

Radio Frequency Interference

Detection, correction and excision.

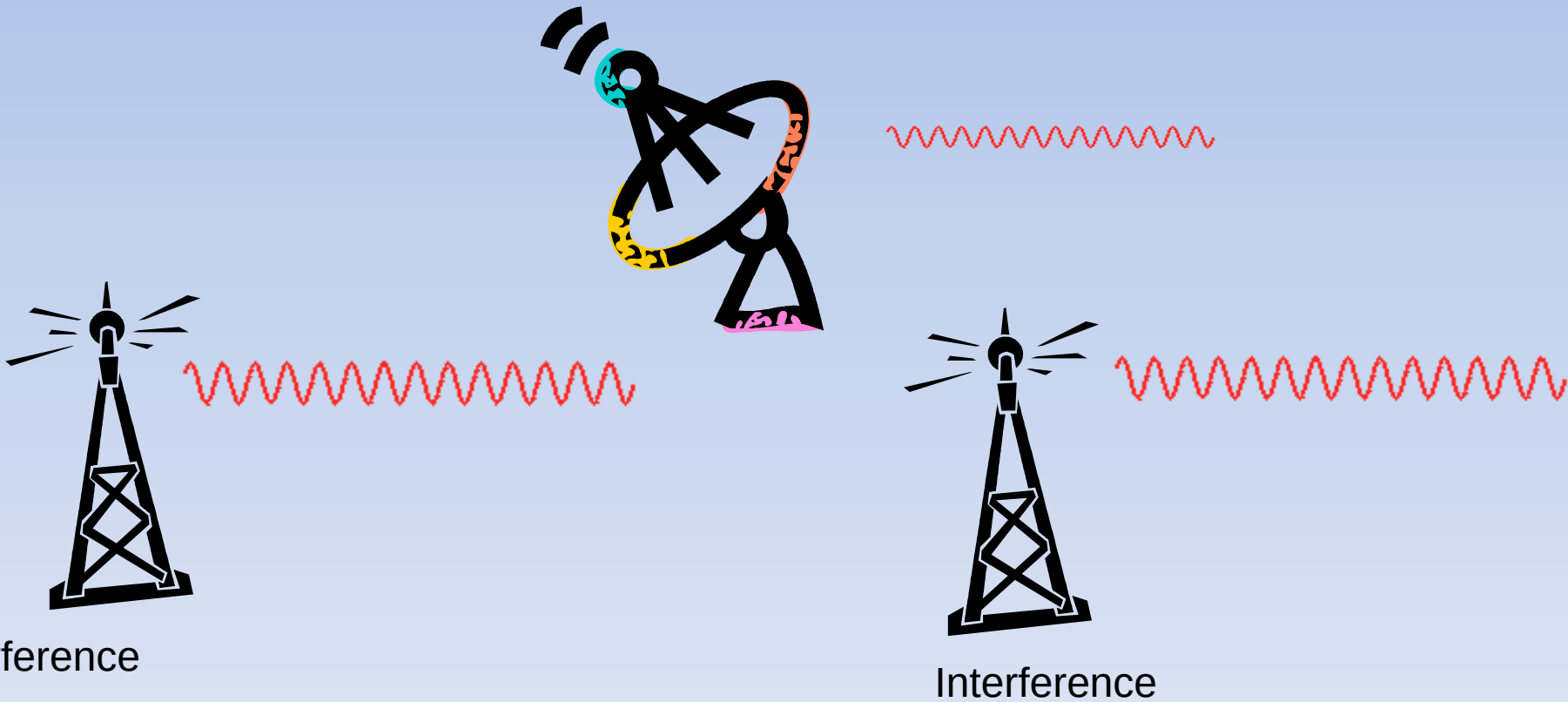
Jonathon Kocz

Swinburne University of Technology

RFI subtraction using a reference antenna.

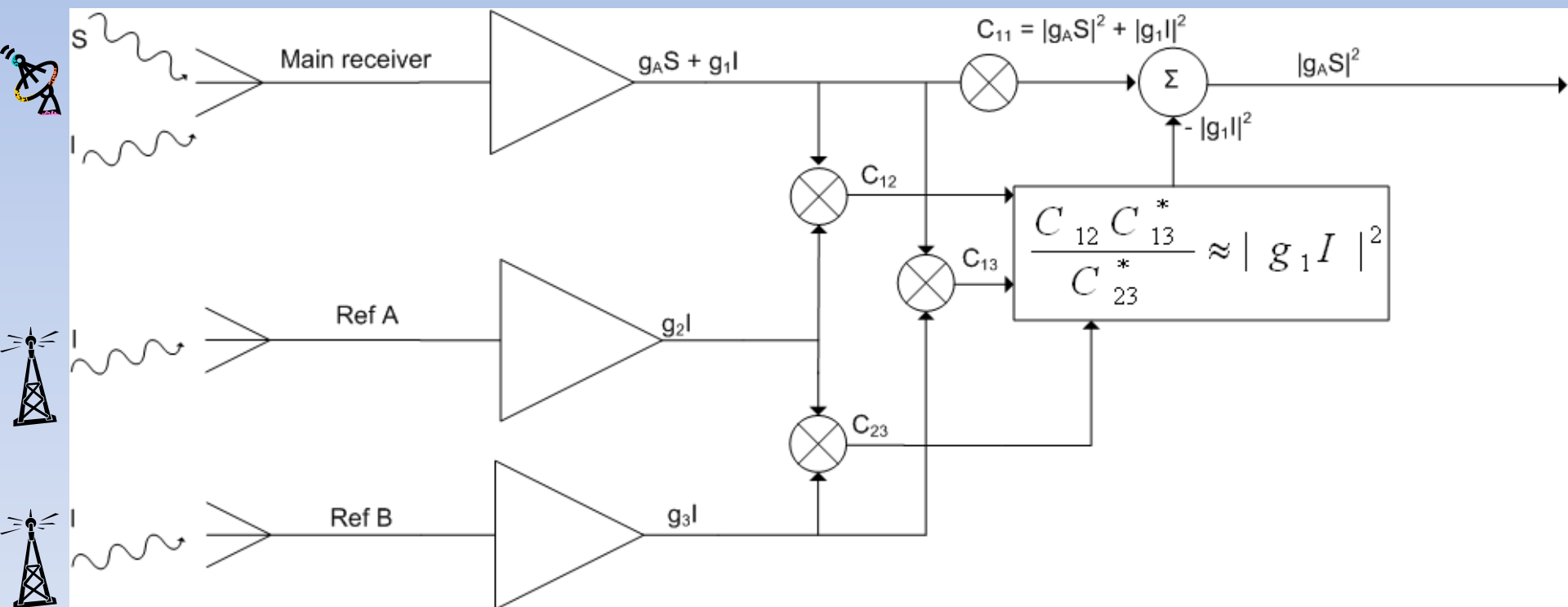
RFI Subtraction

Astronomy + Interference

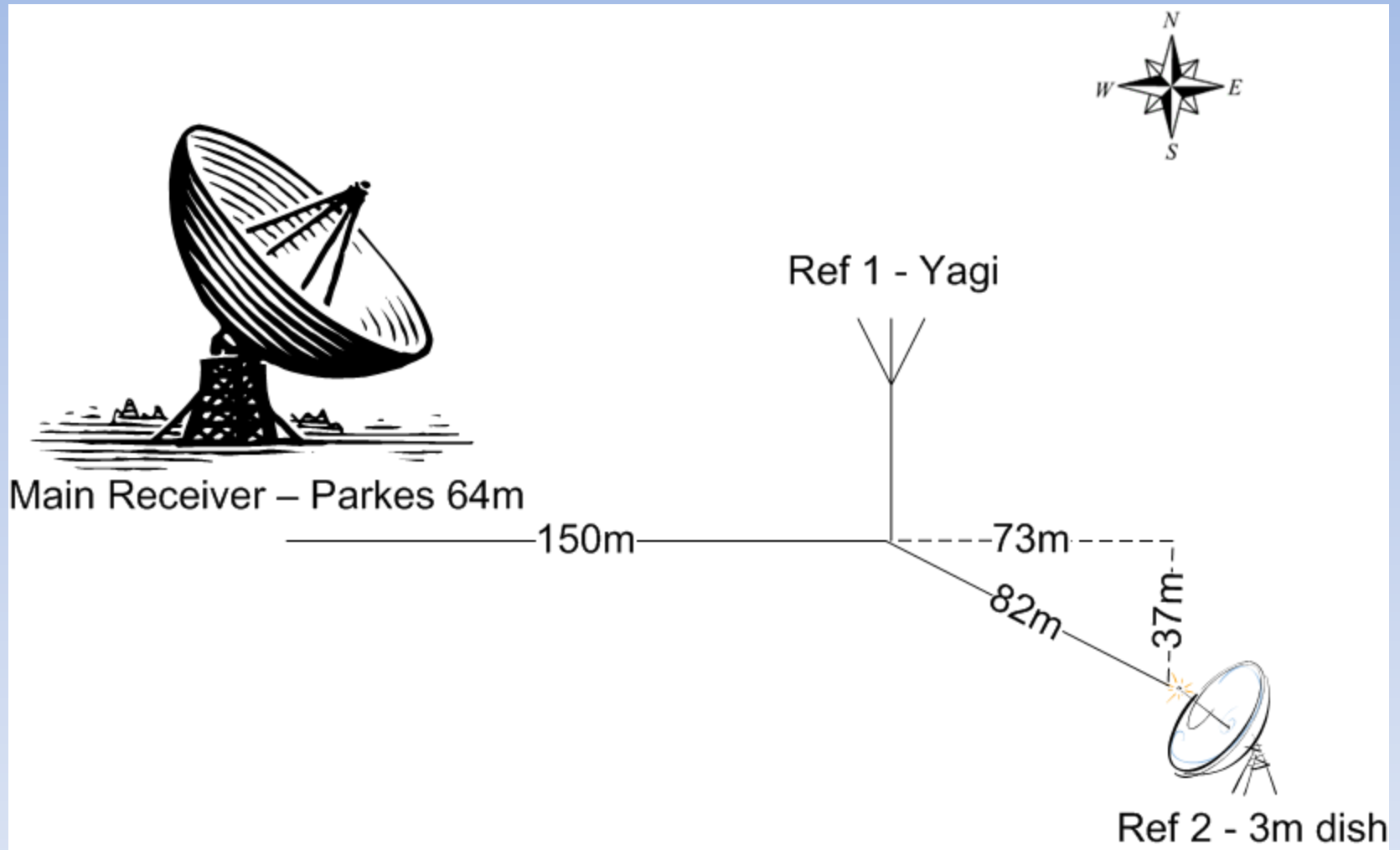


$$(\text{Astronomy} + \text{Interference}) - (\text{Interference}) = \text{Astronomy}$$

