

# Real time RFI monitoring for Radio Telescope array

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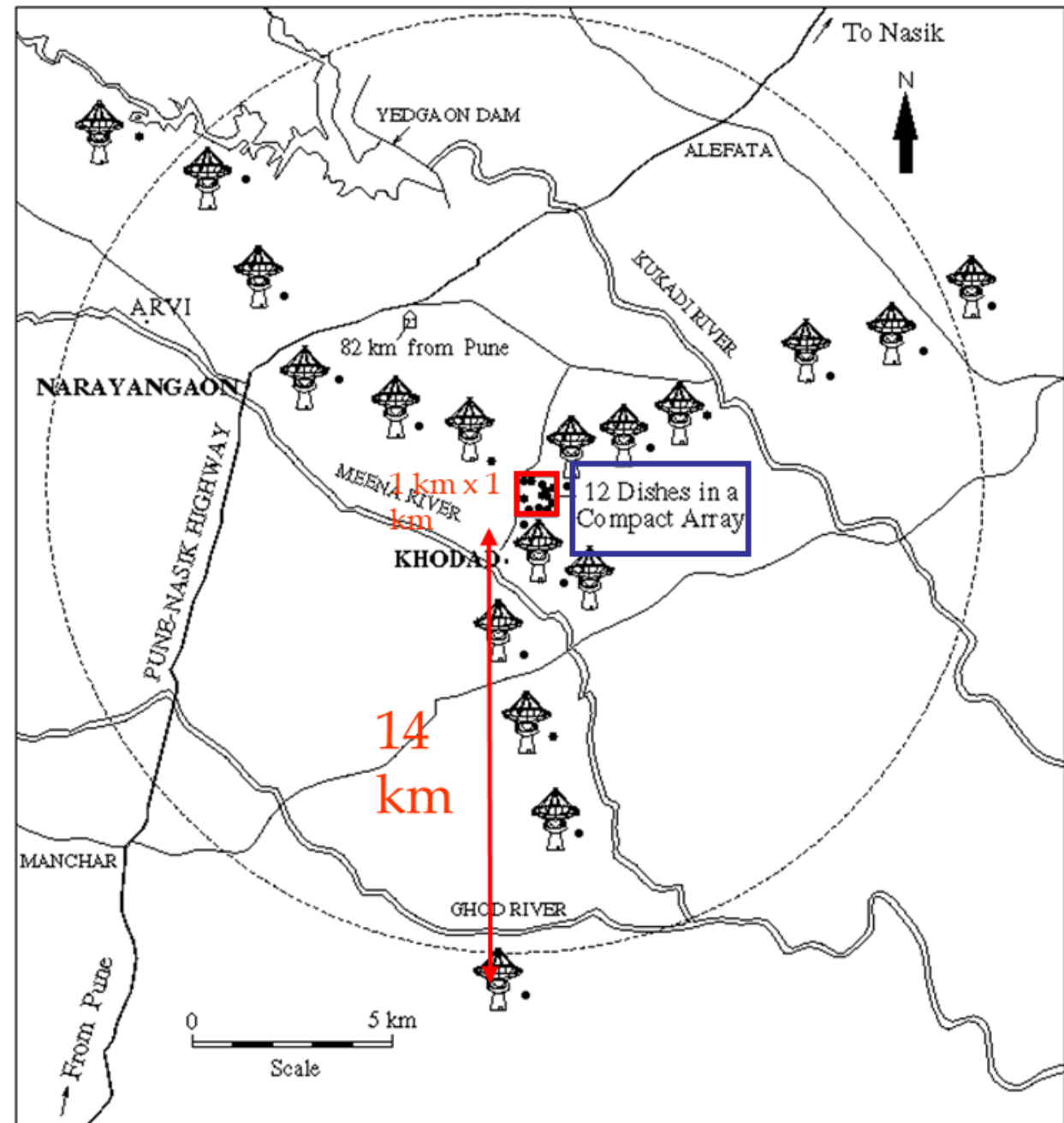
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# LOCATIONS OF GMRT ANTENNAS ( 30 dishes )



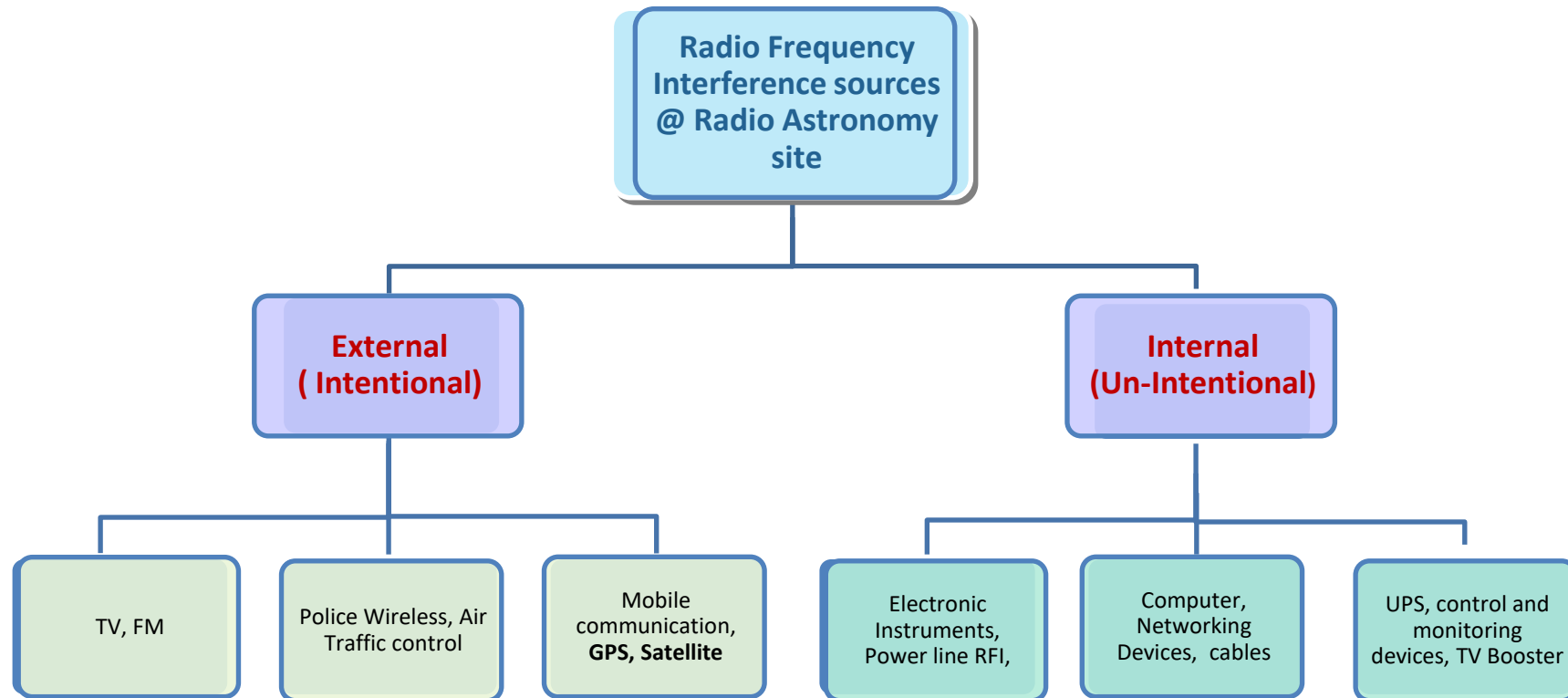
# Introduction

- ▶ The GMRT array of 30 antennas bring in two broadband RF signals from the remotely located antennas to CEB.
- ▶ Operating frequency band of 130-1500 MHz
- ▶ The quality of data and interference present in remotely located frontend system is monitored and diagnosed using the received RF signal.
- ▶ This needs a real time RF monitoring system with 60 channels (30 antennas x 2 polarization).

