Radio Frequency Interference

Detection, correction and excision.

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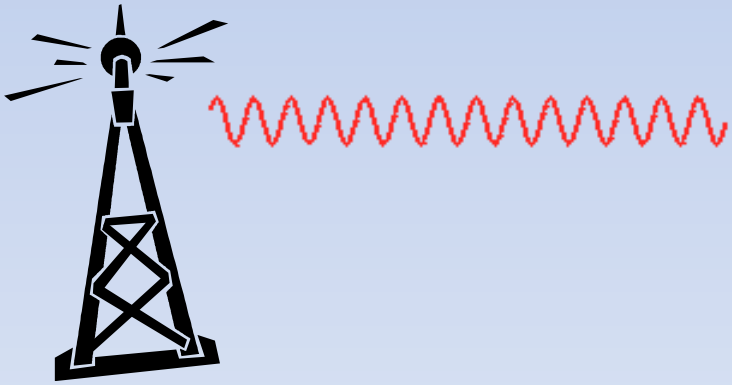
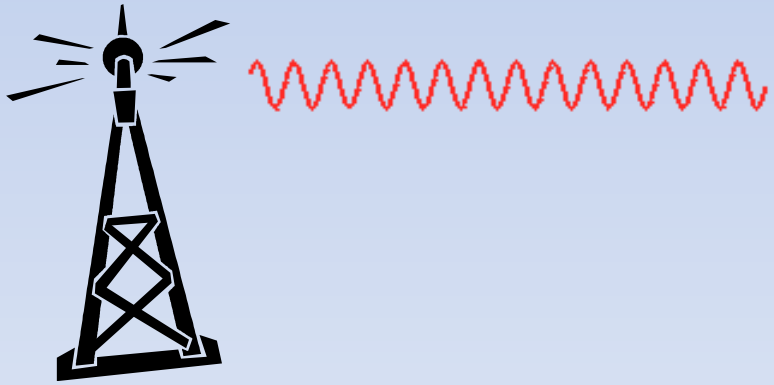
SWINBURNE UNIVERSITY OF TECHNOLOGY

RFI subtraction using a reference antenna.

