

DBF in Focal Plane Array



Guided by –
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Flow

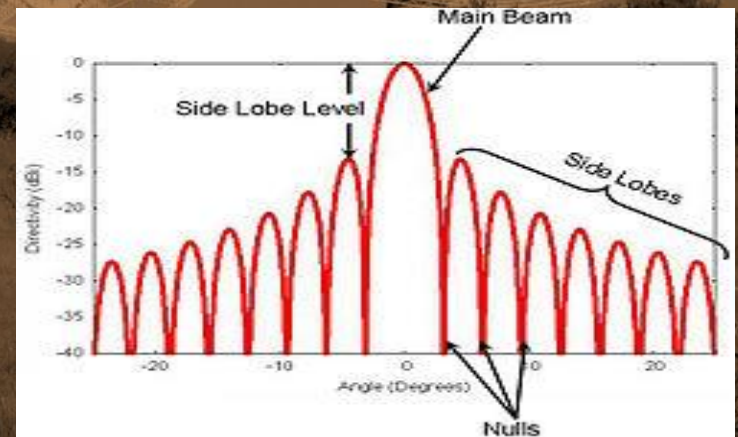
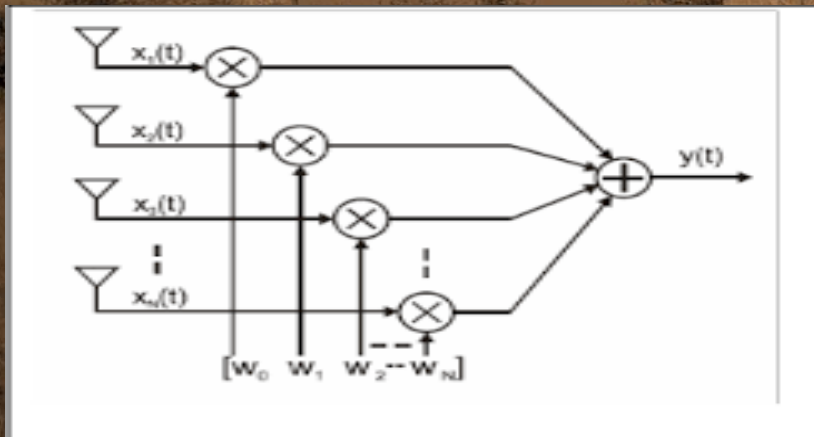
- ❑ **Theory of Beamforming**
Beamforming Techniques
Performance Impacting Factors
Analysis through Matlab simulation.
- ❑ **LOFAR Station Signal Processing**
Functioning of DCU,RCU,RSP,BLP Module.

Theory Of Beamforming

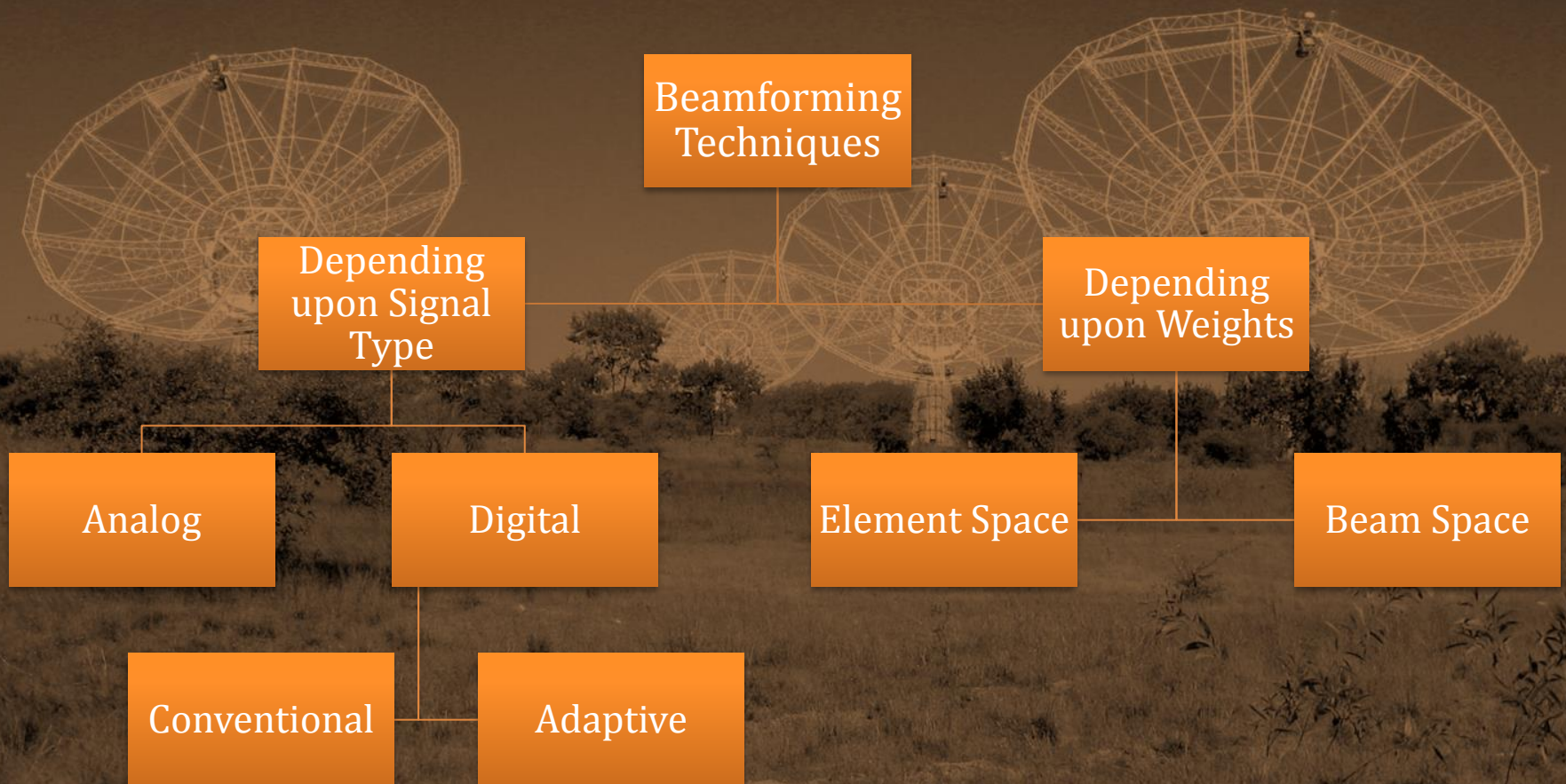
What is Beamforming ?