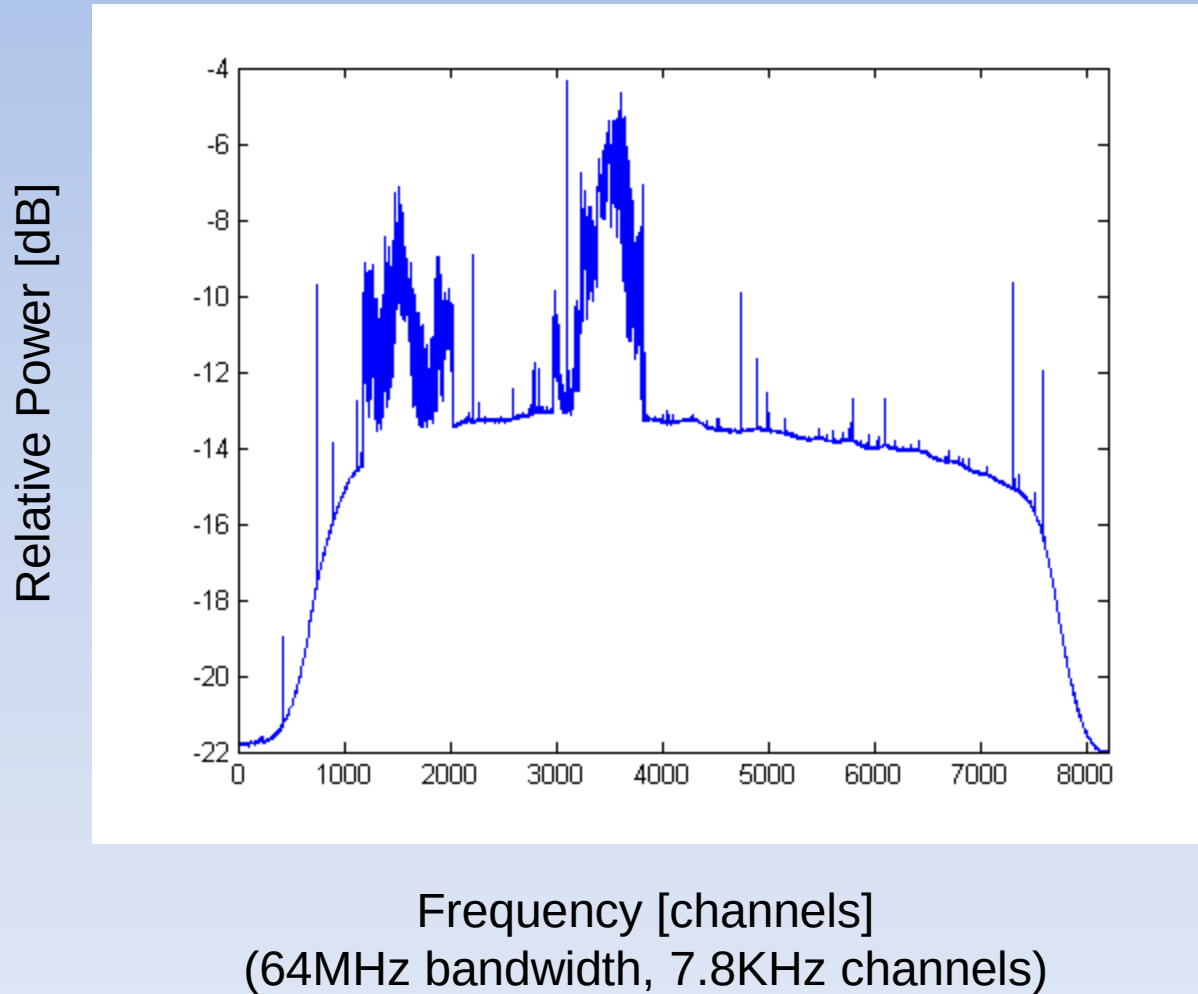
RFI Subtraction



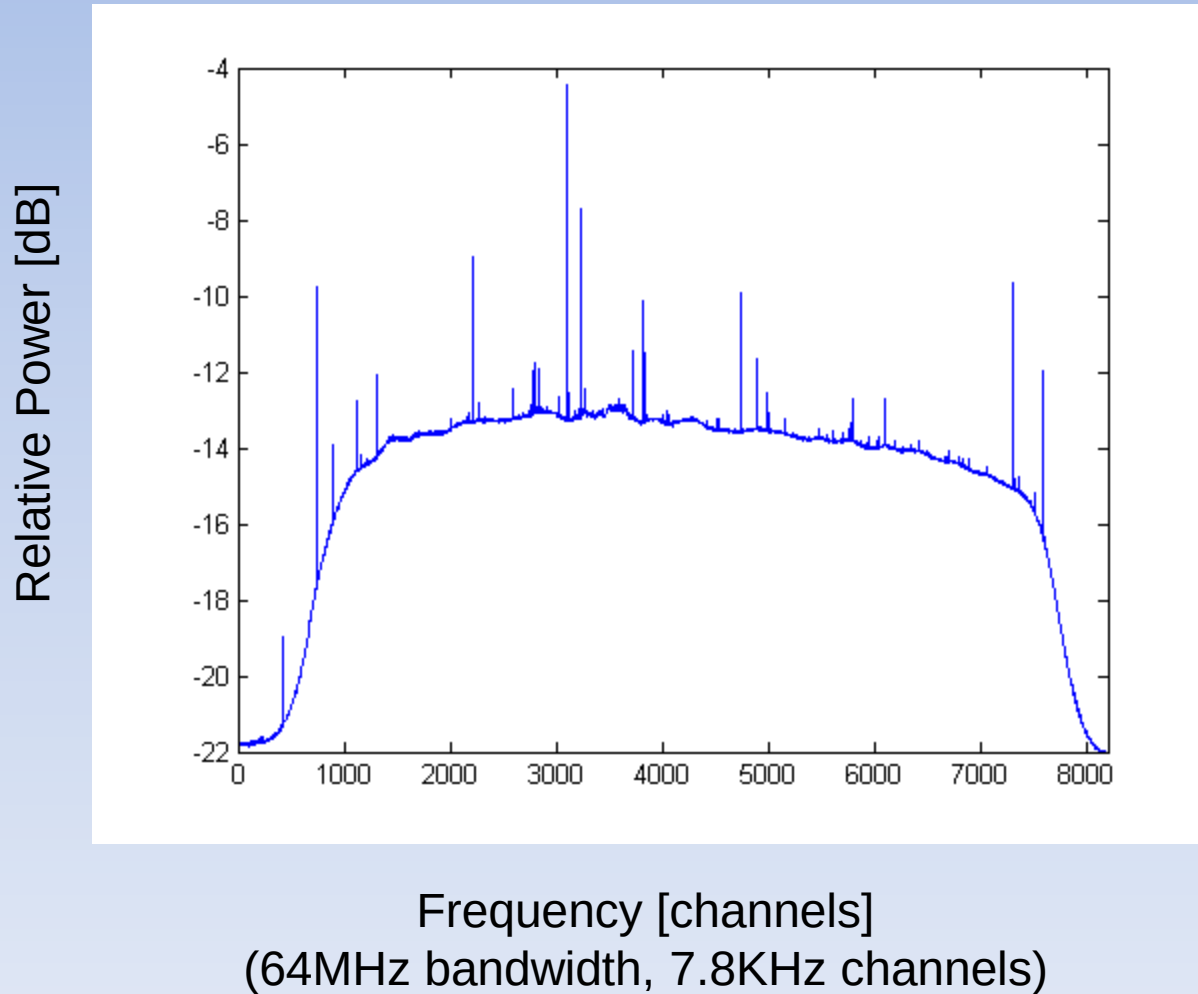
RFI Subtraction – Experimental Setup



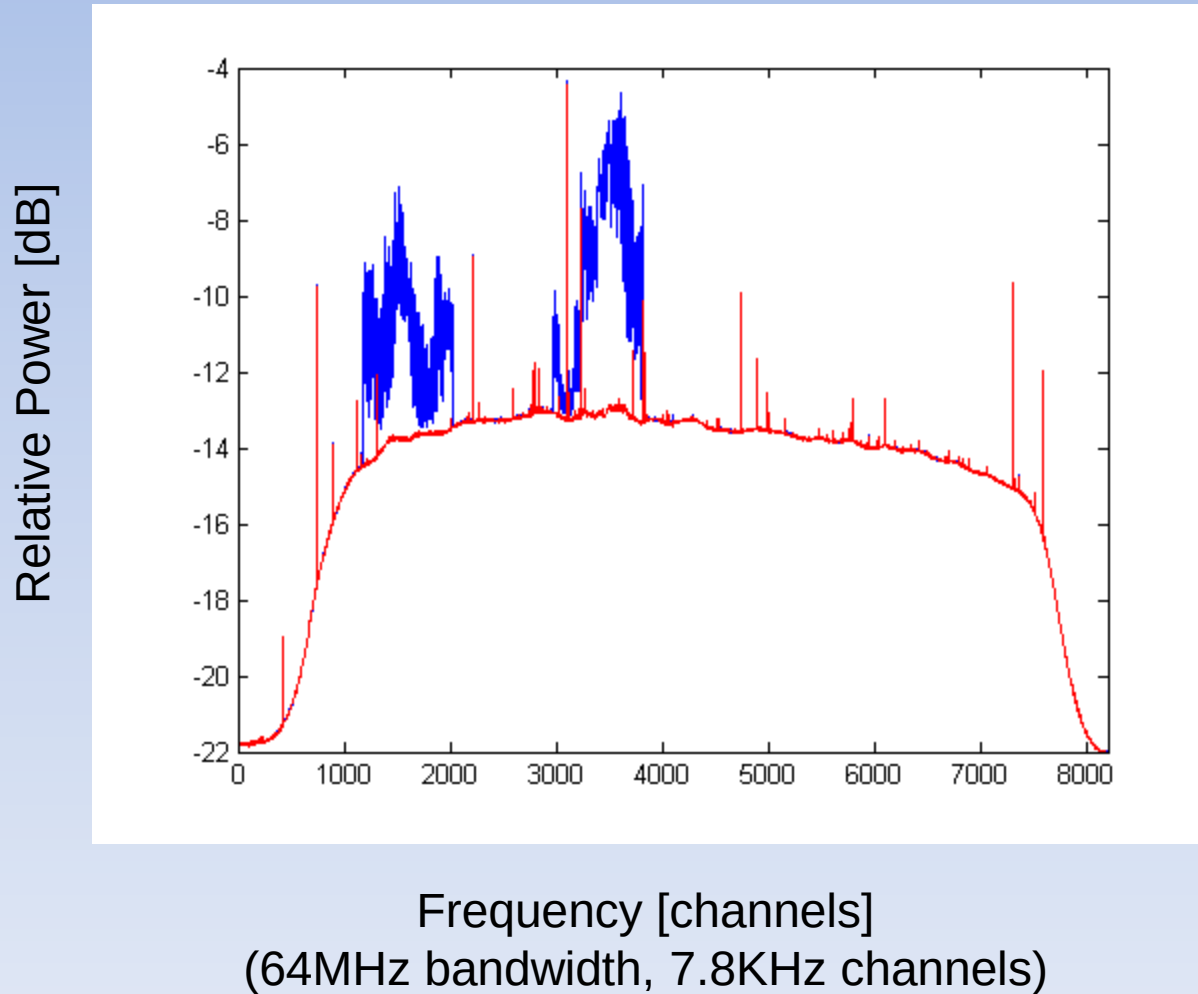
RFI Subtraction - Results



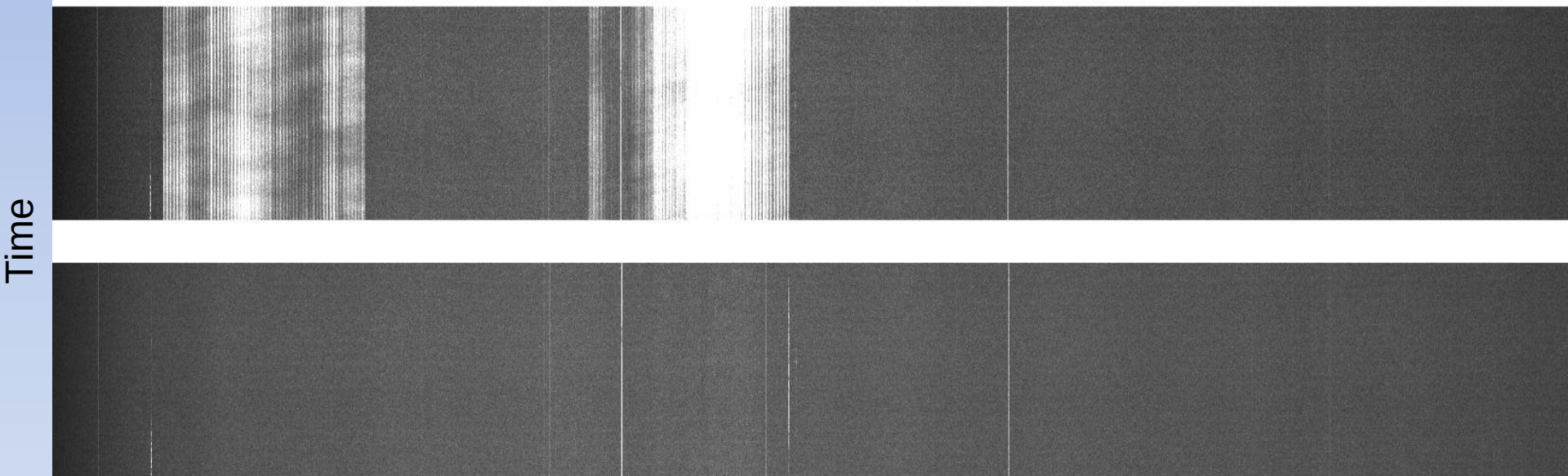
RFI Subtraction - Results



RFI Subtraction - Results



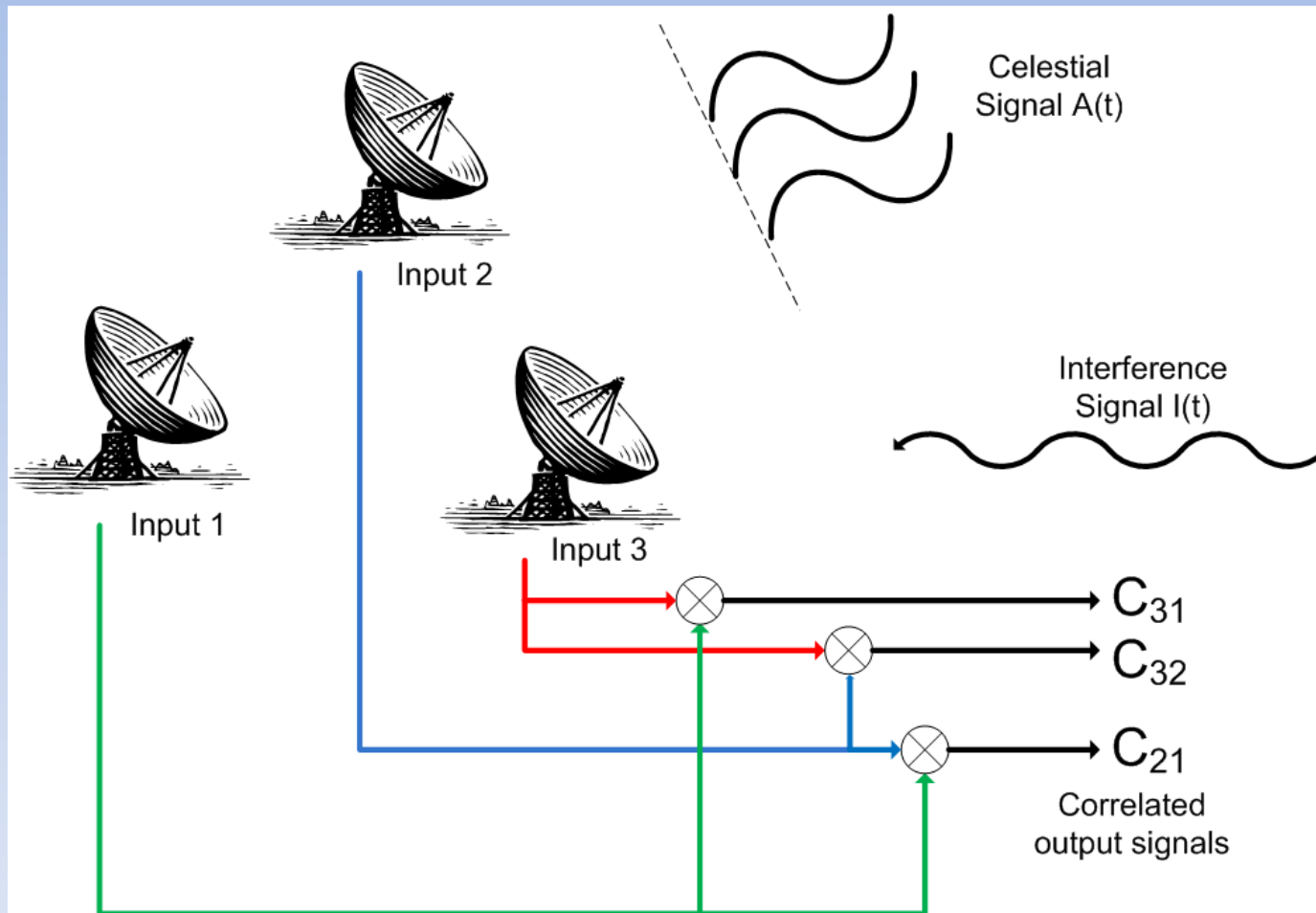
RFI Subtraction - Results



Frequency [channels]
(64MHz bandwidth, 7.8KHz channels)

Spatial Filtering with a multibeam receiver.

Spatial Filtering



Spatial Filtering

$$\begin{pmatrix} C_{11} & C_{12} & C_{13} \\ C_{21} & C_{22} & C_{23} \\ C_{31} & C_{32} & C_{33} \end{pmatrix}$$