RFI Subtraction

Astronomy + Interference



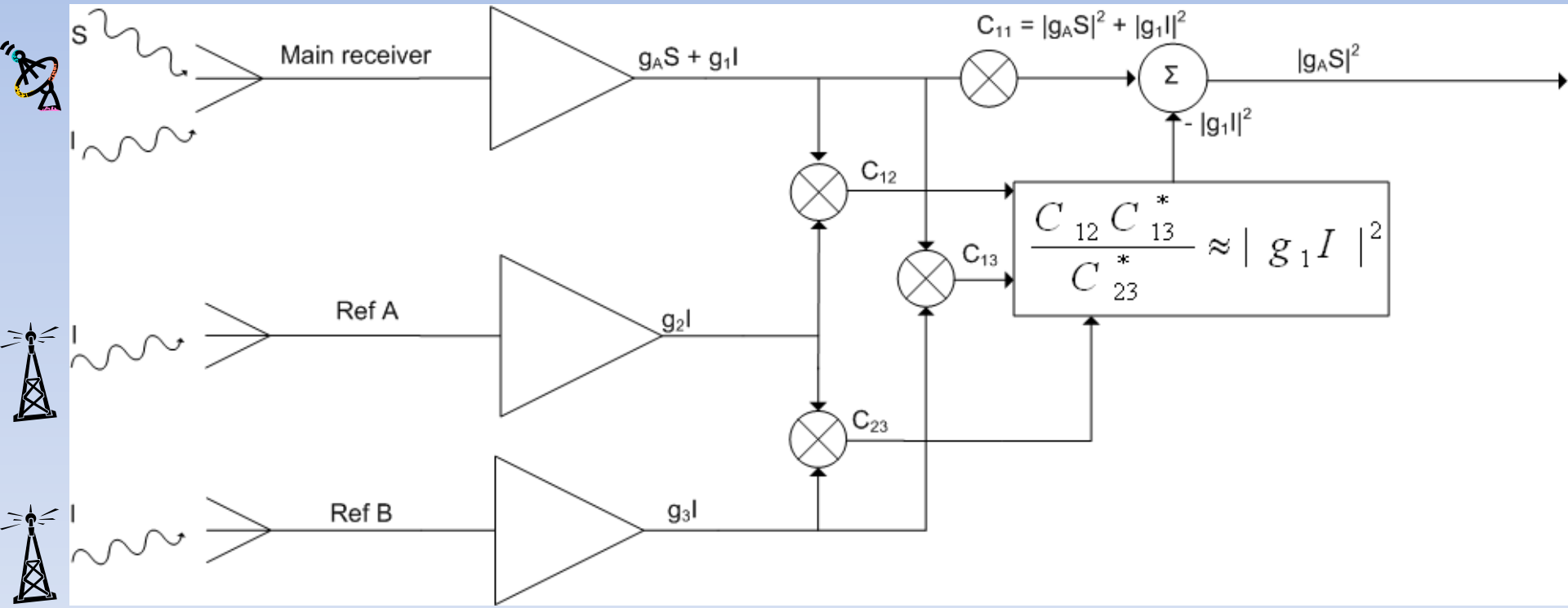


Interference

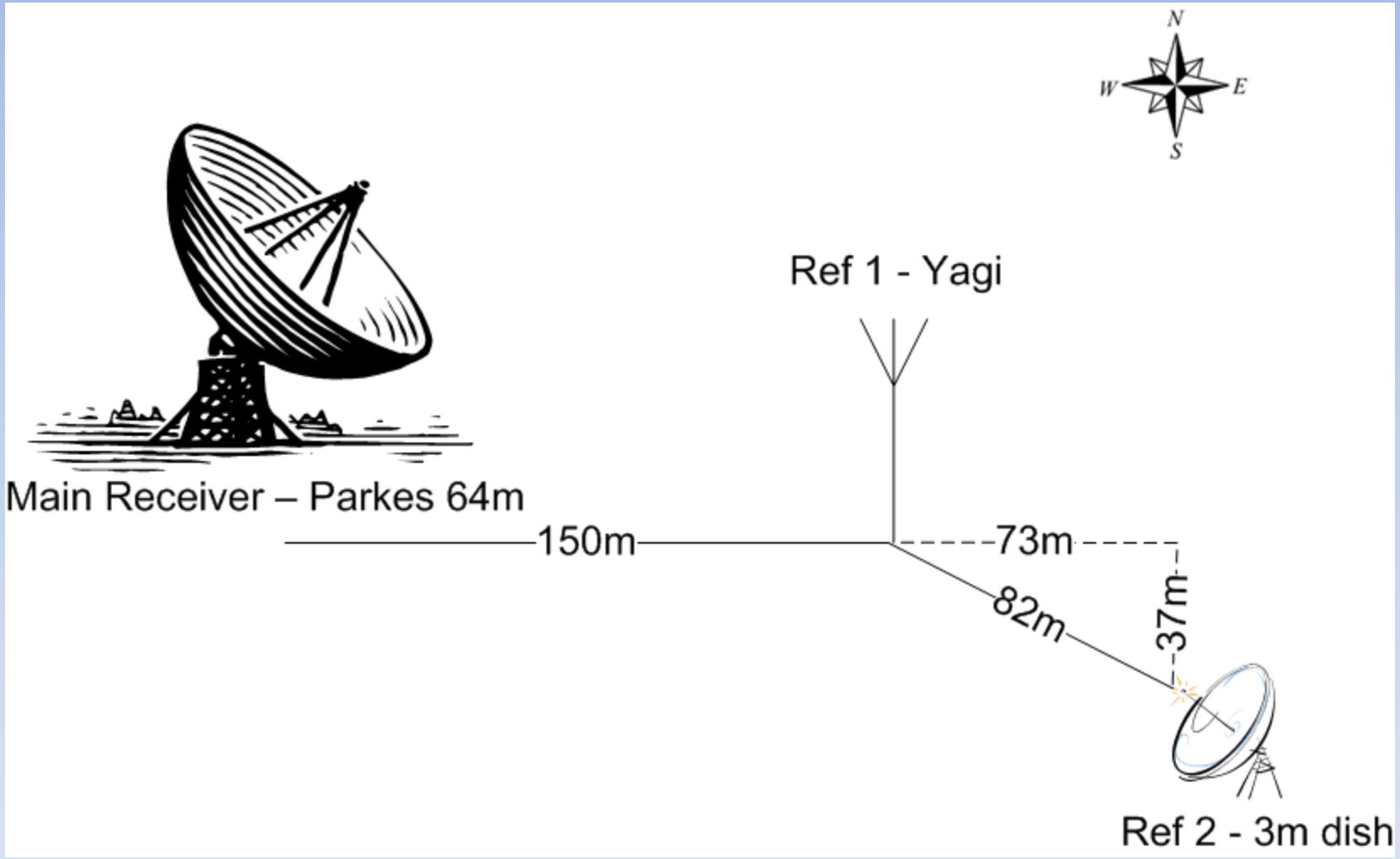
Interference

(Astronomy + Interference) – (Interference) = Astronomy

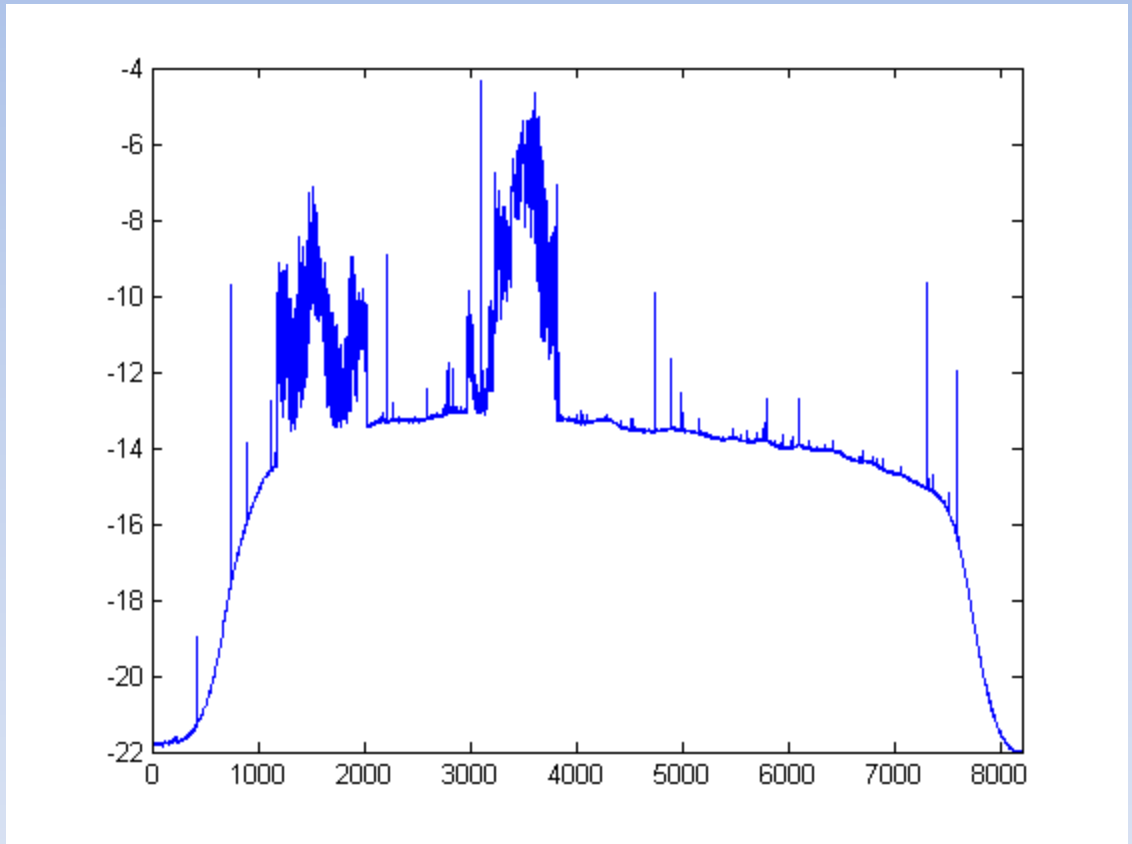
RFI Subtraction



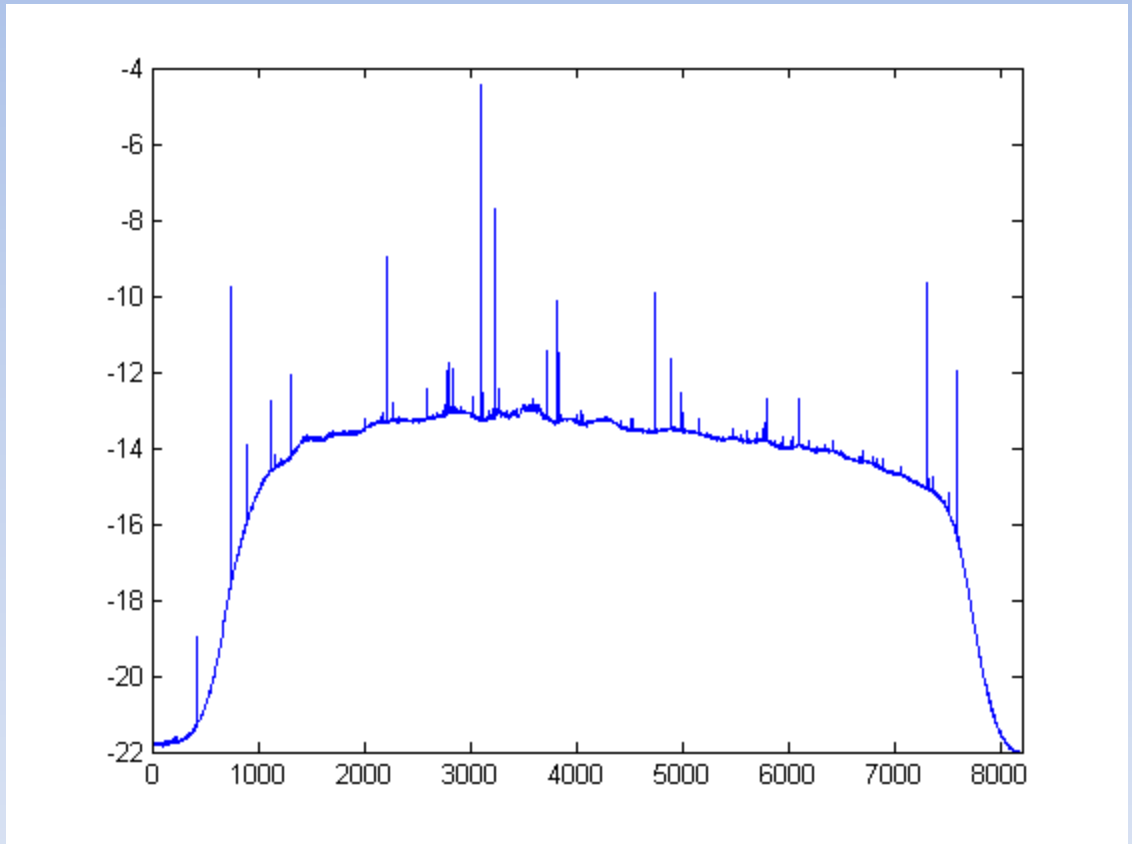
RFI Subtraction – Experimental Setup



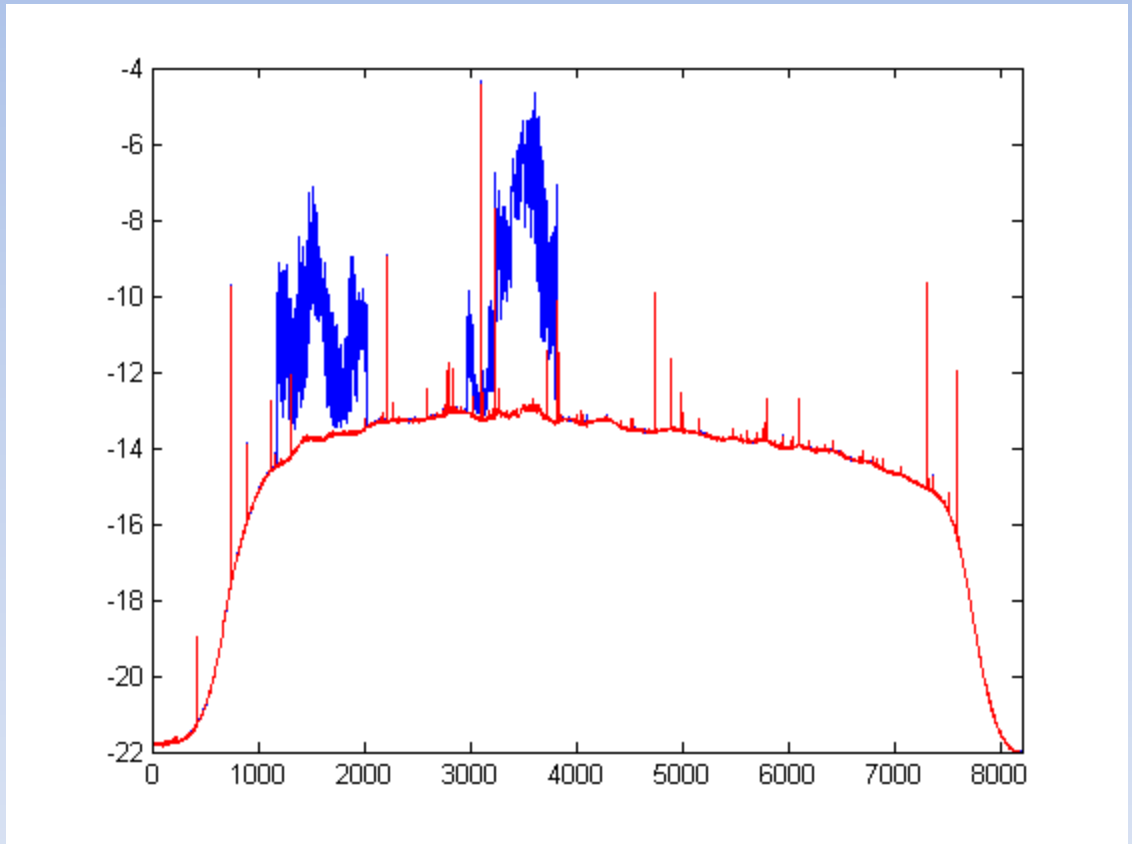
RFI Subtraction - Results



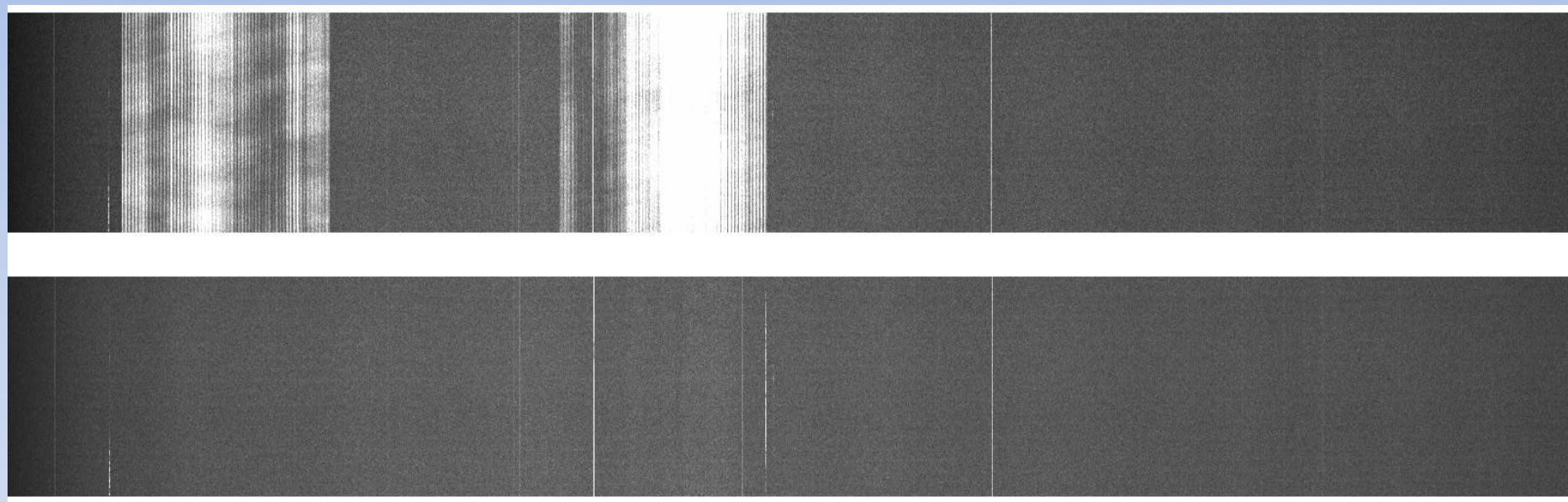
