



Upgraded GMRT: Real-time RFI Mitigation in the Backend System

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Current Team Members:

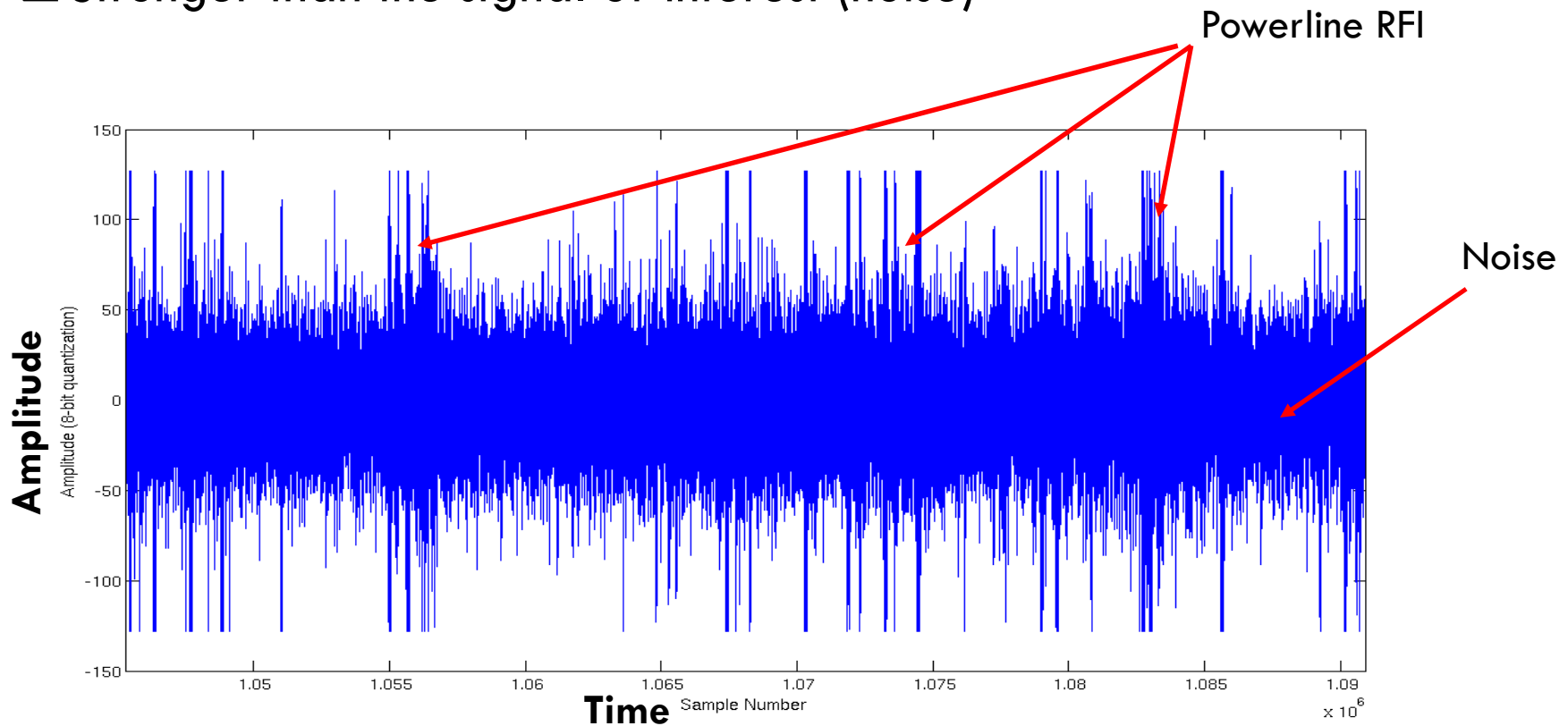