Correlation Matrix



U

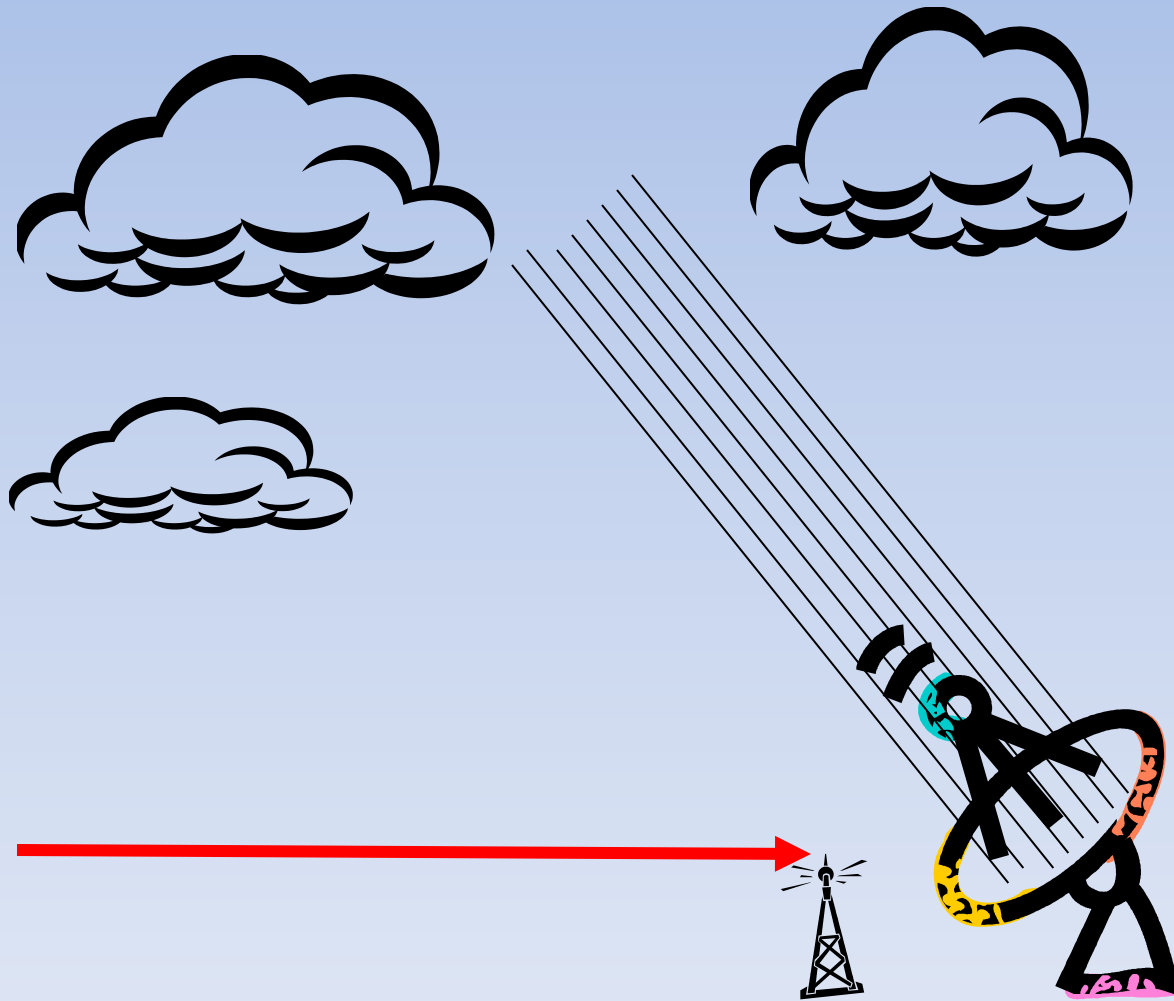
Eigenvector - Direction Matrix

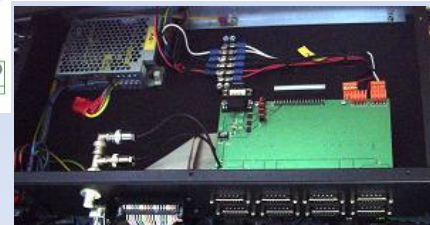
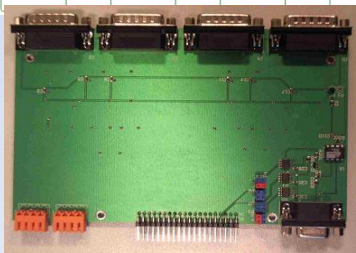
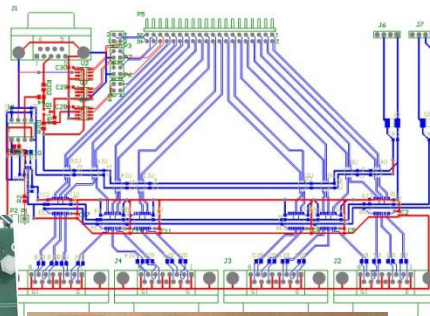
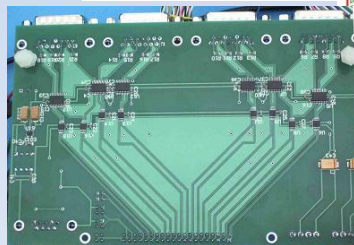
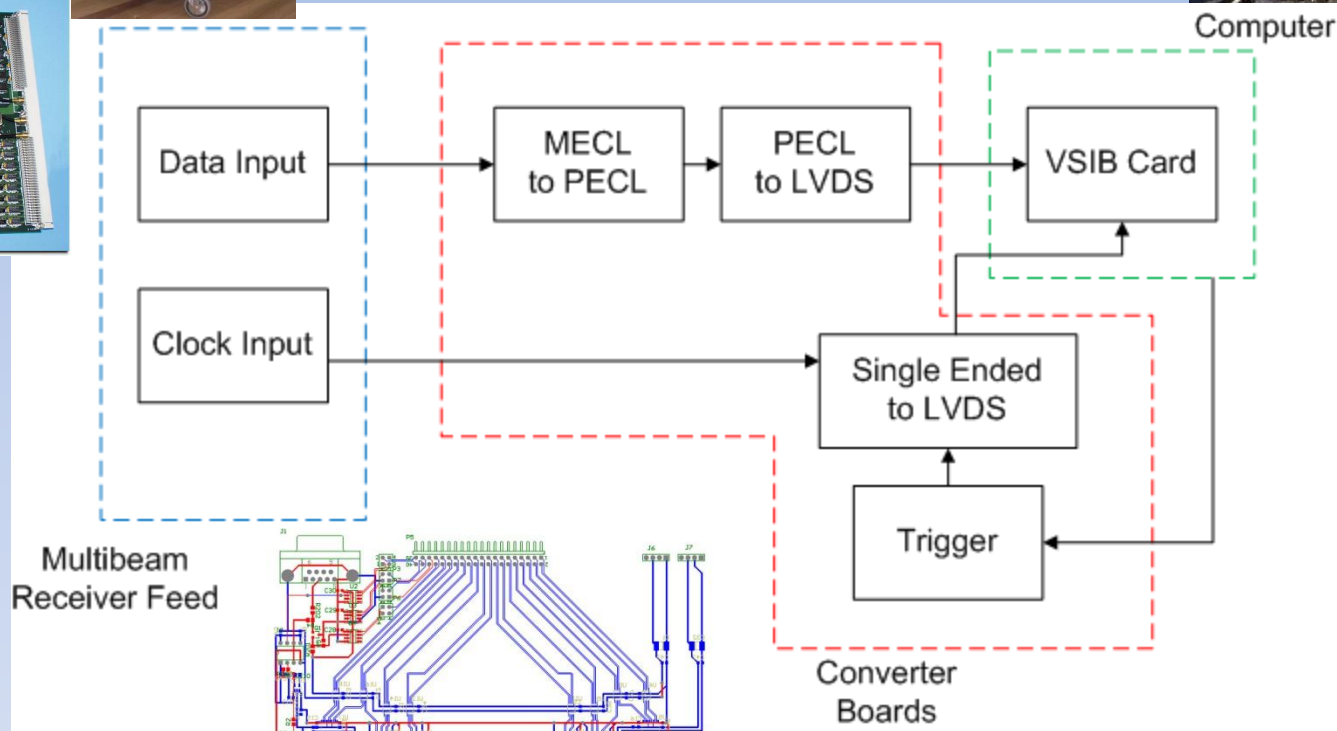