Beamforming or **spatial filtering** is a signal processing technique used in sensor arrays for directional signal transmission or reception. Beamforming allows controlling amplitude and phase of each antenna element.

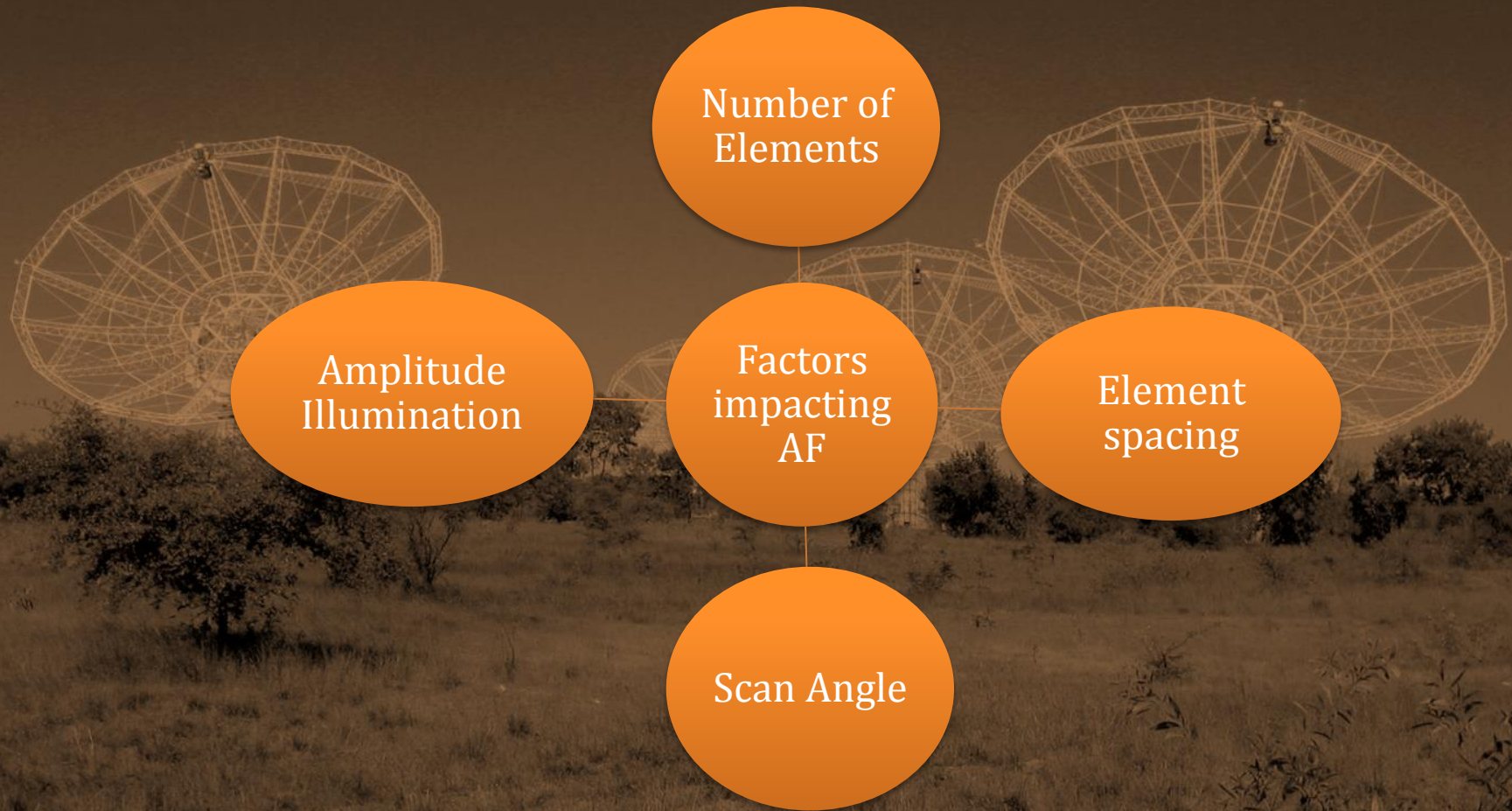
Combined amplitude and phase control allows one to adjust side lobe levels and steer nulls better.