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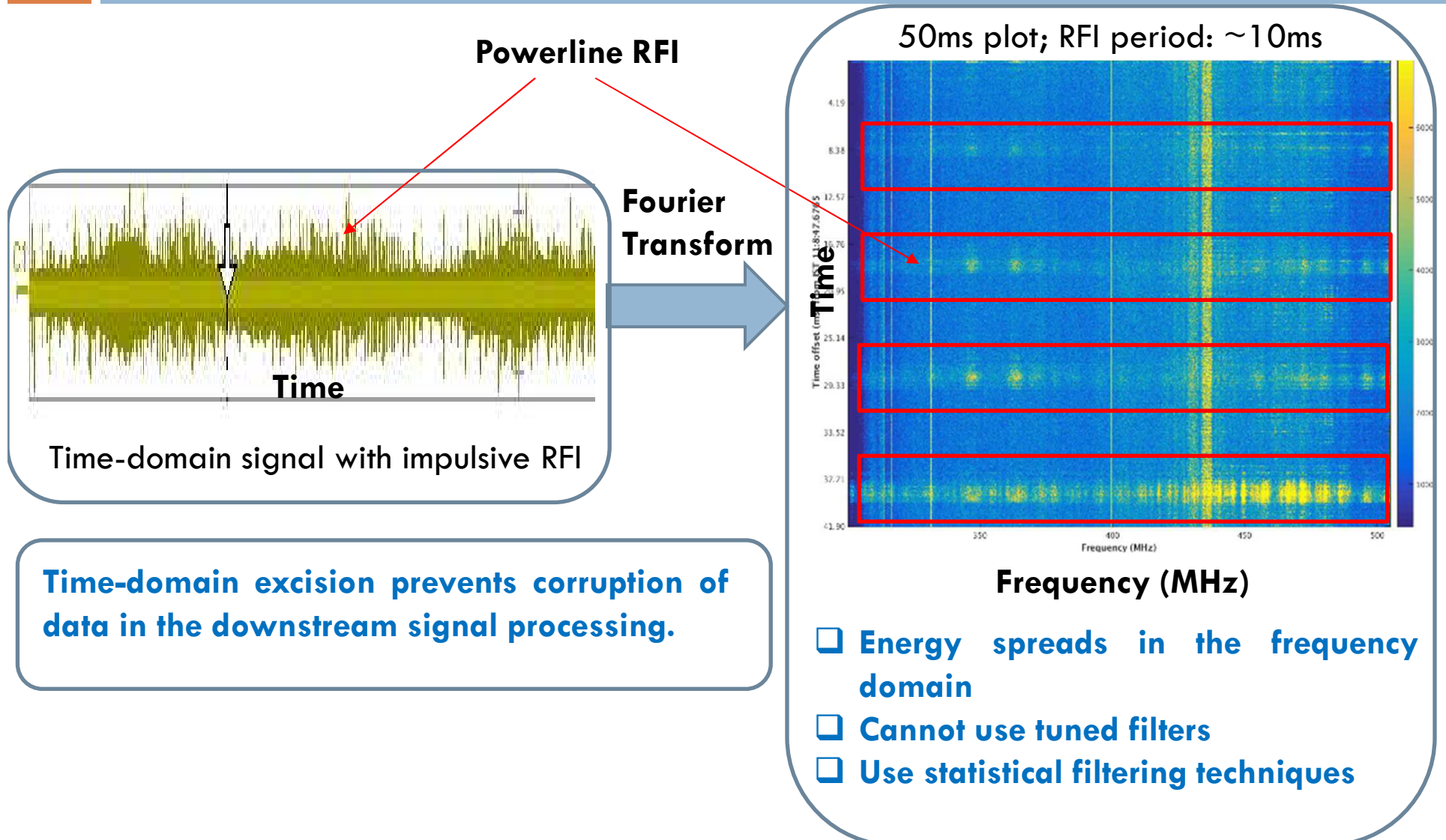
Celebrating 20 years of the GMRT, 5th October 2021

