \approx c / \Delta t$  50 μs → 20 kHz
- Radio astronomy suppression requirements ($T_{sys} * 10^{-4}$)
  - Signal-to-Noise Ratio (SNR) ≥ $10^{-4}$

# RFI Excision Successes

- Radar pulse blanker at Arecibo
- Adaptive cancellation of TV repeater at the ATNF
- Real-time frequency channel suppression within pulsar passband
- Off-line DME and Radar pulse blanking near redshifted OH lines on GBT

- Well-defined combination science objective and RFI problem
- Sustained long-term effort (science pay-off vs extra effort required)

# RFI suppression we get "for free"

- RFI coherence loss on longer interferometer baselines
- On-off differencing in single-dish total power observations
- Asynchronous RFI in pulsar observations