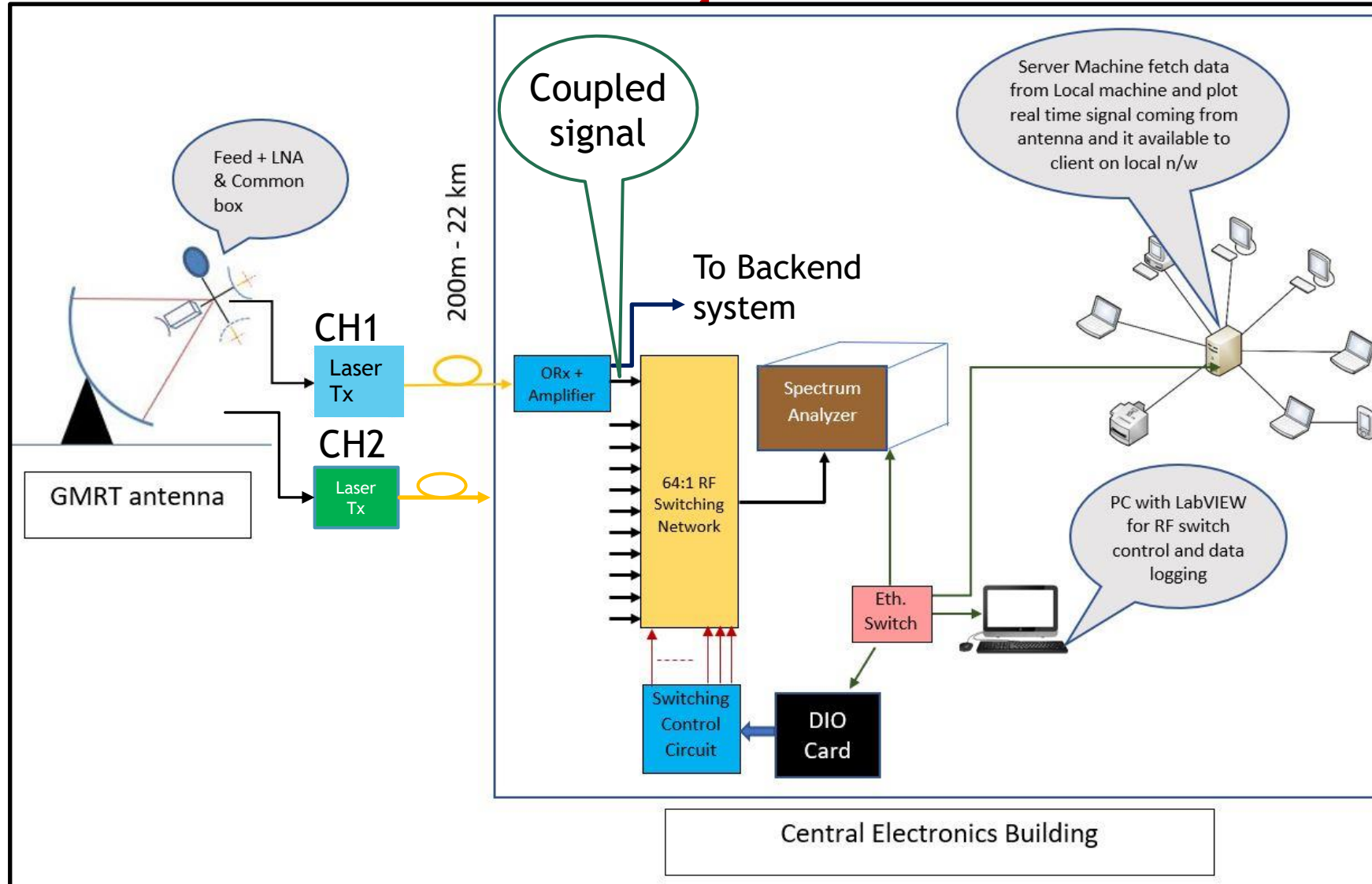
# GMRT Bands

<b>GMRT : Operating Frequency Bands</b>		
<b>Frequency</b>	<b>Radio Astronomy band</b>	<b>Upgraded system Bandwidth</b>
<b>150MHz</b>	<b>150-153.6MHz</b>	<b>130-260MHz</b>
<b>235MHz</b>	<b>230-235MHz</b>	<b>250-500MHz</b>
<b>327MHz</b>	<b>322-328.6MHz</b>	<b>250-500MHz</b>
<b>610MHz</b>	<b>604-616MHz</b>	<b>550-900MHz</b>
<b>1060-1420MHz</b>	<b>1400-1427MHz</b>	<b>1000-1450MHz</b>