Powerline RFI

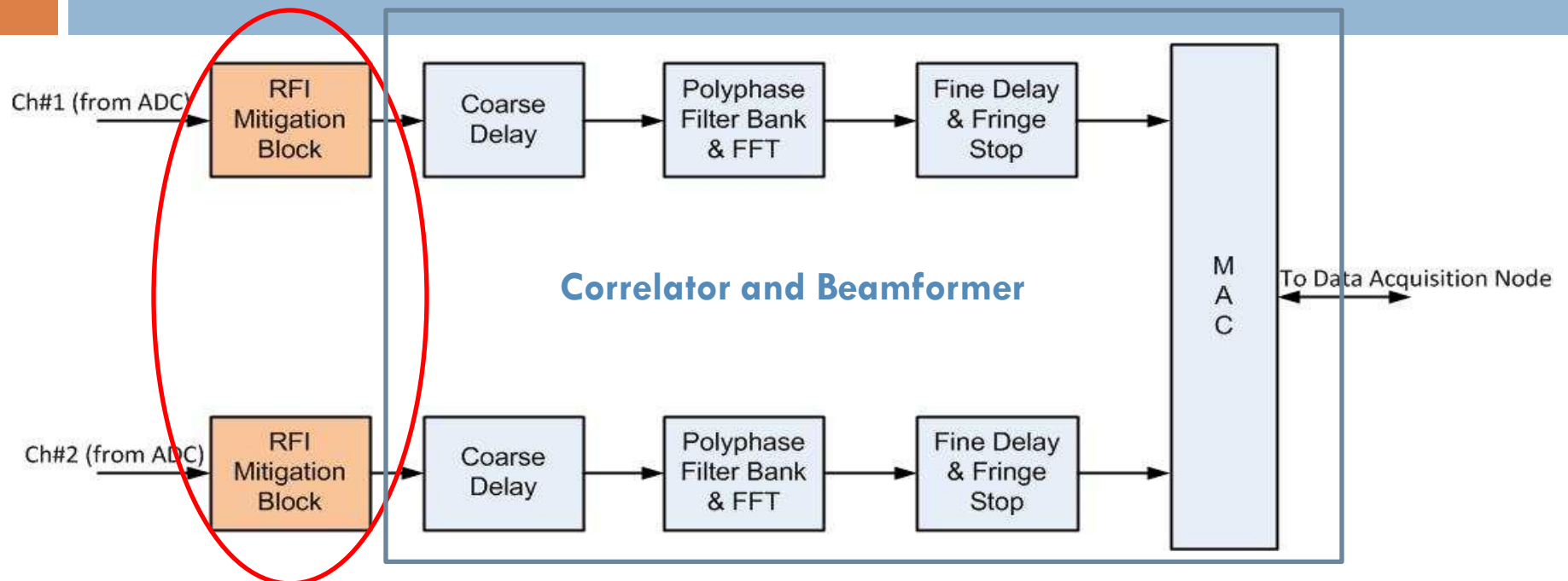
- ❑ Major source of interference below 800 MHz
- ❑ Cause: Gap discharge on HV transmission lines/distribution equipment
- ❑ Stronger than the signal of interest (noise)



