

# Parabolic Dish Focus, Zoom and Tilt

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# EME Prevention

- TREES – no window

# Solution – new QTH

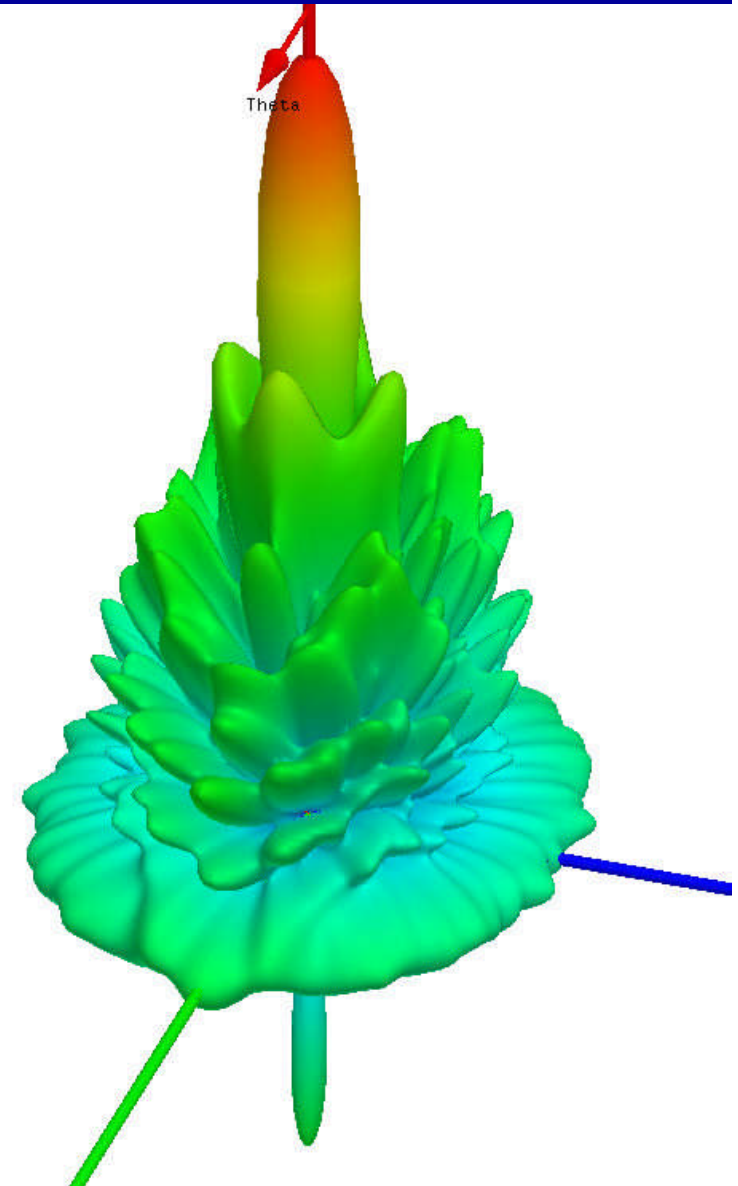
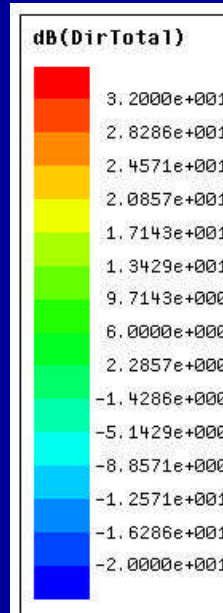


# Clear View



# Dish Pattern Simulation

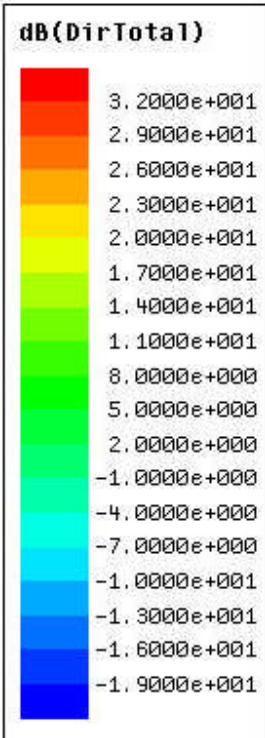
- Ansoft HFSS
- More detail than measurement
- No reflections
- See affect of focus, zoom, and tilt