RFI Subtraction - Results



RFI Subtraction - Results



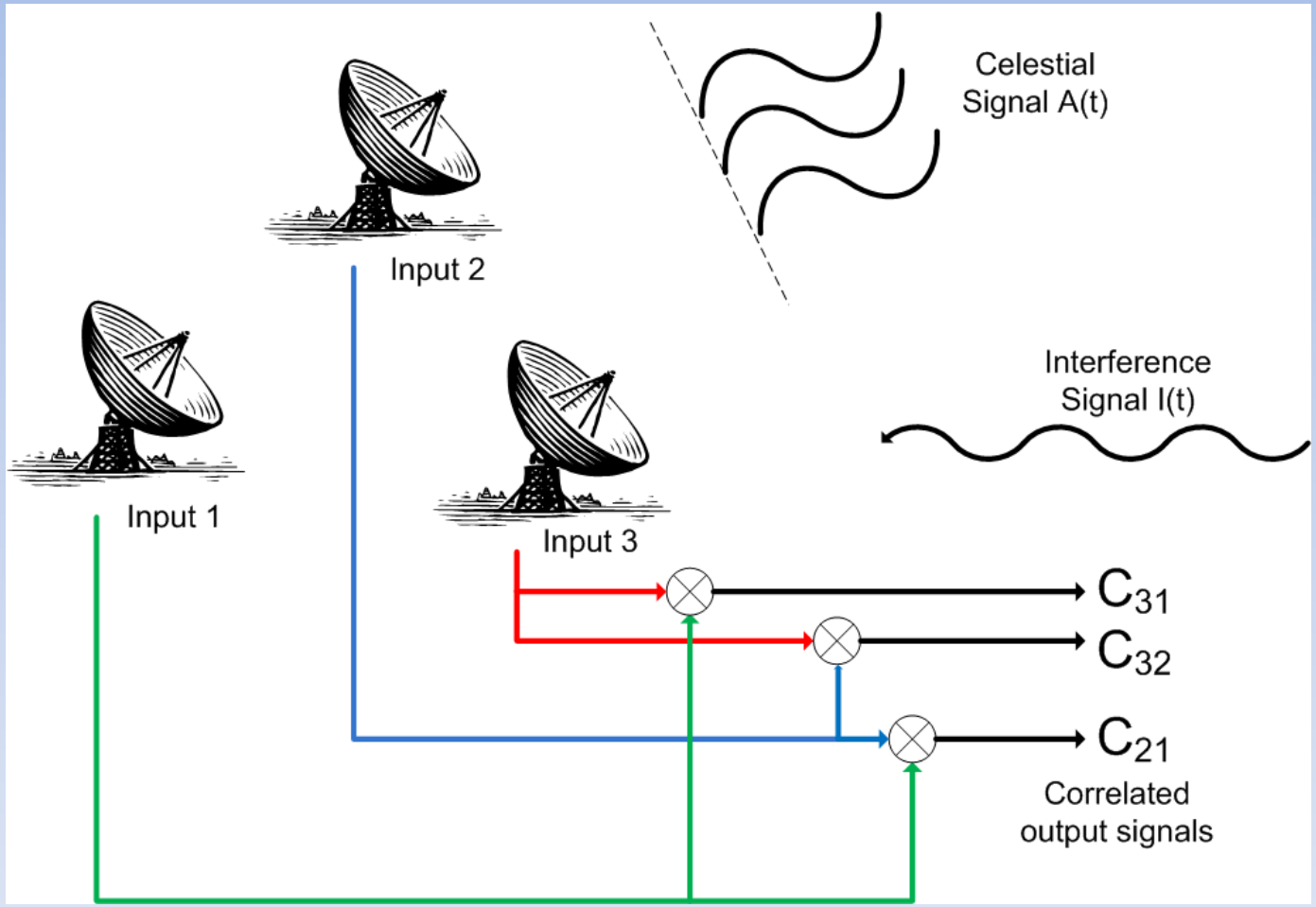
RFI Subtraction - Results



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

Spatial Filtering with a multibeam receiver.

Spatial Filtering



Spatial Filtering

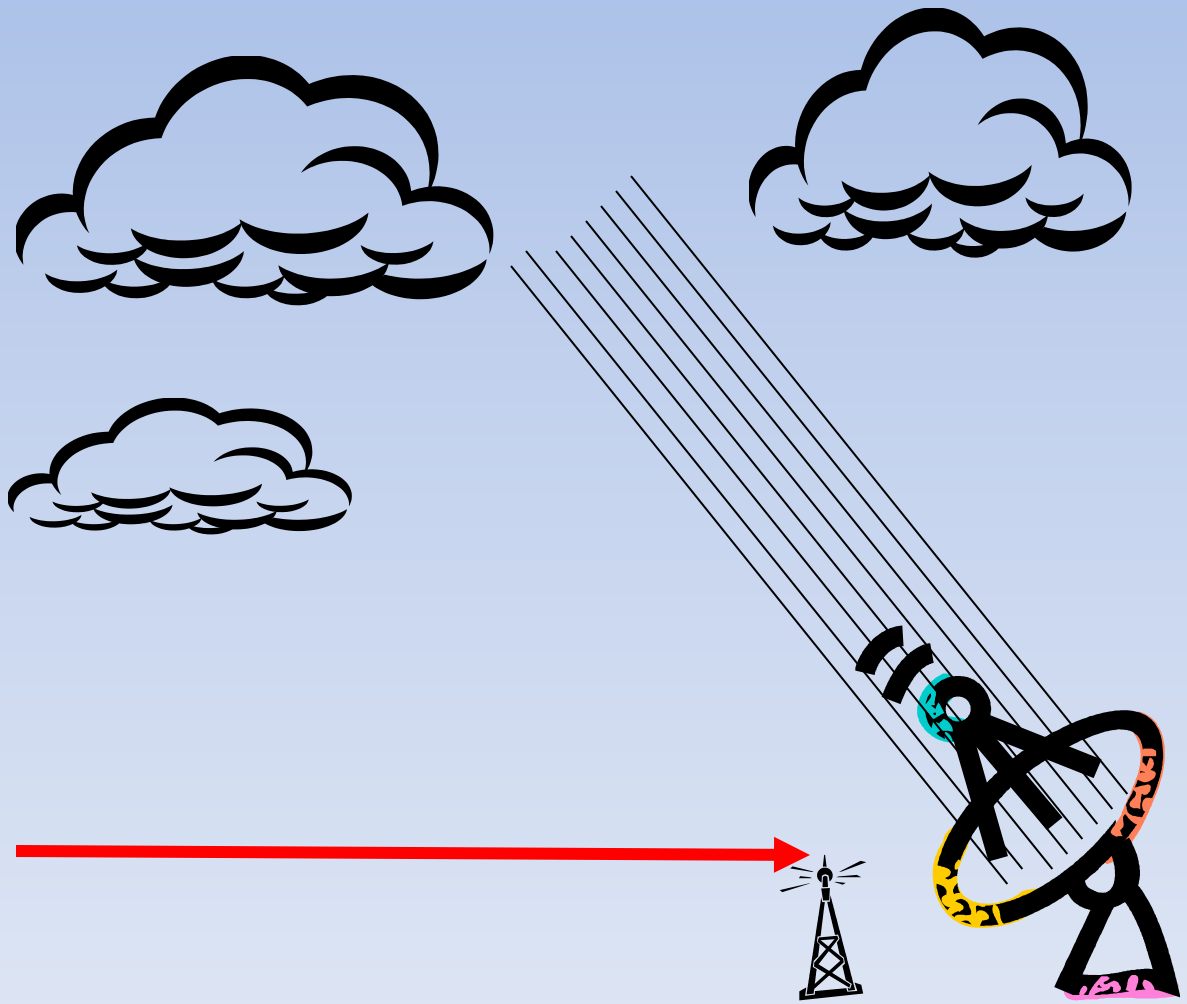
$$\begin{pmatrix} C_{11} & C_{12} & C_{13} \\ C_{21} & C_{22} & C_{23} \\ C_{31} & C_{32} & C_{33} \end{pmatrix}$$