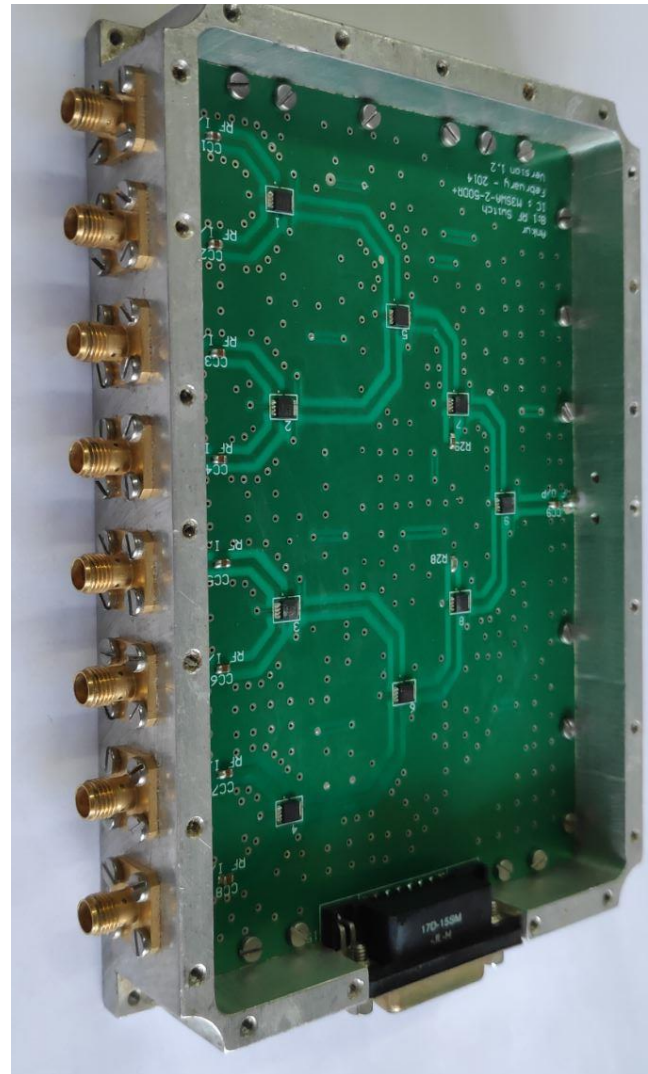
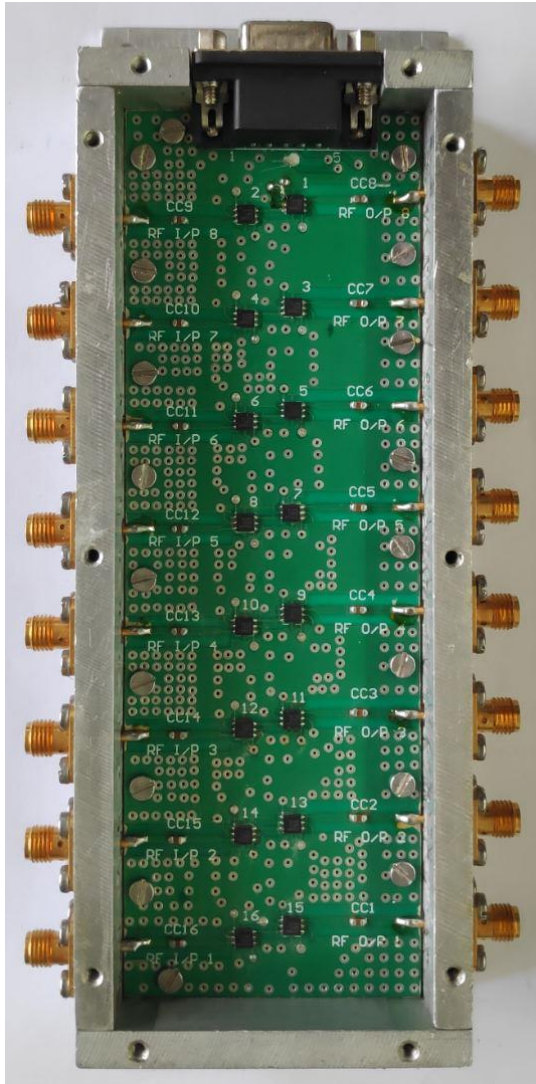
# Radio Frequency Interference sources