Beamforming Techniques



Performance impacting factors



Number of Elements

In an Array, there is trade-off between the number of elements and the AF performance.

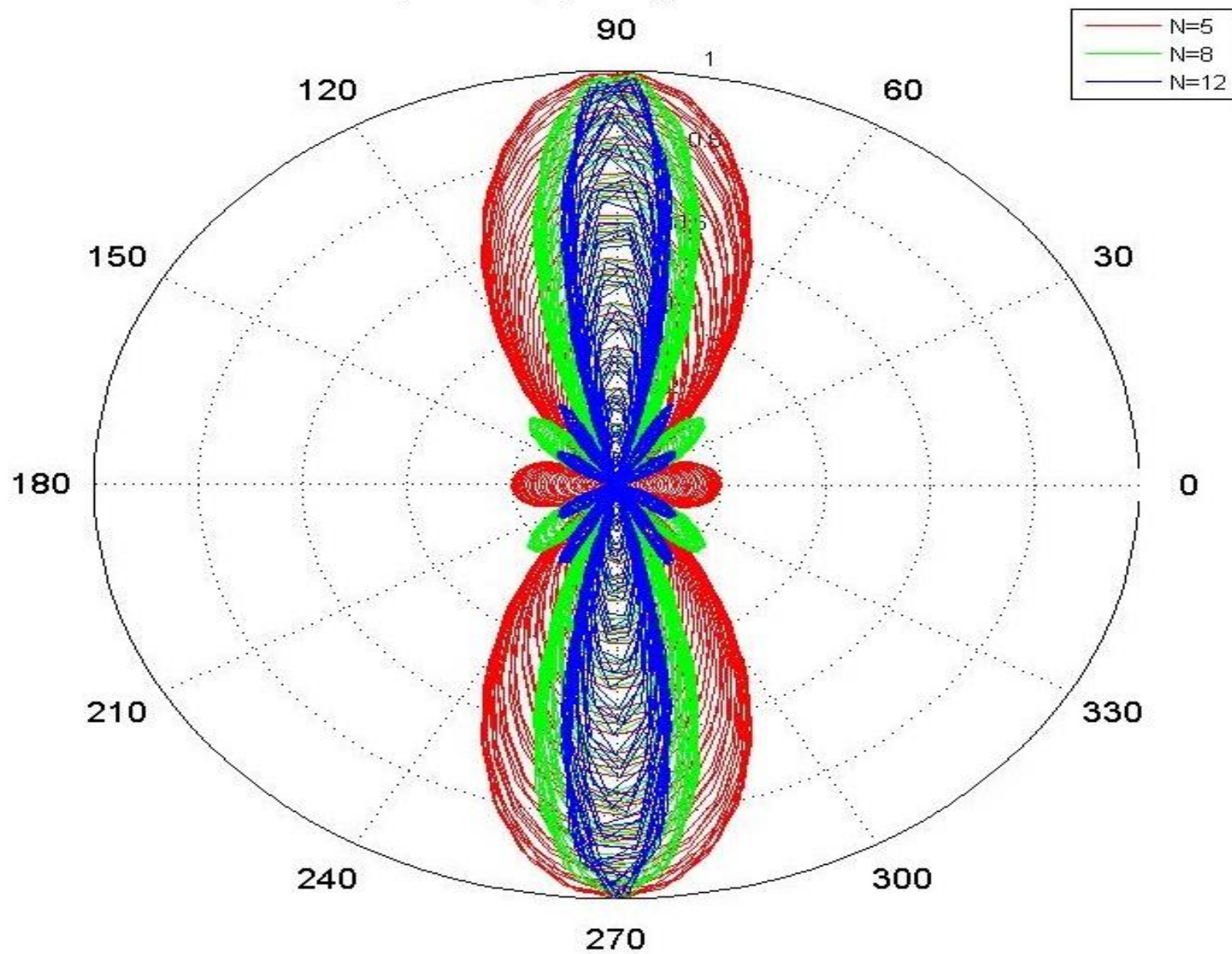
Advantages of more number of elements :

- AF has more sidelobes but their levels are lower.
- Improves directionality and interference is cancelled more effectively.
- Number of nulls is increased and they are deeper.
- The beams are narrower and the gain of the array is higher.