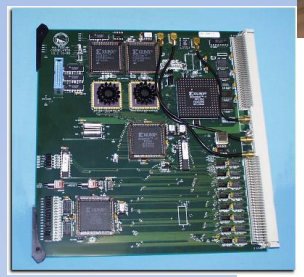
Correlation Matrix

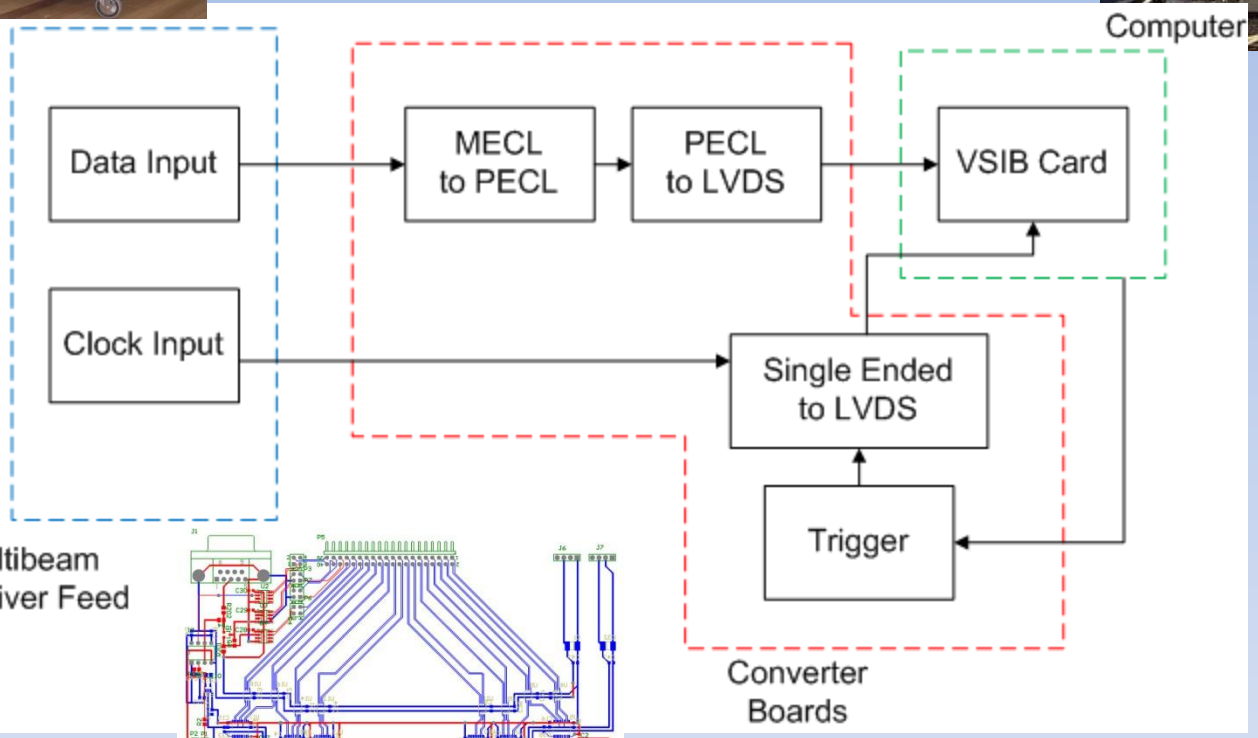
Eigenvector - Direction Matrix

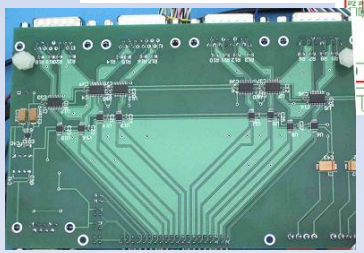
Eigenvalue - Power Matrix

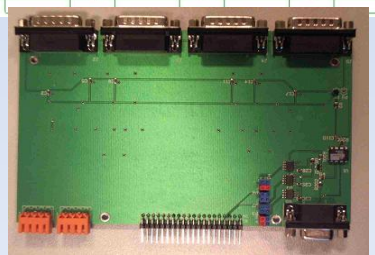
Parkes Multibeam Experiment



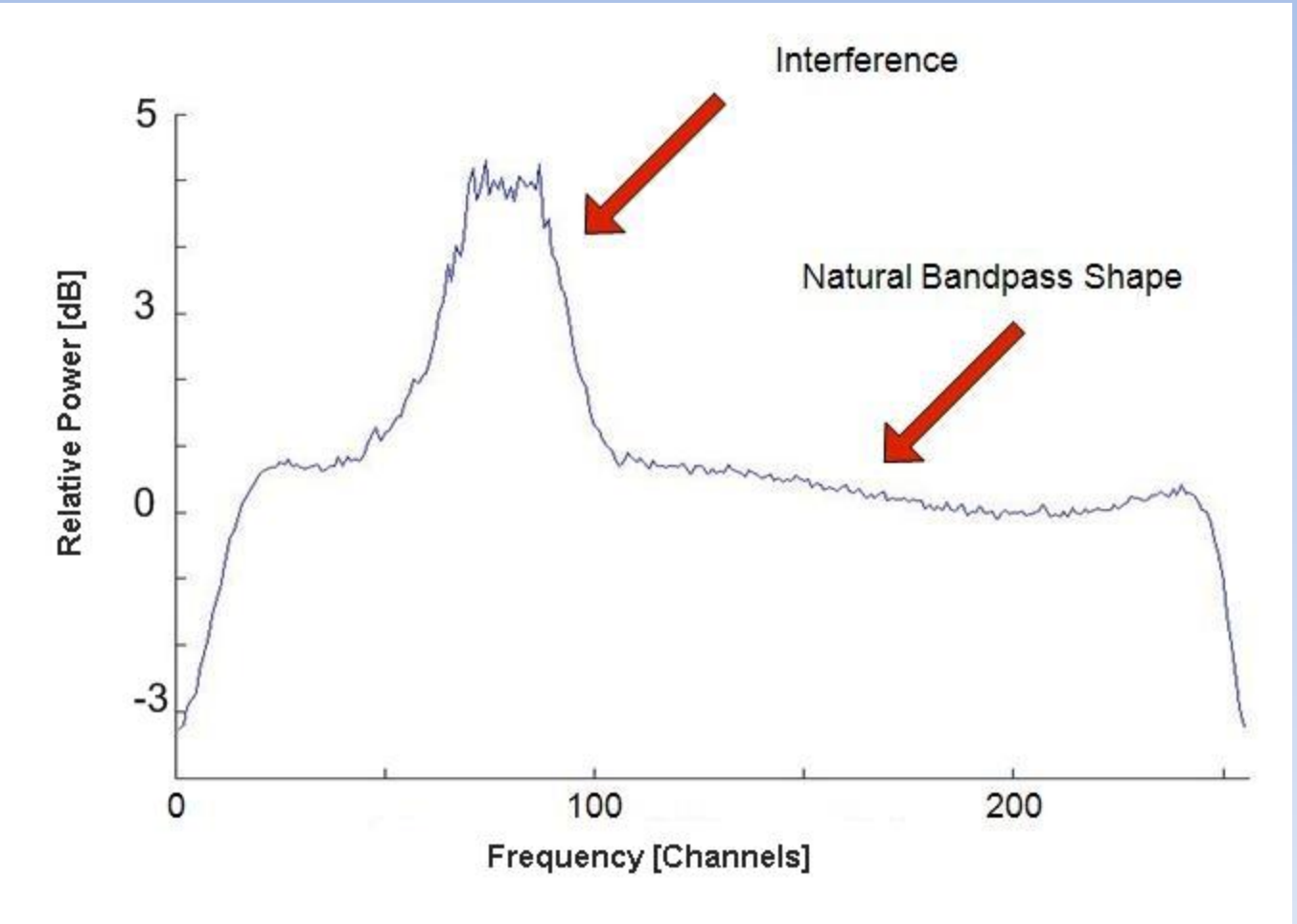



Computer
Data Input
MECL
to PECL
PECL
to LVDS
VSIB Card
Clock Input
Single Ended
to LVDS
Trigger
Multibeam
Receiver Feed
Converter
Boards