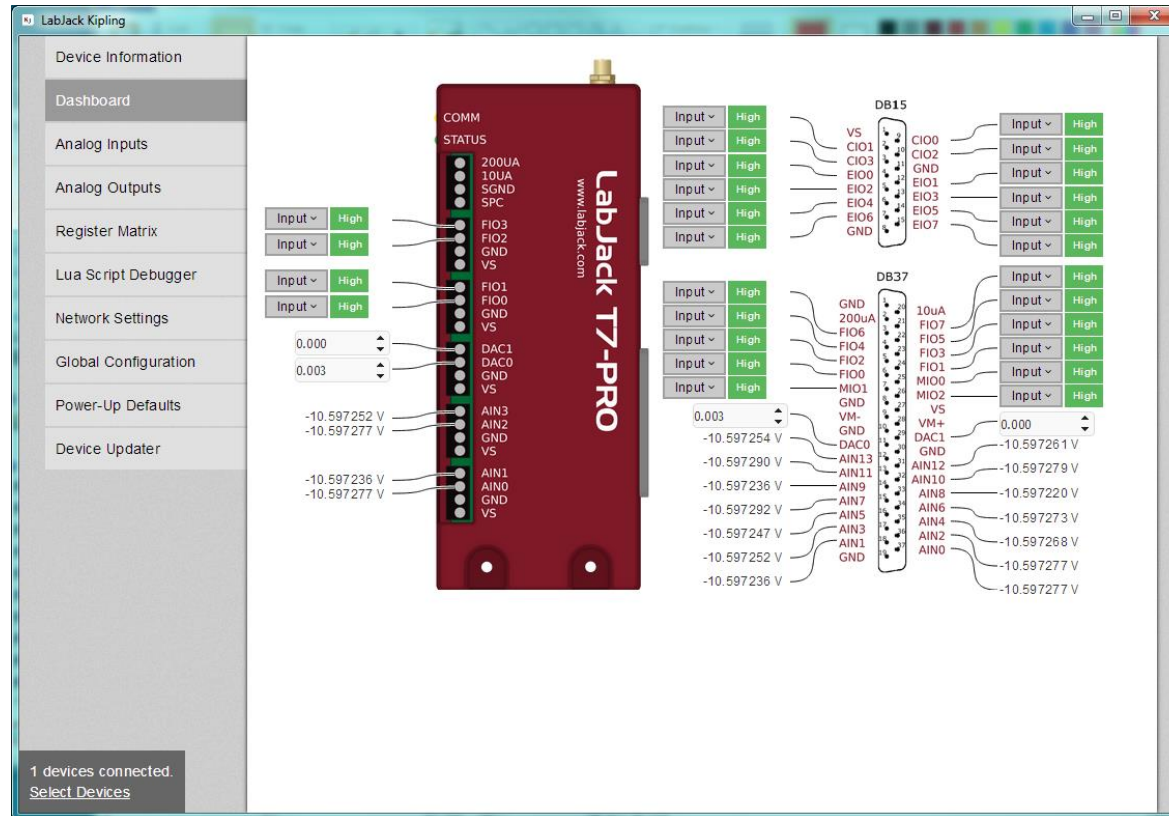
# Block Diagram of 60:1 RF monitoring



# Integrated 8:8 and 8:1 RF switch



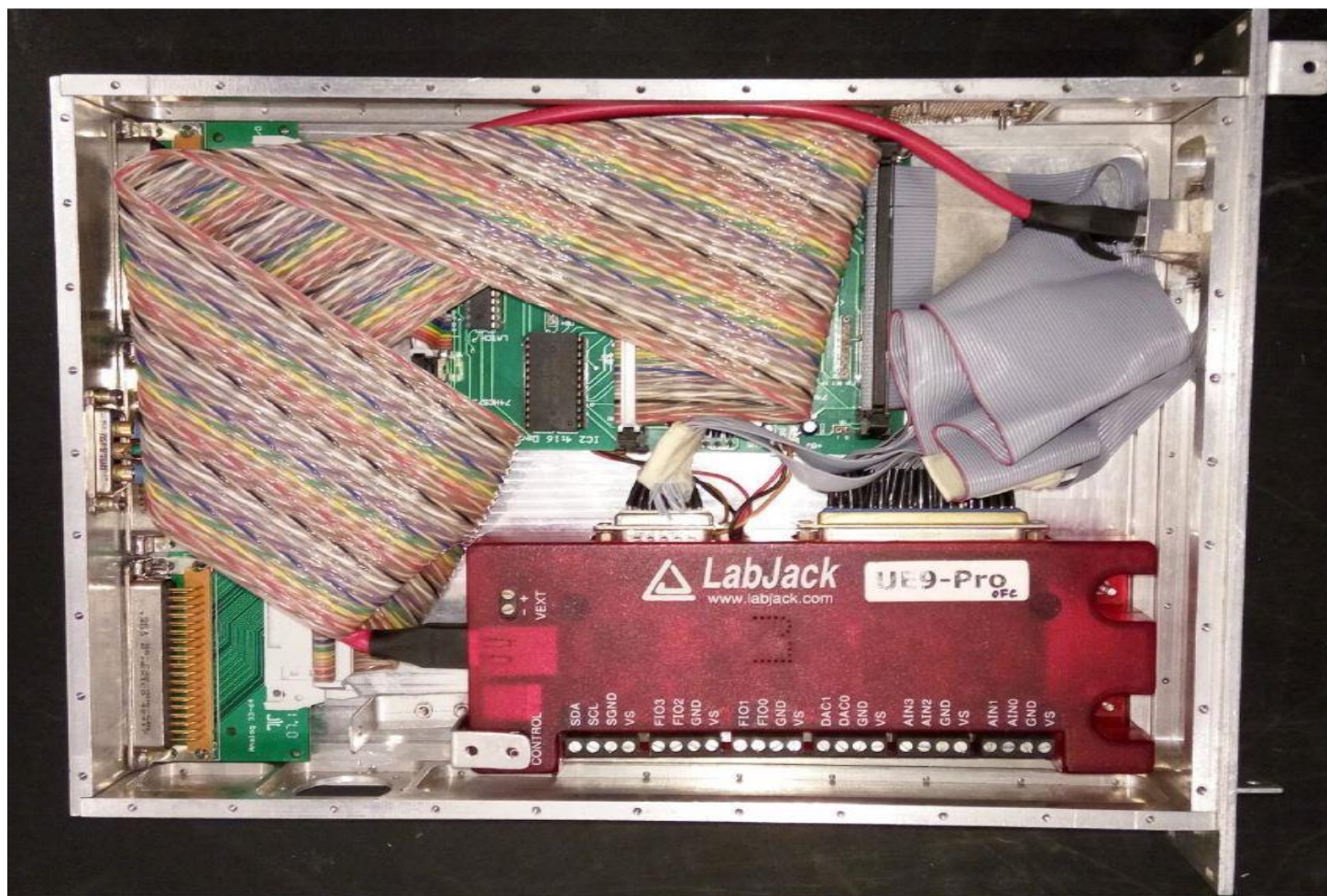
# Multifunction Data Acquisition (DAQ) hardware



LabJack is a multipurpose measurement and automation devices which provide analog and digital inputs and outputs.

LabVIEW drivers for Labjack card is available for high level programming.