Need for Real-time Excision

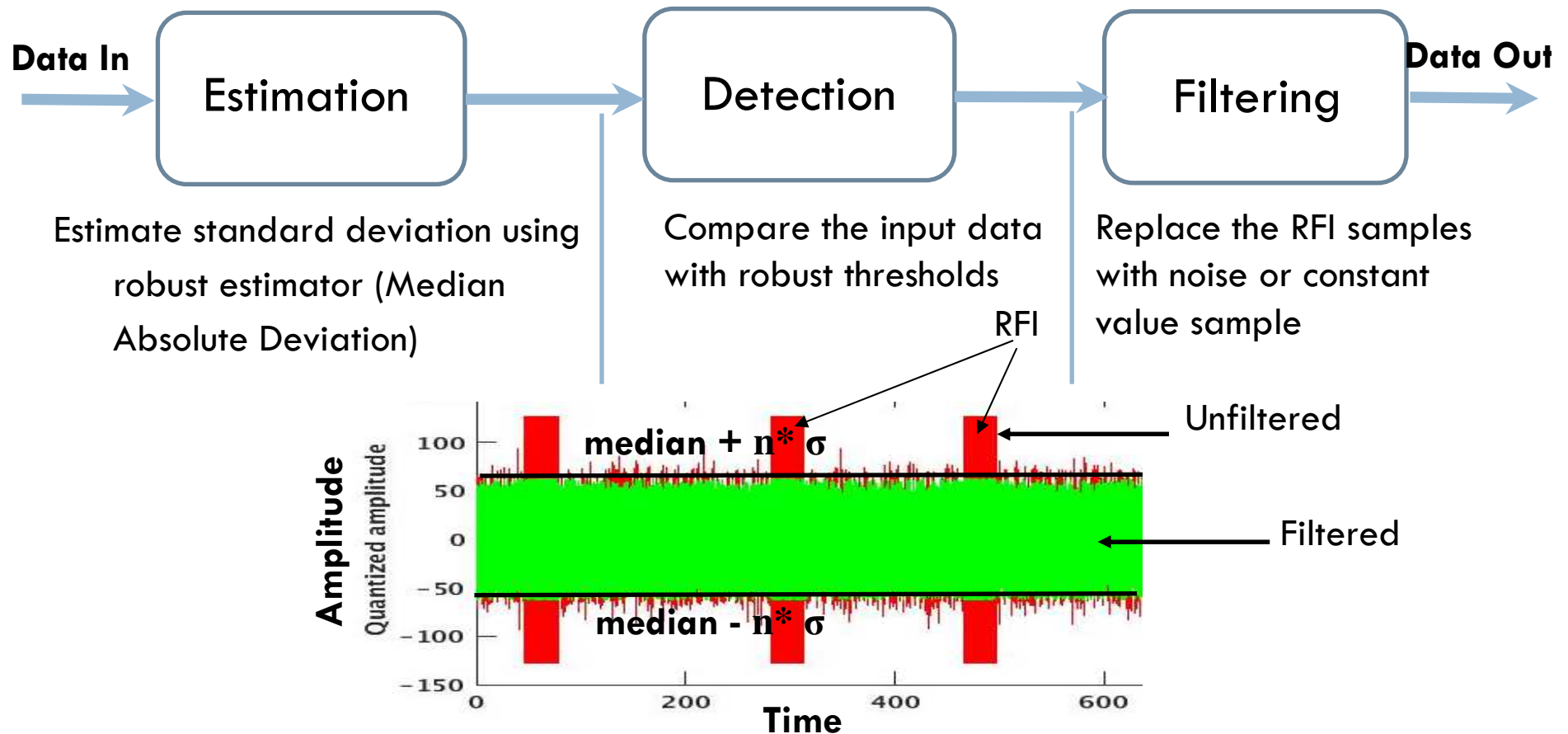


Real-time Mitigation in GMRT Wideband Backend



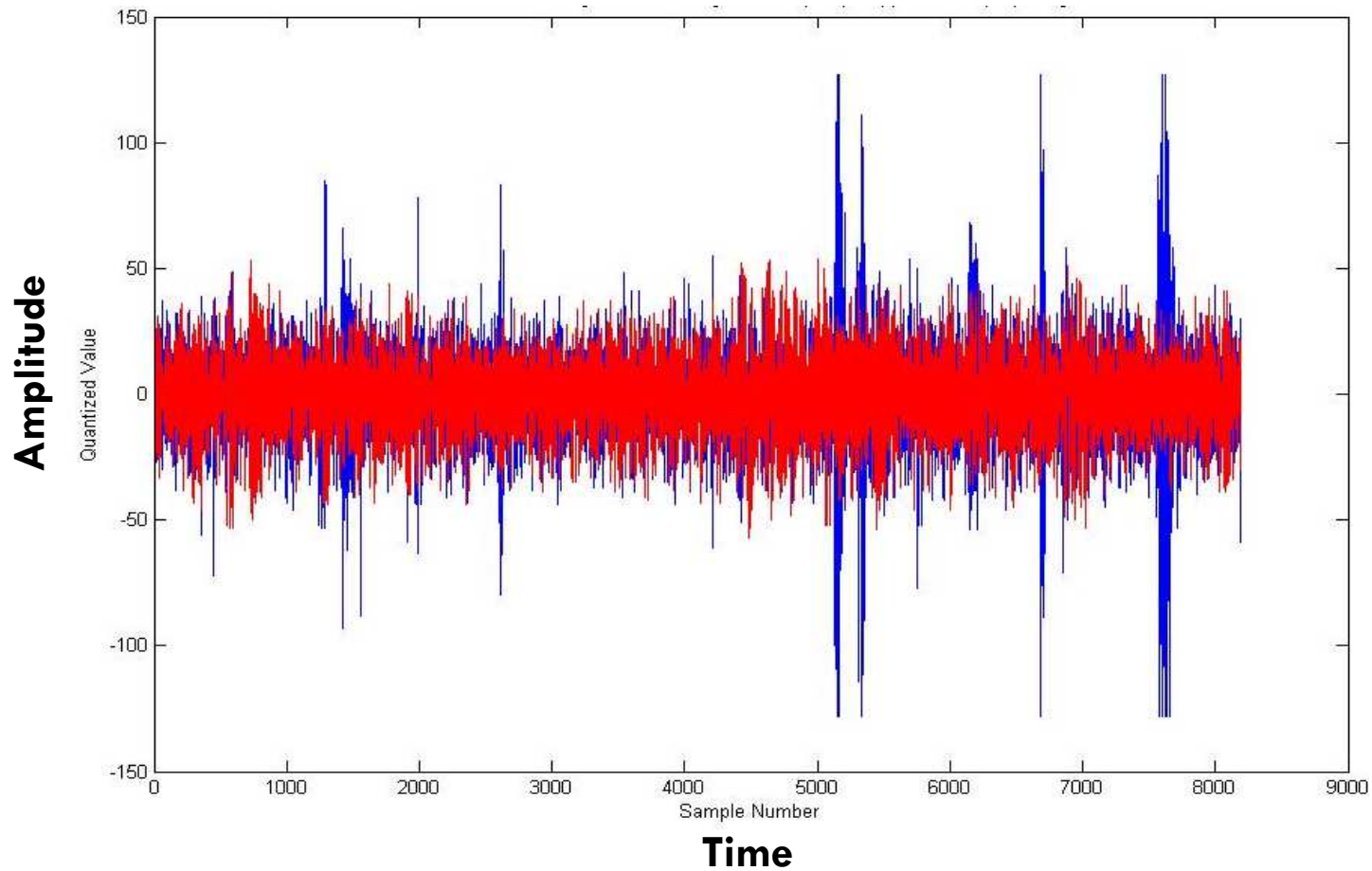
- ❑ Operates in time-domain on each antenna (and polarization)
- ❑ Implementation challenge: Real-time on Nyquist sampling rate of 800 MHz (samples arriving at 1.25ns)
- ❑ Statistical techniques: detects outliers from the data

