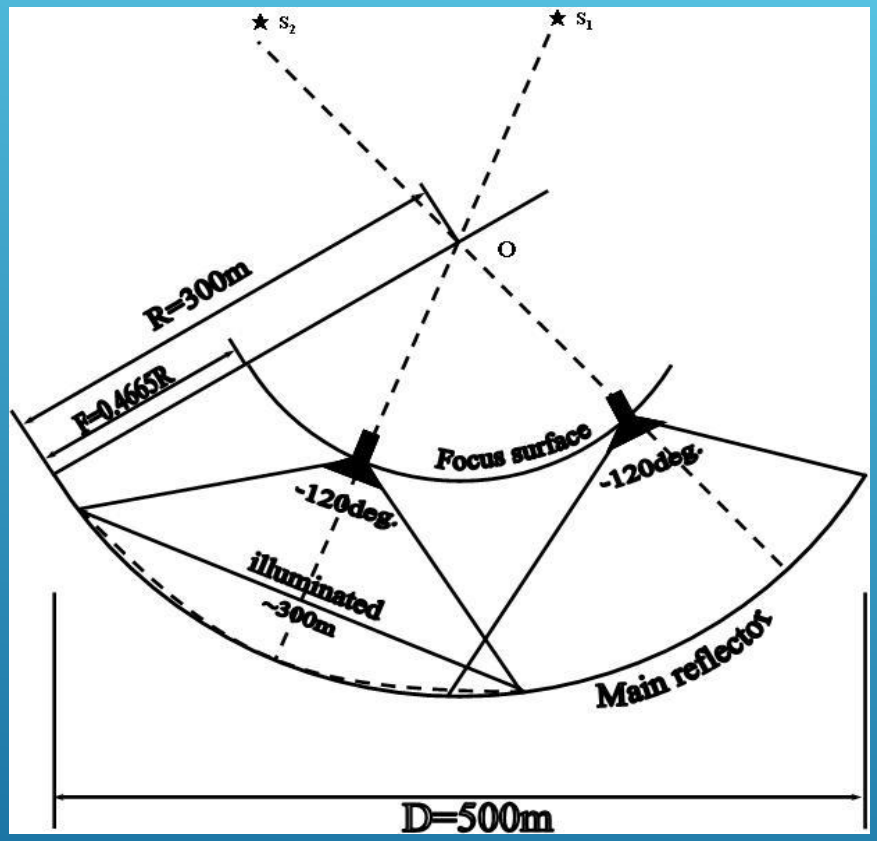
Development Of Phased Array Feeds For FAST

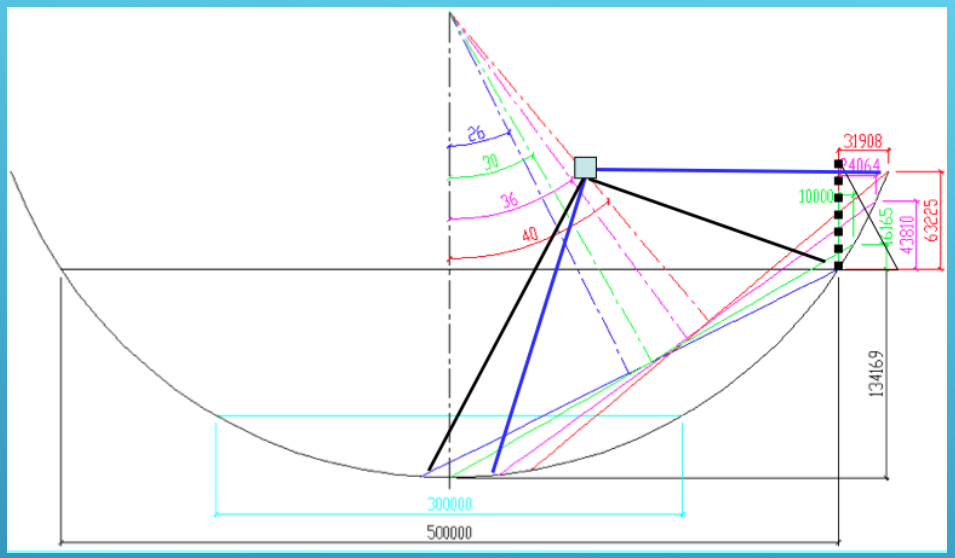
FAST Project/JLRAT

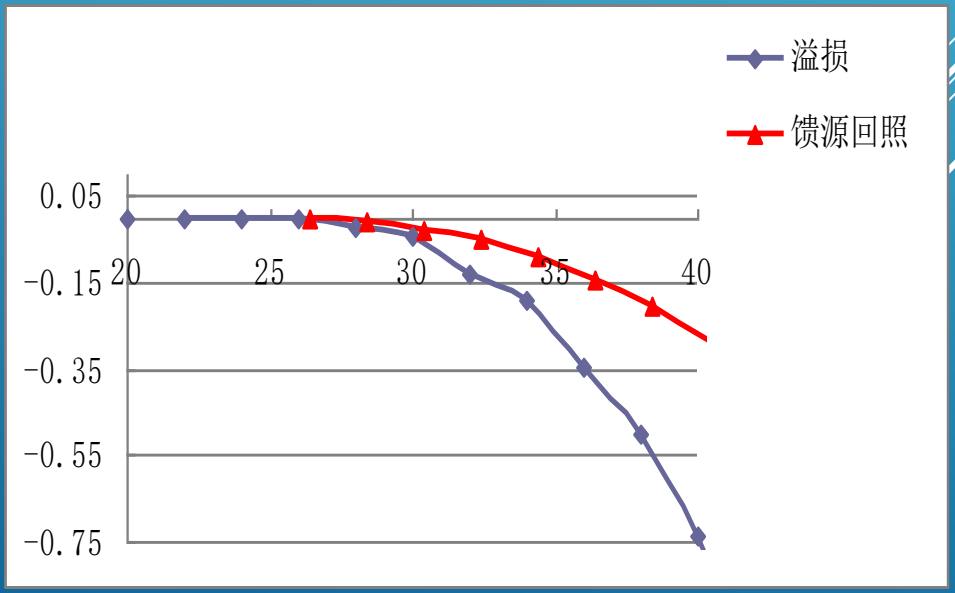
PAF Workshop 2016, Cagliari

2016/08/23

FAST Optics & Back Illumination

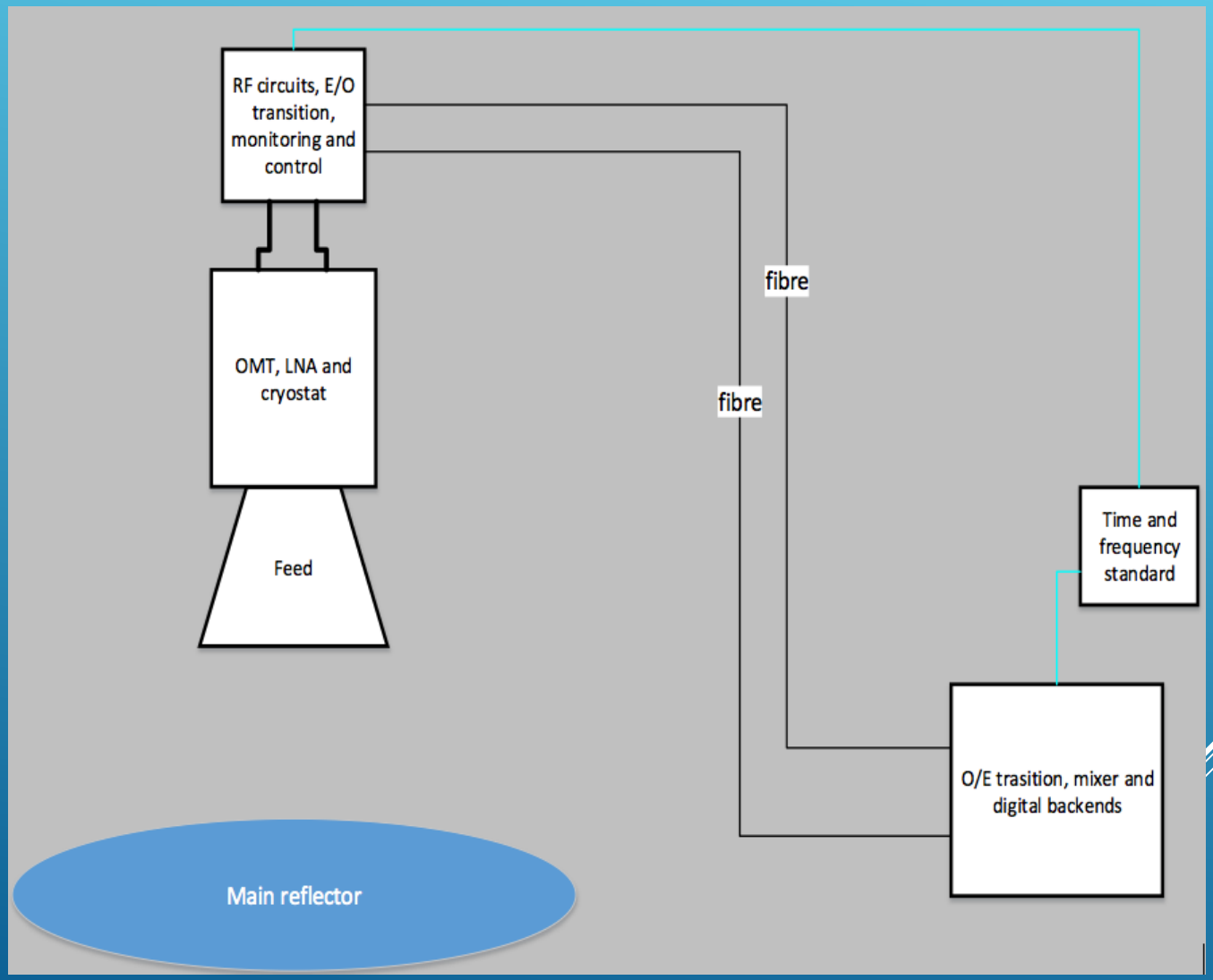






FAST Optics & Back Illumination

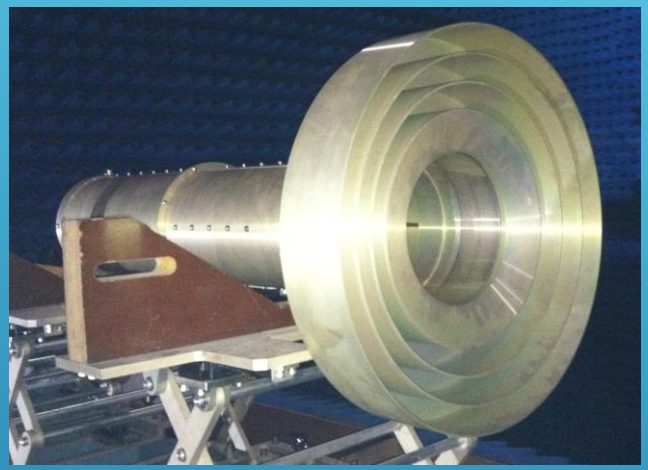
Receiver Scheme For FAST

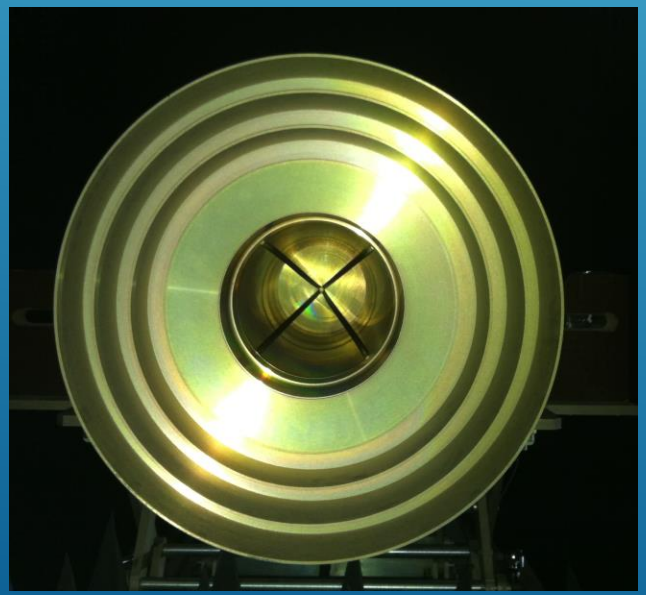


7 Sets Of Frontend

No.	Frequency range[a] (MHz)	Number of Beams	Polarization Mode[b]	System Temperature[c]
1	70-140	1	RCP & LCP	1000
2	140-280	1	RCP & LCP	400
3	270-1620	1	RCP & LCP	150
4	560-1020	1	RCP & LCP	60
5	1100-1900	1	RCP & LCP	25
6	1050-1450	19	X & Y linear	25
7	2000-3000	1	RCP & LCP	25