# Shielded Enclosure for the Control Unit

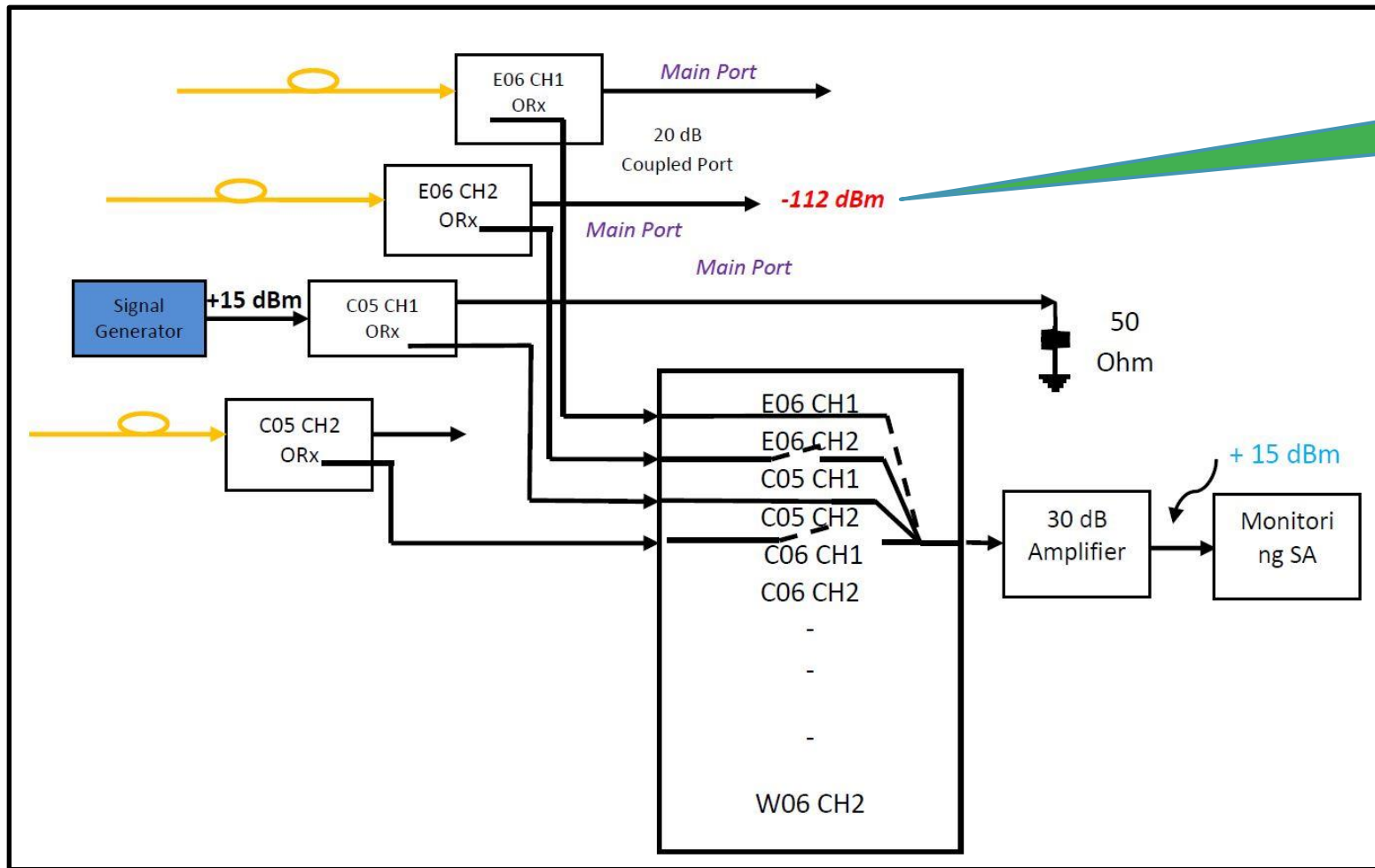


Switching control signal conditioning circuit

Digital logic used to minimize the use of control bits

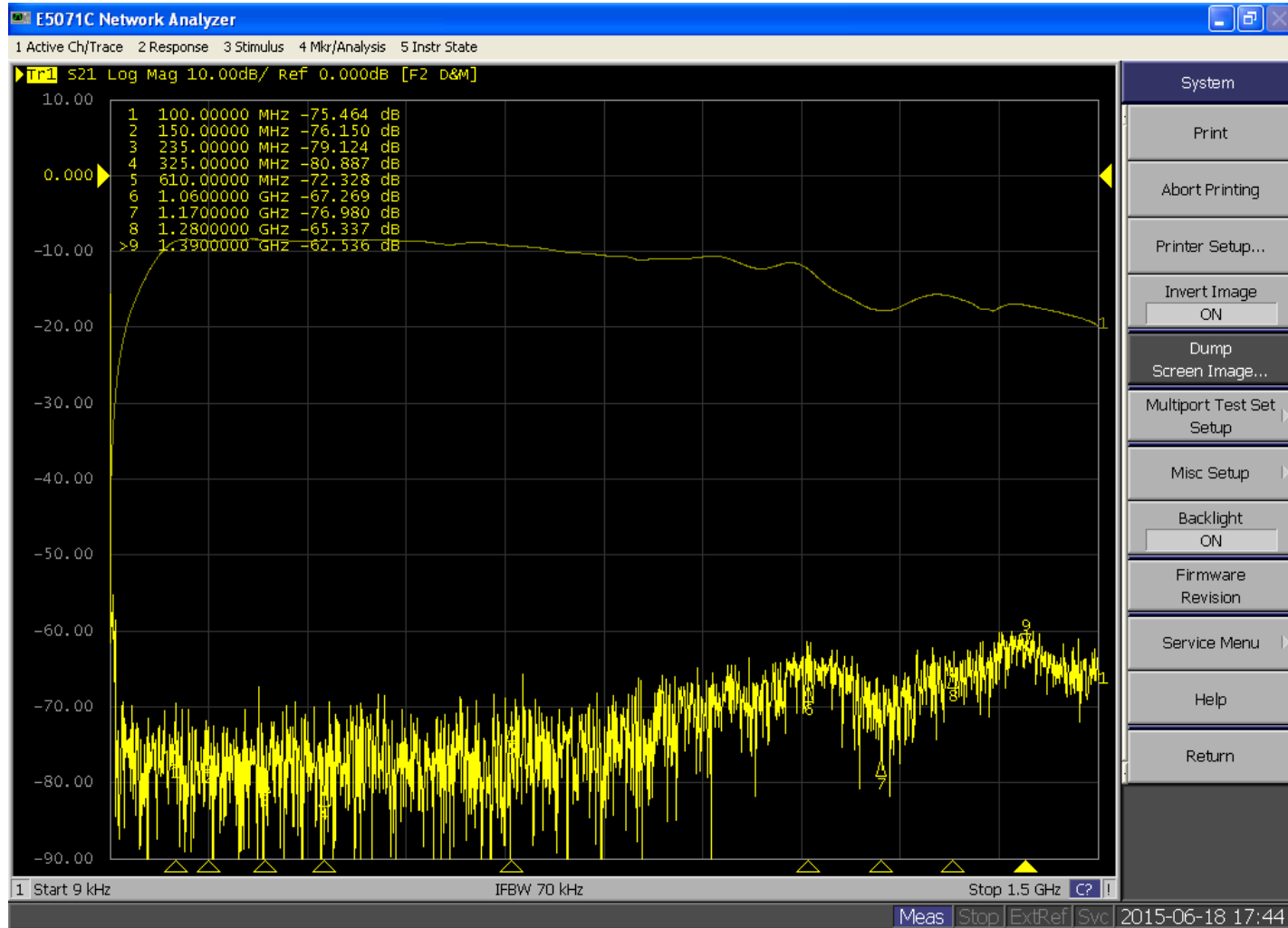