S

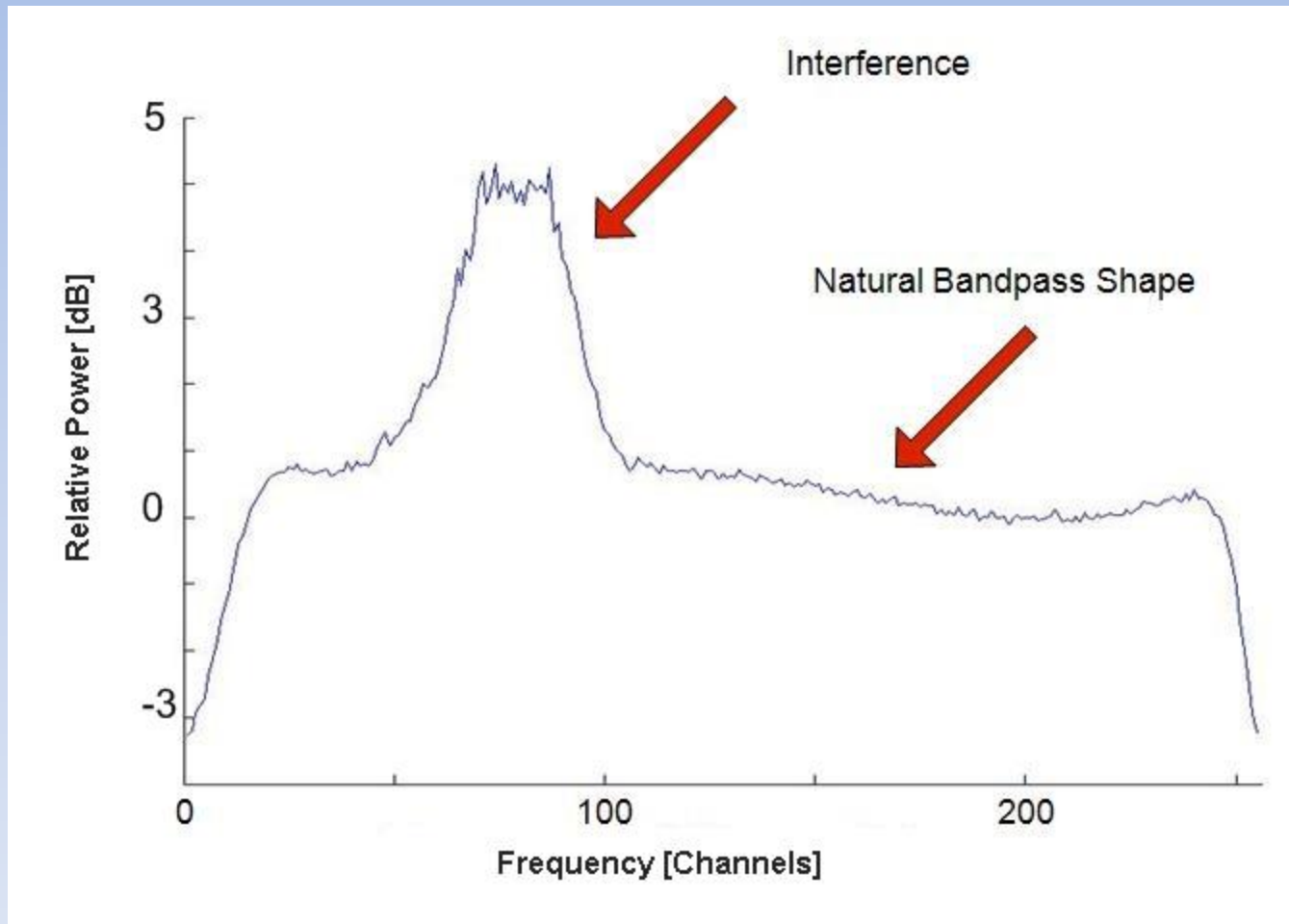
Eigenvalue - Power Matrix

Parkes Multibeam Experiment

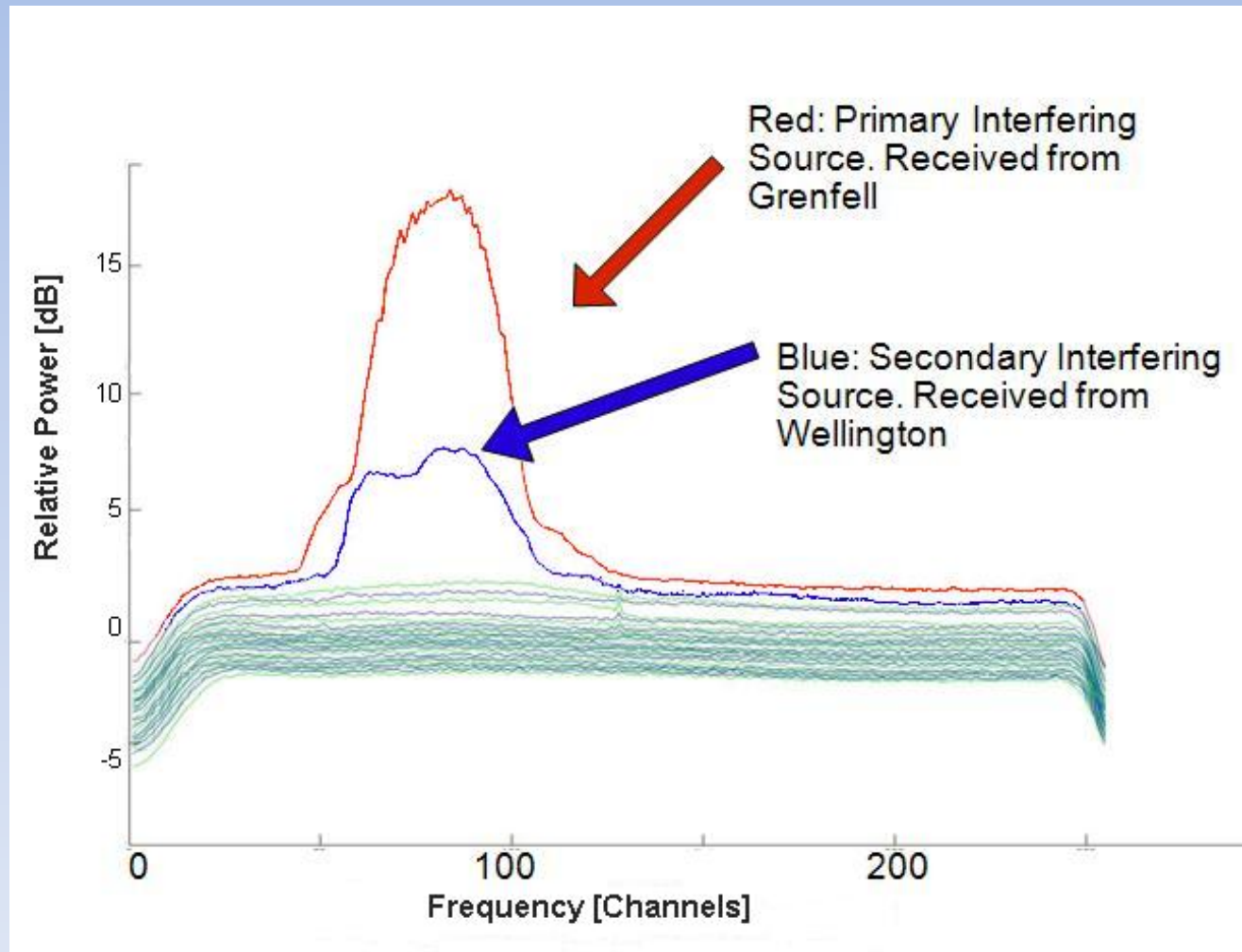




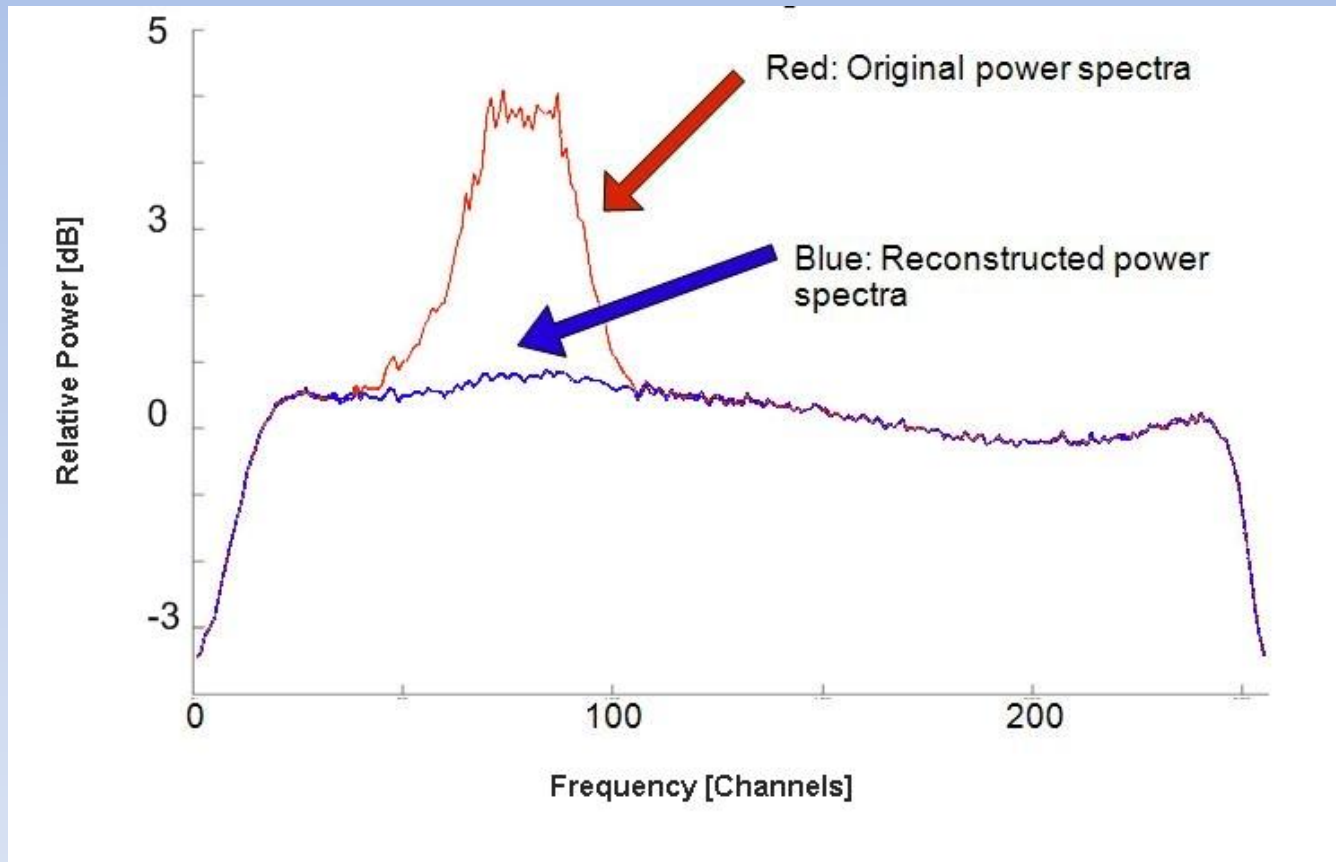
Results



Results

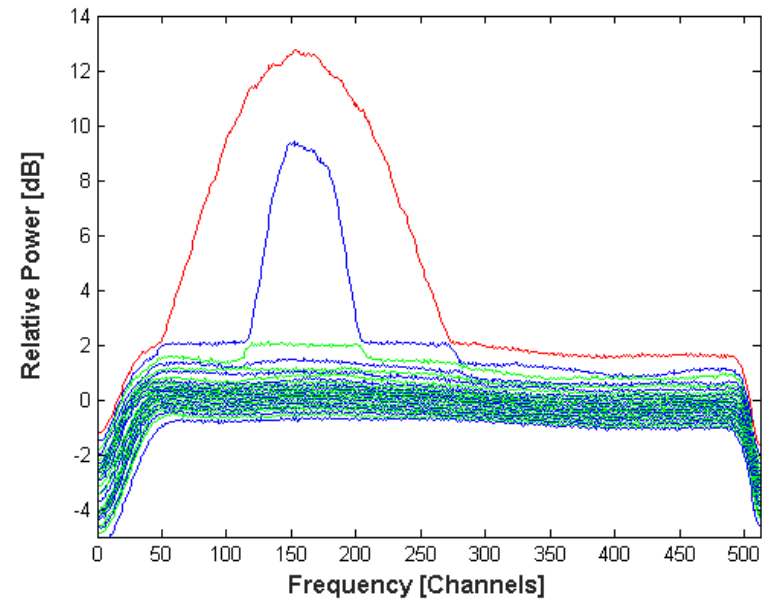
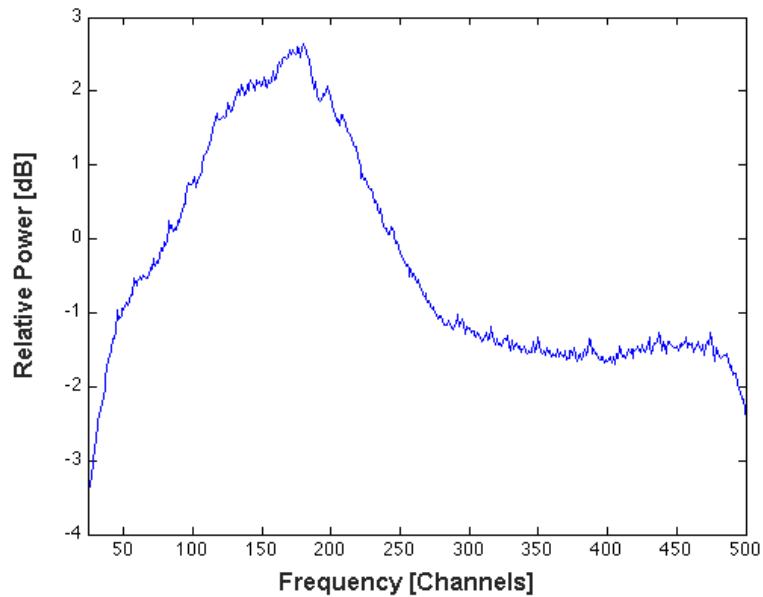