Matlab Simulation

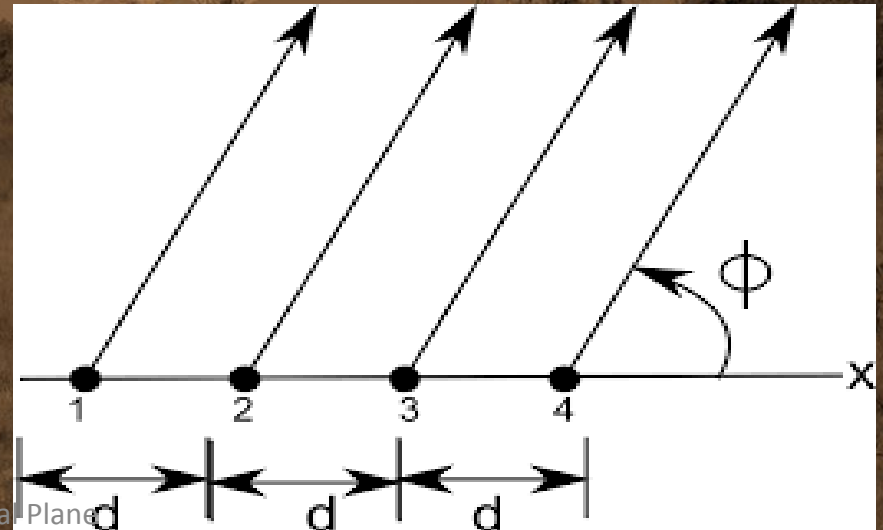
Varying the Number of Elements :