# Adjacent channel isolation measurement



Isolation of 127 dB

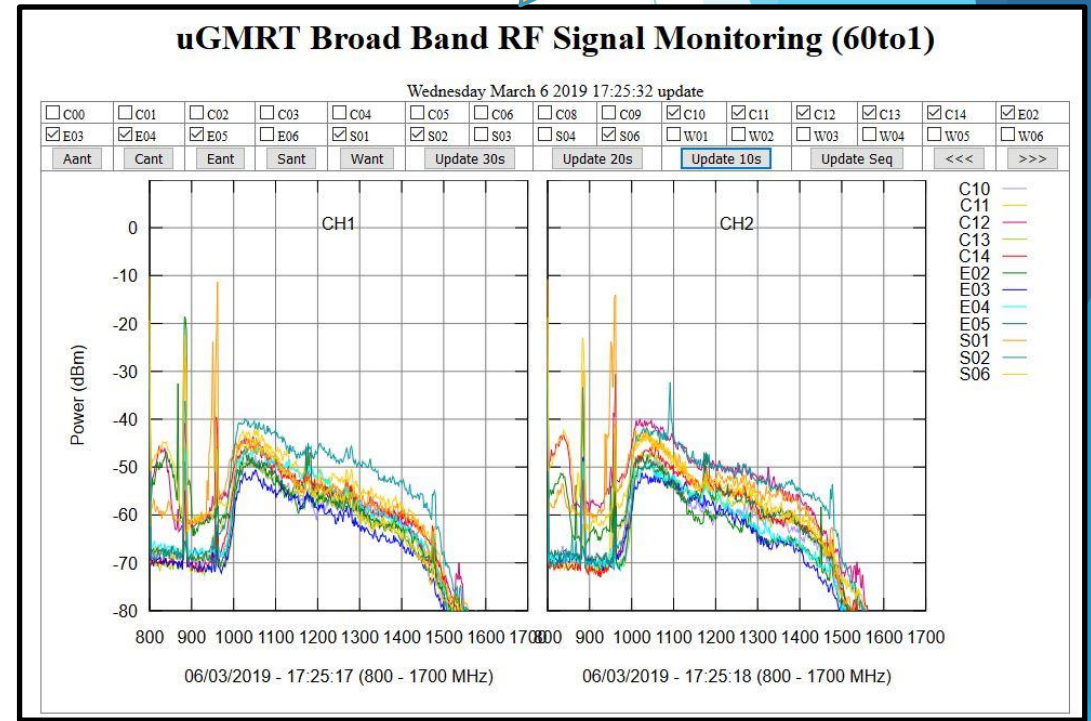
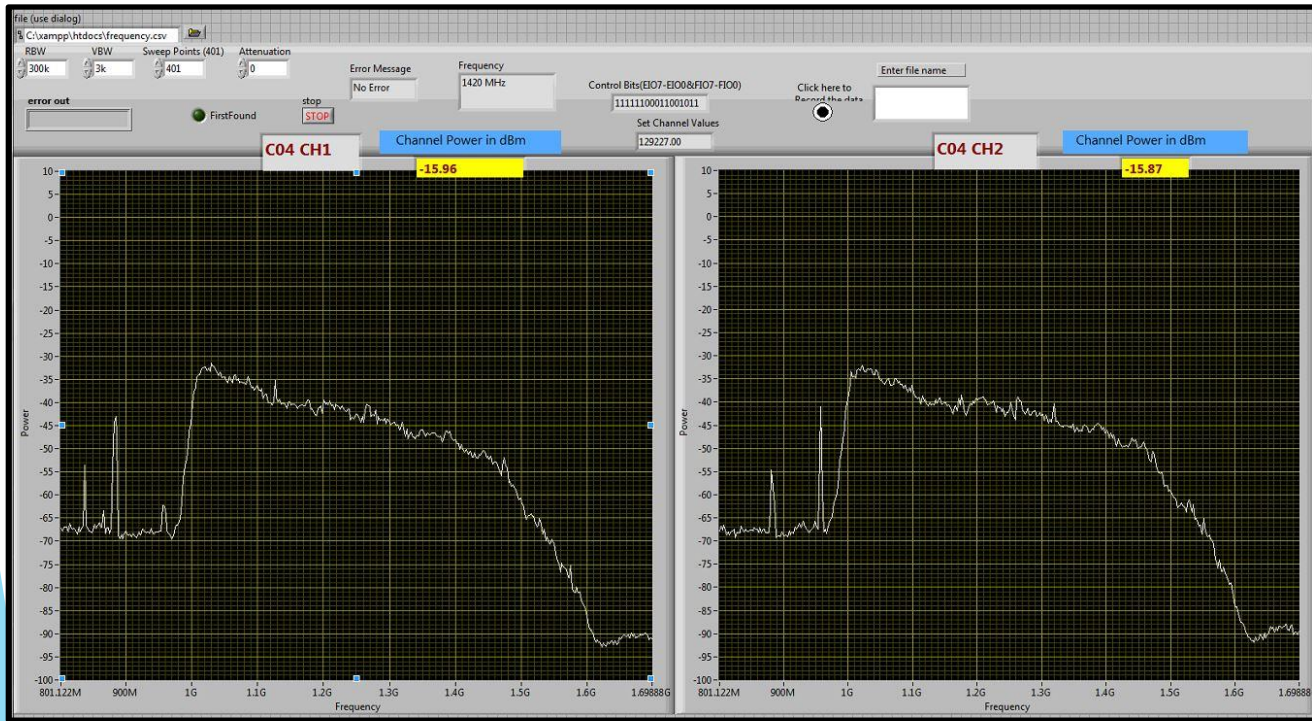
# Isolation Between I/P and O/P port with switch ON and OFF