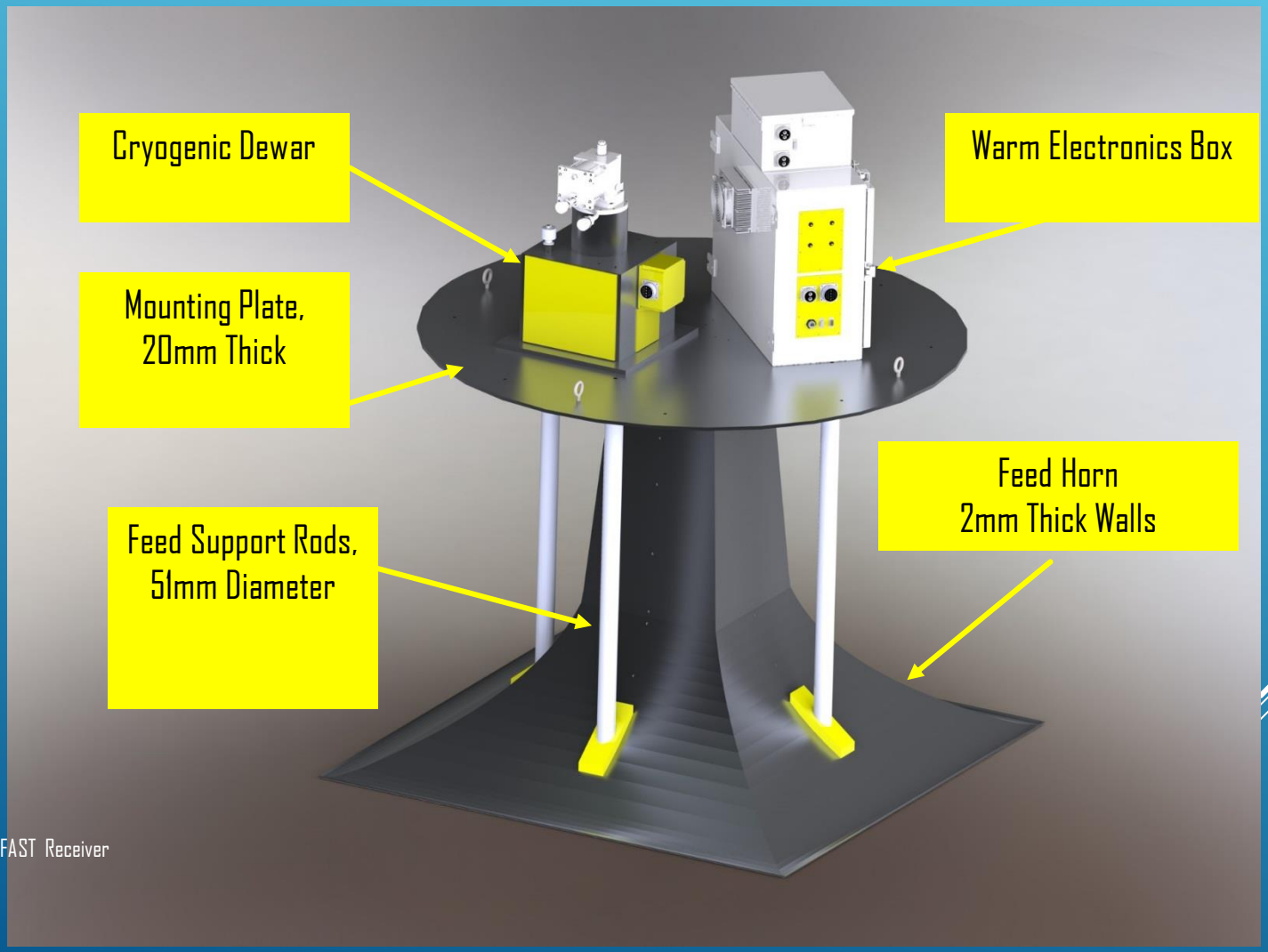
L-SPF, S-SPF, 560-1120MHz



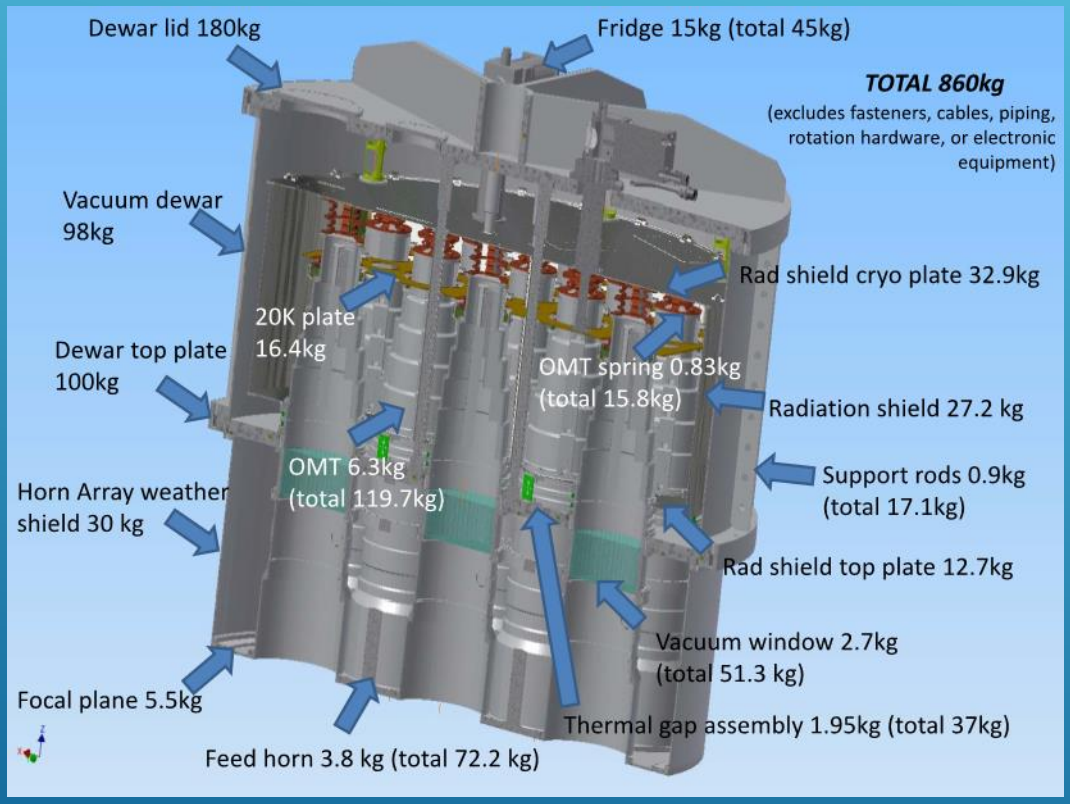


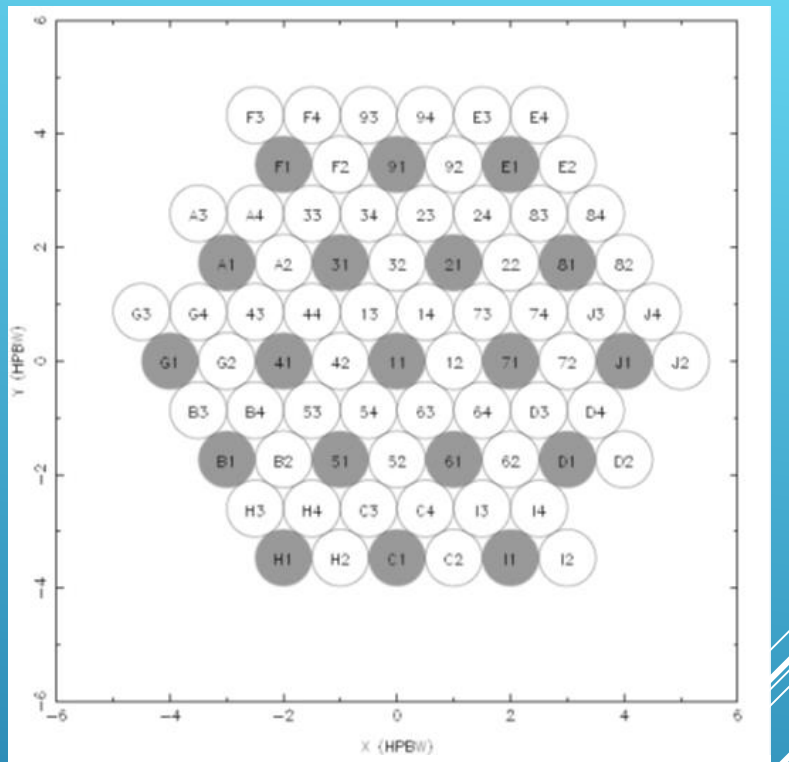
Overall View of FAST 0.27 to 1.62 GHz Receiver

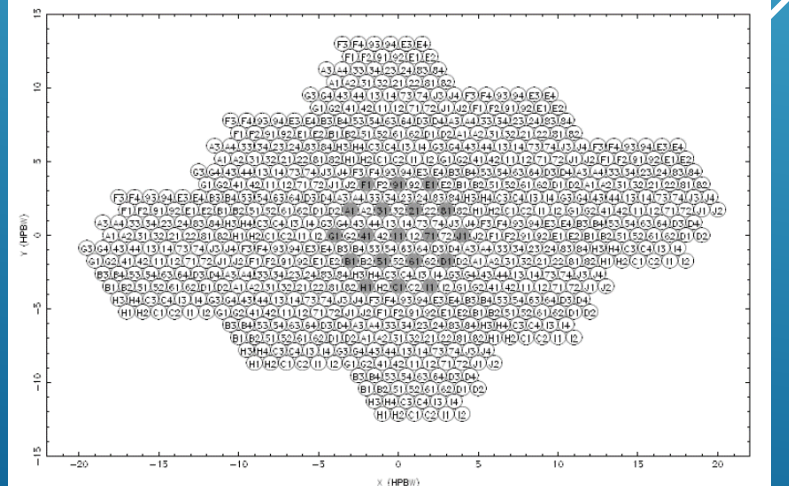
- Round mounting plate has diameter of 1.5m.
- Feed is 1.453m square at the bottom
- All boxes are RFI sealed and water sealed
- Weight estimate is 200 kg. Material is mostly aluminum



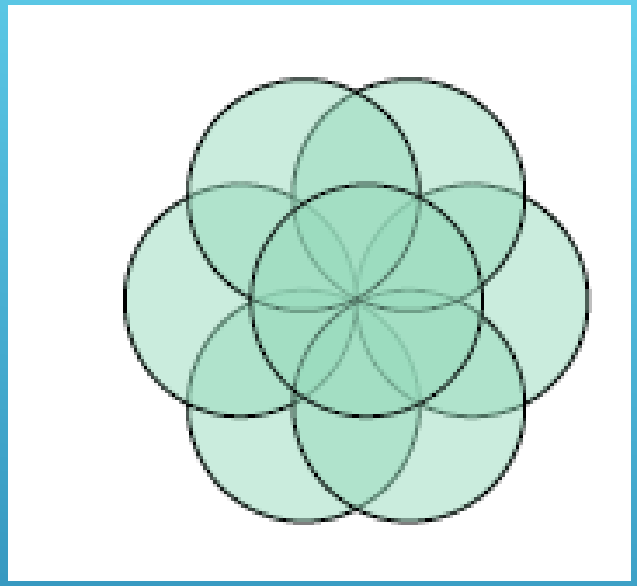
19-horn Receiver By CSIRO





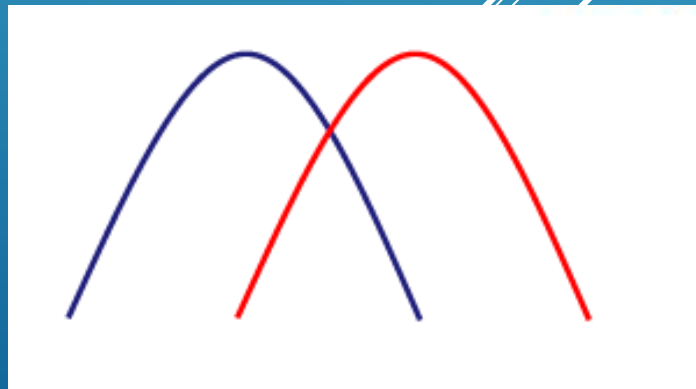


PAF'S Application on FAST



Observing Modes :

1. Continuous Sky Coverage
2. Achieve higher gain
3. Electronic Scanning
4. Dynamic beam forming to compensate the residual positional error (FAST)