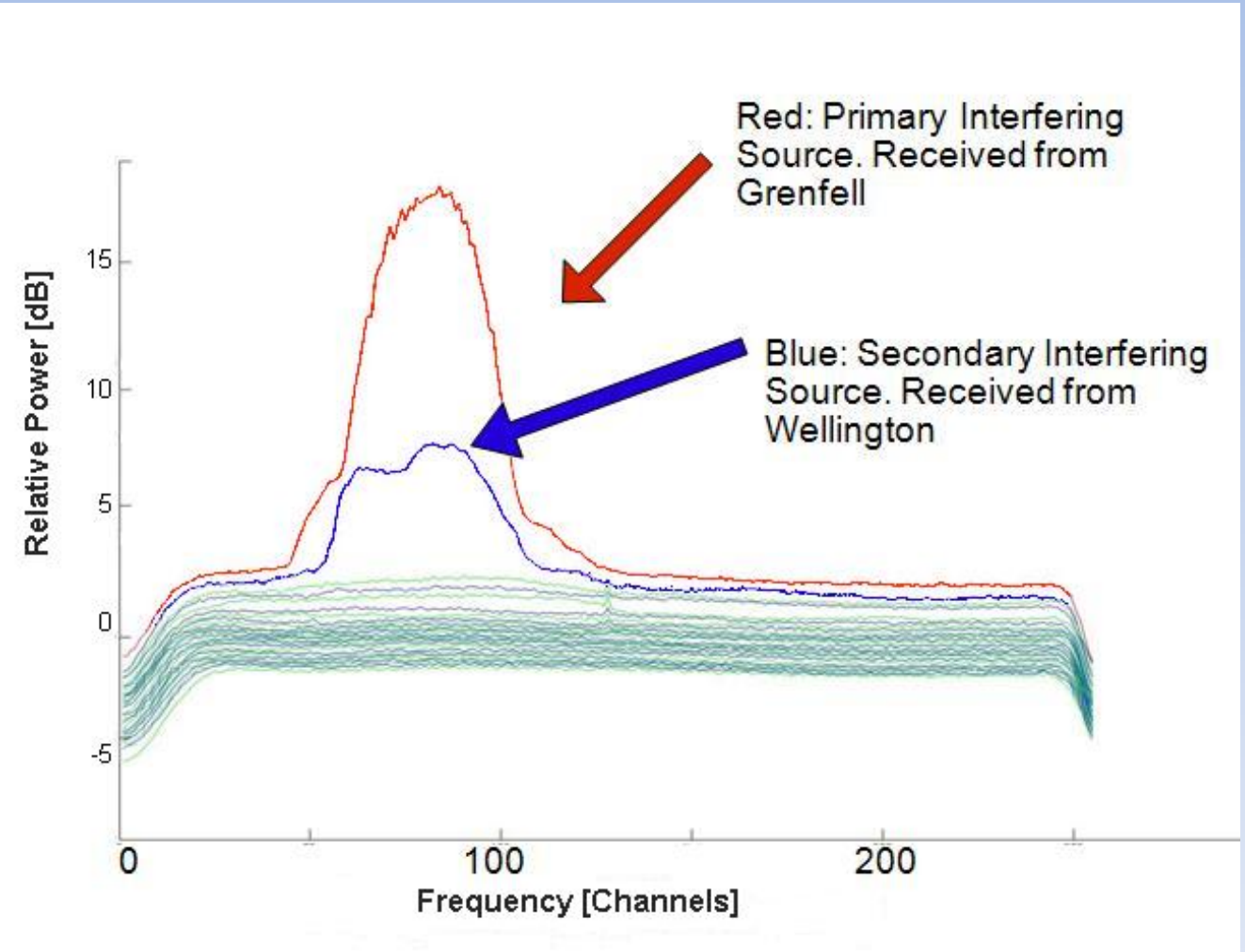


Results



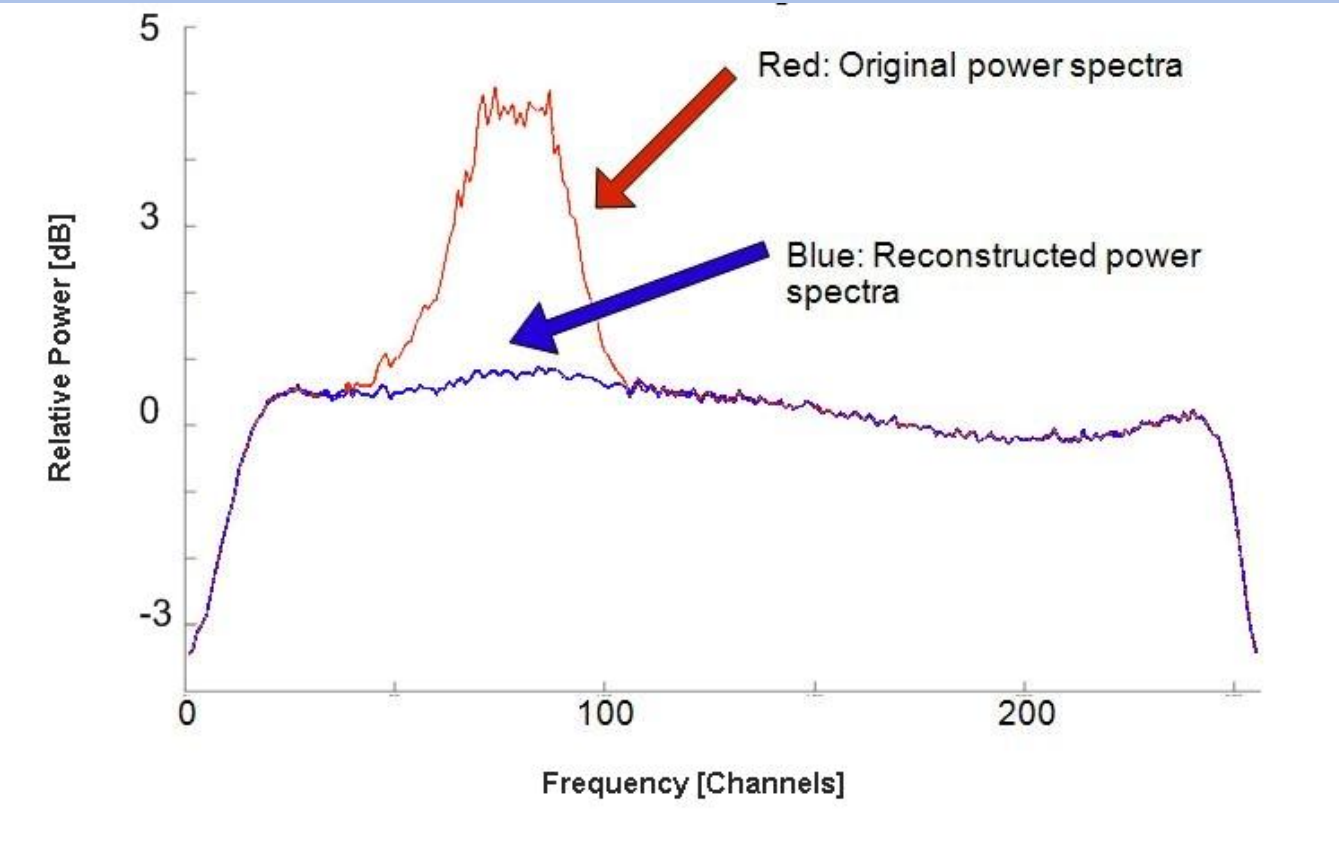
8MHz bandwidth, 32kHz channels

Results



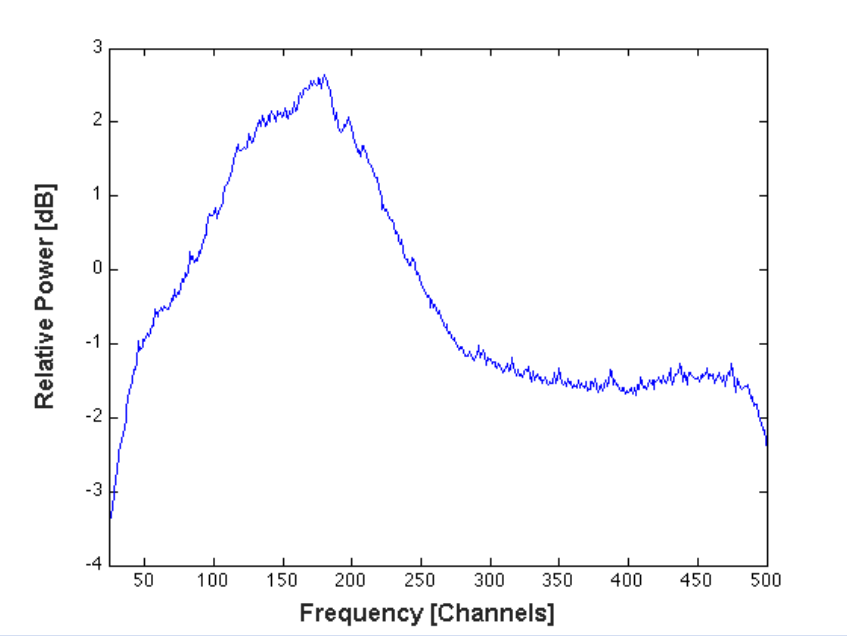
8MHz bandwidth, 32kHz channels

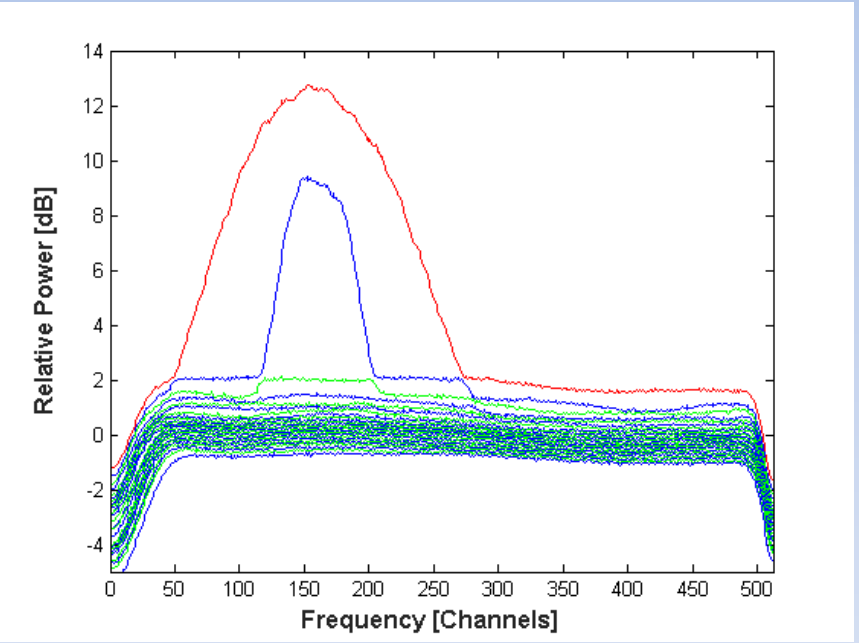
Results



8MHz bandwidth, 32kHz channels

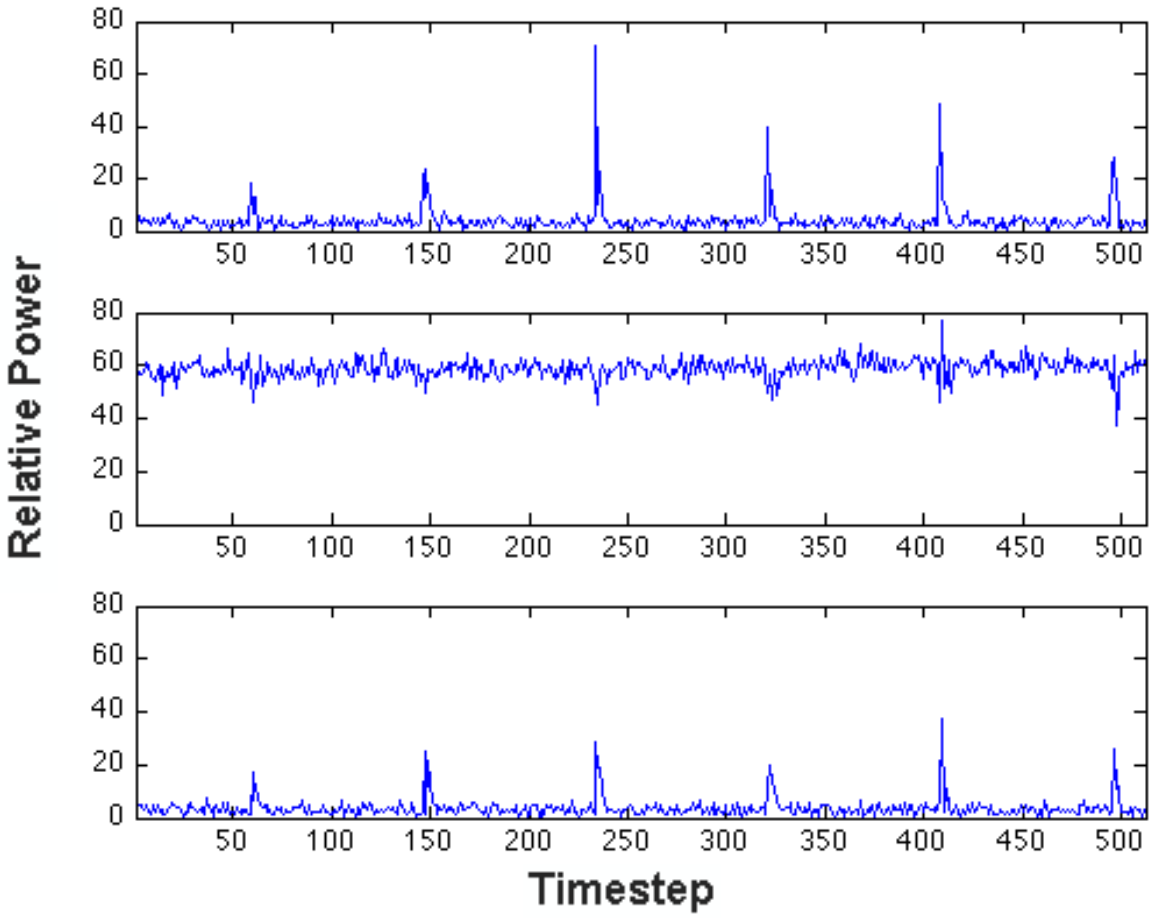
Vela





8MHz bandwidth, 16kHz channels

Vela



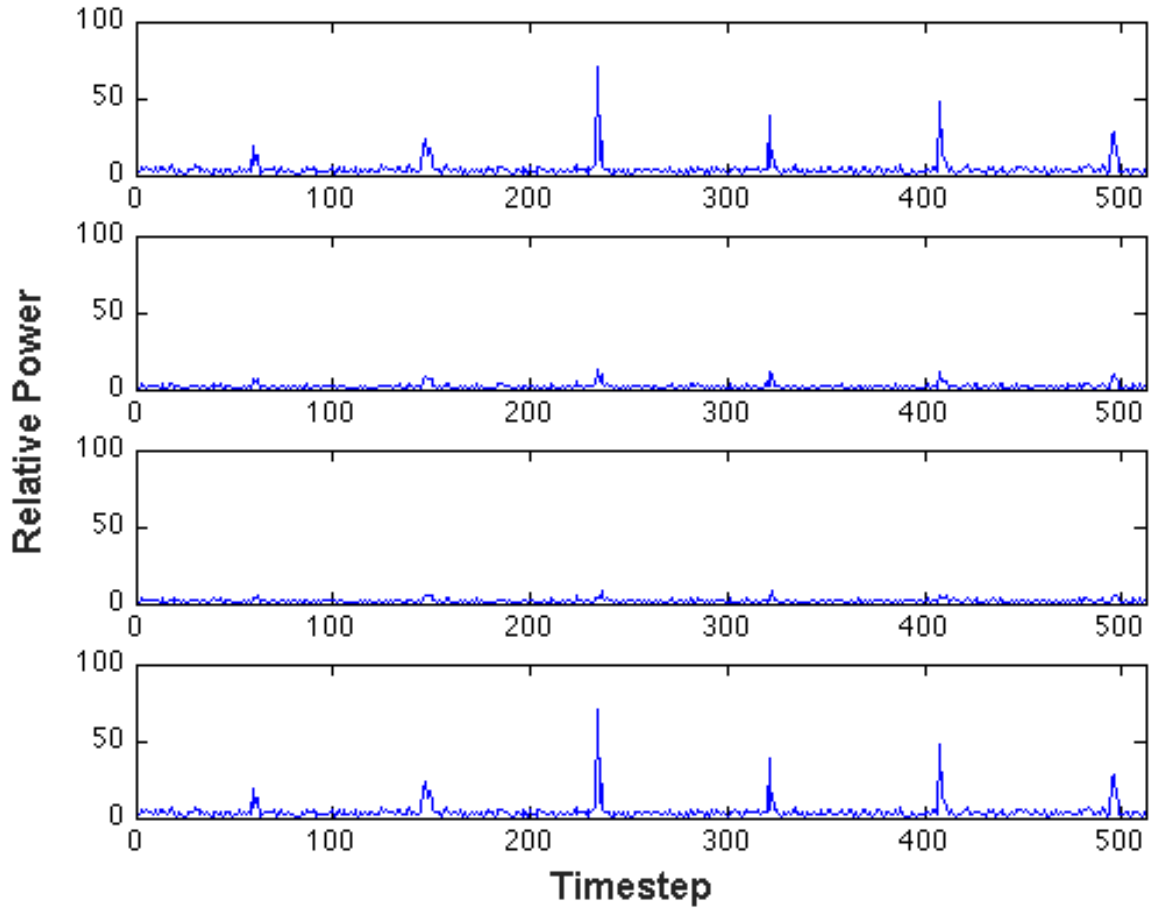
Interference Free
(SNR: 28.91)

Before Subtraction

After Subtraction
(SNR: 16.54)

(One timestep = 1ms)

Risks!

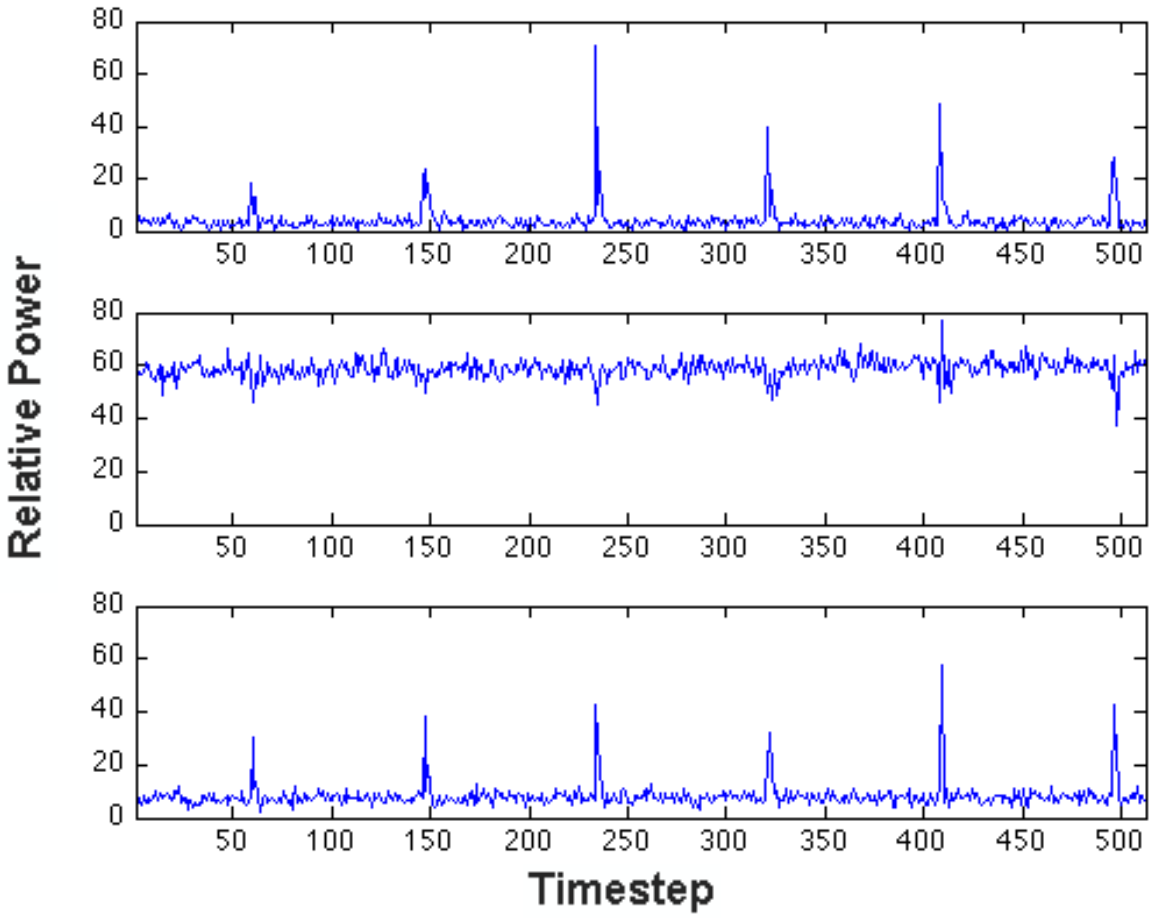