# Spectrum Display of the Monitoring System

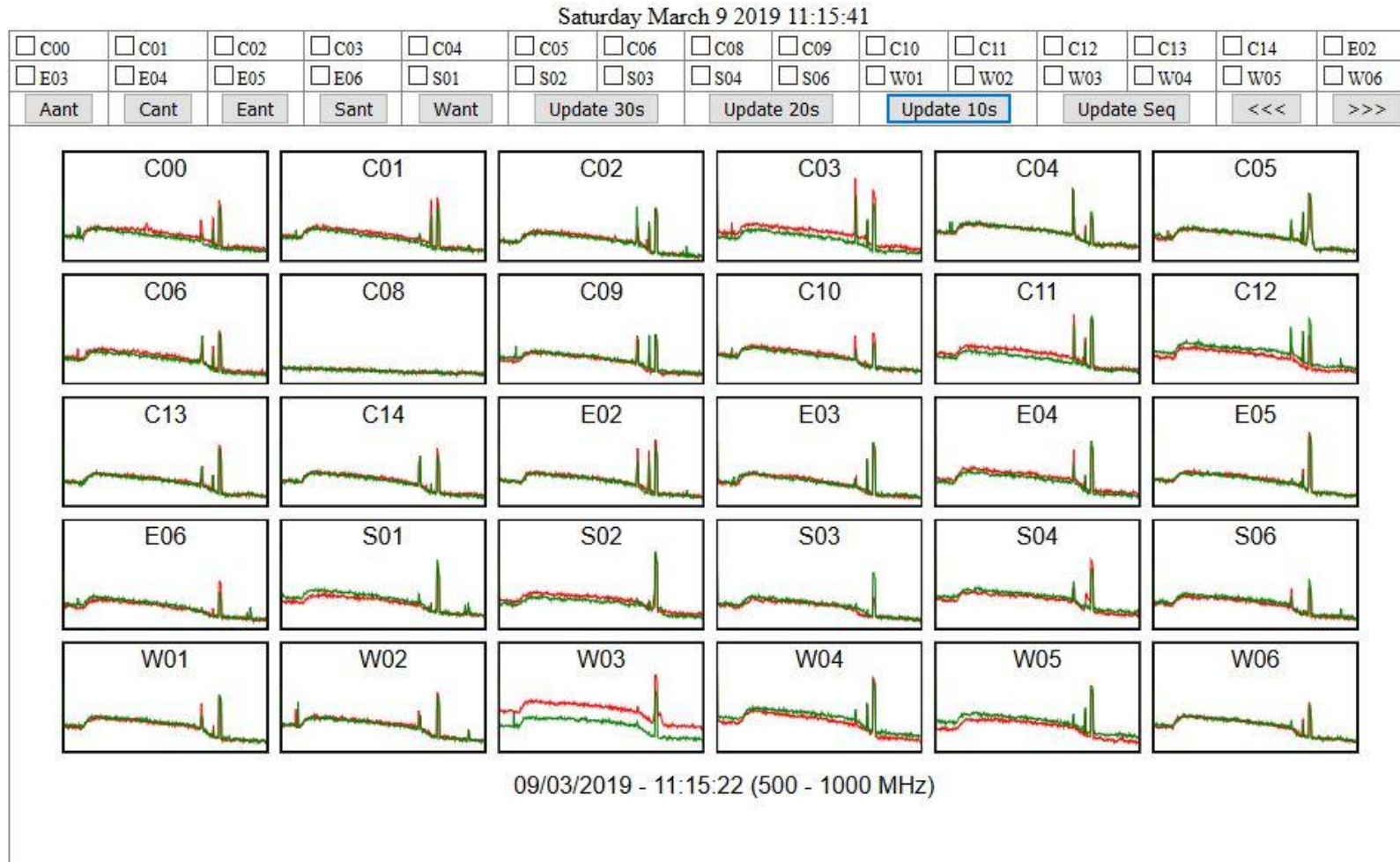
LabVIEW Spectrum Display

Antenna plots on server



# 30 antenna array monitoring window for the control room operator

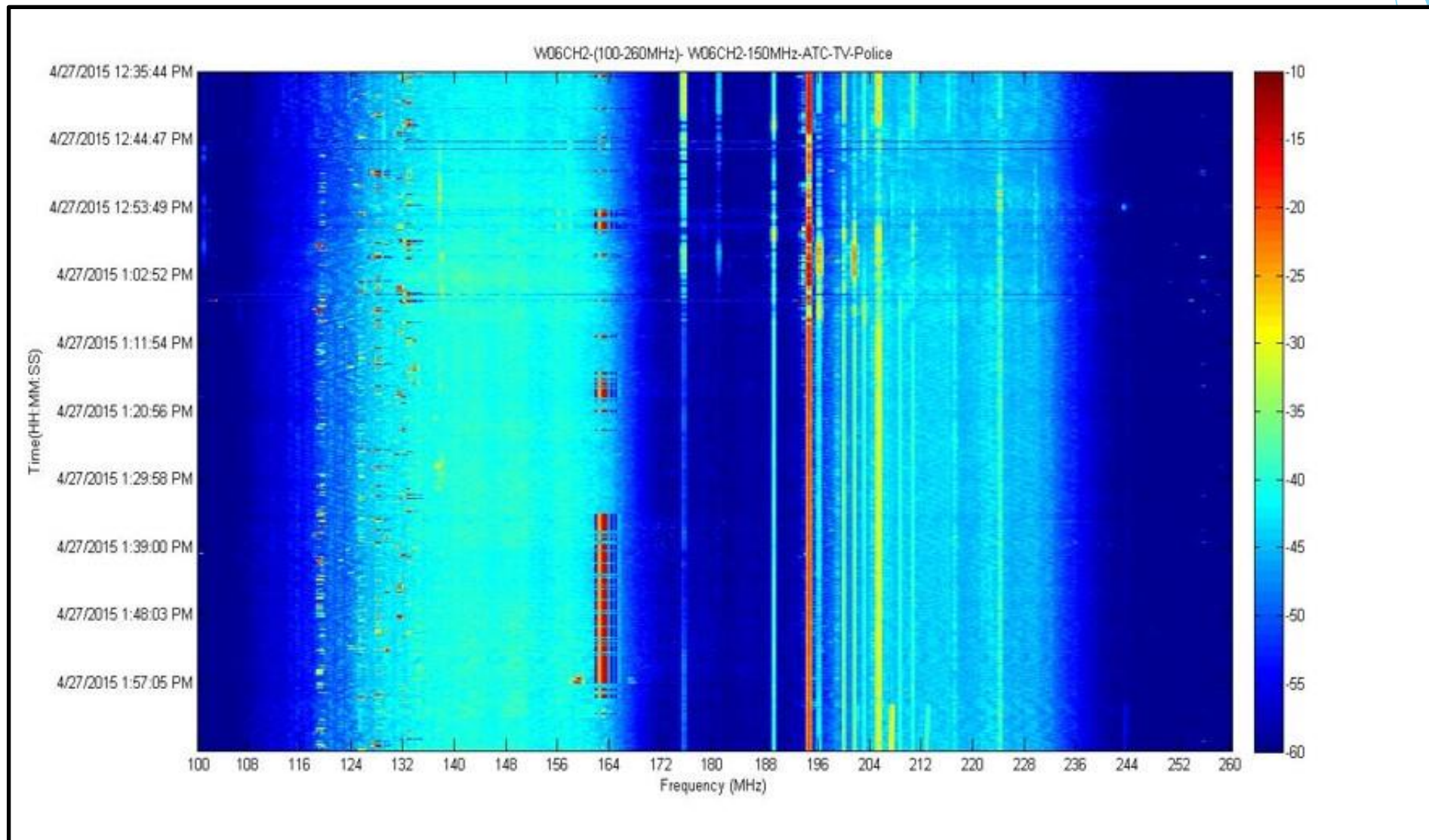
## uGMRT Broad Band RF Signal Monitoring (60to1)



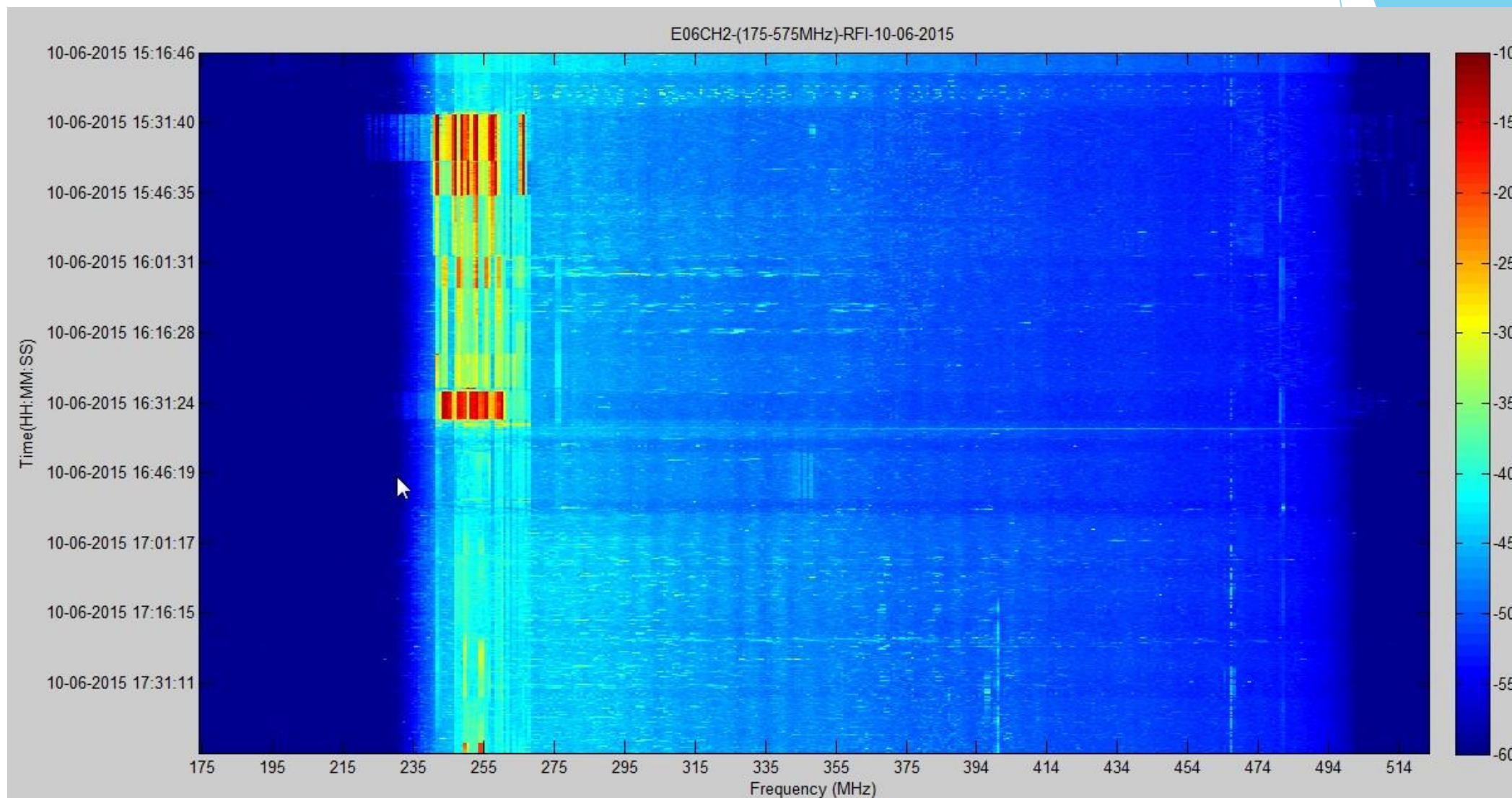
# Other Applications of the Monitoring system

