Parabolic Dish Focus, Zoom and Tilt

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EME Prevention

• TREES – no window

Solution – new QTH



Clear View



Dish Pattern Simulation

- Ansoft HFSS
- More detail than measurement
- No reflections
- See affect of focus, zoom, and tilt



Better Feed

- More gain
- Smaller sidelobes
- Same beamwidth



15λ Dish,

Super-VE4MA feed



Dish Focus



0.25λ Closer to Reflector

3.2000e+00
2.8286e+00
2.4571e+00
2.0857e+00
1.7143e+00
1.3429e+00
9.7143e+00
6.0000e+00
2.2857e+00
-1.4286e+00
-5.1429e+00
-8.8571e+00
-1.2571e+00
-1.6286e+00
-2.0000e+00



0.5λ Closer to Reflector

dB ((DirTotal)
	3,2000e+001
_	2.9000e+001
	2.6000e+001
_	2.3000e+001
	2.0000e+001
	1.7000e+001
	1.4000e+001
	1.1000e+001
	8.0000e+000
	5.0000e+000
	2,0000e+000
	-1.0000e+000
	-4.0000e+000
	-7,0000e+000
	-1.0000e+001
	-1.3000e+001
	-1.6000e+001
	-1.9000e+001



0.75λ Closer to Reflector



1λ Closer to Reflector



1.25 λ Closer to Reflector

3,2000e+001
2.9000e+001
2.6000e+001
2.3000e+001
2.0000e+001
1.7000e+001
1.4000e+001
1.1000e+001
8,0000e+000
5.0000e+000
2.0000e+000
-1.0000e+000
-4.0000e+000
-7.0000e+000
-1.0000e+001
-1.3000e+001
-1.6000e+001
-1.9000e+001



1.5λ Closer to Reflector

dB(Di	irTotal)	
	2.2000004	Theta
	3,20006+001	
	2,02000+001	
	2.45710+001	
	2.00370+001	
	1.71436+001	
	1,34296+001	
	9.71436+000	
	6.00006+000	
	2.2857e+000	
	-1.4286e+000	
	-5.1429e+000	
	-8.8571e+000	
	-1.2571e+001	
	-1.6286e+001	
	-2.0000e+001	

1.75λ Closer to Reflector



dB(DirTotal)

3,2000e+001
2.9000e+001
2.6000e+001
2.3000e+001
2.0000e+001
1.7000e+001
1.4000e+001
1.1000e+001
8.0000c+000
5.0000e+000
2,0000e+000
-1.0000e+000
-4.0000e+000
-7,0000e+000
-1.0000e+001
-1.3000e+001
-1,6000e+001
-1.9000e+001

2λ Closer to Reflector

_	3,2000e+001
	2.9000e+001
	2.6000e+001
	2.3000e+001
	2.0000e+001
	1.7000e+001
	1.4000e+001
	1.1000e+001
	8.0000e+000
	5.0000e+000
	2,0000e+000
	-1.0000e+000
	-4.0000e+000
	-7.0000e+000
	-1.0000e+001
	-1.3000e+001
	-1.6000e+001
	-1.9000e+001



2.5λ Closer to Reflector



3λ Closer to Reflector

dB(D	irTotal)		
	3,2000e+001	ī	
_	2.9000e+001	1	
	2.6000e+001	1	
_	2.3000e+001		
	2.0000e+001	1 Theta	
	1.7000e+001	1	
	1.4000e+001	1	
	1.1000e+001	1	
	8.0000e+000		
-	5,0000e+000	a	
	2.0000e+000	a	
	-1.0000e+000	a	
	-4.0000e+000	a	
	-7.0000e+000		
	-1.0000e+001	1	
	-1.3000e+001	1	
	-1.6000e+001		
	-1.9000e+001	1	
			-

Plot the gain vs focus shift



Axial Defocusing Loss



Focus Summary

- As Feed moves toward reflector, pattern gets wider, gain decreases (*Conservation* of *Energy*)
- Other direction similar
- Focus is critical for deep dish
 - $-\frac{1}{4}\lambda$ error = \sim 1dB - For any diameter dish

How to focus accurately

- Range > 50x Rayleigh Distance (Imbriale)
 Not practical for EME dish
- Sun Noise
- Celestial Sources (Larger dishes)





f/D

Practical Focus Error

- Normal antenna range ~= Rayleigh Distance
- Focus at infinity = measured gain ~1 dB low
- Focus on range = real gain ~ 1 dB low
 Feed will be too far from reflector

> Focus at 5x Rayleigh Distance = tiny error

Focus for **BIG** Dish



Offset Dish

3.2000e+001
3,0000e+001
2.8000e+001
2,6000e+001
2.4000e+001
2.2000e+001
2.0000e+001
1.8000e+001
1,6000e+001
1.4000e+001
1.2000e+001
1.0000e+001
8.0000e+000
6.0000e+000
4.0000e+000
2.0000e+000
0.0000e+000

18 inch DSS Dish, W2IMU dual-mode feed

15.7 wavelengths



Better Feed

- More gain
- Smaller sidelobes
- Same beamwidth

D	irlotal)
	3.2000e+001
	3.0000e+001
	2.8000e+001
	2.6000e+001
	2.4000e+001
	2.2000e+001
	2.0000e+001
	1.8000e+001
	1,6000e+001
	1.4000e+001
	1.2000e+001
	1.0000e+001
	8.0000e+000
	6.0000e+000
	4.0000e+000
	2.0000e+000
	0.0000e+000

The

18 inch DSS Dish, Skobelev optimized dual-mode feed

Feed 0.83λ closer to reflector



Feed 1.66 λ closer to reflector



Feed 0.83 λ away from reflector



downtilt

Offset Dish Focus Shift

Axial feed shift tilts pattern

- Closer tilts up
- Away tilts down
- Maximum gain only small decrease
- Axial gain decrease due to pattern tilt

Lateral Feed Shift

Beam Scanning
Multiple feeds – several bands

 Lateral Feed shift causes beam shift in opposite direction

Lateral Feed Shift - Focus

Shifted Focus follows Petzval Surface

 Parabola with ½ radius of curvature
 Tangent to focal plane at focus

- Shifted Focus farther away from reflector
- Adjust for Maximum Gain

Shift - Maximum Gain Contour



Scanning Limit (1 dB Loss)



Feed-scanning Loss



Feed Pointing



Straight Ahead Best

Zoom Control

- Move feed in or out to broaden pattern
- Easier to find signals
- BUT
- Maximum beamwidth increase ~3 times
- Gain ~10 dB lower at 3X beamwidth
- Gain never higher anywhere than focused
- So zoom only finds strong signals
- Small shift can fill in null around main beam

Alternative to Zoom

• Align bearing accurately

- Beacon
- Sun
- Compass
- Know your pattern
- Search by ½ beamwidth
 - For 4 degree beam, move in 2 degree steps



- A few degrees uptilt can enhance terrestrial signals
- More for rain scatter
- Offset zoom = tilt
 - Bad idea no intuitive reference for level

RV tilt gauge good for dishes



Summary

- Accurate focus is important, especially for deep dishes
- Sun noise or celestial source needed for accurate focus
- Lateral shifted feed adjusted independently
- Zoom has little benefit
- Tilt is useful, best done mechanically
- Location of dish is important
- www.w1ghz.org

W1GHZ --> Vermont