The Filtering Algorithm – Detecting and Removing Outliers



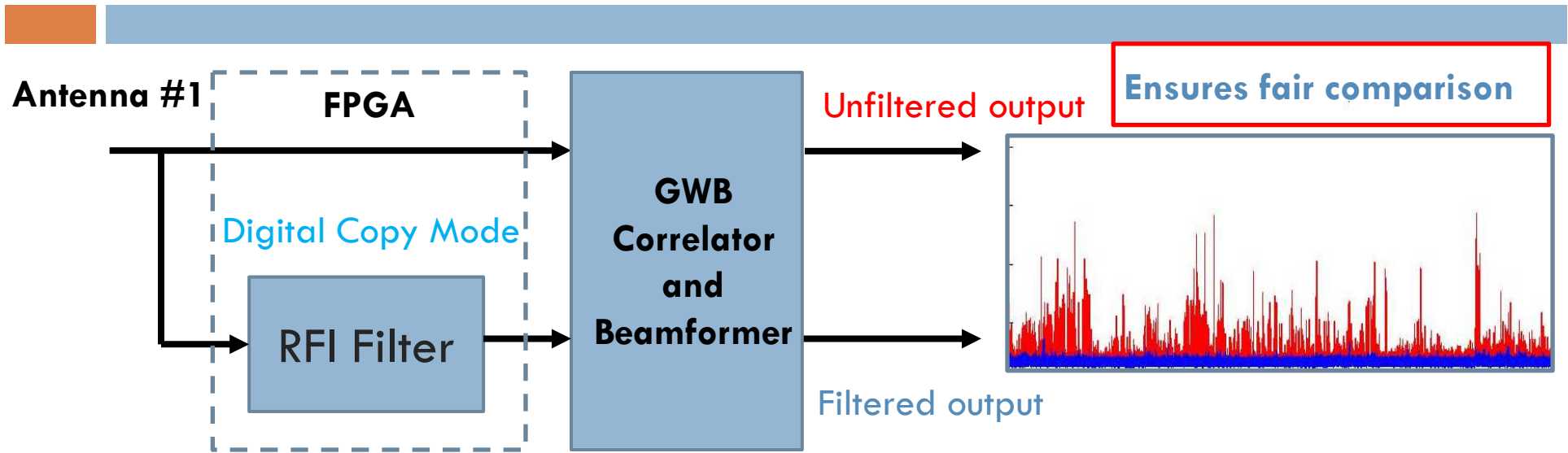
Computing recursive median in real-time was the most challenging aspect of this system