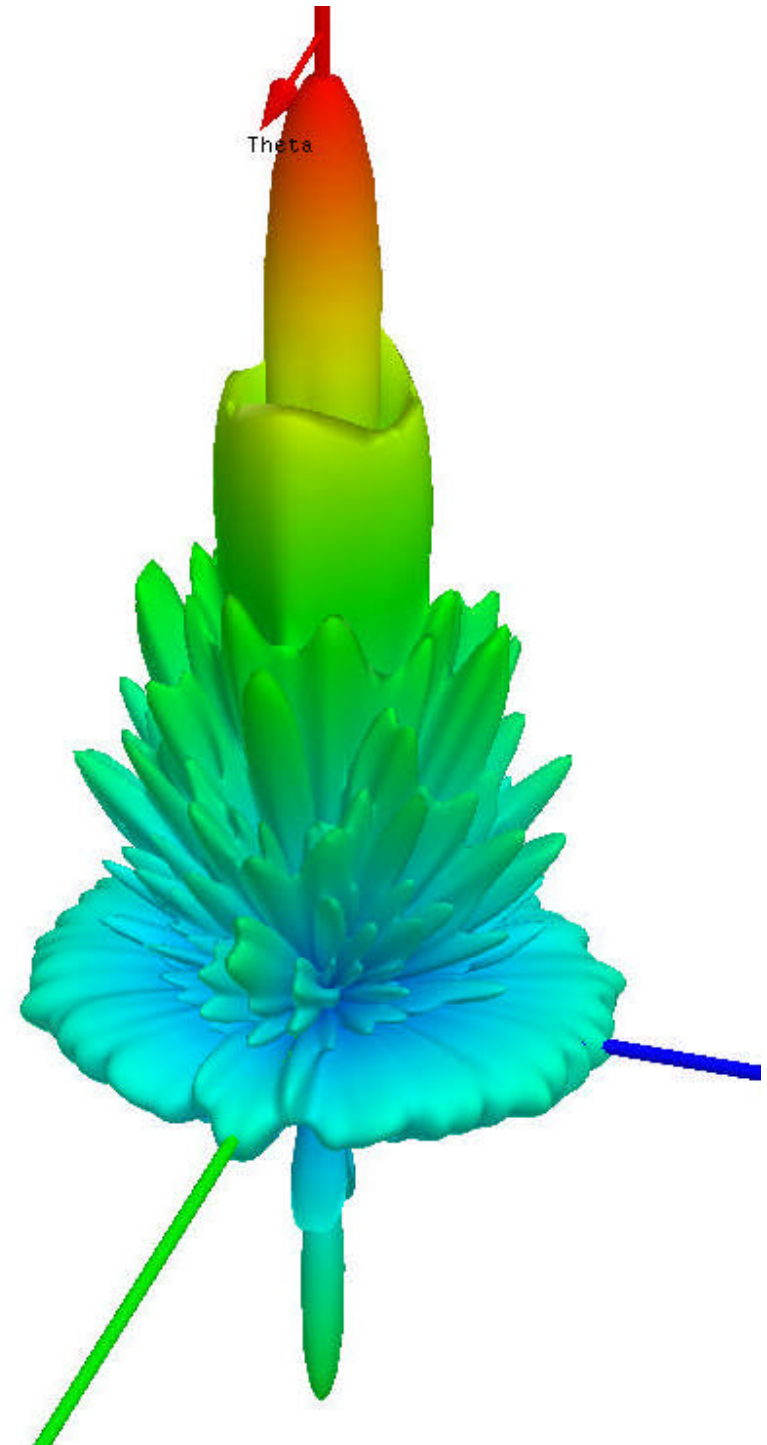
15 $\lambda$  Dish,  
Coffee-can feed