Results



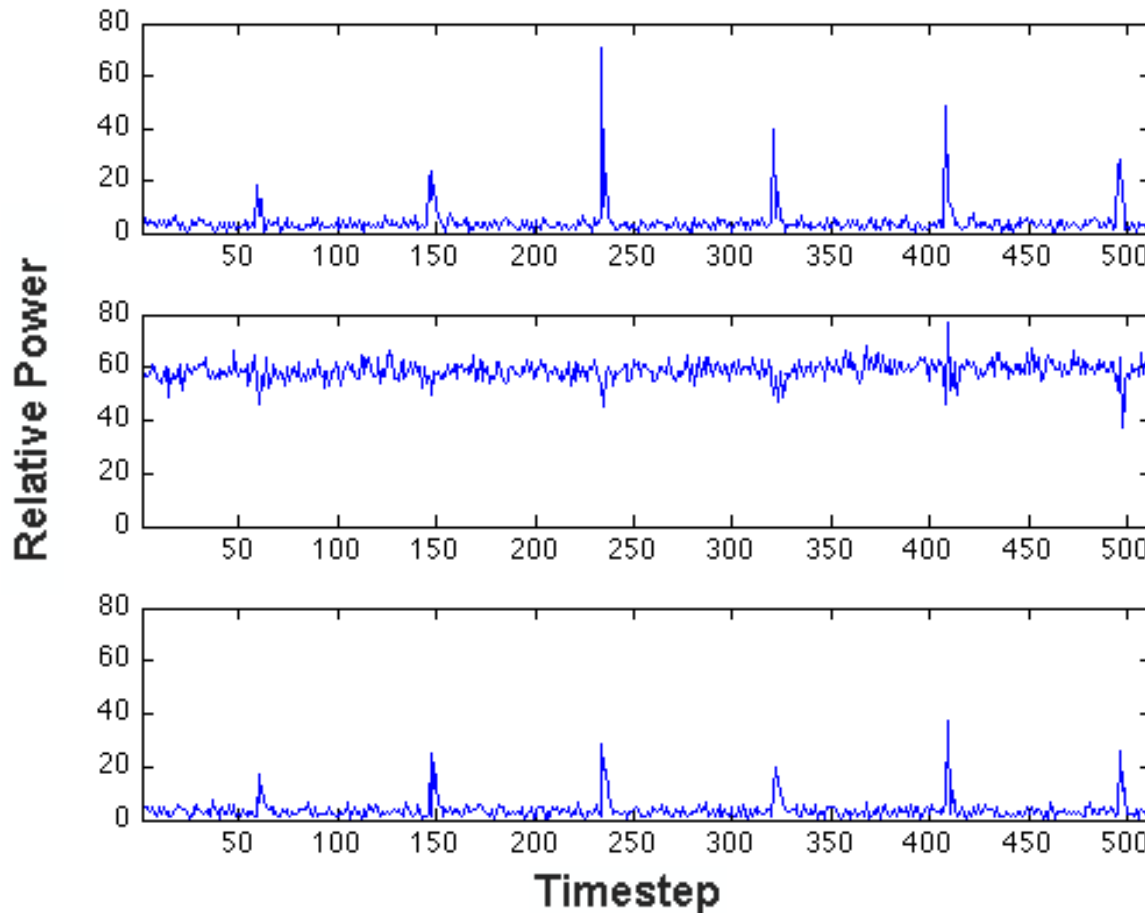
8MHz bandwidth, 32kHz channels

Vela



8MHz bandwidth, 16kHz channels

Vela



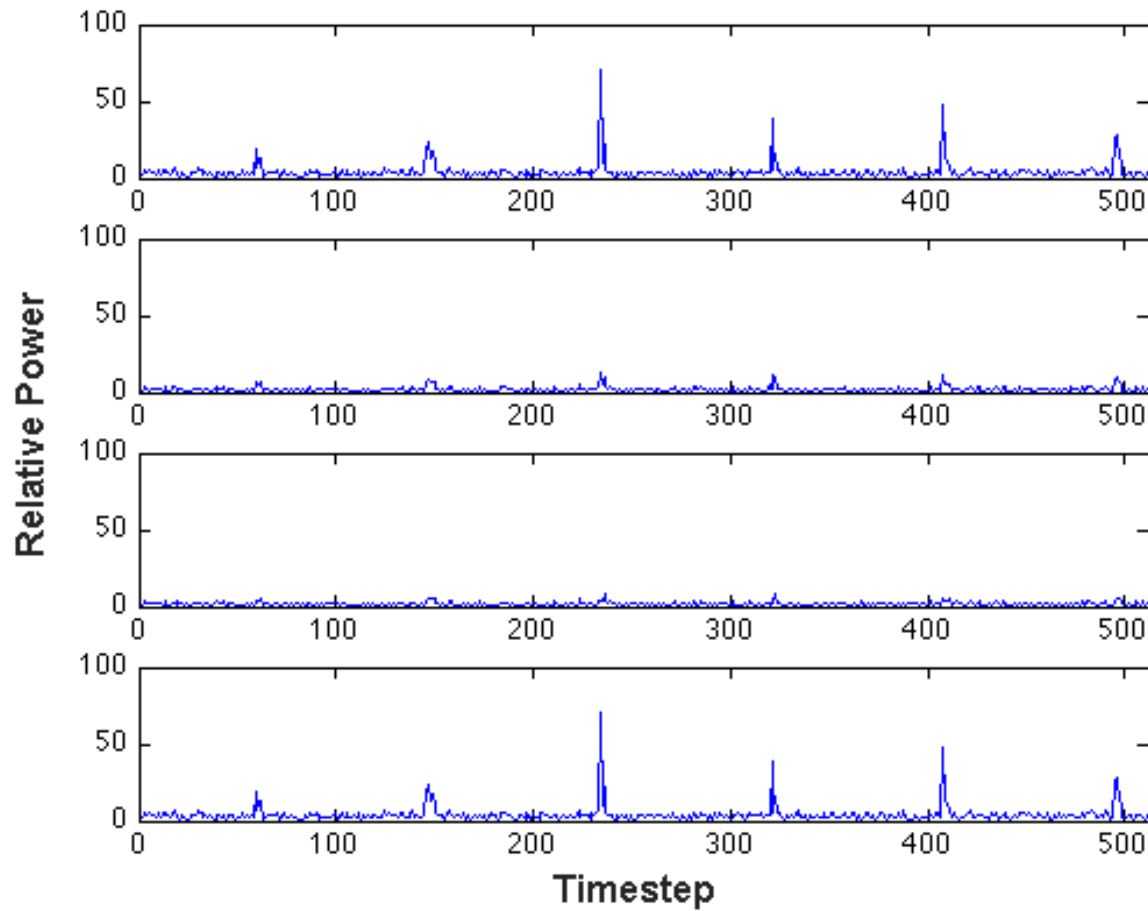
← Interference Free
(SNR: 28.91)

← Before Subtraction

← After Subtraction
(SNR: 16.54)

(One timestep = 1ms)

Risks!