Resultant Pattern with freq=150e6, spacing=0.5 and number of elements varied

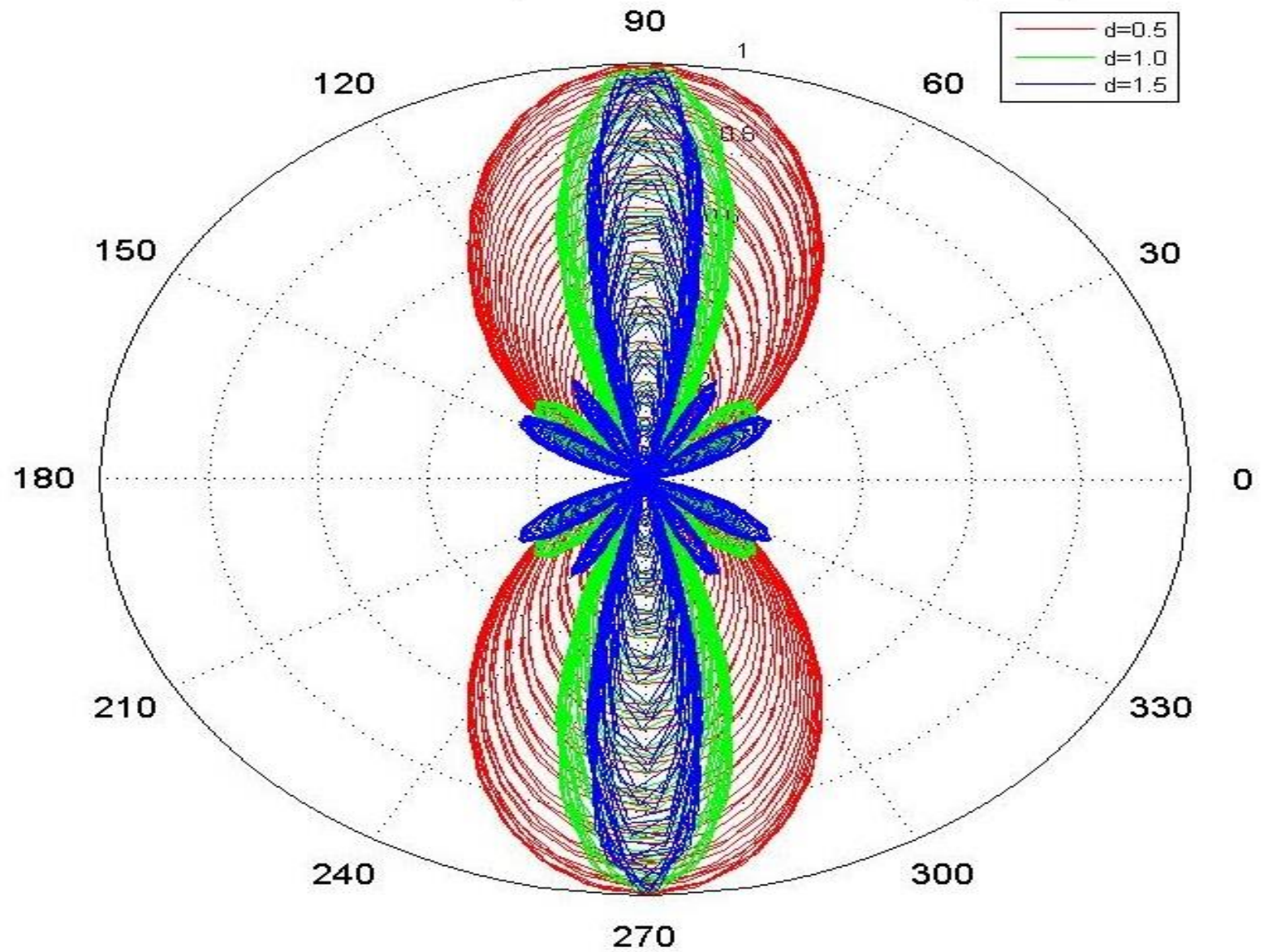


Element Spacing

- Determines the aperture for the array.
- As the spacing is increased, sidelobes, with equal gain to the main beam, appear. These are called “**grating lobes**”.
- The grating lobes can be prevented by reducing the element spacing.
- As the elements are closer to each other, their mutual coupling increases.
- Matlab Simulation
Varying the Number of Elements :



Resultant Pattern with freq=150e6, elements=4 and spacing varied



LOFAR Station Signal Processing

The embedded processing of LOFAR Station is to convert the antenna signal to baseband level, filter the digital antenna data, transform the data into frequency domain, select frequency ranges and beamforms them.