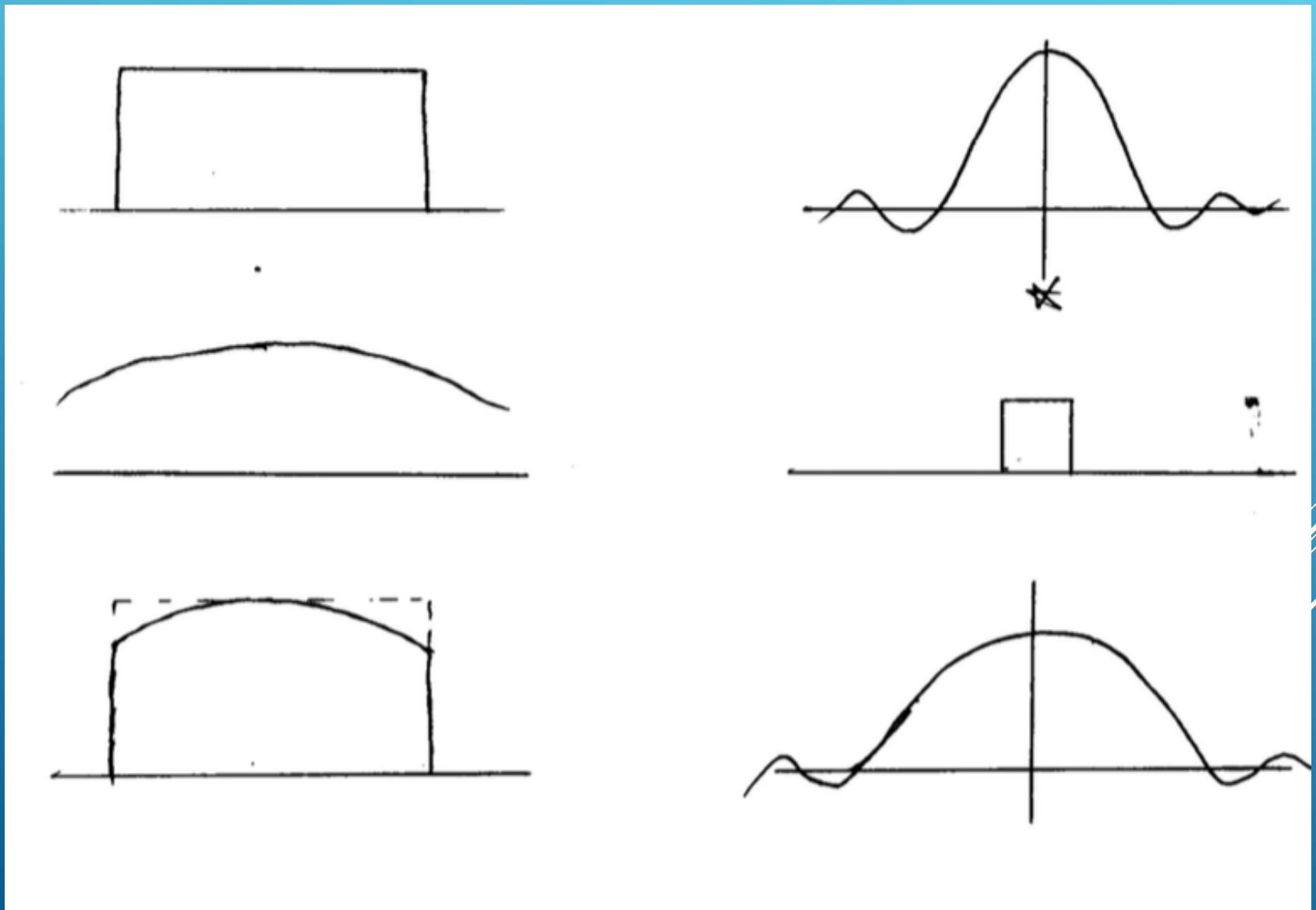


PAF @ 70MHZ, 400-700MHZ

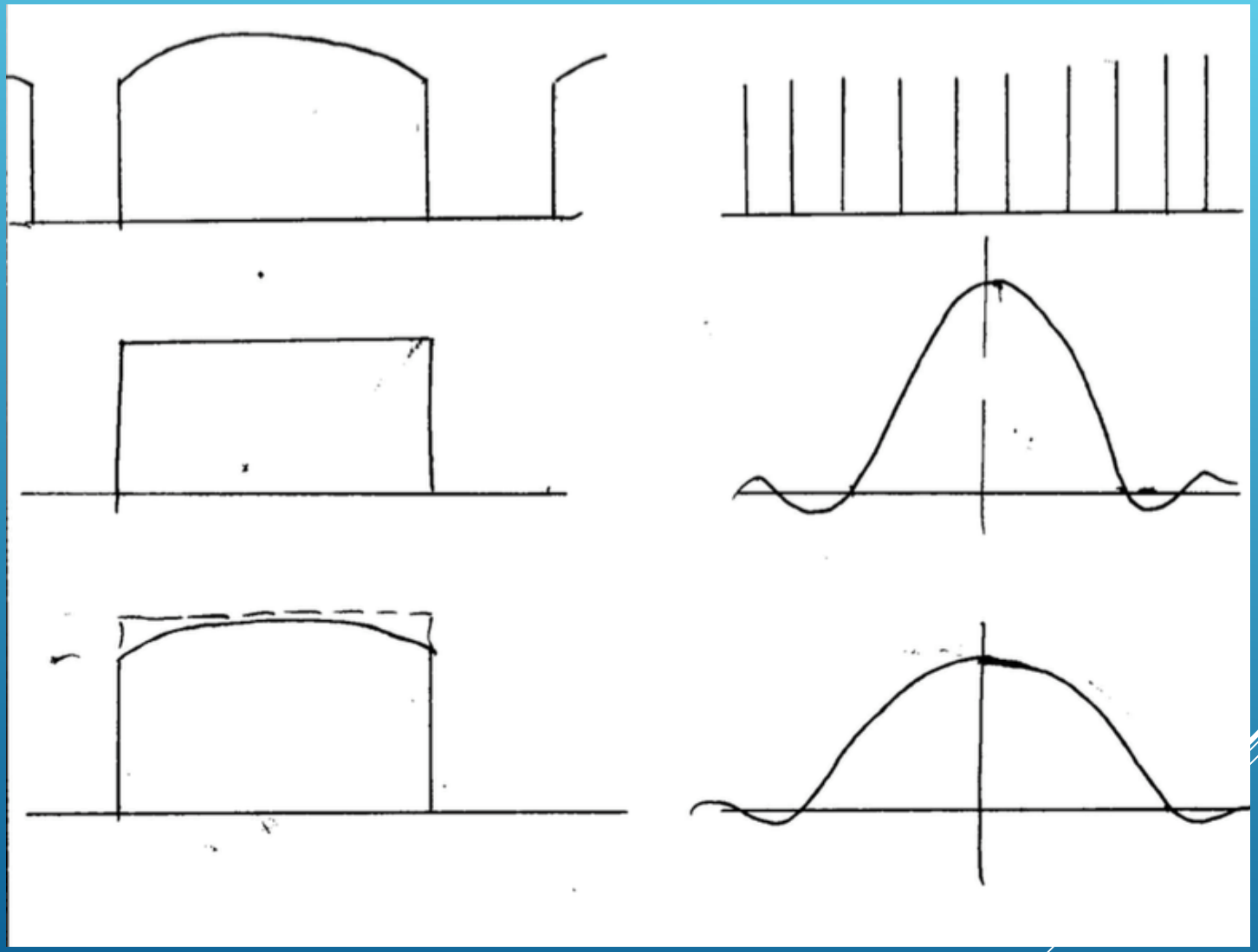
At 70MHz, the feed is large. PAF consists of small elements. This makes it easy to manufacture, installation of the PAF on FAST telescope. And the PAF may also enable optimization of far-field pattern.

At 400-700MHz, PAF may enable multi-beam sky coverage for pulsar search, and act as a receiving antenna of in-coherent scattering radar.