First Result

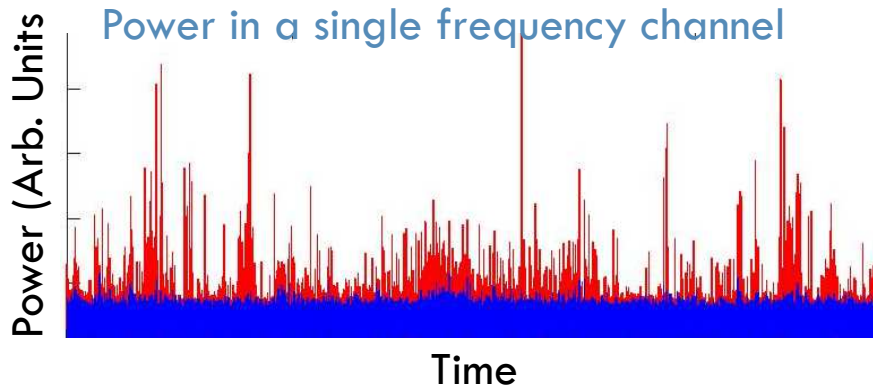


GMRT 150MHz time series with RFI (blue) and 3σ filtered (red)

Simultaneous Testing: Digital Copy Mode



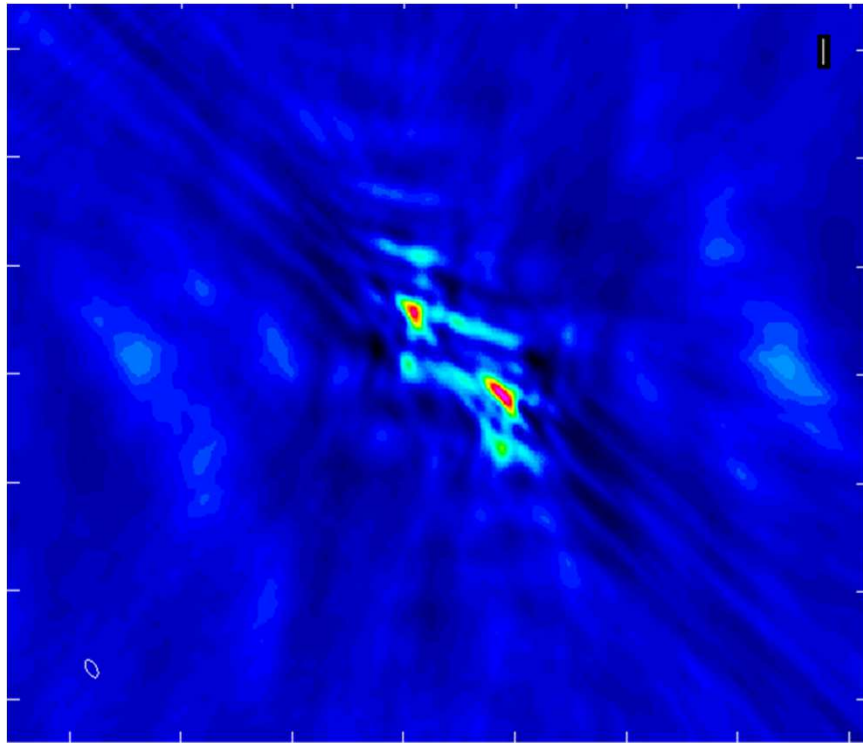
Offline Data Analysis



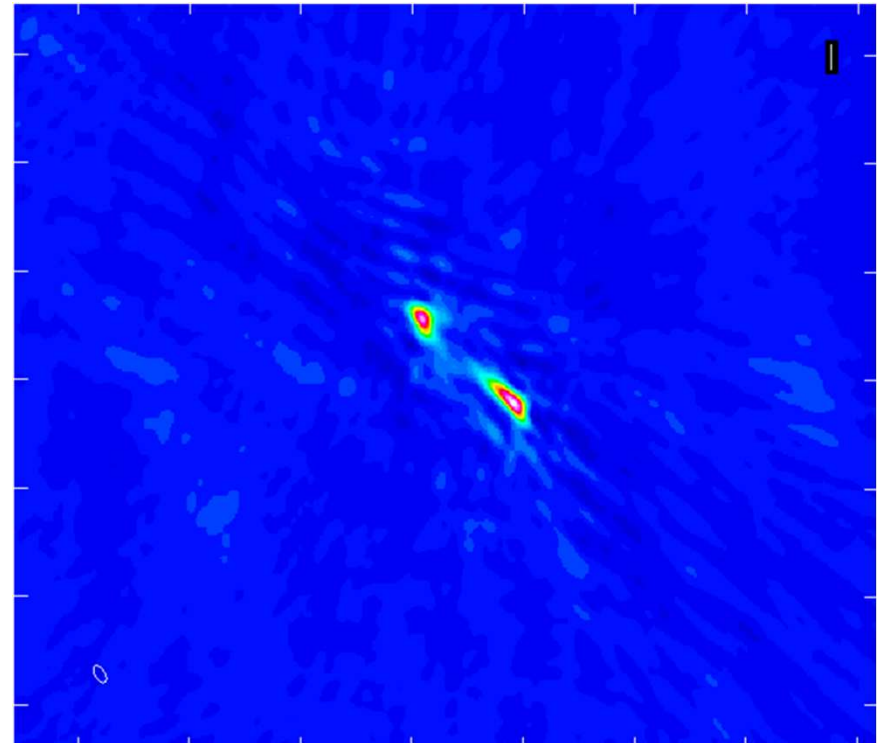
- Cross-correlation function
- Closure phase
- Imaging performance
- Beamformer data analysis
- SNR improvement