Interference Free
(SNR: 28.91)

Interference free,
after subtraction

(One timestep = 1ms)

Vela



Interference Free
(SNR: 28.91)

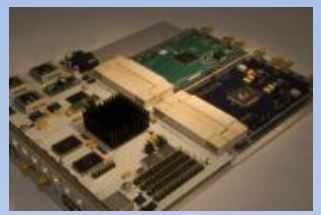
Before Subtraction

After Subtraction
(SNR: 20.86)

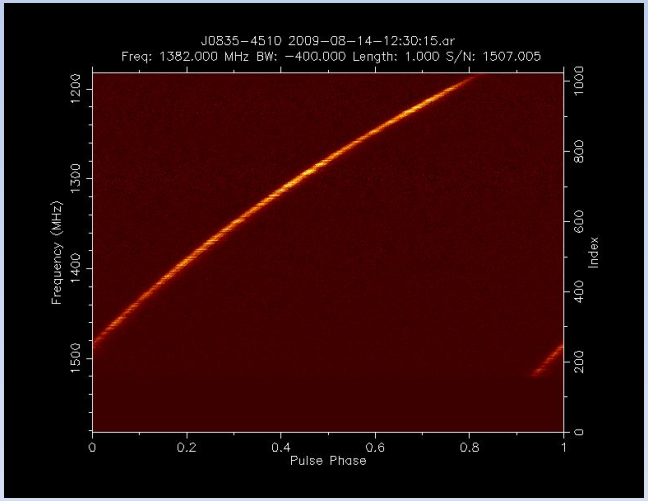
(One timestep = 1ms)

Excision – Automated blanking

Berkeley Parkes Swinburne Recorder (BPSR)

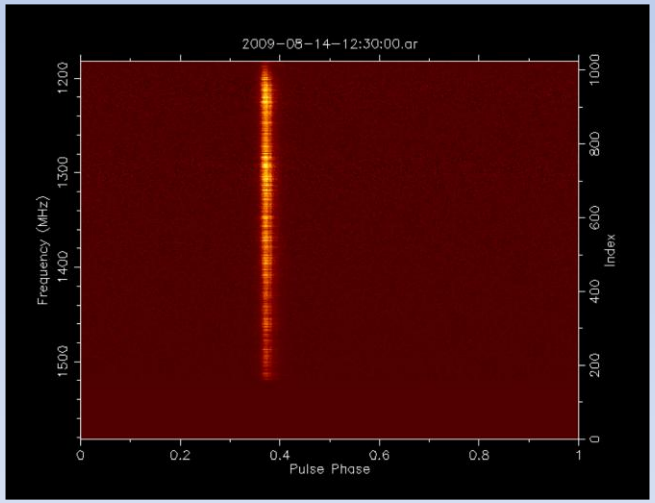


8-bit, 64us time series data from 13 beams



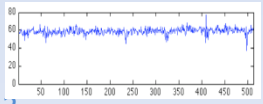
Frequency (MHz)

Pulse Phase



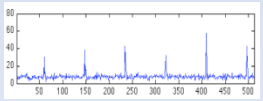
Frequency (MHz)

