

A new antenna for HF-VHF array

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Introduction

The radio frequency band especially HF (High Frequency) to VHF (Very High Frequency) bands containing a lot of radio source information. Such as solar radio bursts, pulsar, planets burst and so on.

But in this band especially the frequency below 100MHz, we have to use many element antennas to form an array beam for improving Gain and Effective Area. The performance of element is one of key parameters for getting good observation results. We have to pay attention to Structural stability and consistency, trend of impedance variation and the purity of polarization.

In this poster, we will introduce our new inverted "V" HF-VHF antenna with a smoother impedance variations range from 0.8Ω to 631.1Ω comparing with the LOFAR LBA antenna whose maximum value is more than one thousand.

And it also has perfect axial ratio less than 0.5dB which is satisfied with the SKA requirement 2165: polarization purity and requirement 2135-38 /2814-15: sensitivity per polarization.

Design Concept

There are many types of antenna for HF-VHF band radio Astronomy. Such as LOFAR LBA , LWA, and so on.In this band, we have to face many difficulties, such as wide input bandwidth (7-9 octaves) , radio frequency interferences, structure stability, consistency for more than 10 thousand elements, cost, materials reliability in outdoors and so on.

But as a first rule for radio astronomy observations, we must focus on the physics needing. So there are some key parameters must be considered in design phase.

The first is **bandwidth** which determines system sensitivity. Specific to the antenna design, the antenna needs smooth and small impedance variations for getting better matching with wideband balun which determines the analog receivers' bandwidth

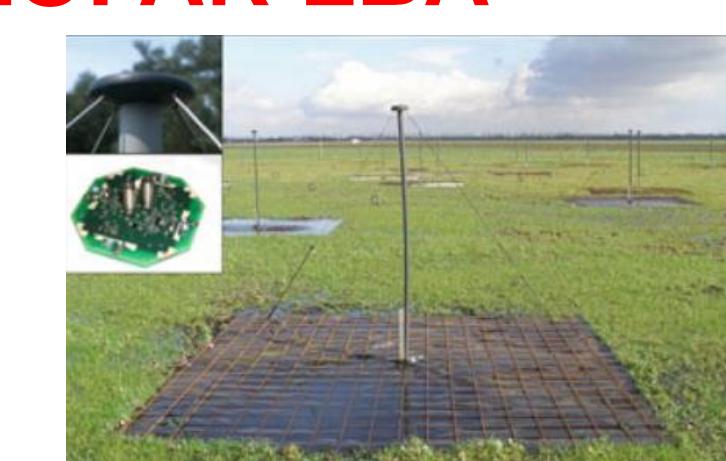
The second is **polarization** which expresses some important information of magnetic field such as solar flares, pulsars and so on.

The third is **consistency** which determines beamforming results.