# Better Feed

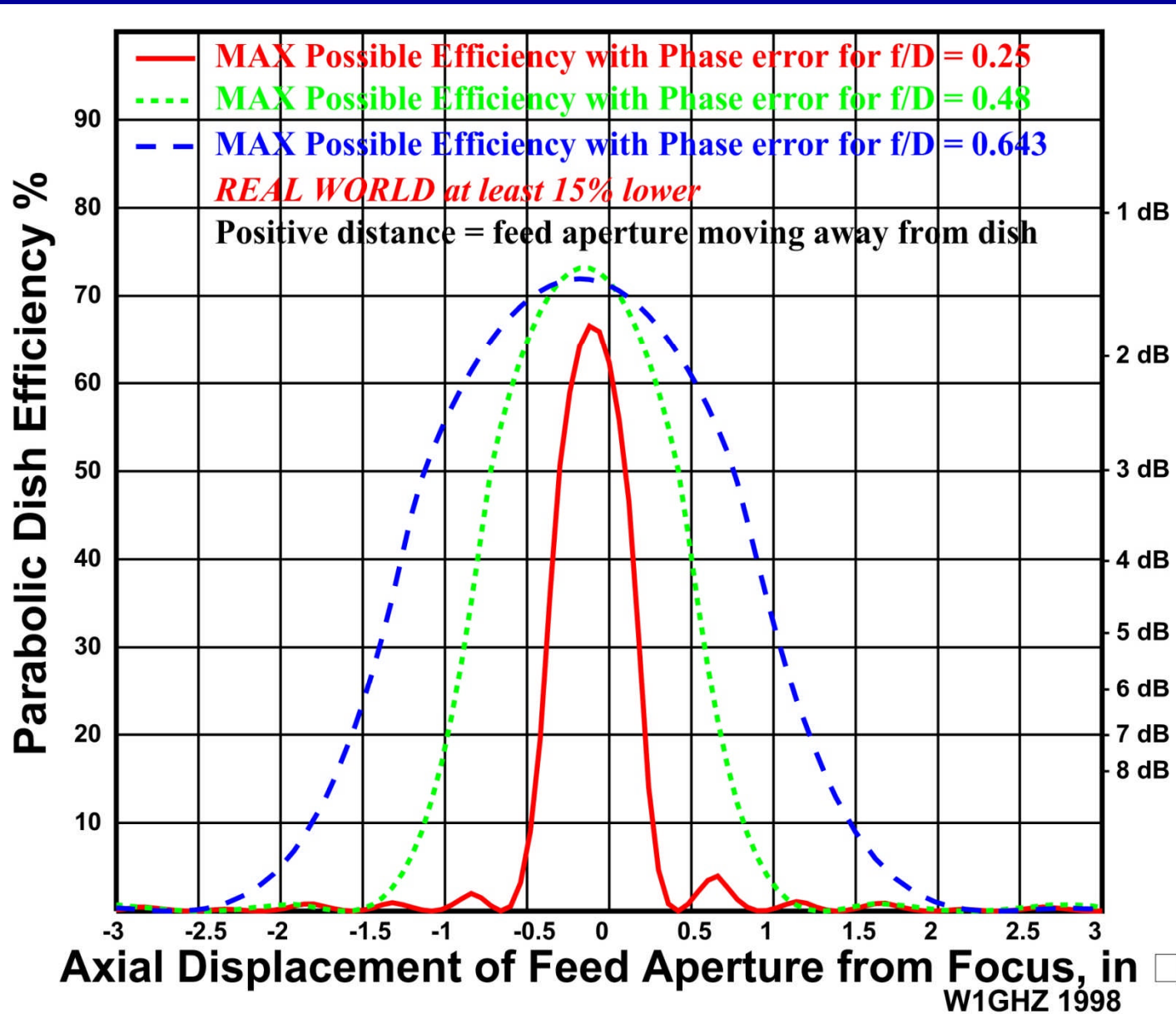
- More gain
- Smaller sidelobes
- Same beamwidth