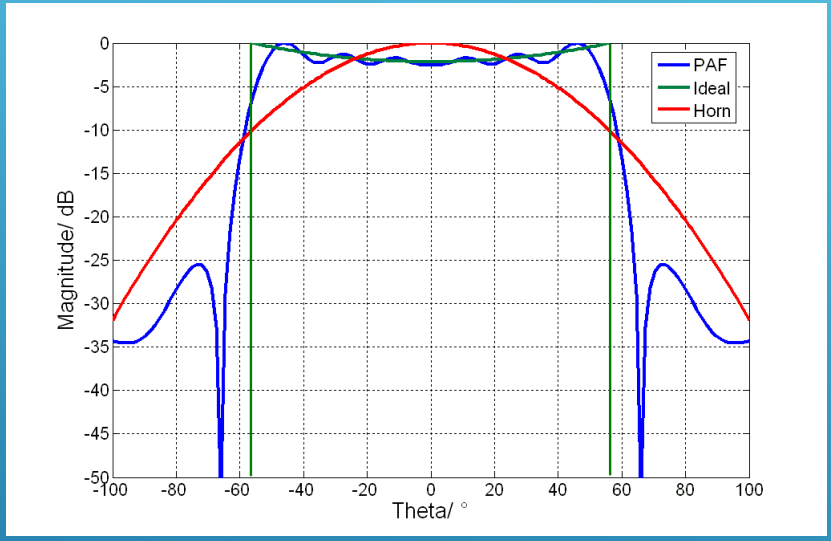
Phased Array Feed

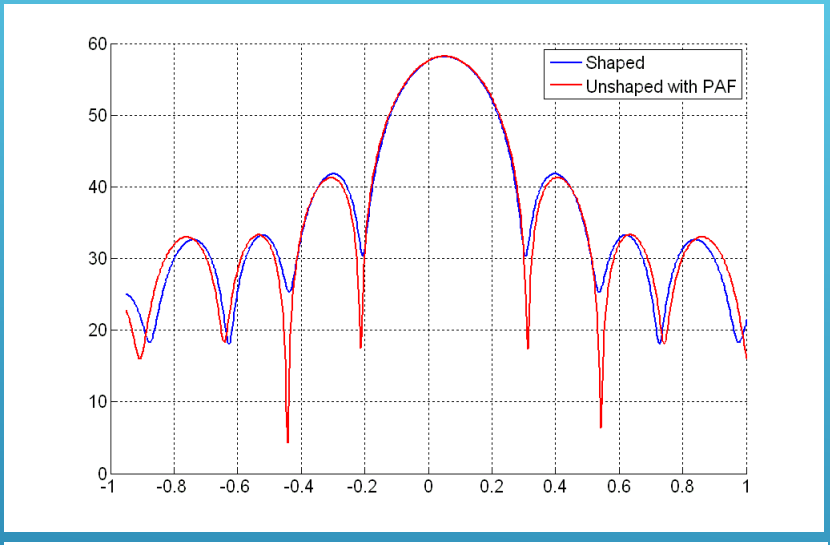


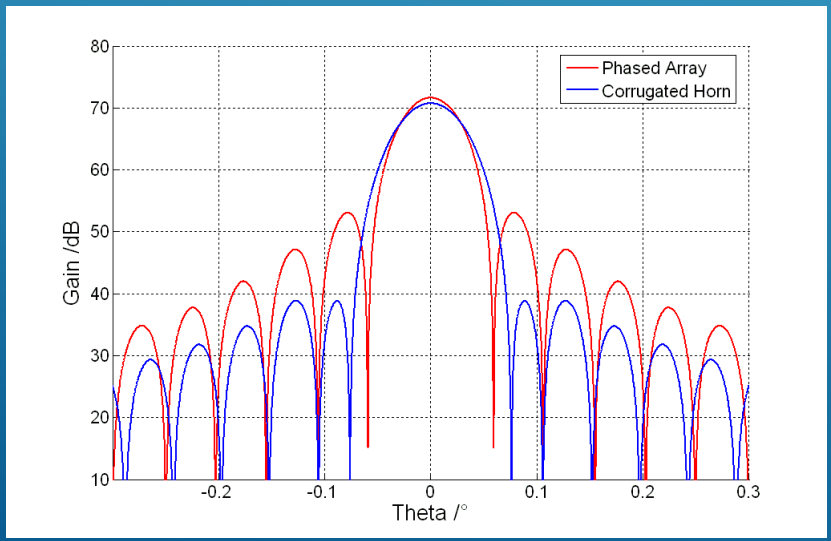
“Sampling” The Focal Field

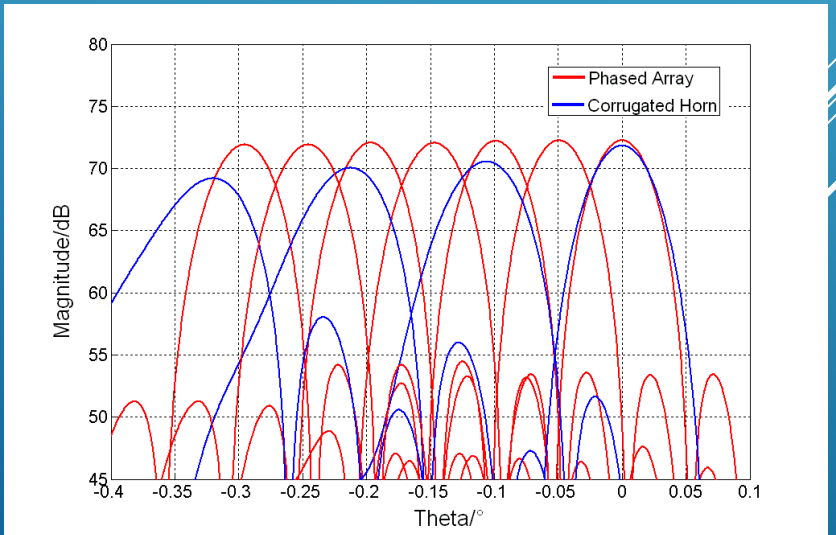


Simulation Results of PAF Performance









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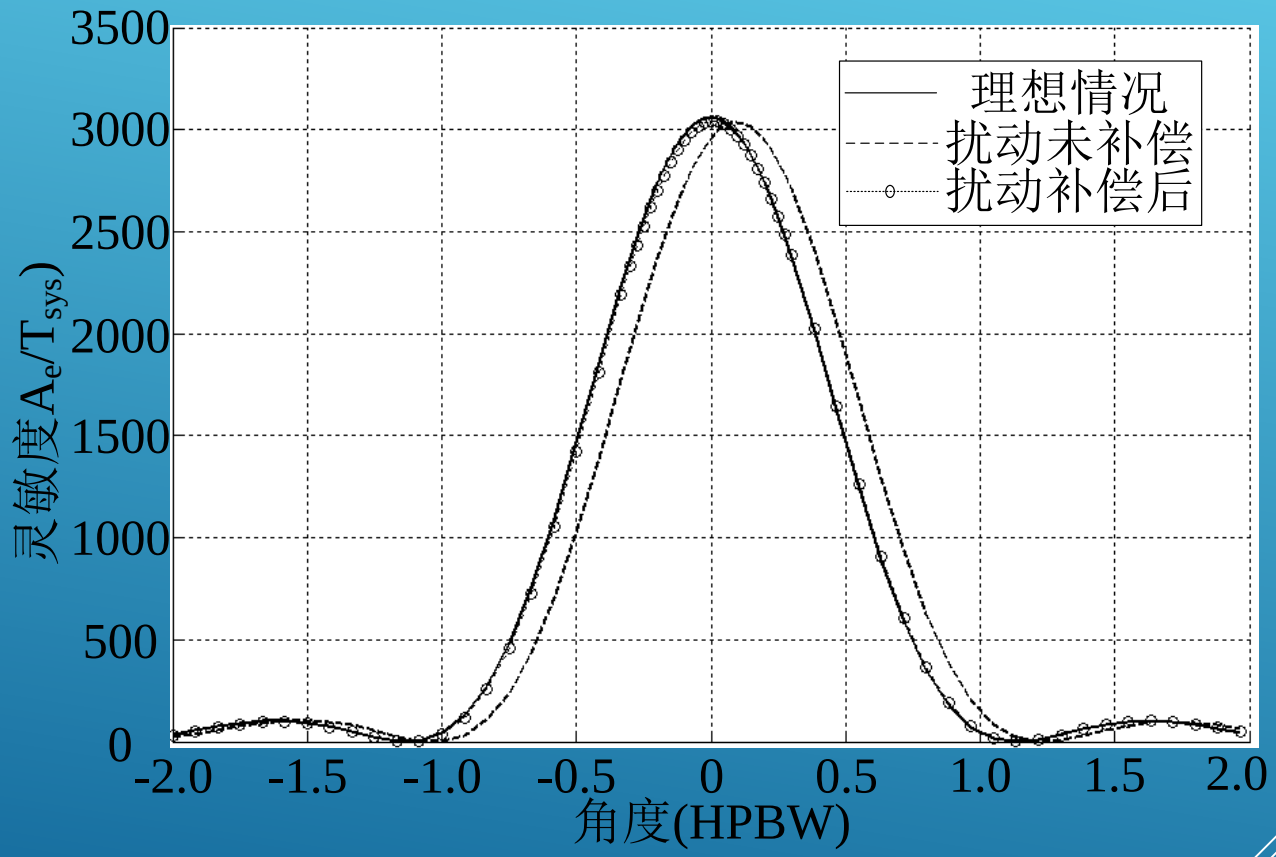
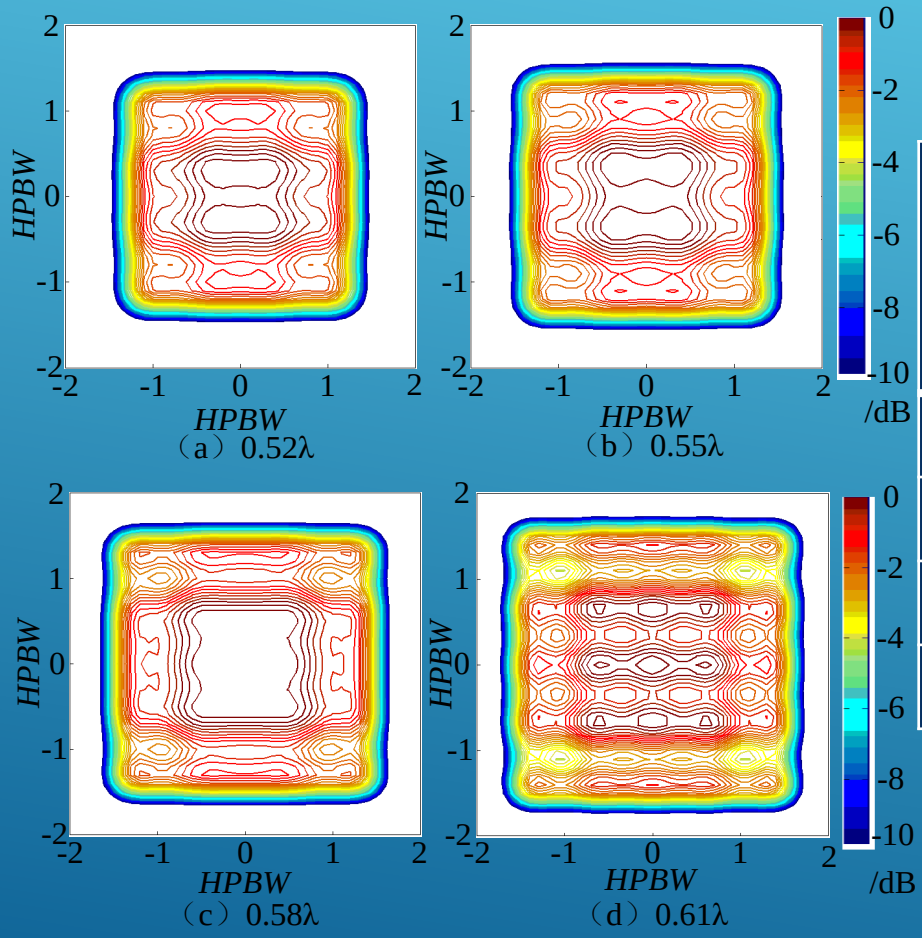
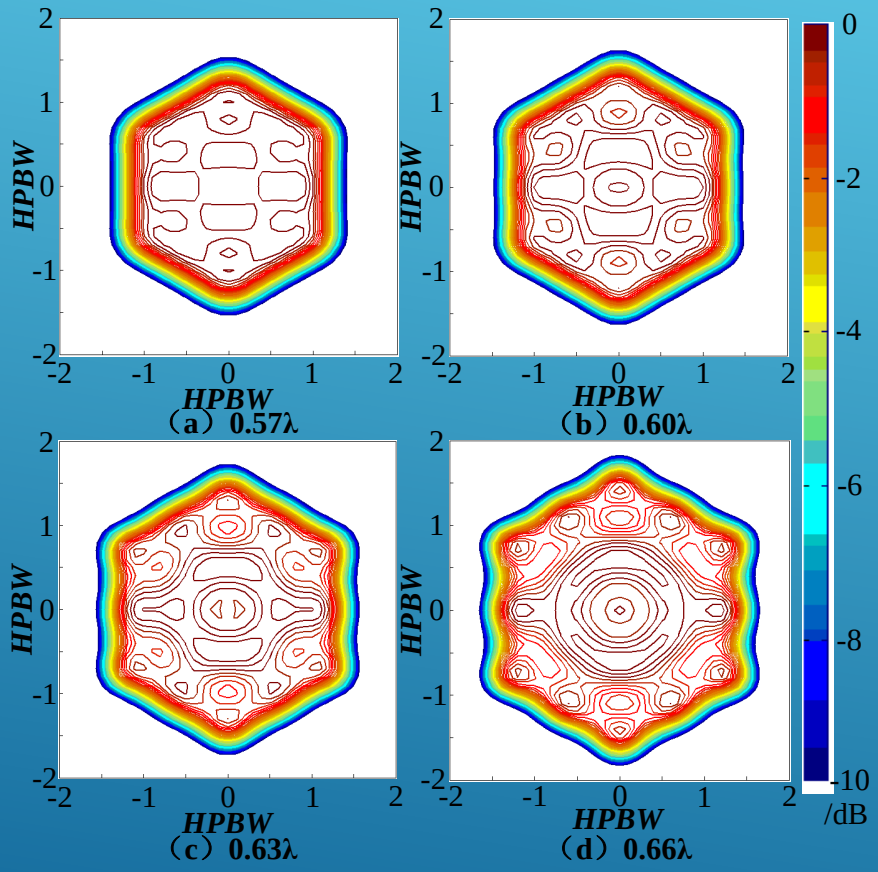


Effect of the Array on Telescope Performance



Element spacing / λ	Beam Efficiency / %	FoV / HPBW	ΔGain / dB
0.52	79.30	1.3×1.3	0.36
0.55	77.80	1.4×1.4	0.48
0.58	75.56	1.5×1.5	0.56
0.61	72.74	1.6×1.6	0.55

Effect of the Array on Telescope Performance

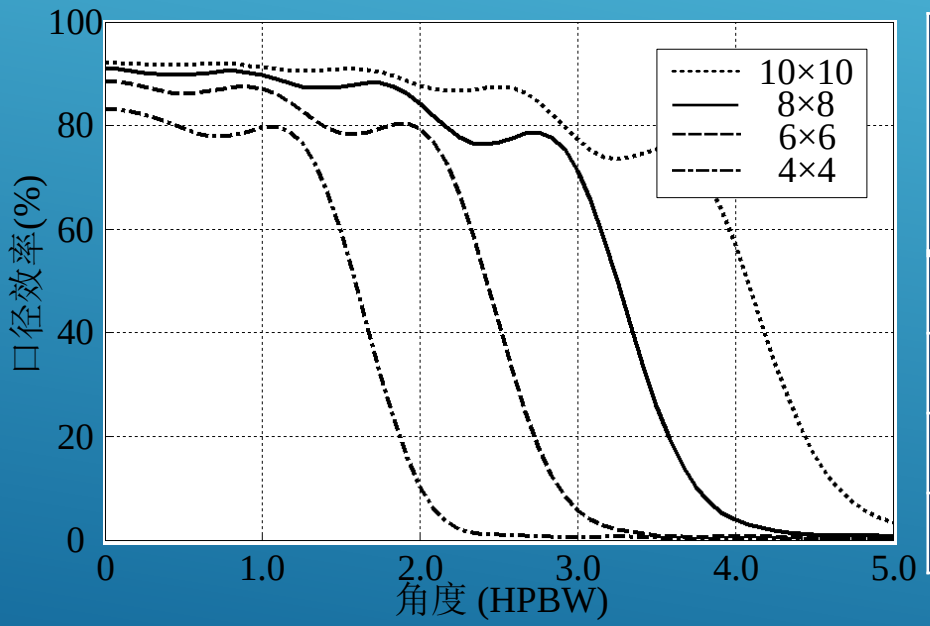


Element spacing / λ	Beam efficiency / %	FoV / HPBW	Δgain / dB
0.57	79.26	1.2×1.2	0.70
0.60	76.10	1.3×1.3	0.62
0.63	71.51	1.4×1.4	0.80
0.66	65.60	1.5×1.5	0.73

Hexagonal array achieves the same gain and FoV, with the disadvantage of larger Δgain

Effect of the Array on Telescope Performance

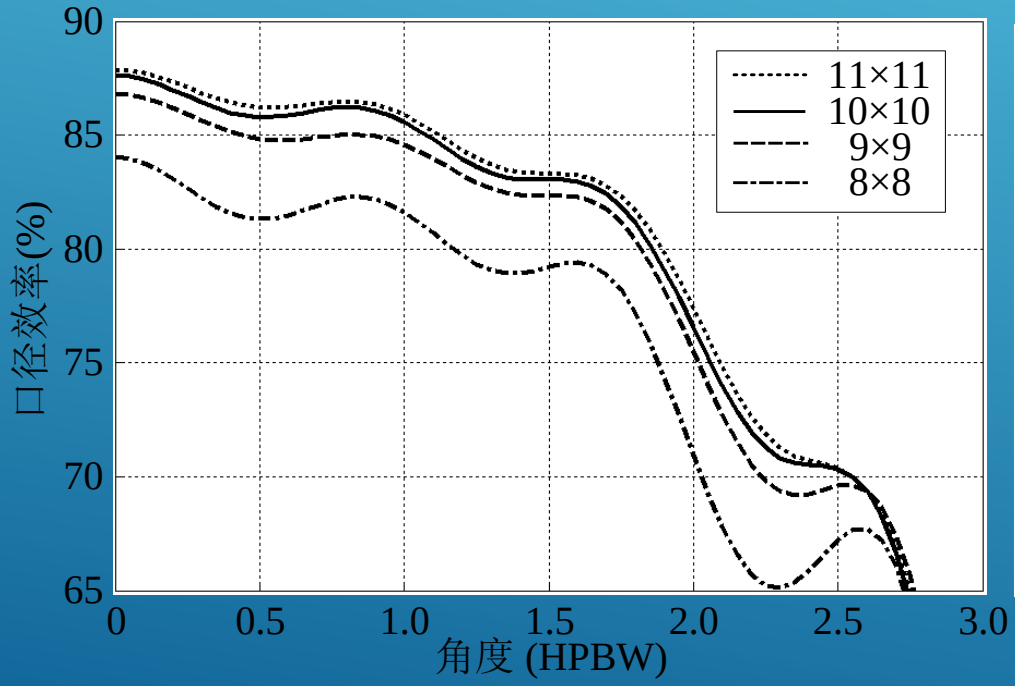
More Elements



Elements / λ	Beam efficiency / %	FoV / HPBW	Δgain / dB
4×4	83.21	1.5×1.5	0.29
6×6	88.68	2.2×2.2	0.13
8×8	90.99	2.9×2.9	0.06
10×10	92.11	3.6×3.6	0.02

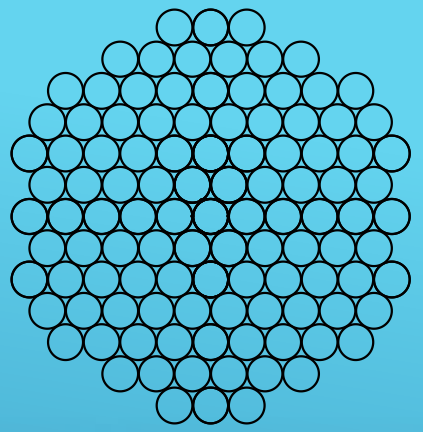
Effect of the Array on Telescope Performance