Pulse Phase



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

$$USV^T$$

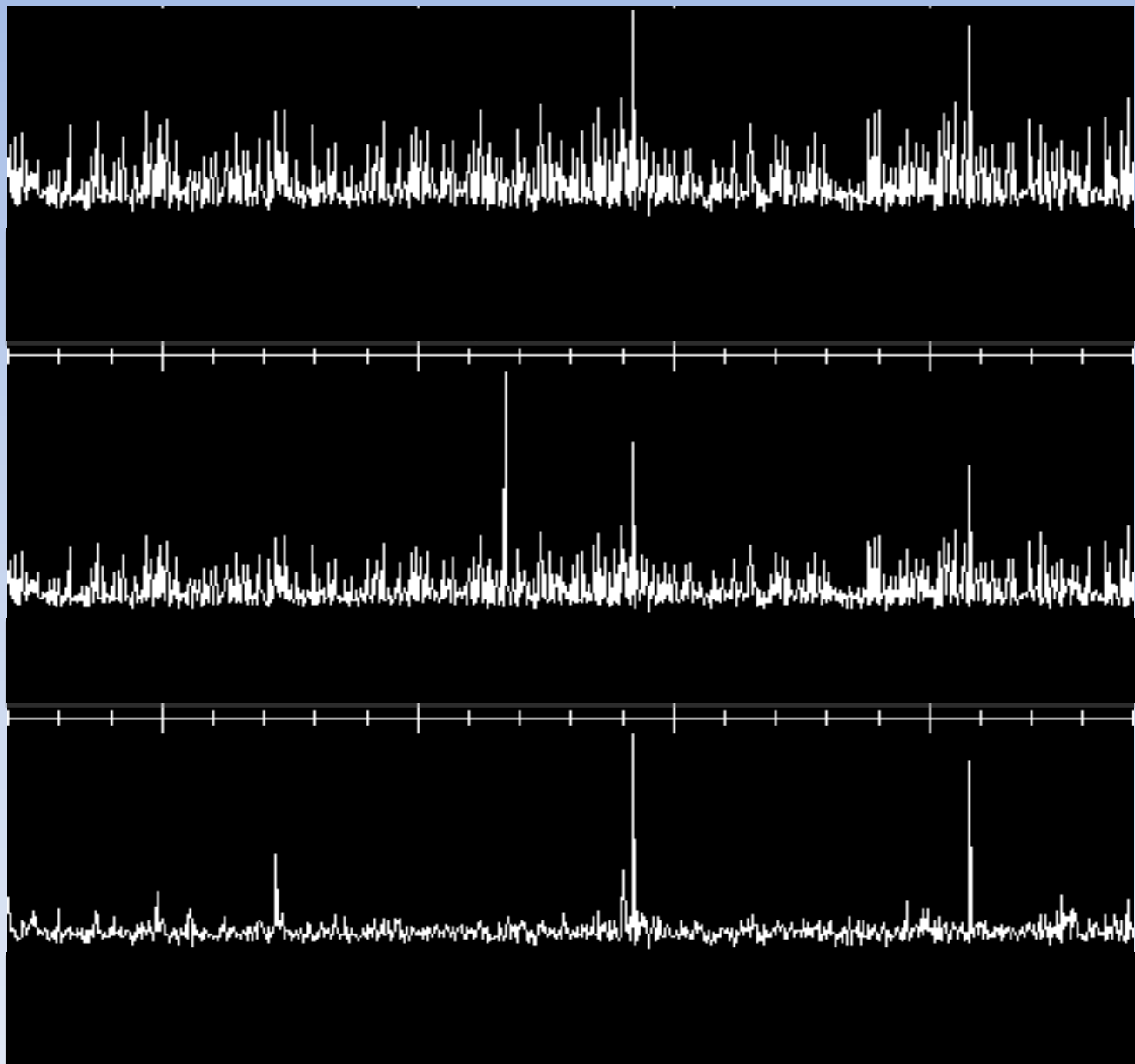


J0410-3107

Current System →

Original Data →

SVD Detection →

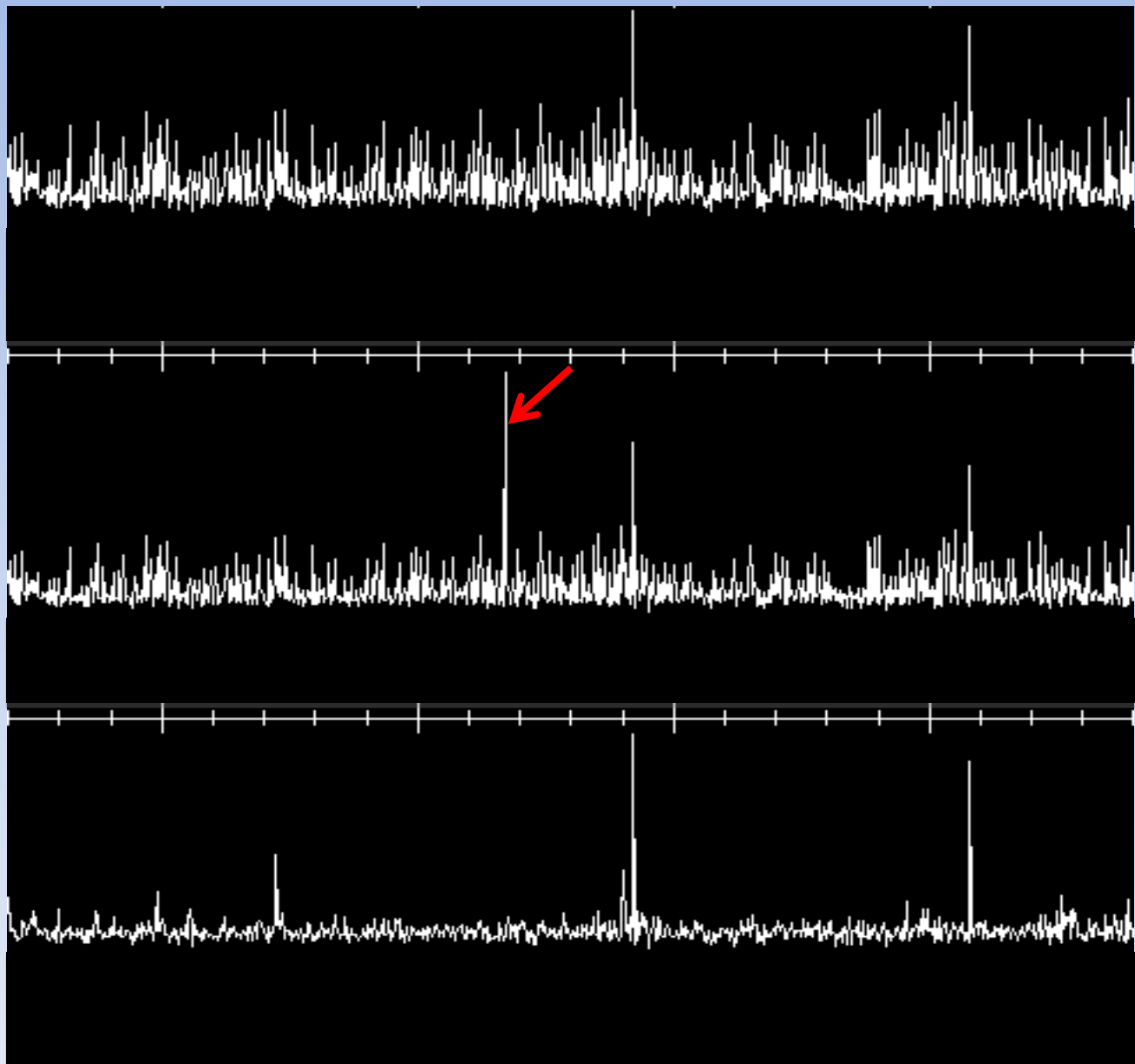


J0410-3107

Current System →

Original Data →

SVD Detection →



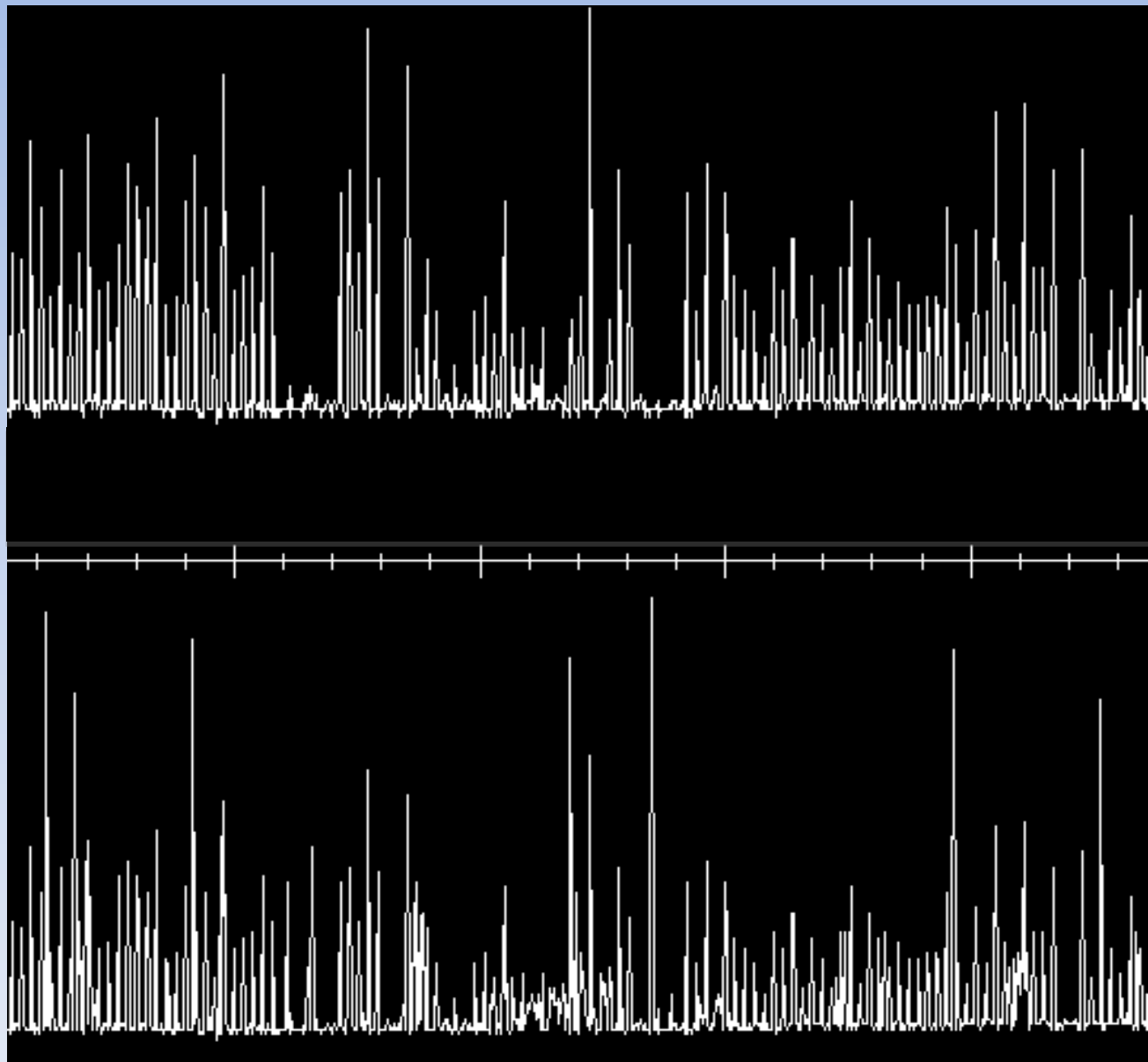
J0410-3107 – Result Measures