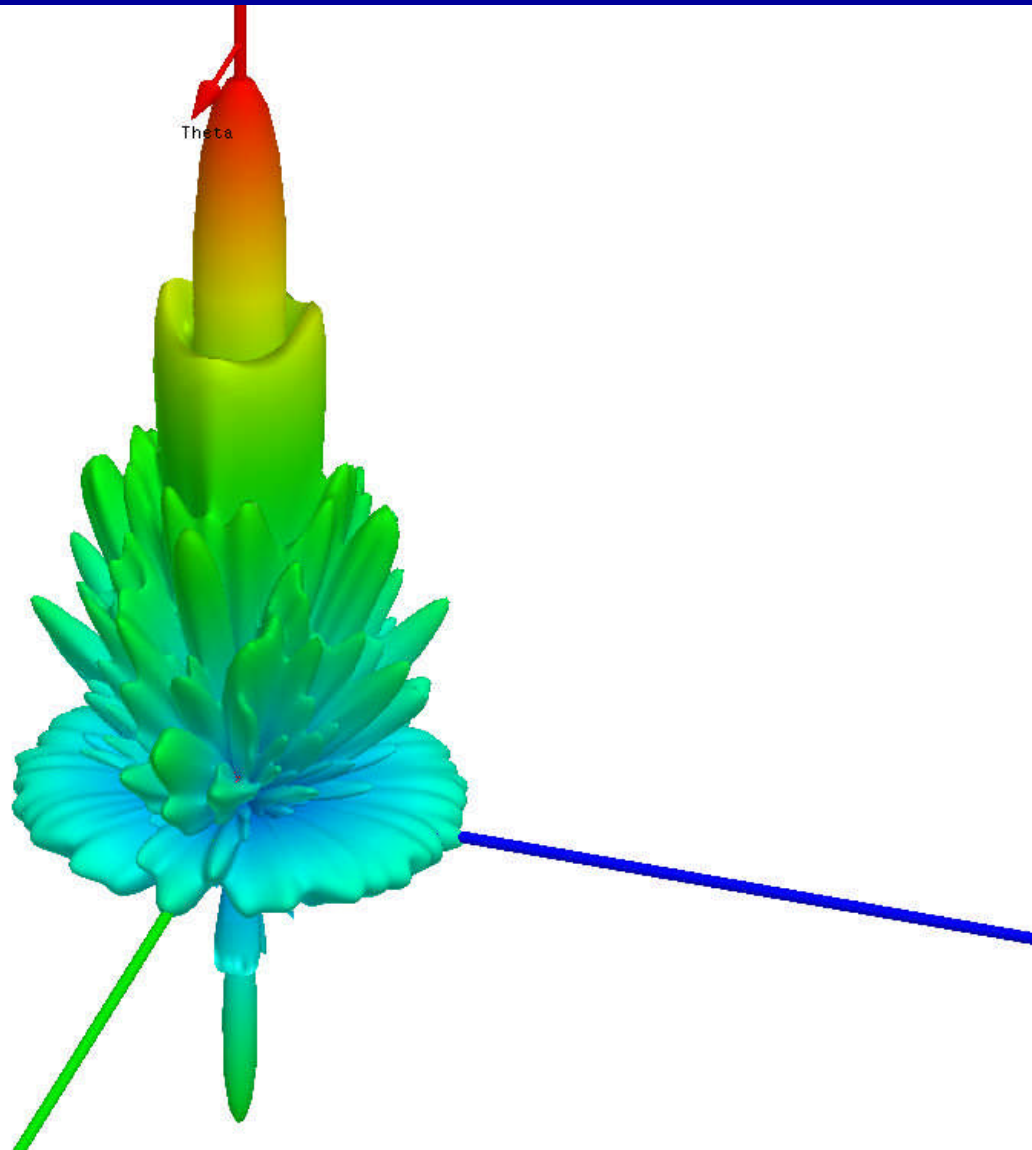
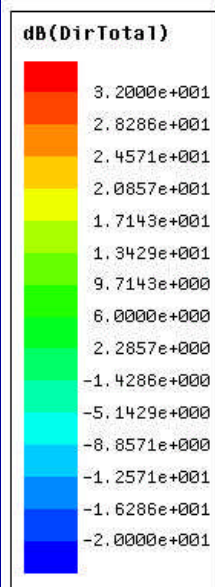
15 $\lambda$  Dish,  
Super-VE4MA feed