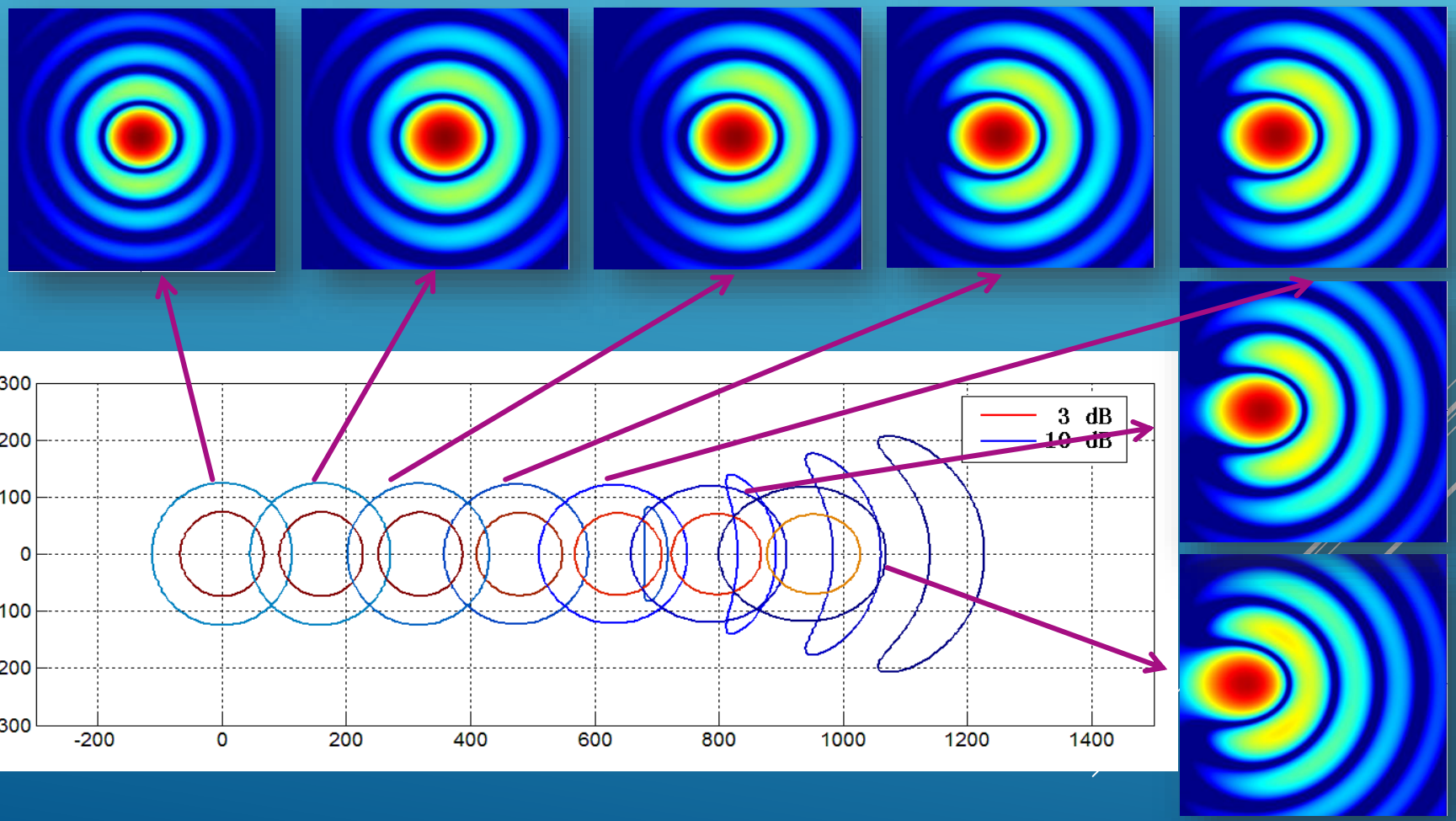
Denser Array



Element spacing / λ	Beam efficiency / %	FoV / HPBW	Δgain / dB
8×8	84.03	2.6×2.6	0.14
9×9	86.79	2.6×2.6	0.10
10×10	87.62	2.6×2.6	0.09
11×11	87.88	2.6×2.6	0.08

FAST PAF Development





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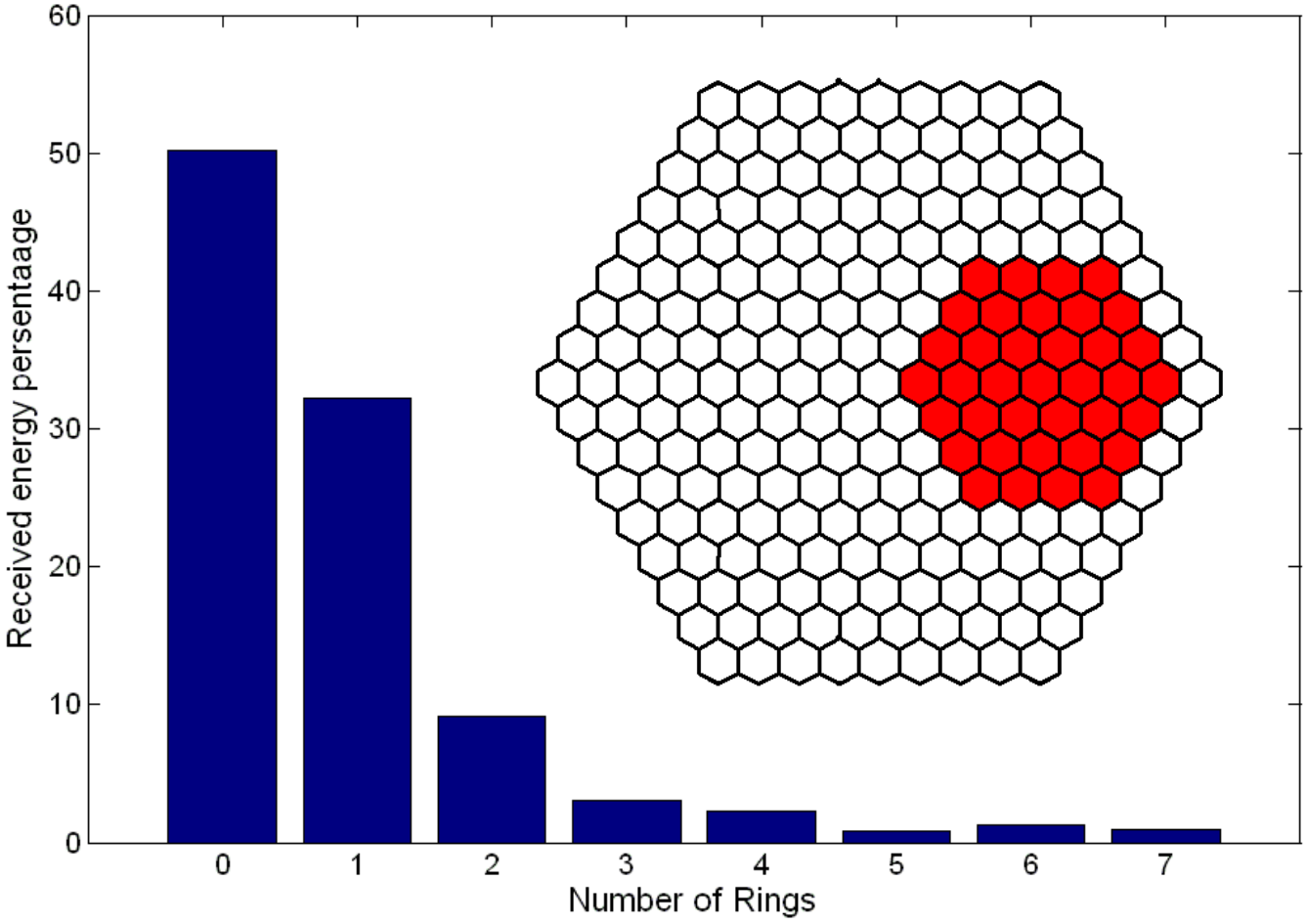
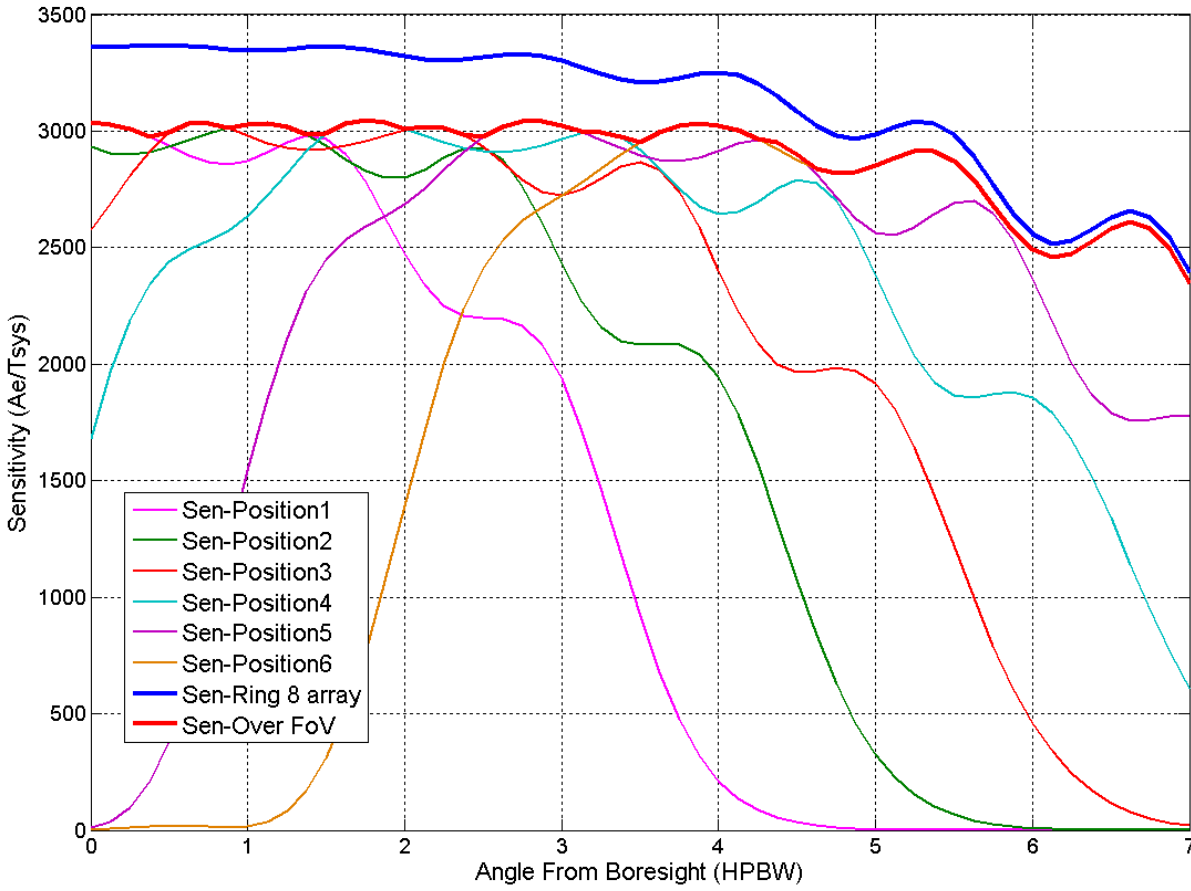


FAST PAF Development

Parameter	Quantity
Array	
Element	Cavity-backed dipole
Amount	217
Arrangement	Hexagnal
Spacing	0.58λ
Proccecing	
No. of Beam	109
No. of Elements for each beam	37



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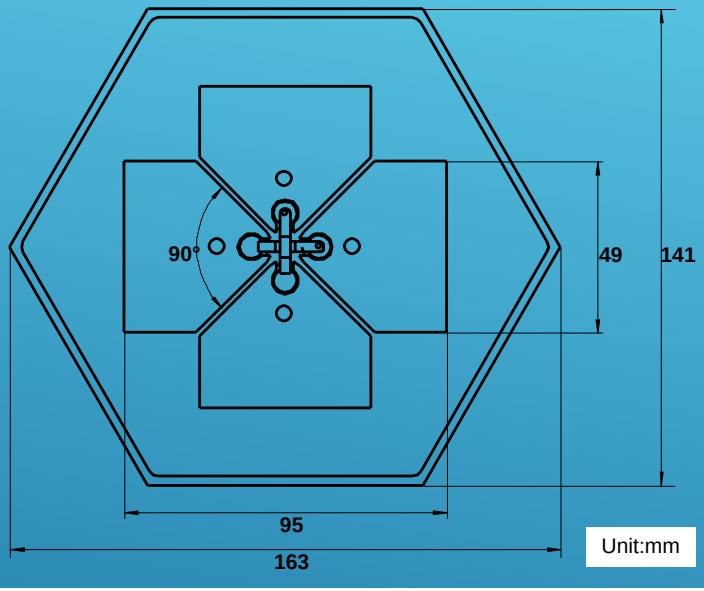
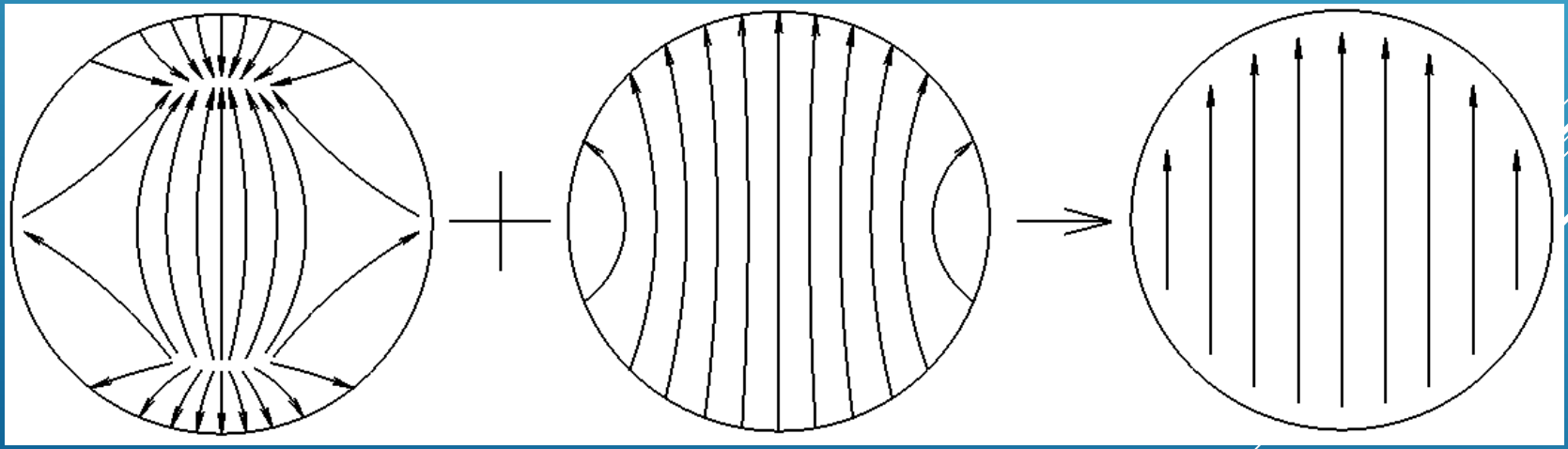