LWDA Array prototype



LOFAR LBA

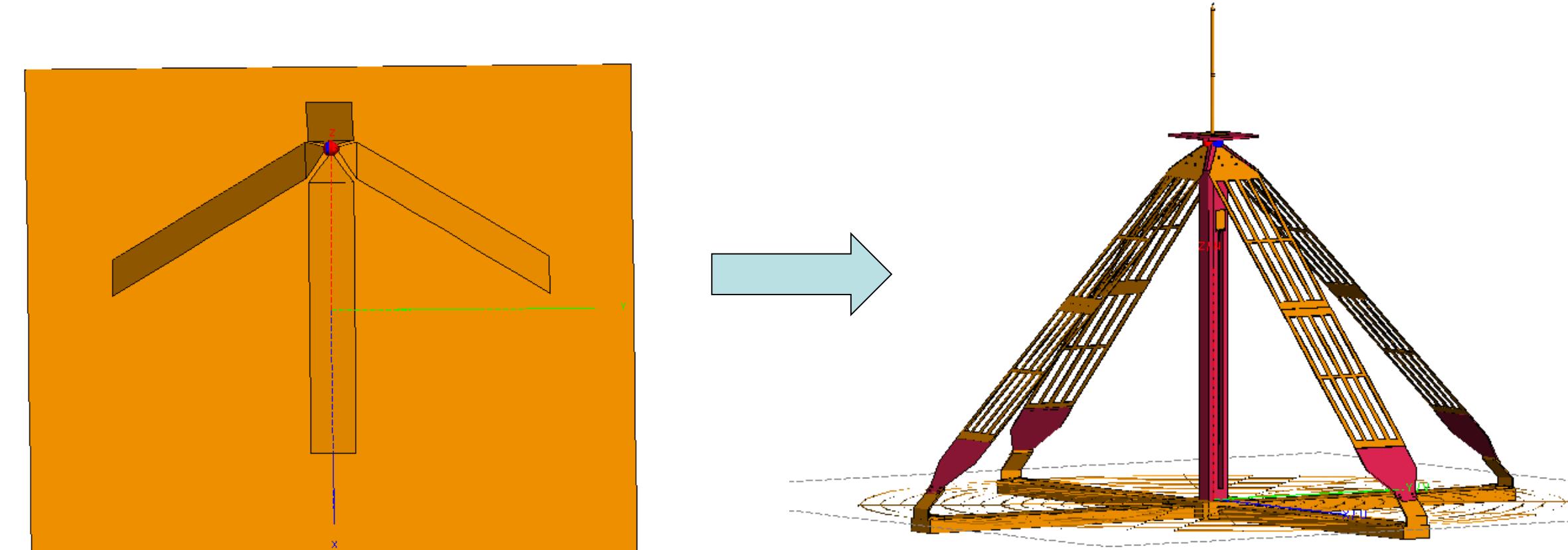


The first thing that came to mind was inverted 'V' antenna with wide sheet metal four arms comparing with LOFAR LBA antenna which uses four thin wires.

But there exists a problem: the wide sheet metal may reduce the polarization purity because of excitation transverse current!

Antenna structure

Combine the advantages of both (LOFAR and LWDA), in our design process, we use multi parallel wires to take place of a whole sheet of metal for one arm.