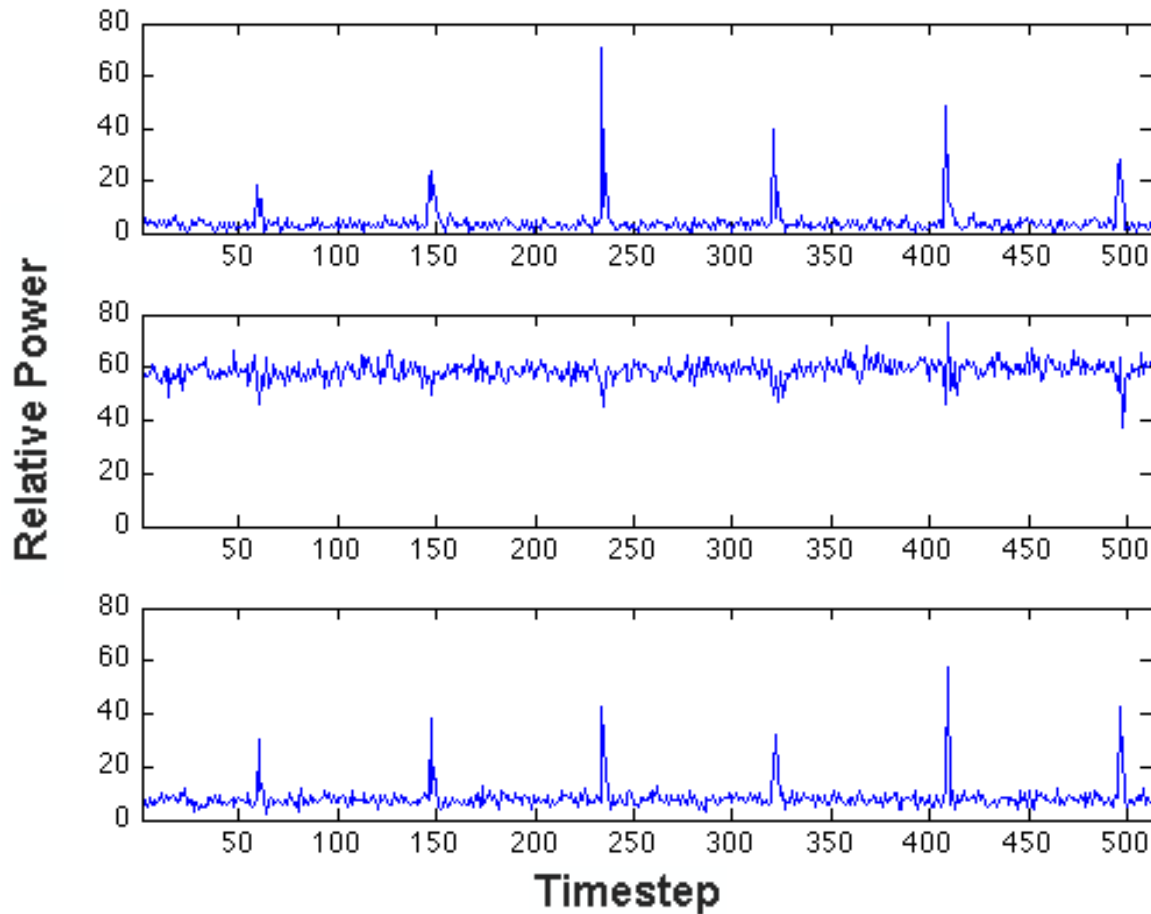


Interference Free
(SNR: 28.91)

Interference free,
after subtraction

(One timestep = 1ms)

Vela



← Interference Free
(SNR: 28.91)

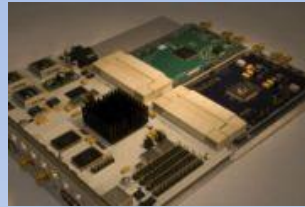
← Before Subtraction

← After Subtraction
(SNR: 20.86)

(One timestep = 1ms)

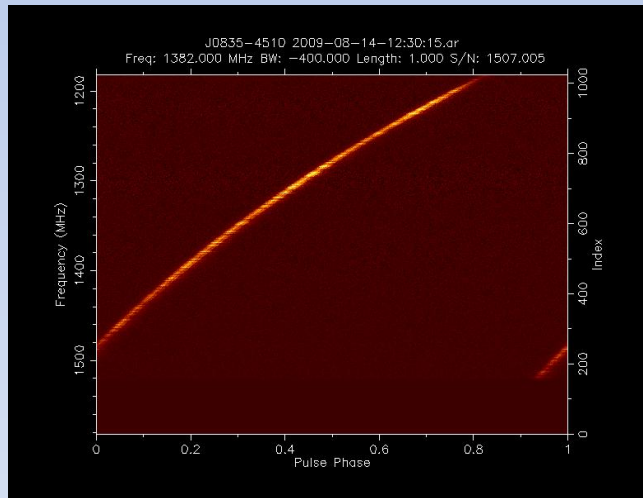
Excision – Automated blanking

Berkeley Parkes Swinburne Recorder (BPSR)



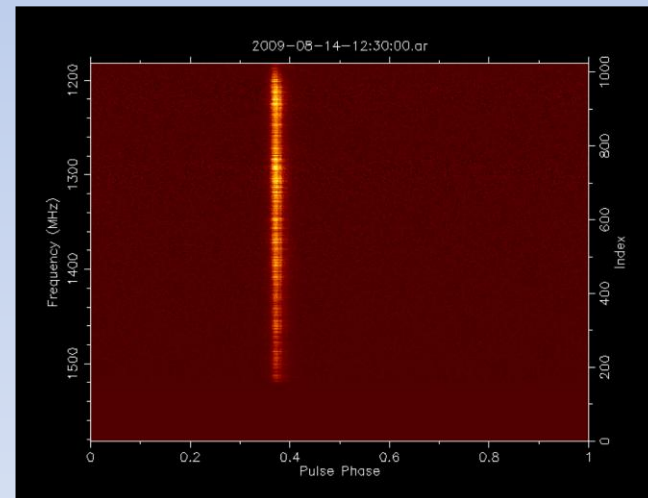
8-bit, 64us time series data from 13 beams

Frequency (MHz)

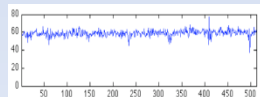


Pulse Phase

Frequency (MHz)

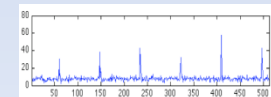


Pulse Phase



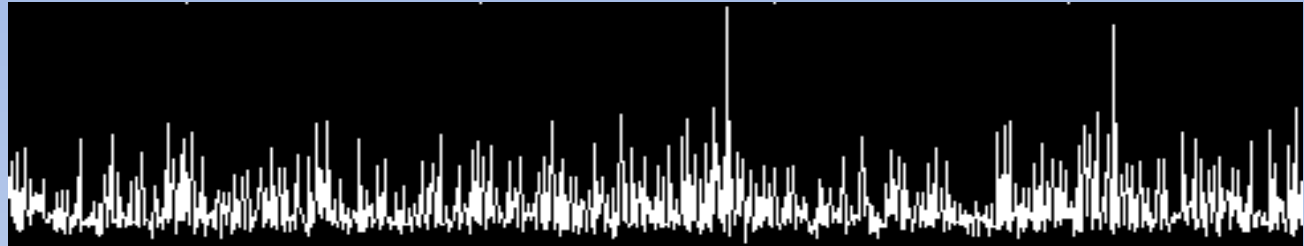
$$\begin{pmatrix} a & b & c & d \\ e & f & g & h \\ i & j & k & l \\ m & n & o & p \end{pmatrix}$$