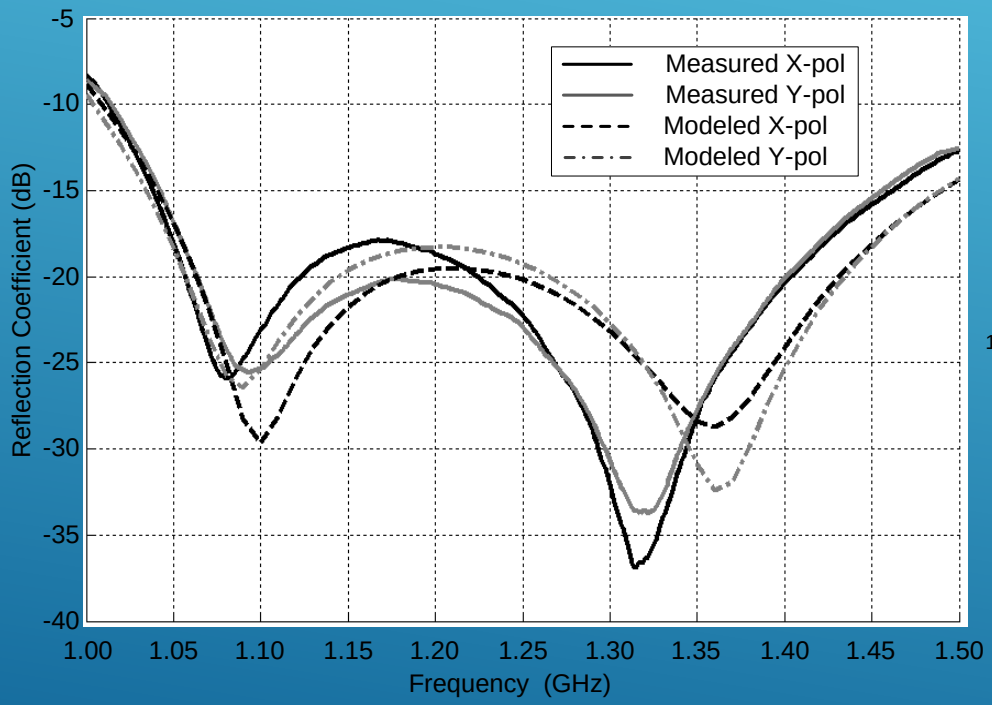


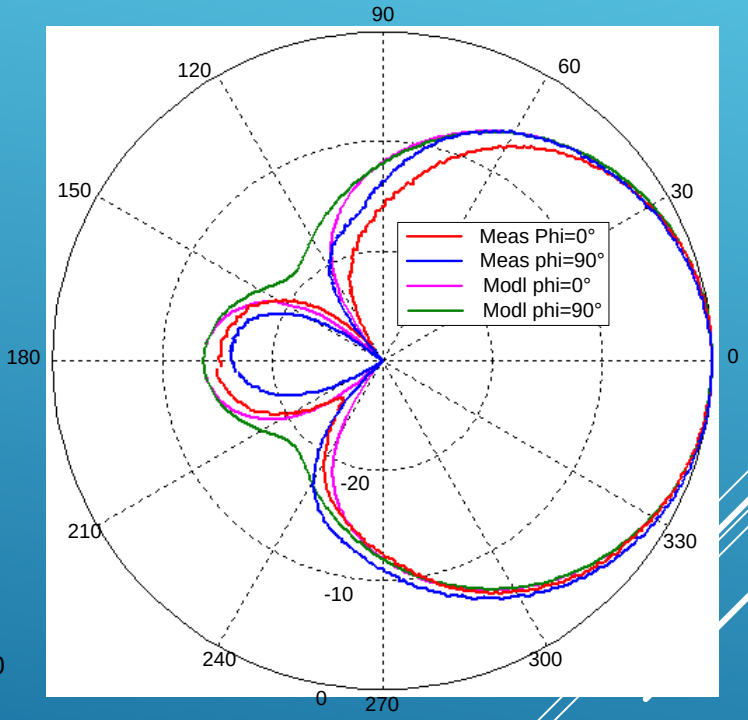
(a)
TM11

(b)
TE11

(c)
混合模

FAST PAF Development





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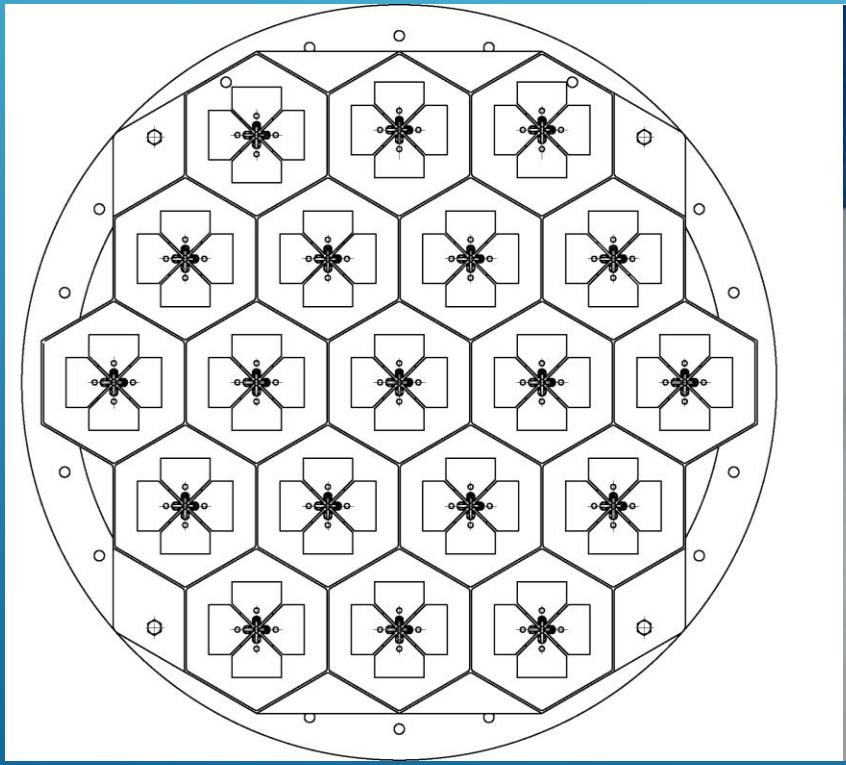

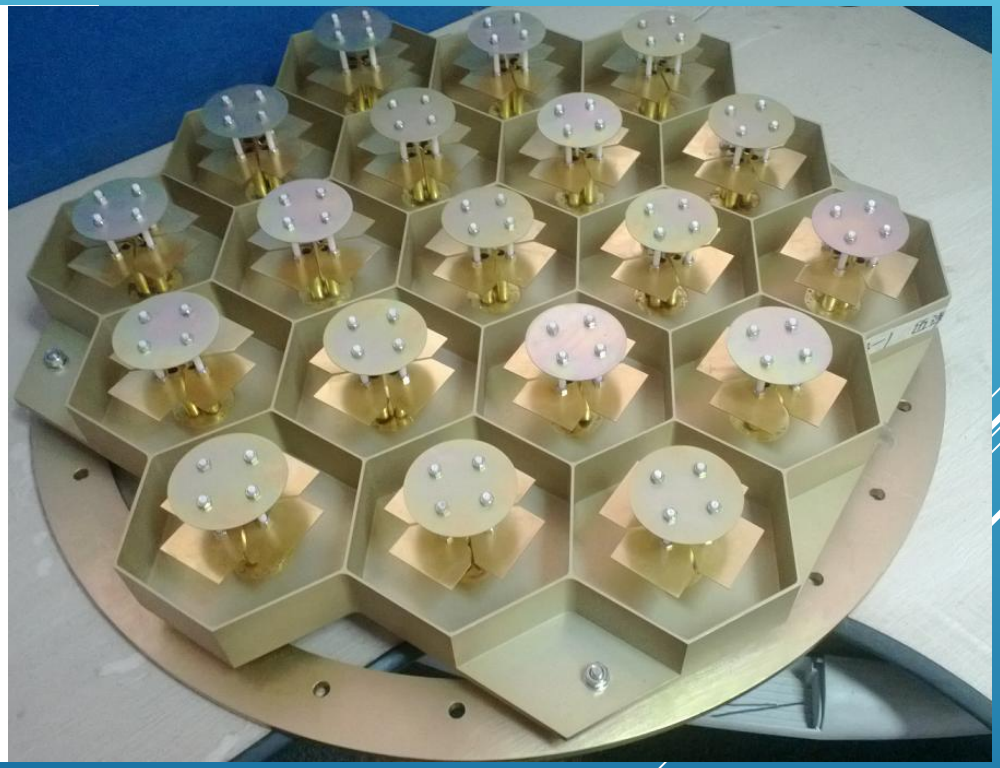

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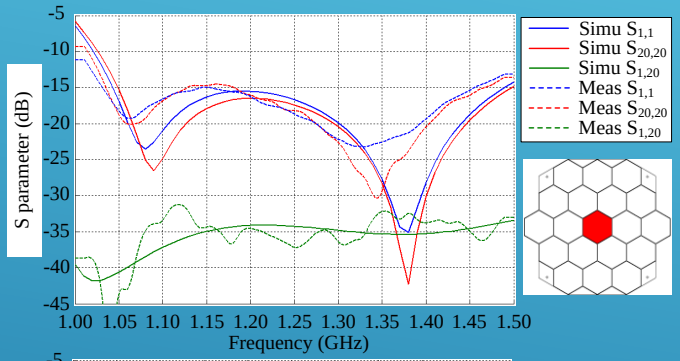

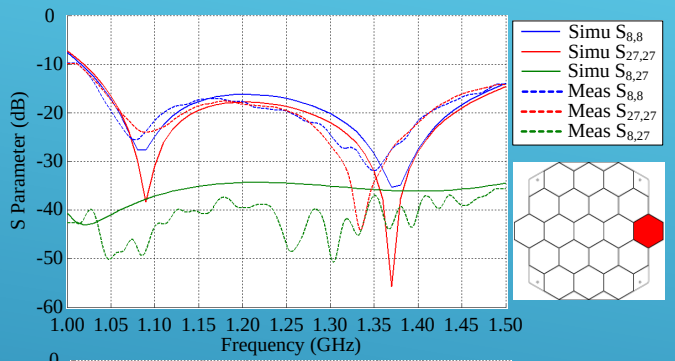

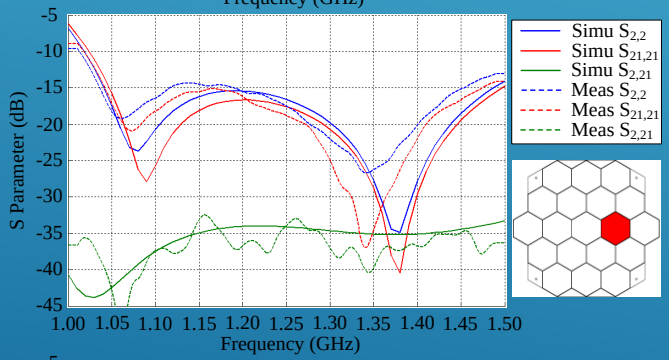

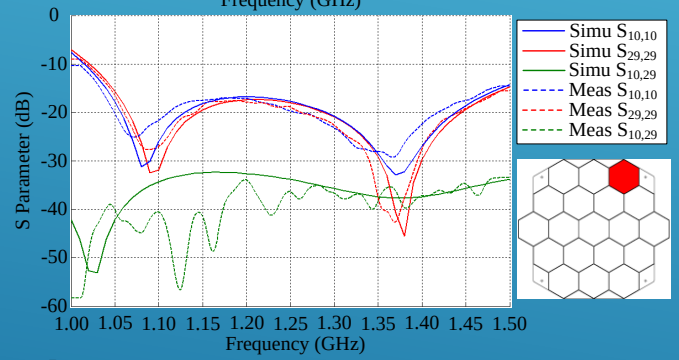

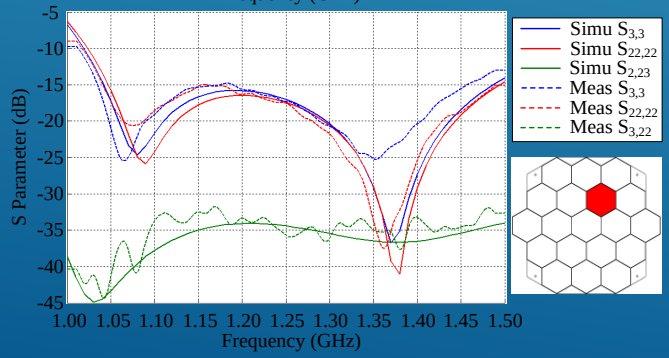

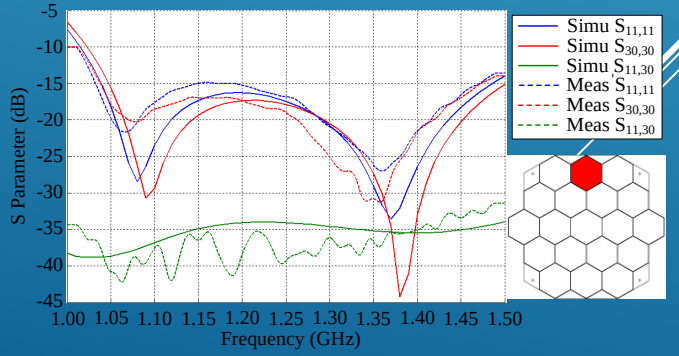

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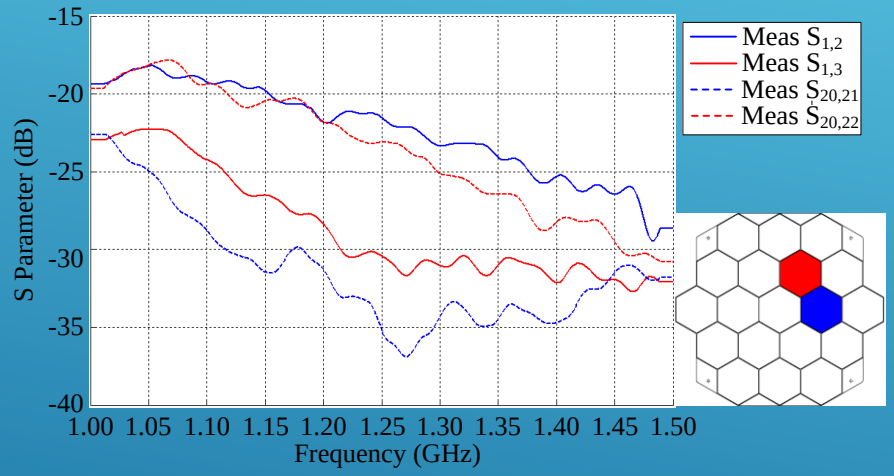