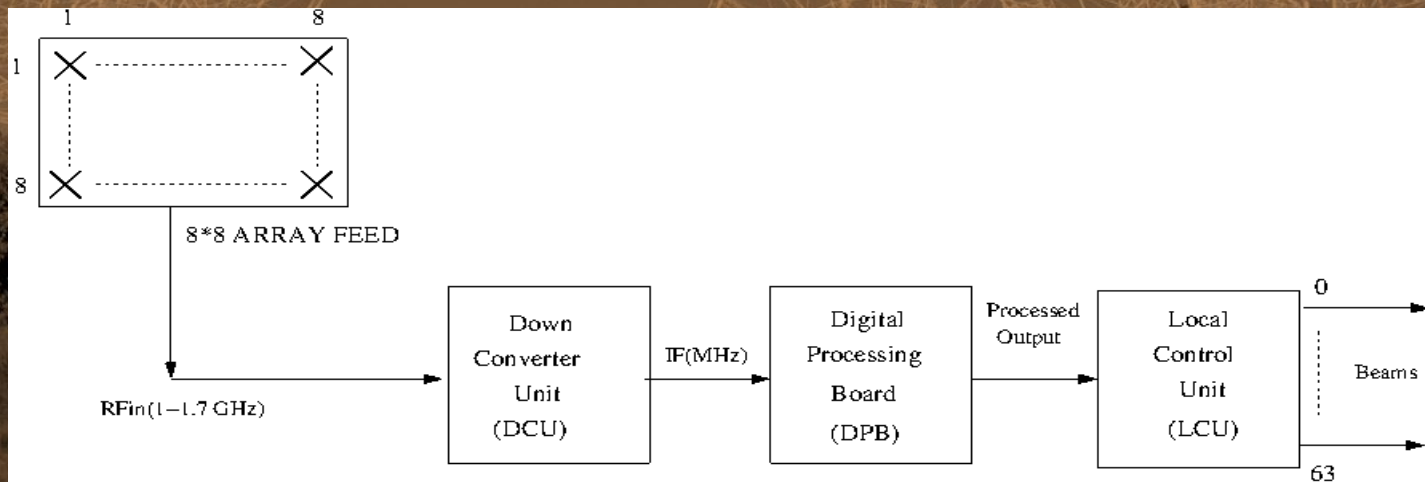


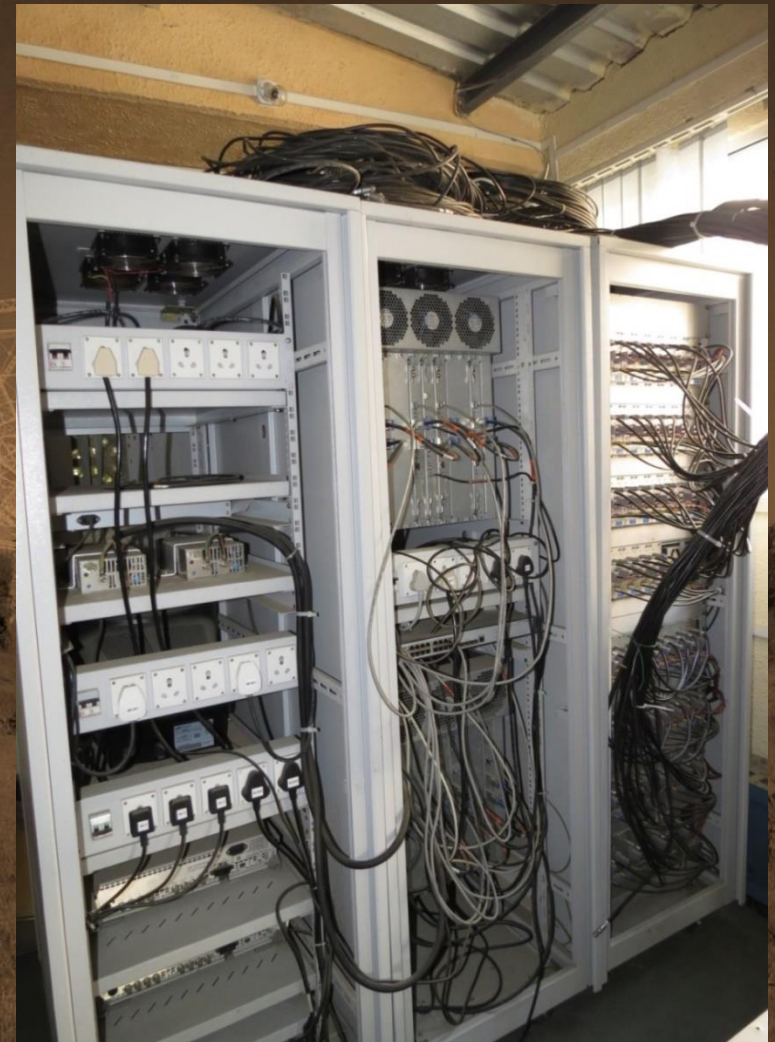
Fig : Receiver chain of FPA Beamformer

FPA Racks

Rack 1 : 64 Down Converter Units

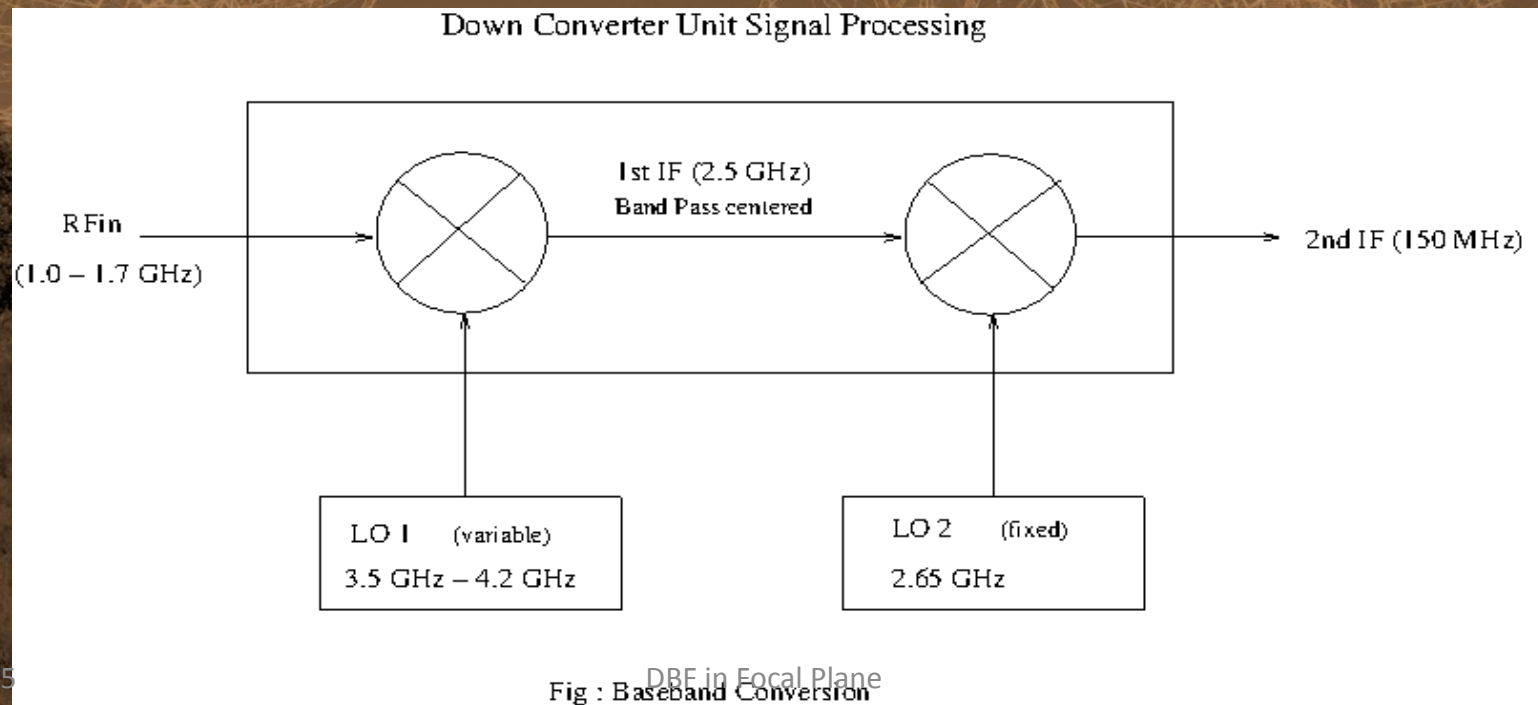
Rack 2 : Two subbracks of Digital Processing Board.

Rack 3 : Local Control Unit PC with Redhat Linux Operating System.