Imaging: Extended Source

Unfiltered



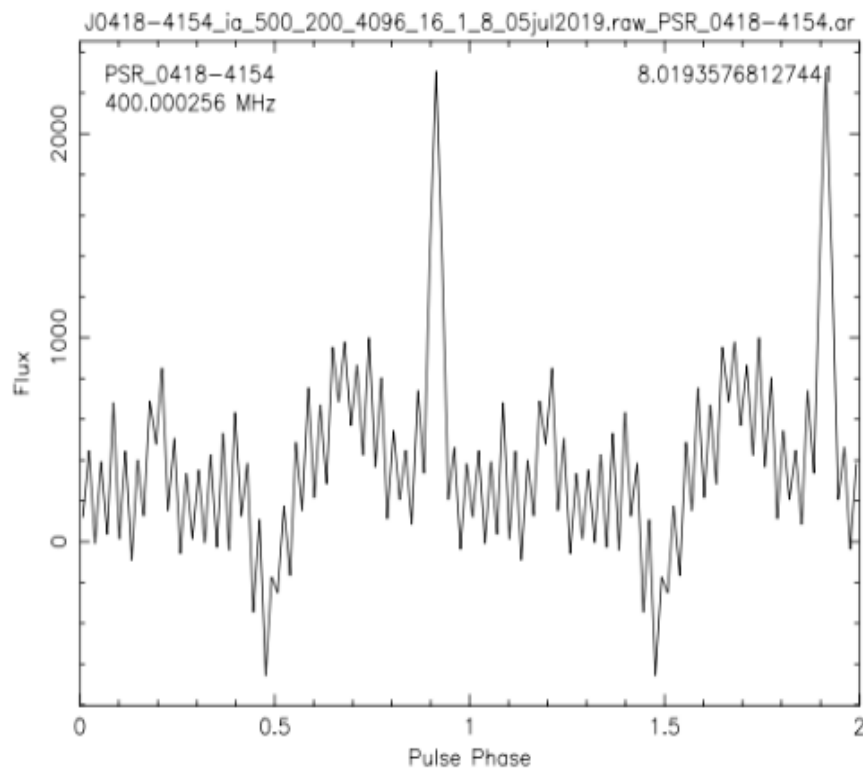
Filtered



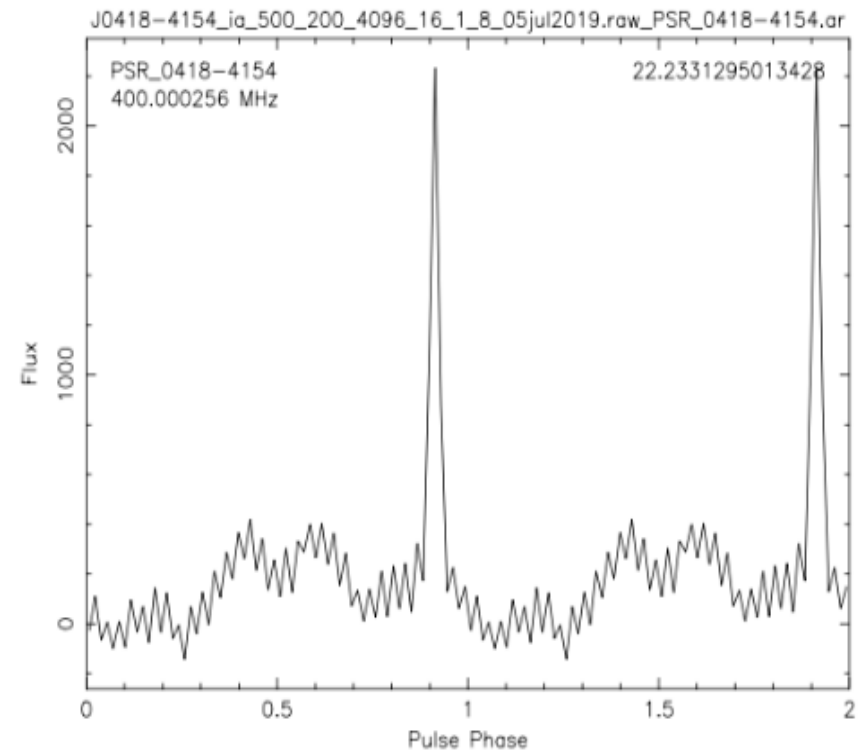
- uGMRT Band-4, 550-850 MHz , 200 MHz RF bandwidth, 2048 spectral channels
- Imaging for baselines < 1 kilolambda (~ 0.5 km)
- Noise RMS - 1.6 mJy/beam (Unfiltered) 0.52 mJy/beam (Filtered)
- Average Flagging: ~ 2.5 -3%

Time-domain Astronomy

Unfiltered



Filtered

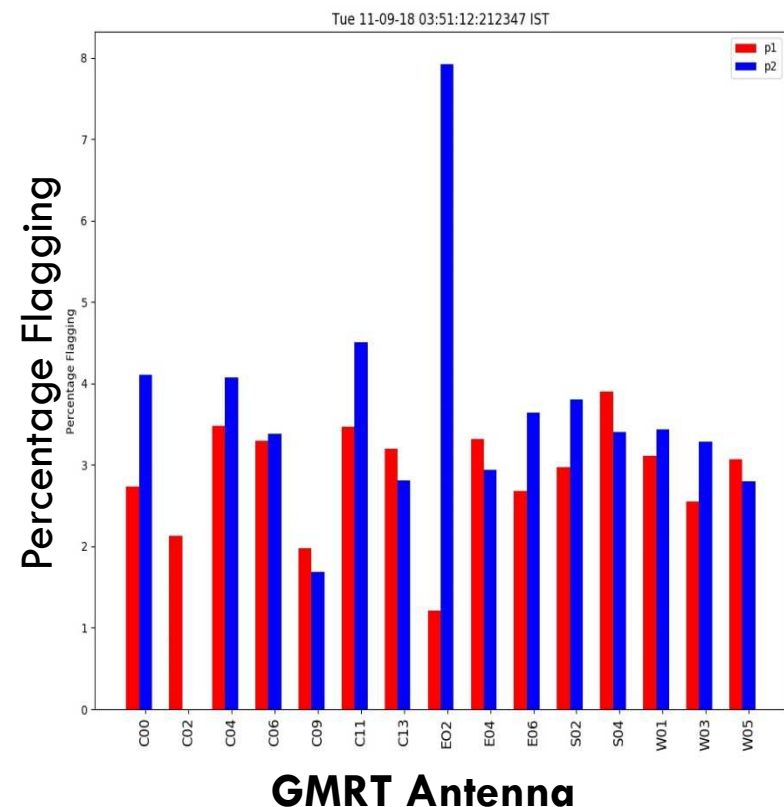


- Pulsar (J0418-4154) profile comparison: Incoherent Array beam - 4096 spectral channels 327.68 μ s integration time.
- SNR improvement by factor of 3; Average Flagging \sim 3%

Filtering System: Features

- Filtering threshold, replacement option are user-defined
- Replacement options – digital noise, threshold, zero, constant value
- Observation command file can include options for recording the flagging count
- Recommended options:
 - ▣ 3σ (pulsar), 4σ (continuum)
 - ▣ Replacement by digital noise
 - ▣ Recording counter every five minutes

Typical counter plot showing antenna-wise flagging percentage



http://www.gmrt.ncra.tifr.res.in/~kdbuch/counter_page/counter_flagging.html

RFI Filtering Usage in GTAC Cycles 39 and 40 (uGMRT Bands-2 and 3)