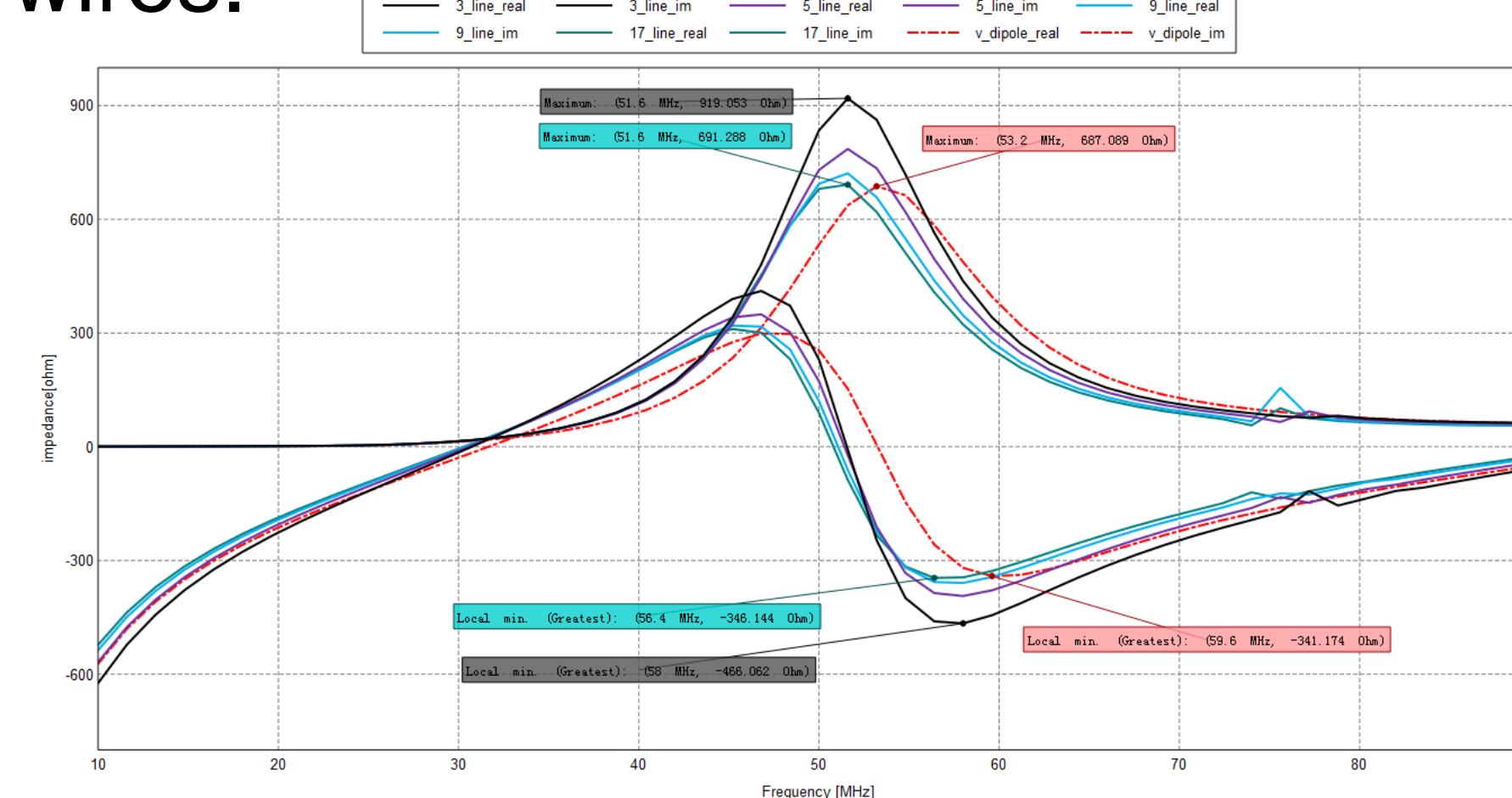


Model of inverted "V" plate dipole antenna with whole sheet metal arm

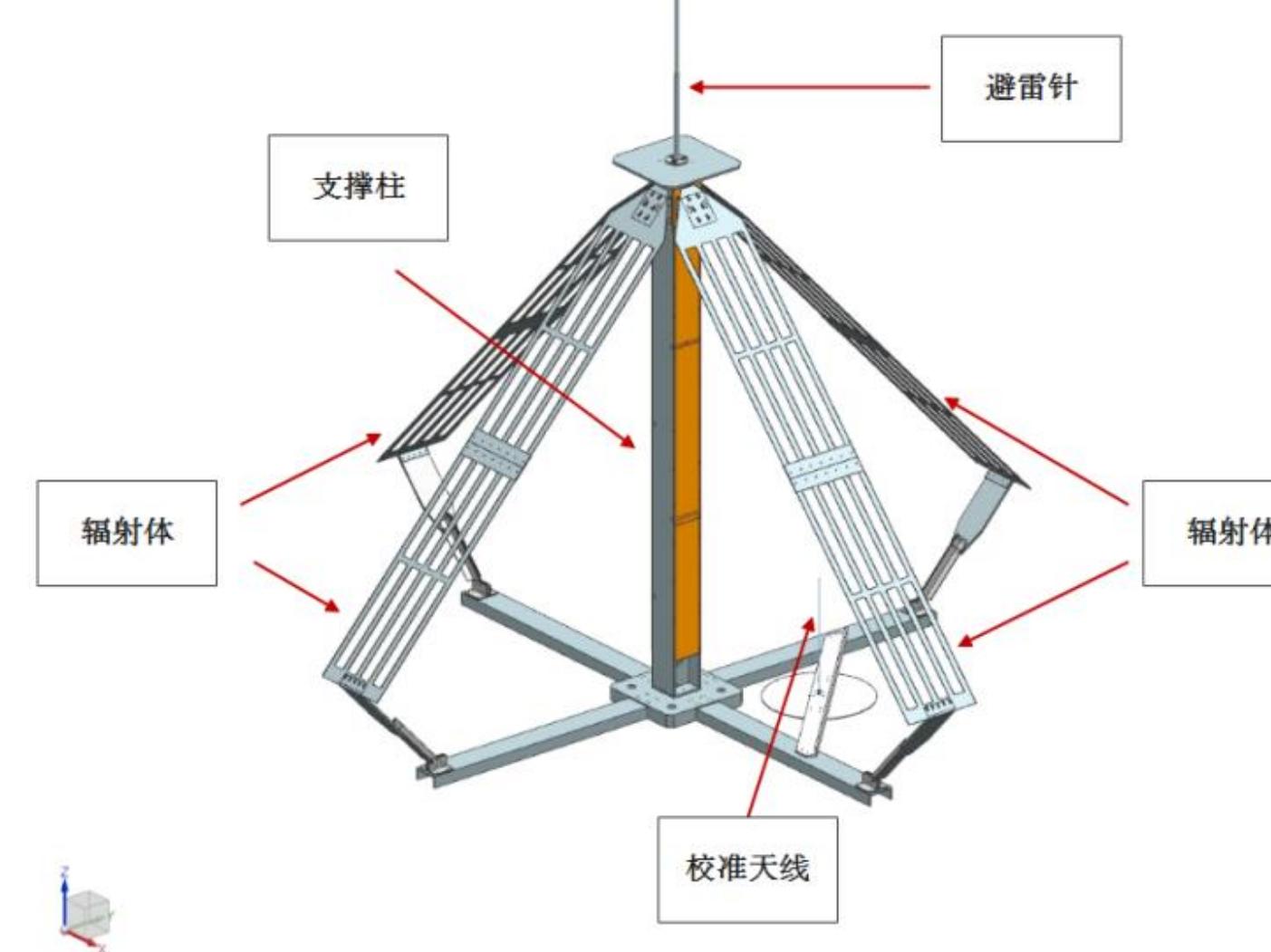
The overall structure of the inverted "V" grid dipole antenna with improved arms.