$$USV^T$$

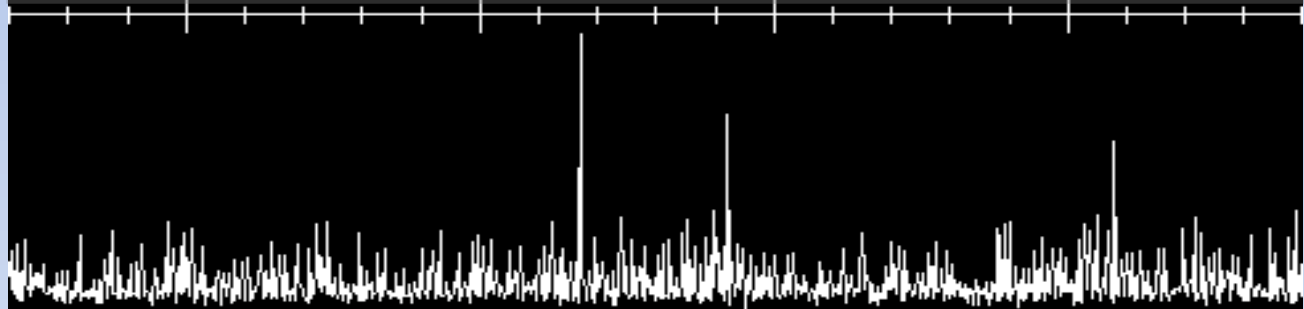


J0410-3107

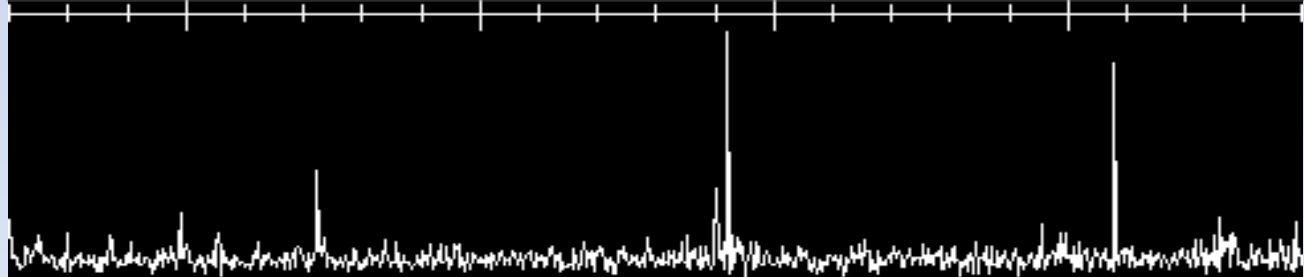
Current System →



Original Data →

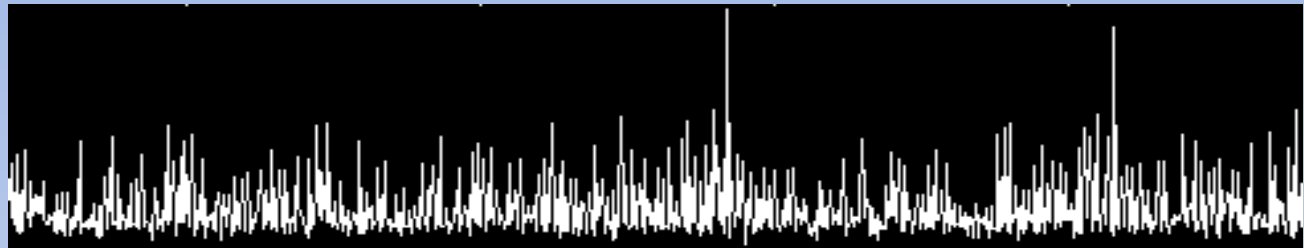


SVD Detection →

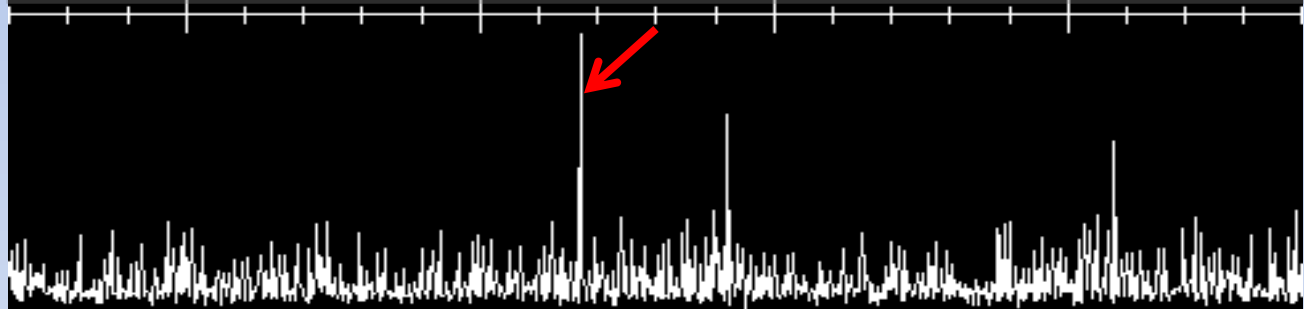


J0410-3107

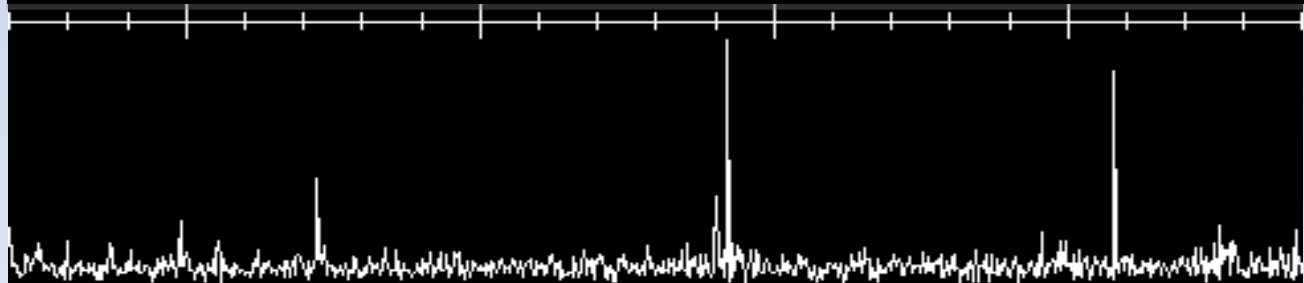
Current System →



Original Data →



SVD Detection →



J0410-3107 – Result Measures

1. Number of spurious RFI pulses:

- Original: 18 RFI candidates
- Current: 18 RFI candidates
- SVD: 0 RFI candidates

2. Number candidate pulses:

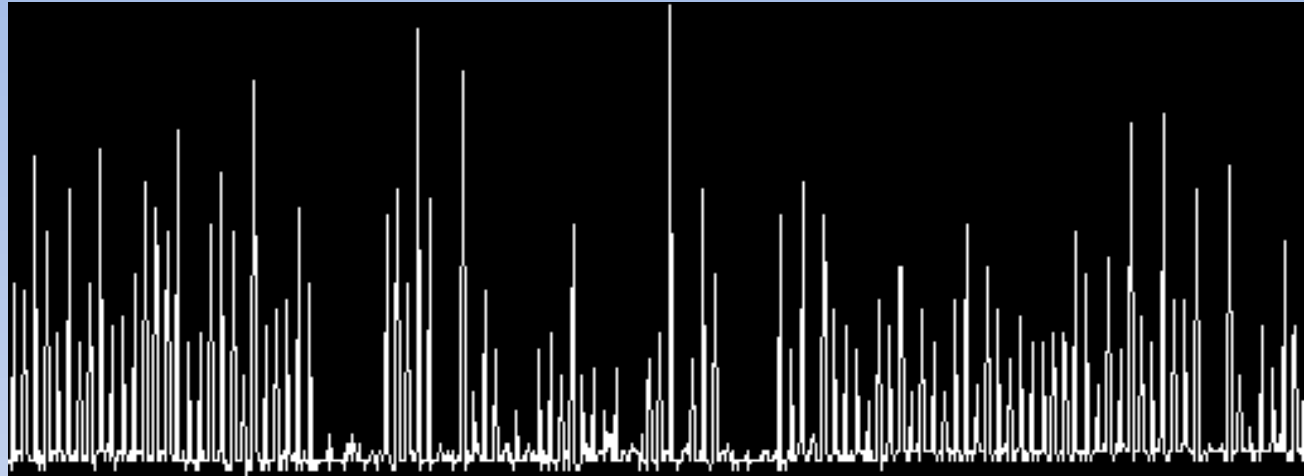
- 9 candidate pulses were found in each case

3. SNR candidate pulses:

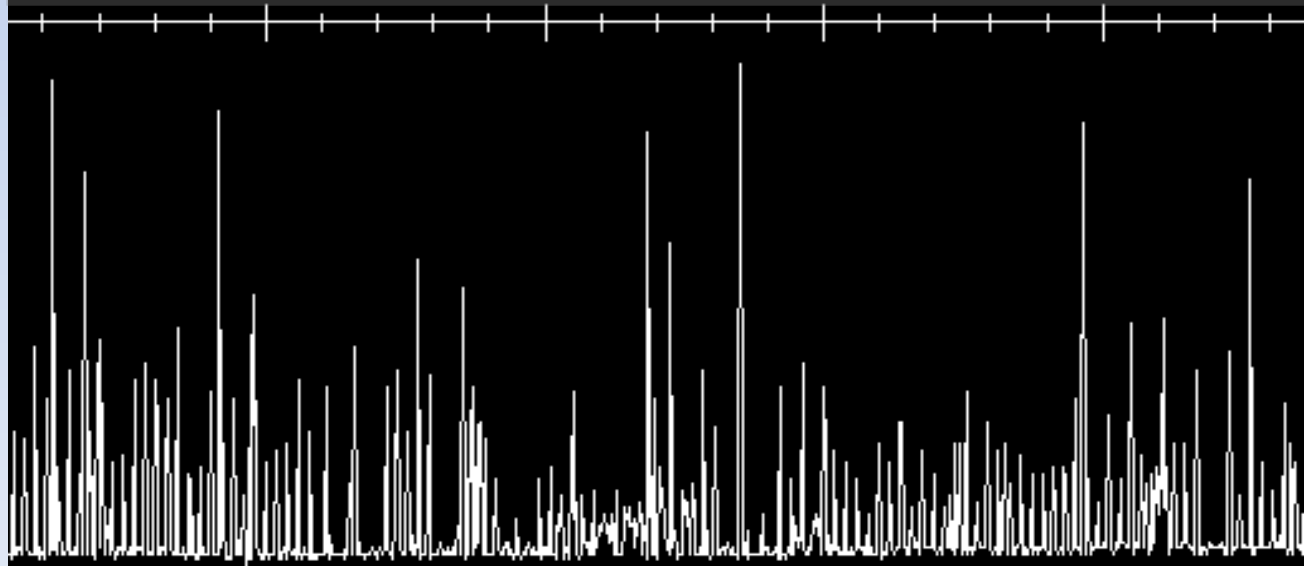
- Original: 26.33
- Current: 25.67 (clipped the highest pulses)
- SVD: 26.607