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 →

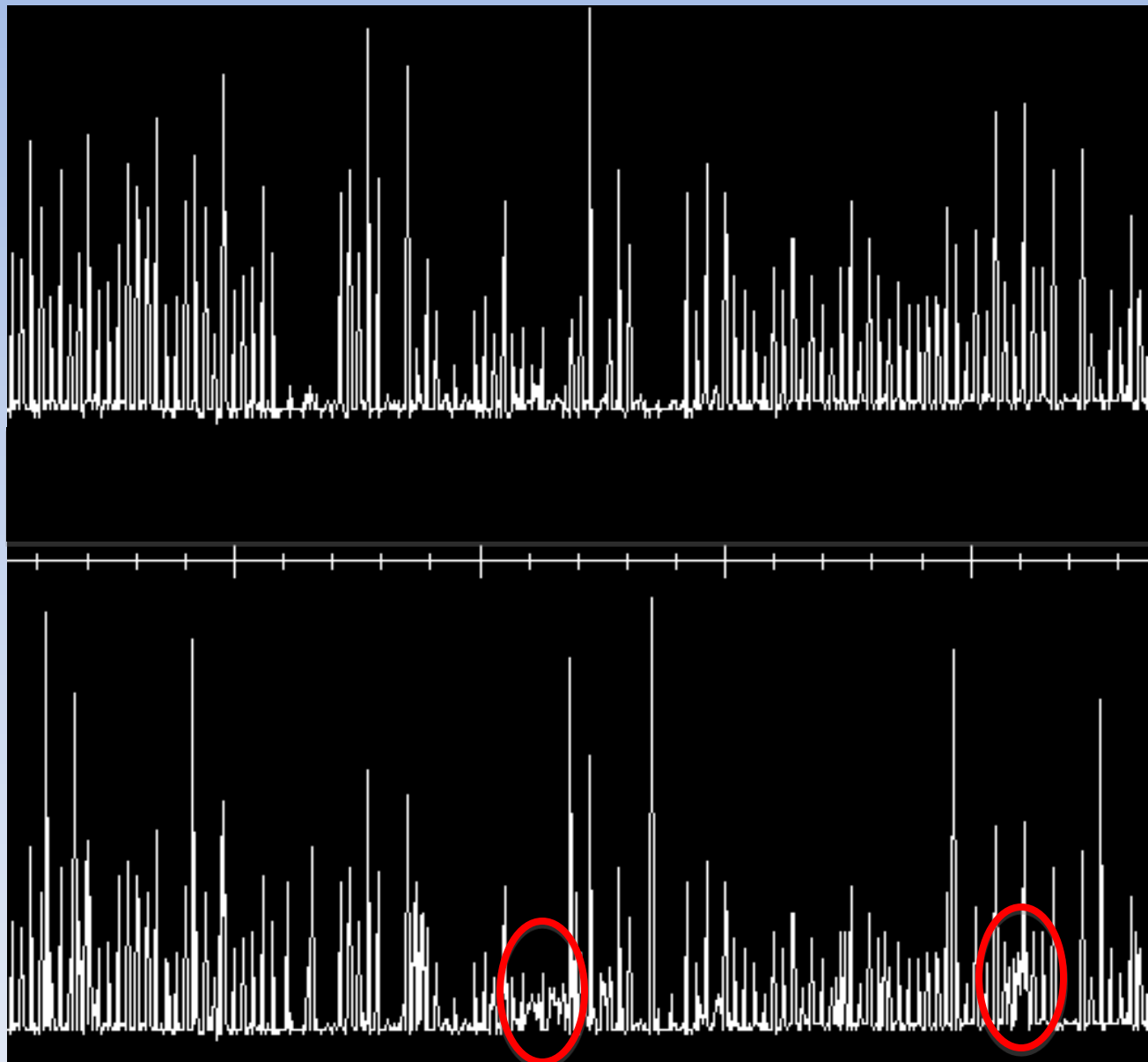
Original Data →



J2048-1616

SVD Detection →

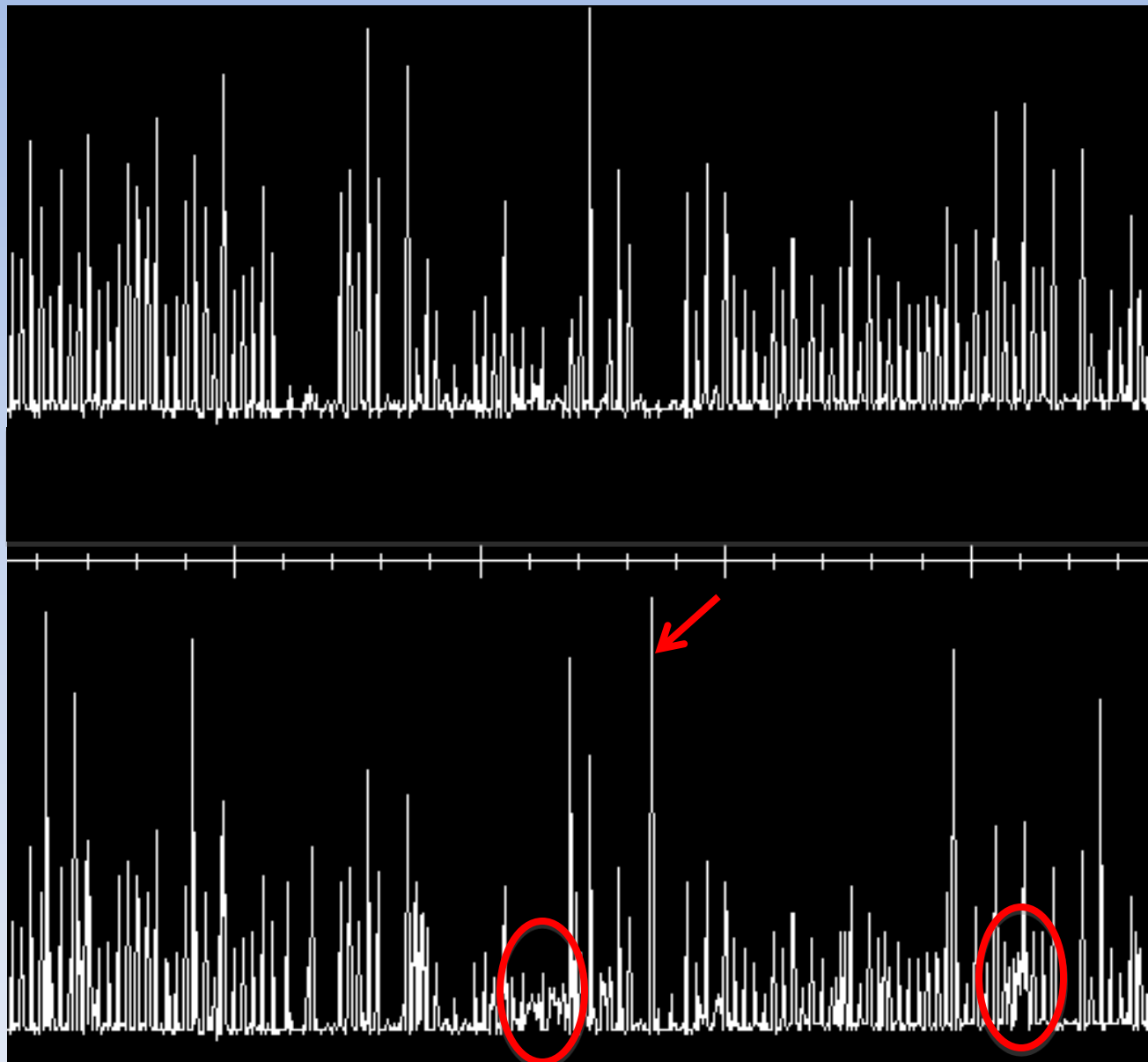
Original Data →



J2048-1616

SVD Detection →

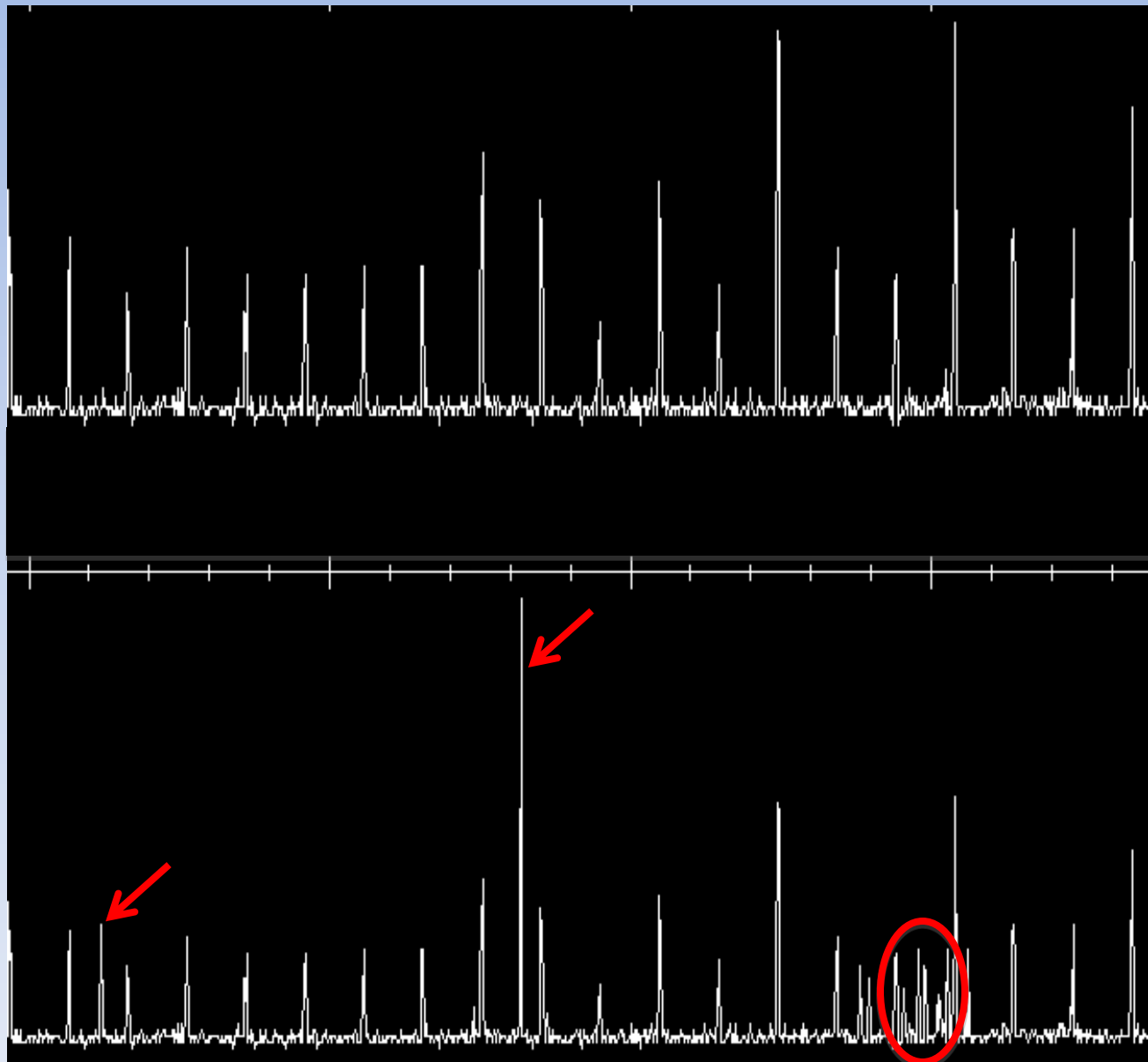
Original Data →



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.