But how many parallel wires for one arm is OK? So We did a simulation experiment.

In this experiment, we use different numbers of wires as input parameters and the impedance variations in whole band with different number of parallel wires.



In final, we decide to use **five** wires for one arm which is flexible for installing and transporting



The number of wires is from 3 to 17. With the number increasing, the maximum of real part of antenna impedance is getting closing the low frequency.

when the number is 17, the impedance is nearly the same with whole sheet metal arm

Antenna structure parameters

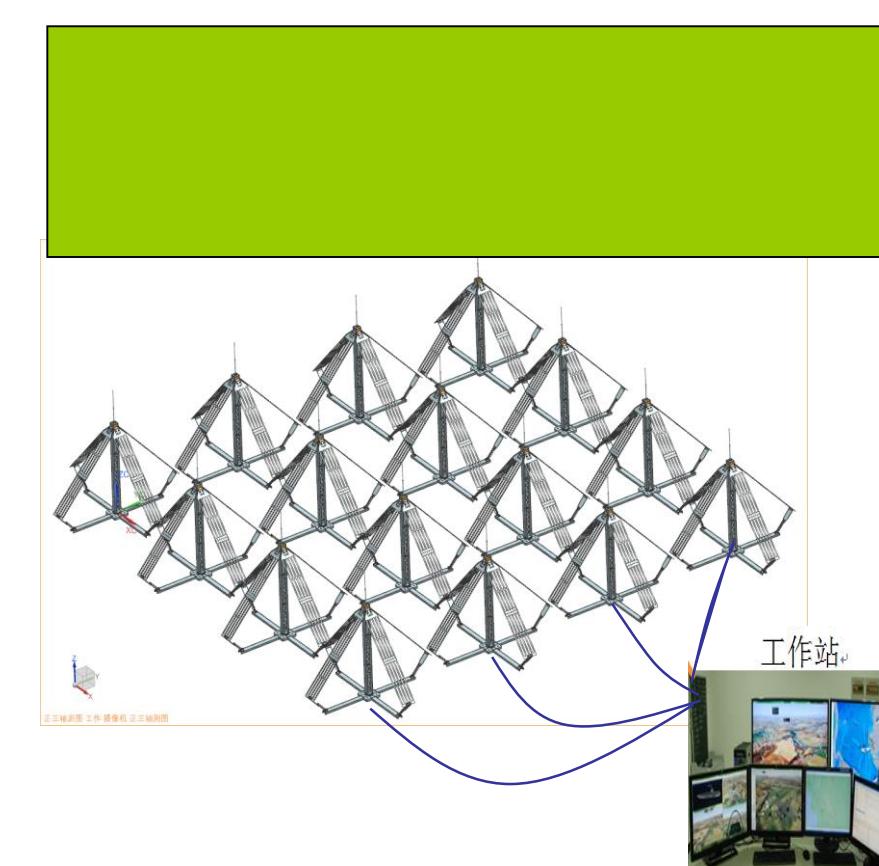
Structure name	Size
Wire width	24mm
Arm width	300mm
Arm length	1800mm
Base plate width	10mm
Distance between the antenna top and the insulation board	10mm

Simulation results

LOFAR LBA VS Our antenna

Patterns

axial ratio<0.5dB 10MHz 50MHz 90MHz



Impedance is from 0.8Ω to 1187Ω Impedance is from 0.8Ω to 631.1Ω

Blue light: right-handed circular polarization
Green light: left-handed circular polarization

Next step

We have got some supports from SKA, Yunnan Provincial Government and Kunming City Government. And we will build a 16-elment experiment array for testing.