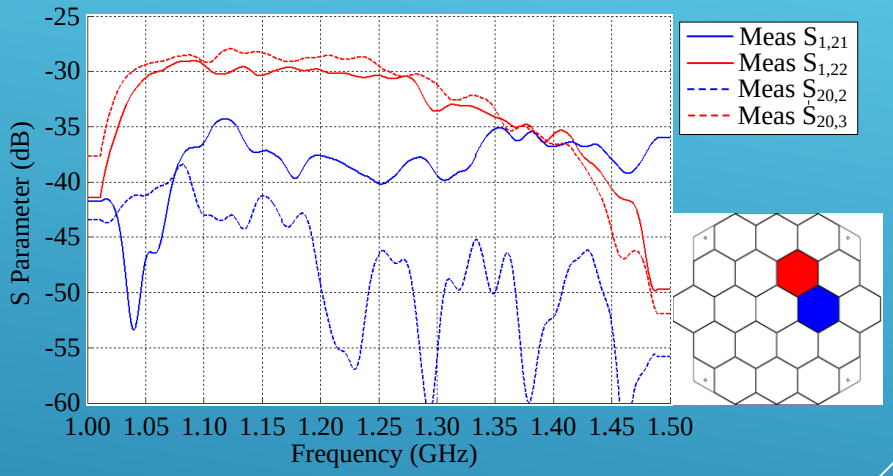

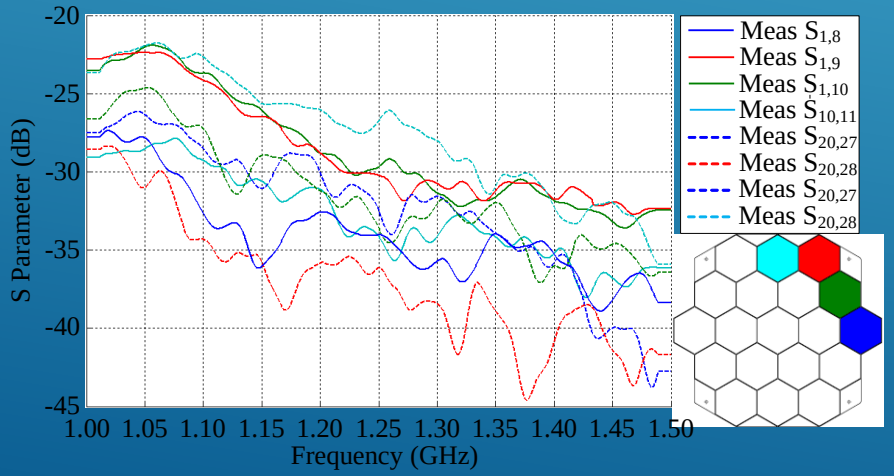

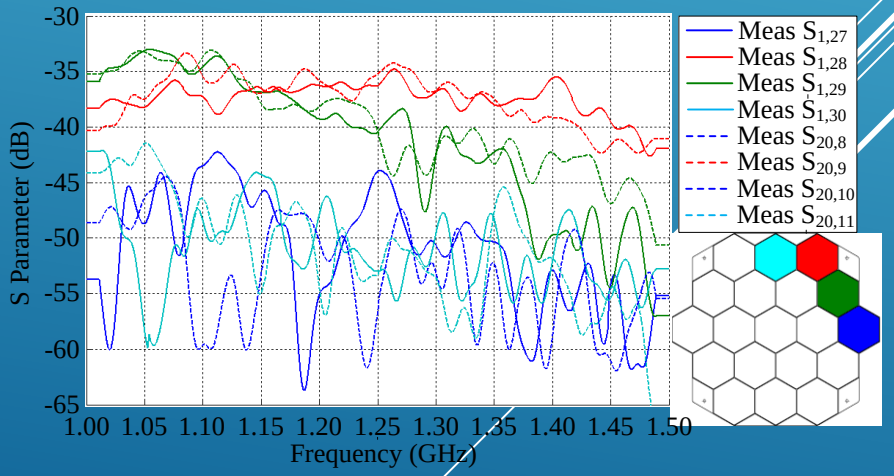

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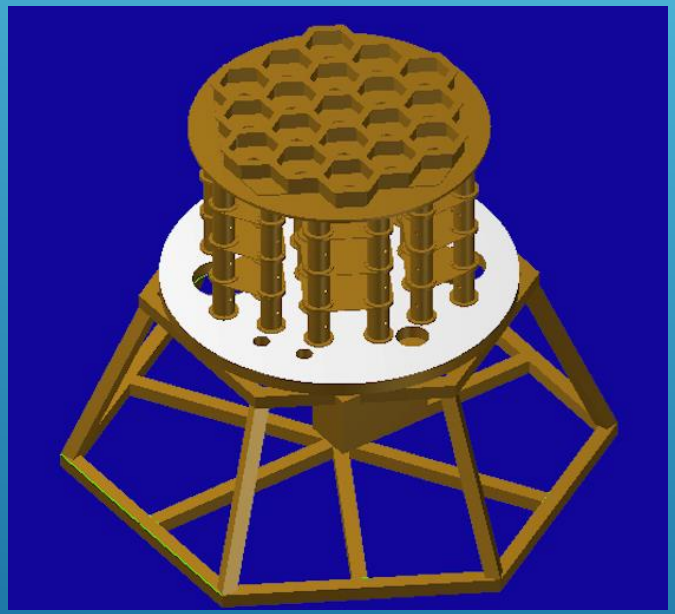
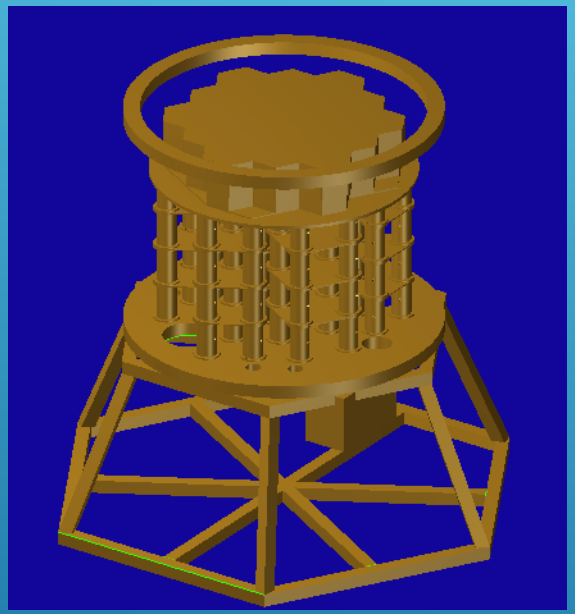




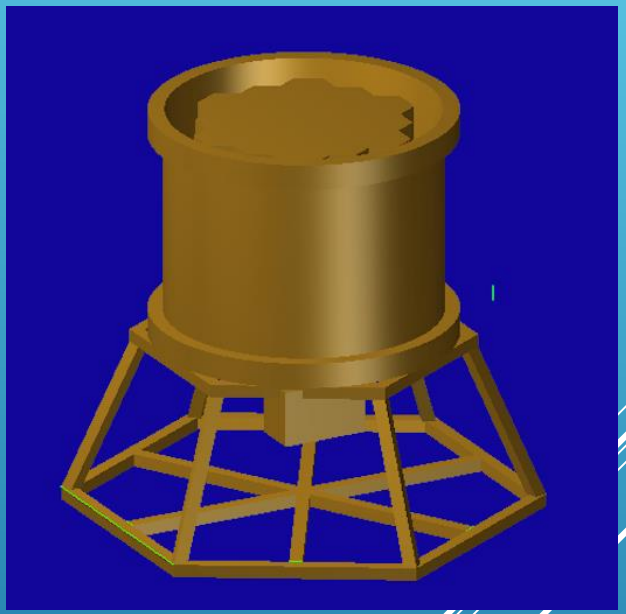
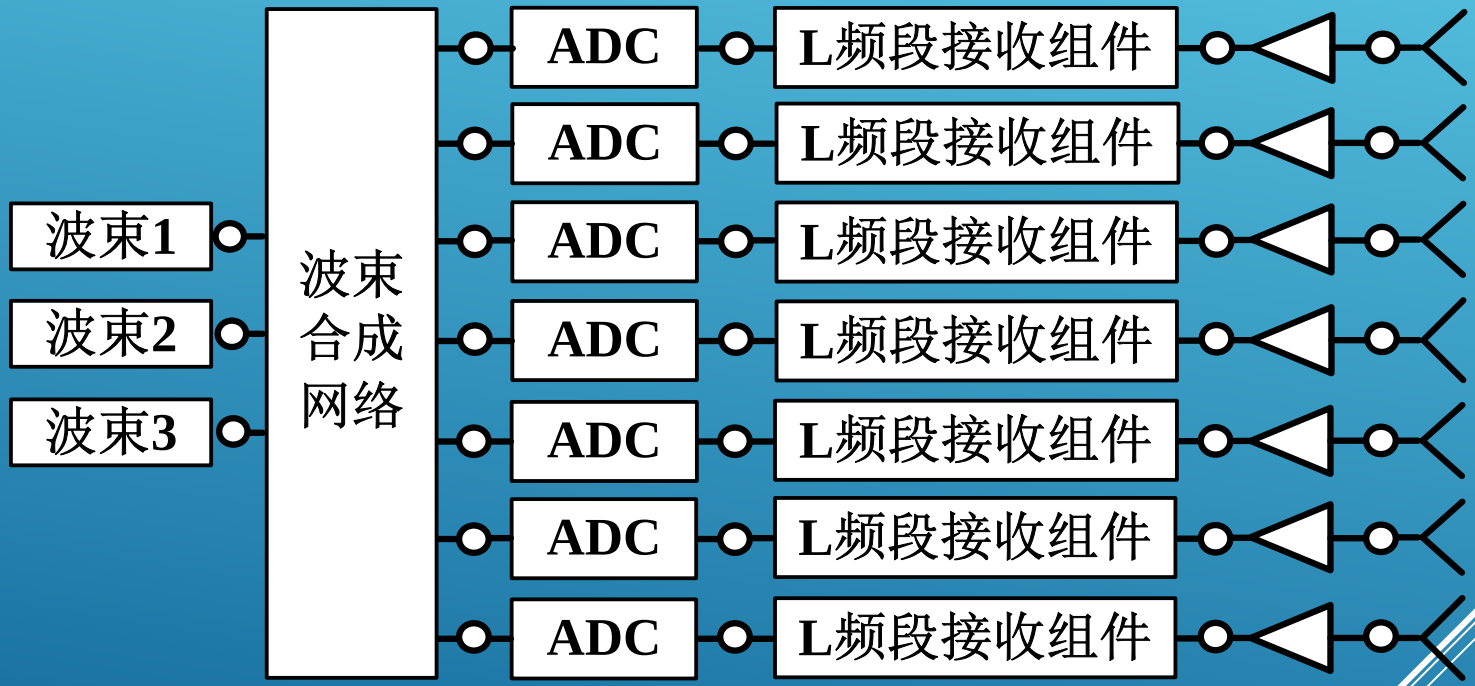