J2048-1616

SVD Detection →

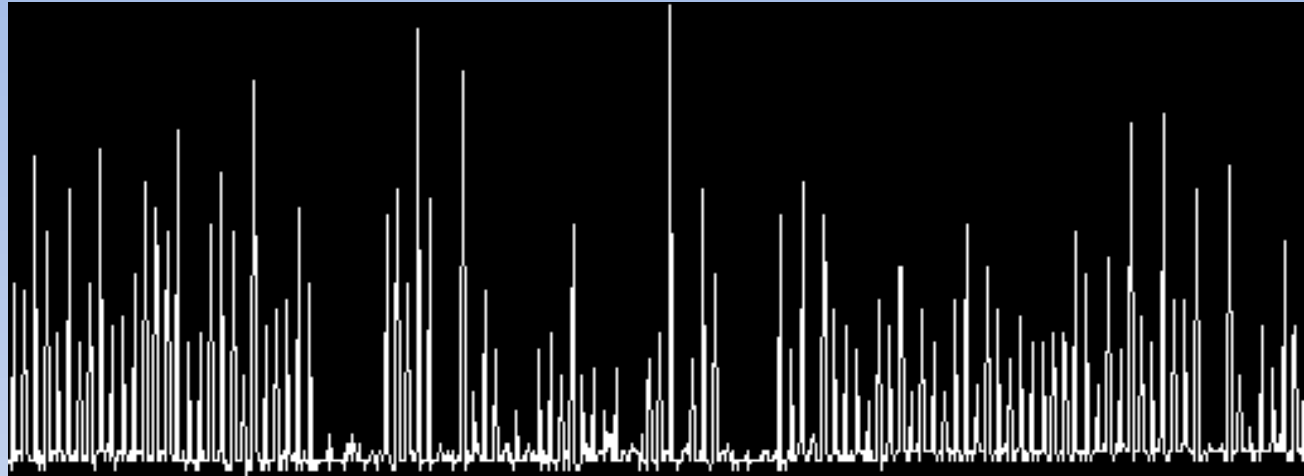


Original Data →

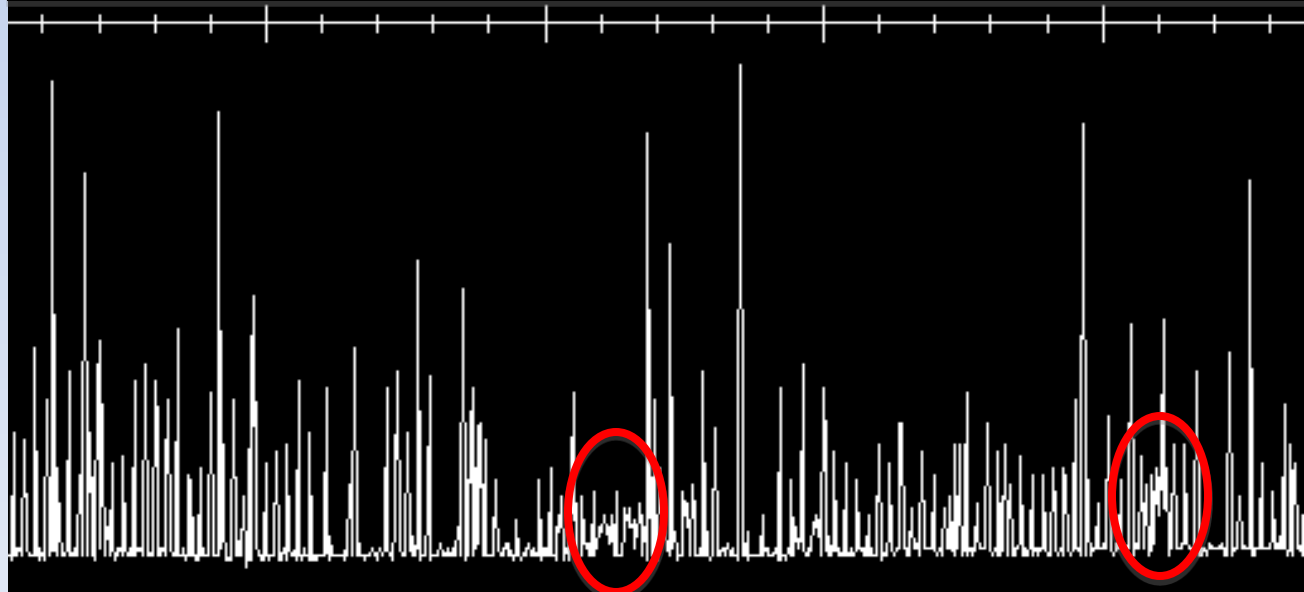


J2048-1616

SVD Detection →

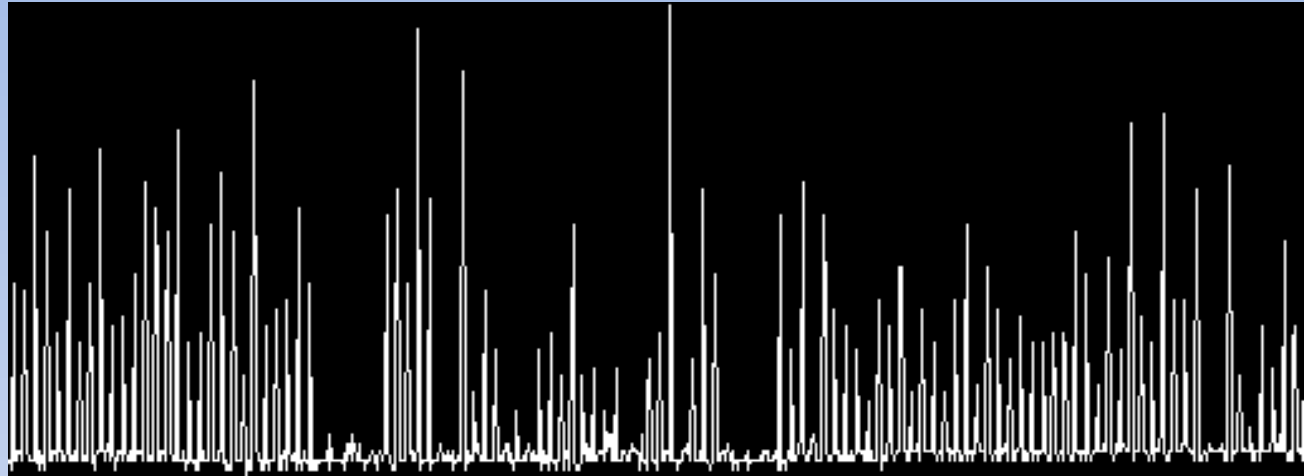


Original Data →

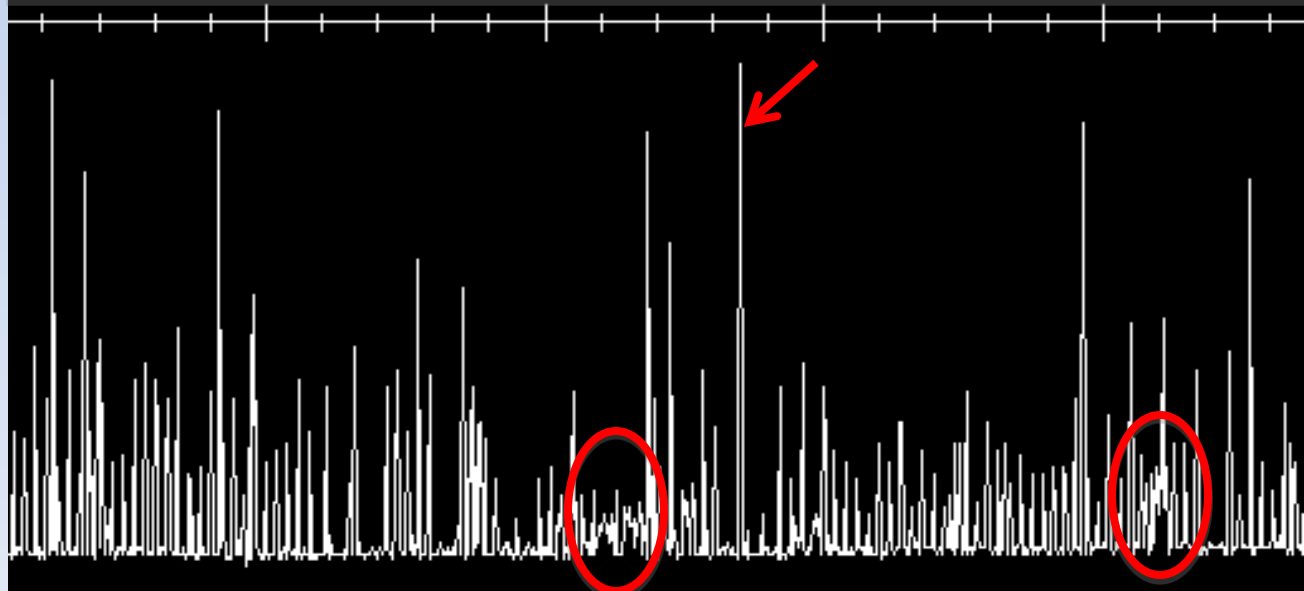


J2048-1616

SVD Detection →

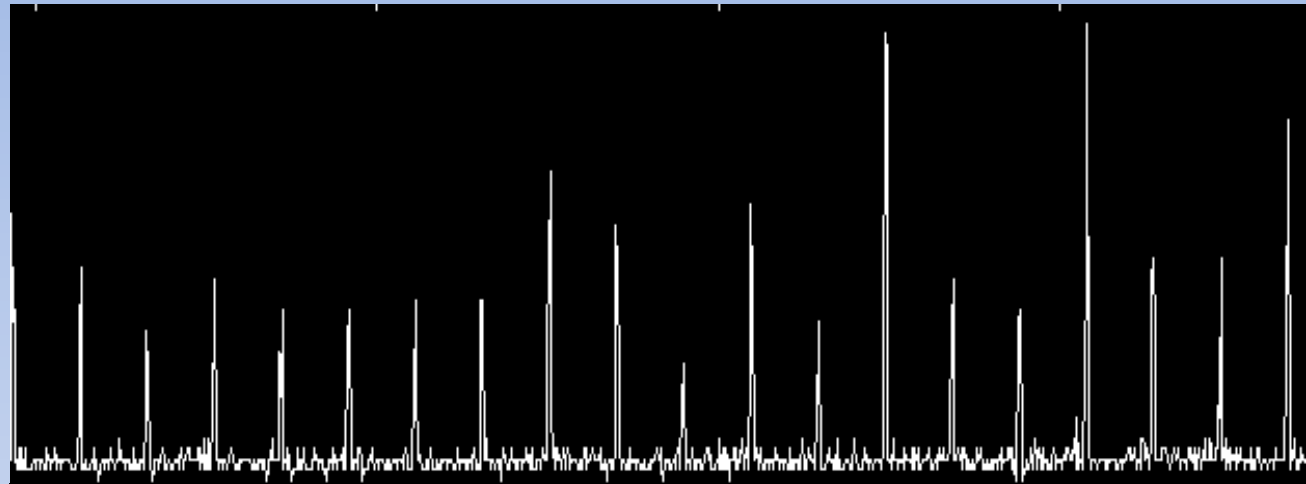


Original Data →

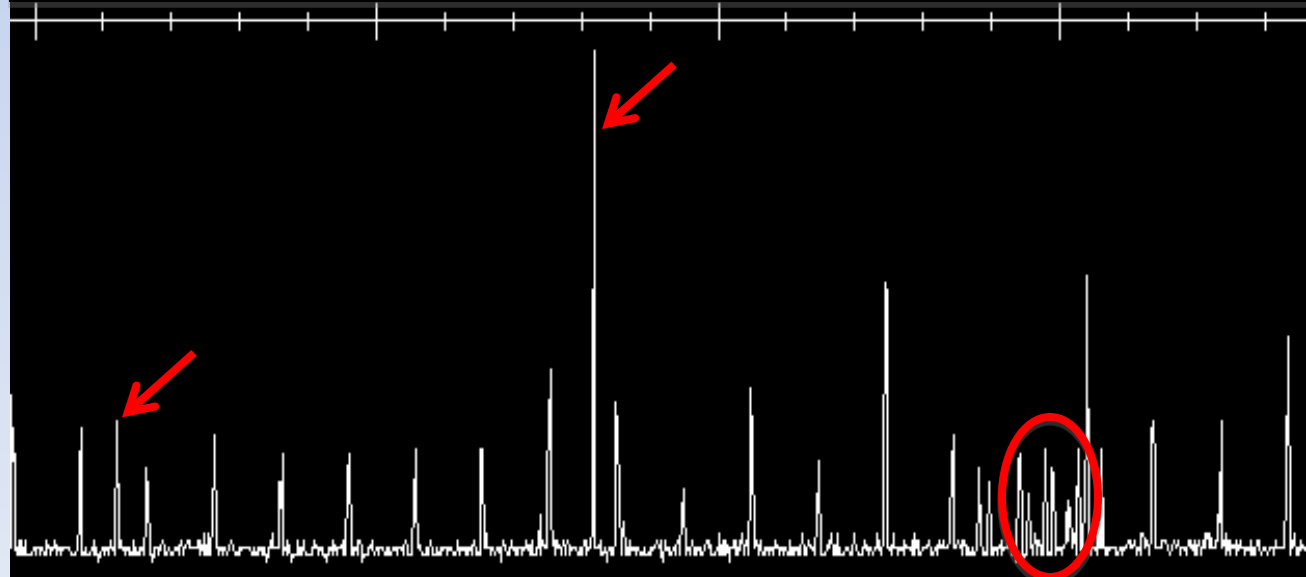


J2048-1616

SVD Detection →



Original Data →



Conclusions

- Reference antennas work beautifully for post-correlation data.
- Spatial filtering with a multibeam receiver is highly effective. - SNR recovered to 70% of the interference free case.
- Correlation and decomposition techniques work nicely for more accurately determining the presence of RFI.