Down Conversion Unit (DCU)

The RF Frequency is down converted to baseband level. It involves double down conversion of the signal where one conversion shifts the RF frequency to first IF at 2.5 GHz and the other to the 150 MHz .



Receiver Unit (RCU)

The IF Freq comes to the Receiver Unit consisting three different input. There's not only the selection for input but also for the filter type. Conversion to baseband is performed using 12 bit ADC.

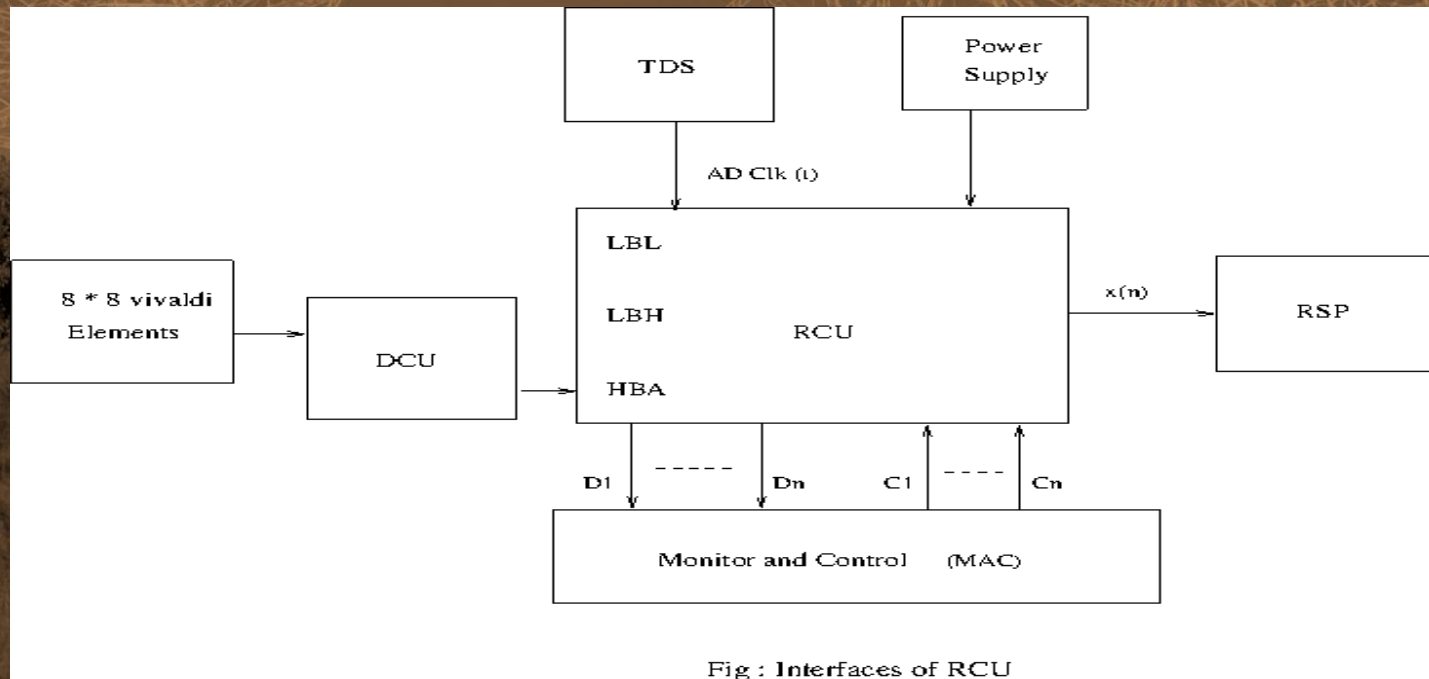


Fig : Interfaces of RCU

Functioning of RSP Board

- Each RSP has 4 AP
- Each AP has 2 RCU connected
- Data from AP comes to the BP

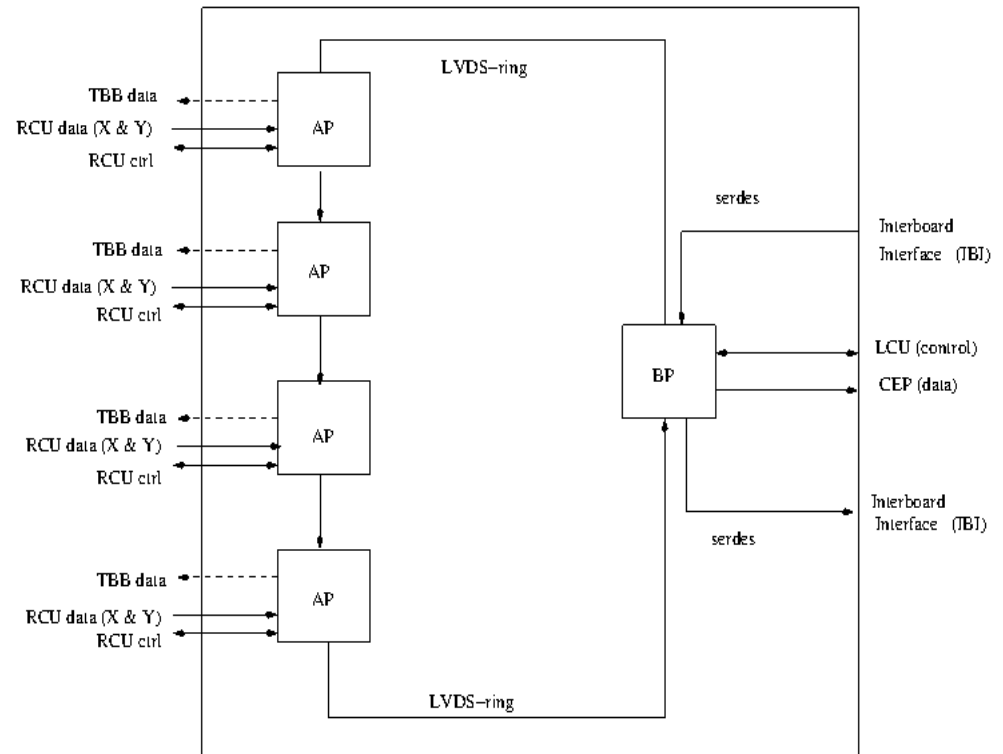