- ▶ Radiation pattern measurement of the antenna using satellite as it far field source
- ▶ To study the IMD products generated in the band due to out of band Interference

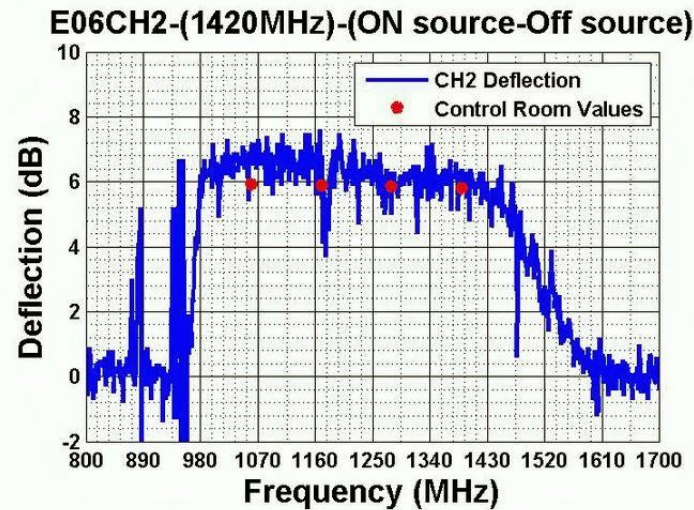
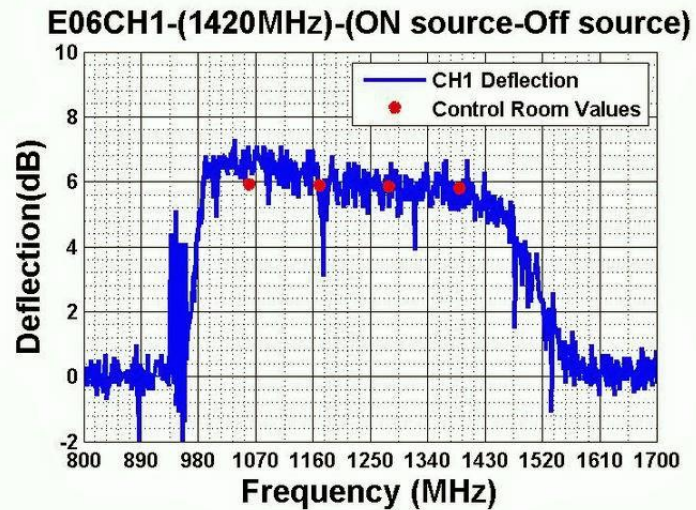
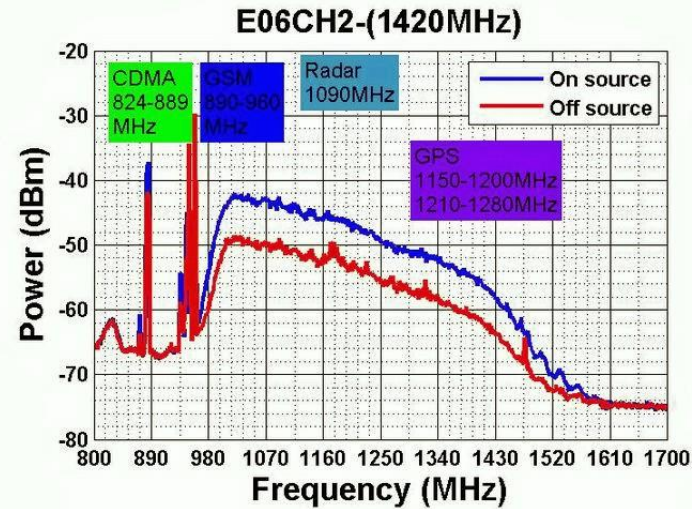
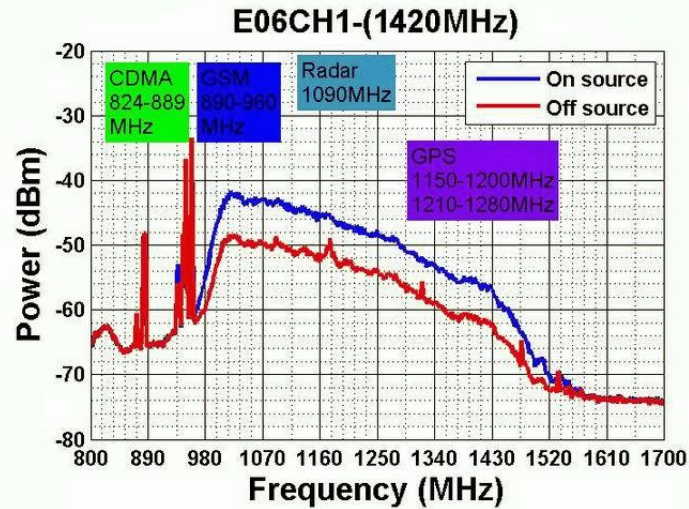
# Spectrogram for Band-2 Observation generated by the monitoring system



# US military Satellite interference seen with the monitoring system



# Antenna Sensitivity (Source Deflection) measurement



# Application

- ▶ Real time RFI monitoring in the band of observation
- ▶ Localised RFI in the array could be identified
- ▶ Real time monitoring of RF band power, frequency response and failure of any antenna in the array.
- ▶ Regular ON source and off source measurement carried with all antenna in the array to study the sensitivity of the antennas in automated way.
- ▶ Stability of the receiver system is studied using spectrum recording and generate spectrogram plot
- ▶ Daily report generation and archiving
- ▶ Remote access to all users

# Future scope

- To provide real time water fall plot for each RF channels.
- **Real time information about RFI during observation and data flagging.**
- Generate alarm for RF saturation and no signal condition due to failure of receiver or Link.
- **Provide information to noise cancellation system for real time mitigation.**
- Direction finding algorithm could be developed with the real time data.
- **Using AI real time tagging of known RF signal in the spectrum**
- Speed of acquiring data could be enhanced using high speed machines and hardware

## conclusion

- ▶ We have implemented 60 channel RFI monitoring system for the 30 antenna array of GMRT.
- ▶ There is wide scope to build various application for spectrum monitoring and characterization with the developed hardware in real time.

# Thank you