Diagram Of The FAST L-band PAF Prototype



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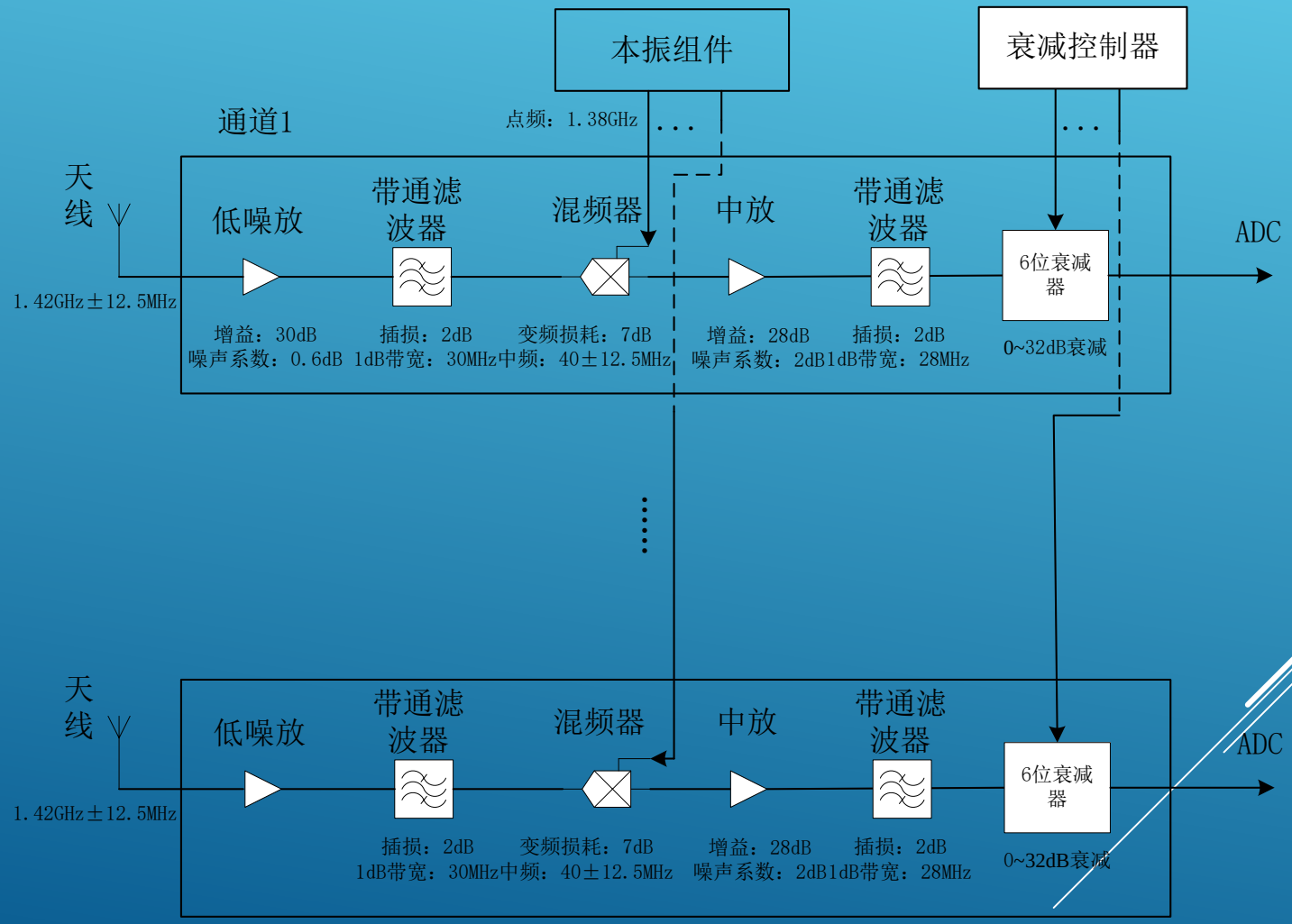
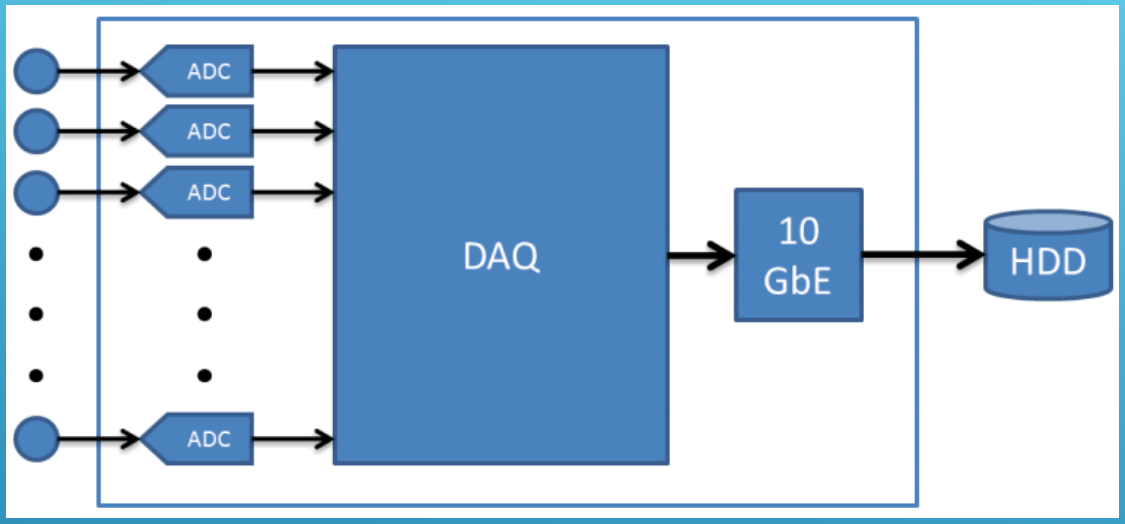
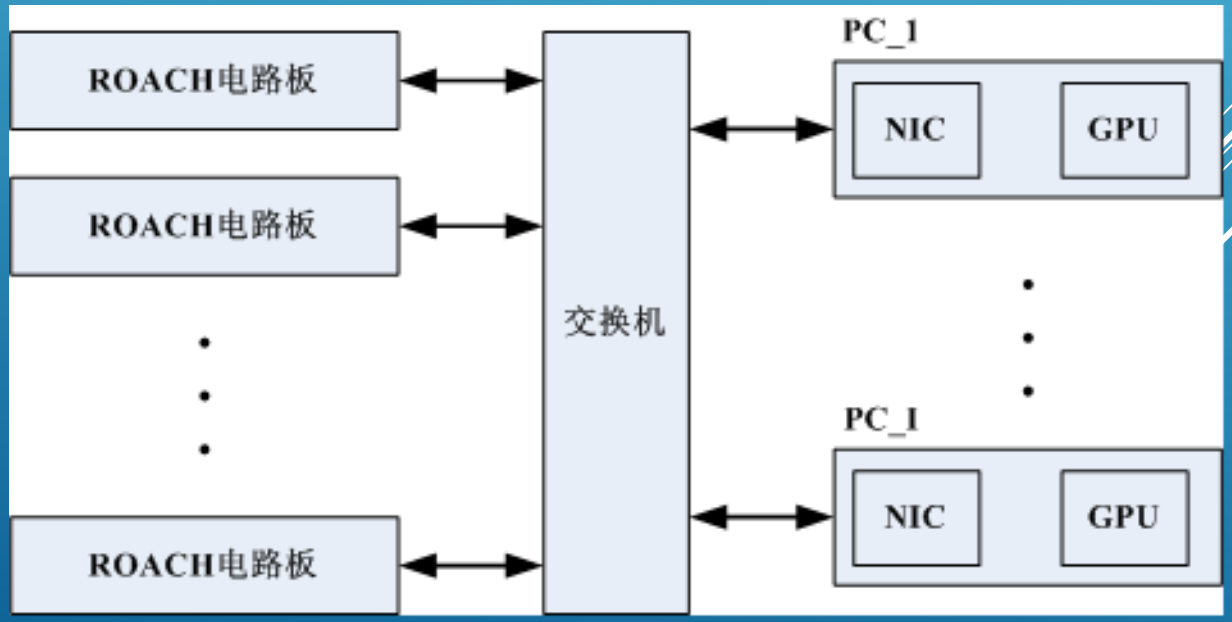
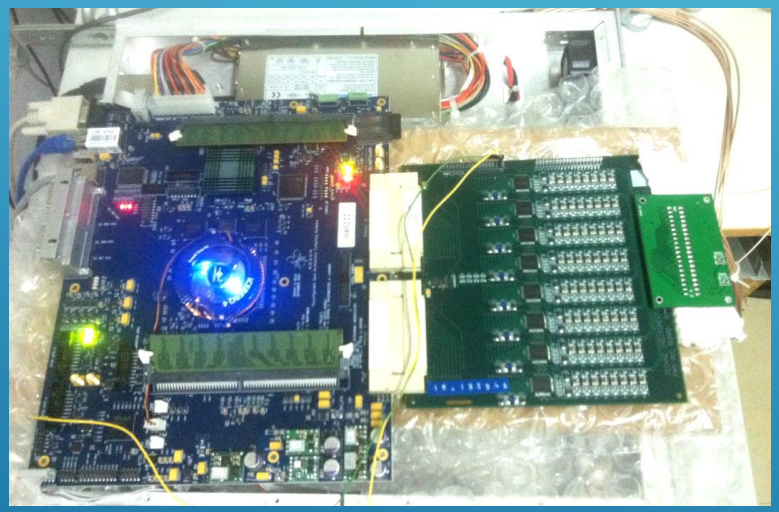


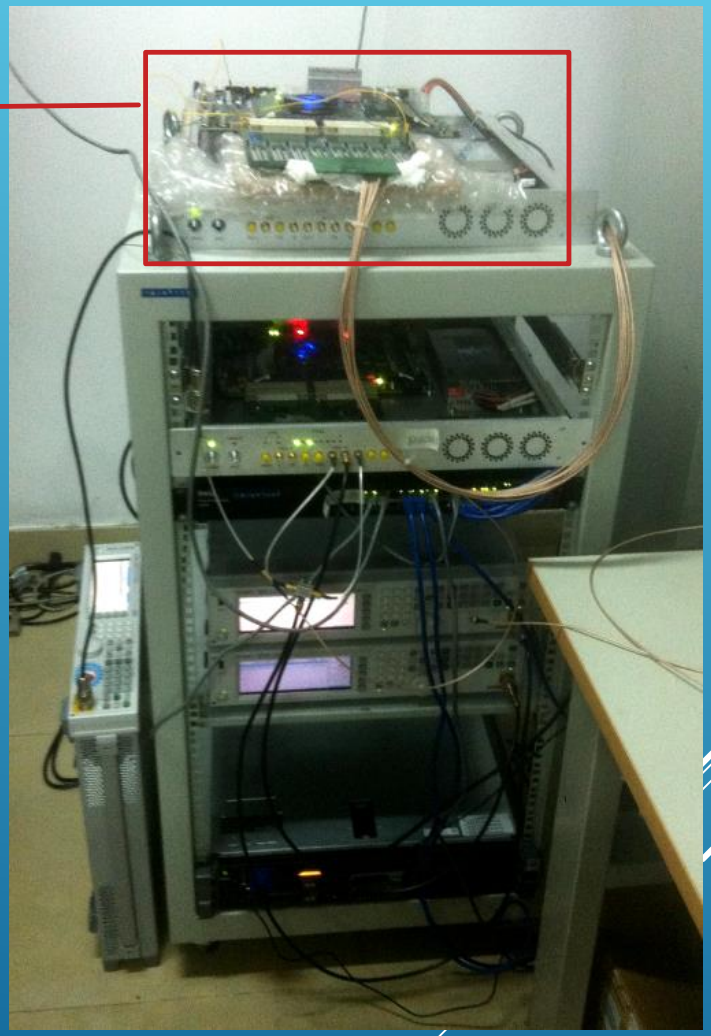
Digital Beam Forming Network



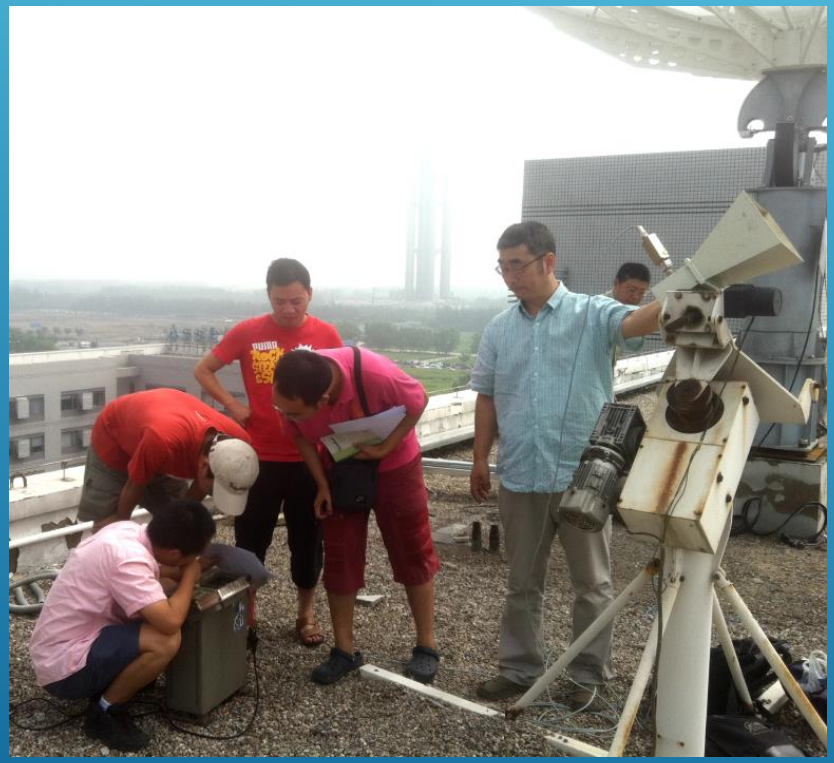


CASPER hardware and Computers

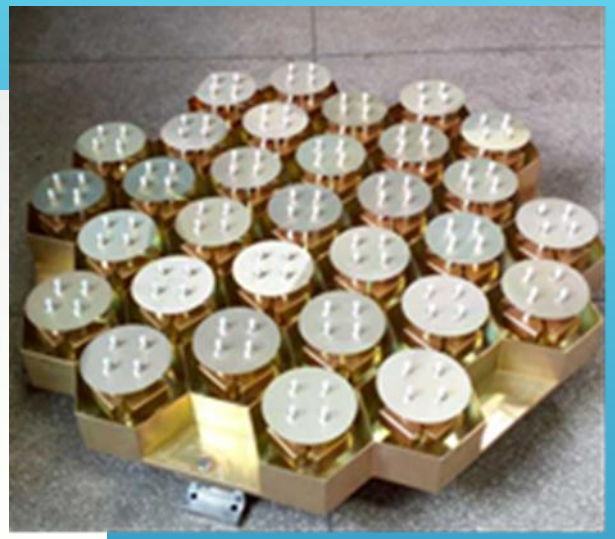




Test Platform I -4.5m at NAOC'Roof



Test Platform II -DVA-C in Shijiazhuang



Thank You For Your Attention!