Fig : Functional Layout of RSP Board

DBF in Focal Plane

Functioning of BLP Module

BLP is a Module inside AP that processes RCU antenna data into beamlet data.

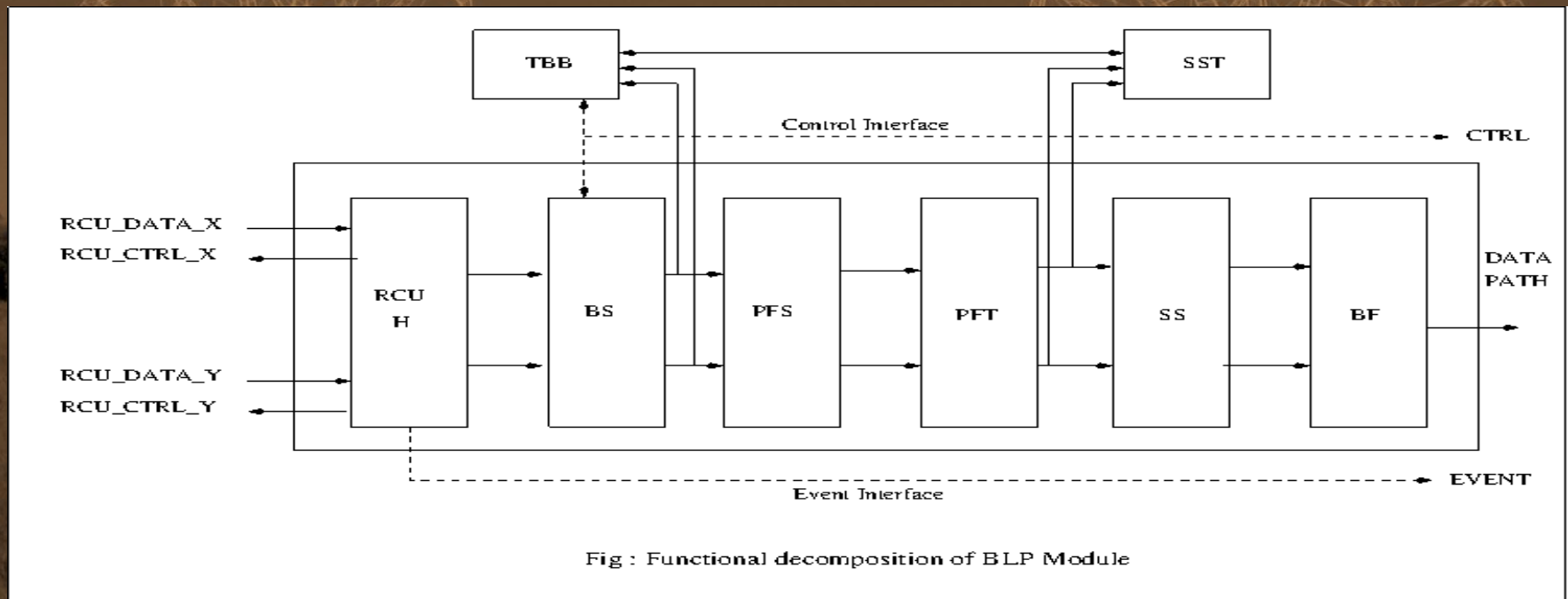


Image Courtesy: LOFAR Station processing

DBF in Focal Plane

Plots of FPA System

1. [Plot \(Providing 150e6 Signal right at the Receiver unit input\)](#)
2. [Plot \(Providing RF signal at the Down converter unit input\)](#)

Future scope for FPA

- Simulation of 64 inputs in matlab using different toolboxes; such as antenna array, phased array etc.
- Performing beamforming by implementing FPA on 15 metre dish.

THANK YOU.!!



By –
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