# Dish Focus



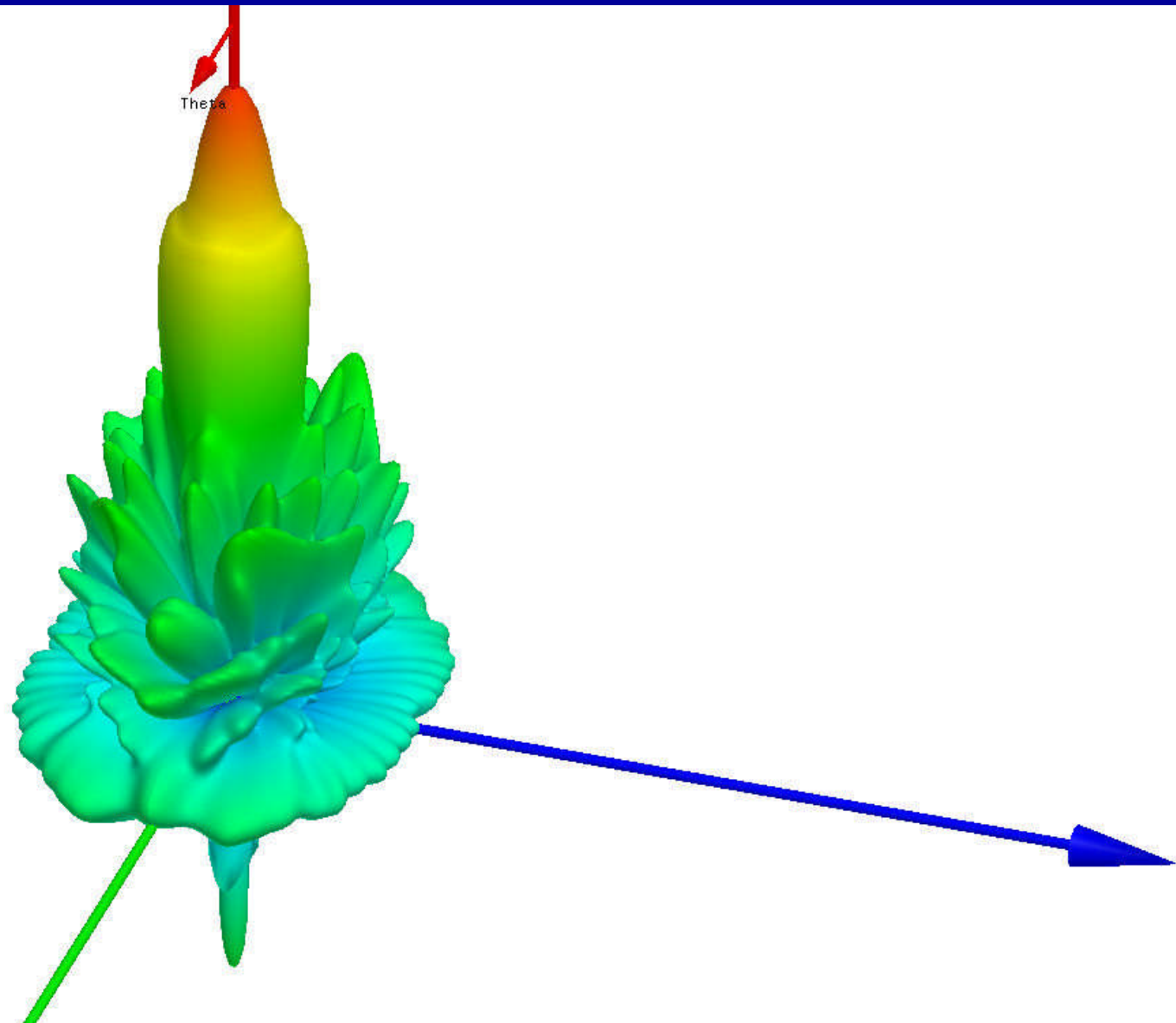
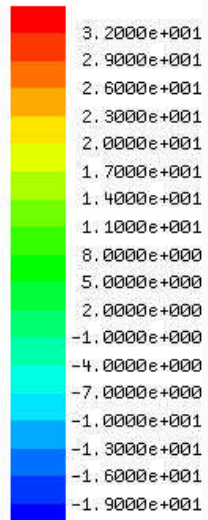
# 0.25 $\lambda$ Closer to Reflector





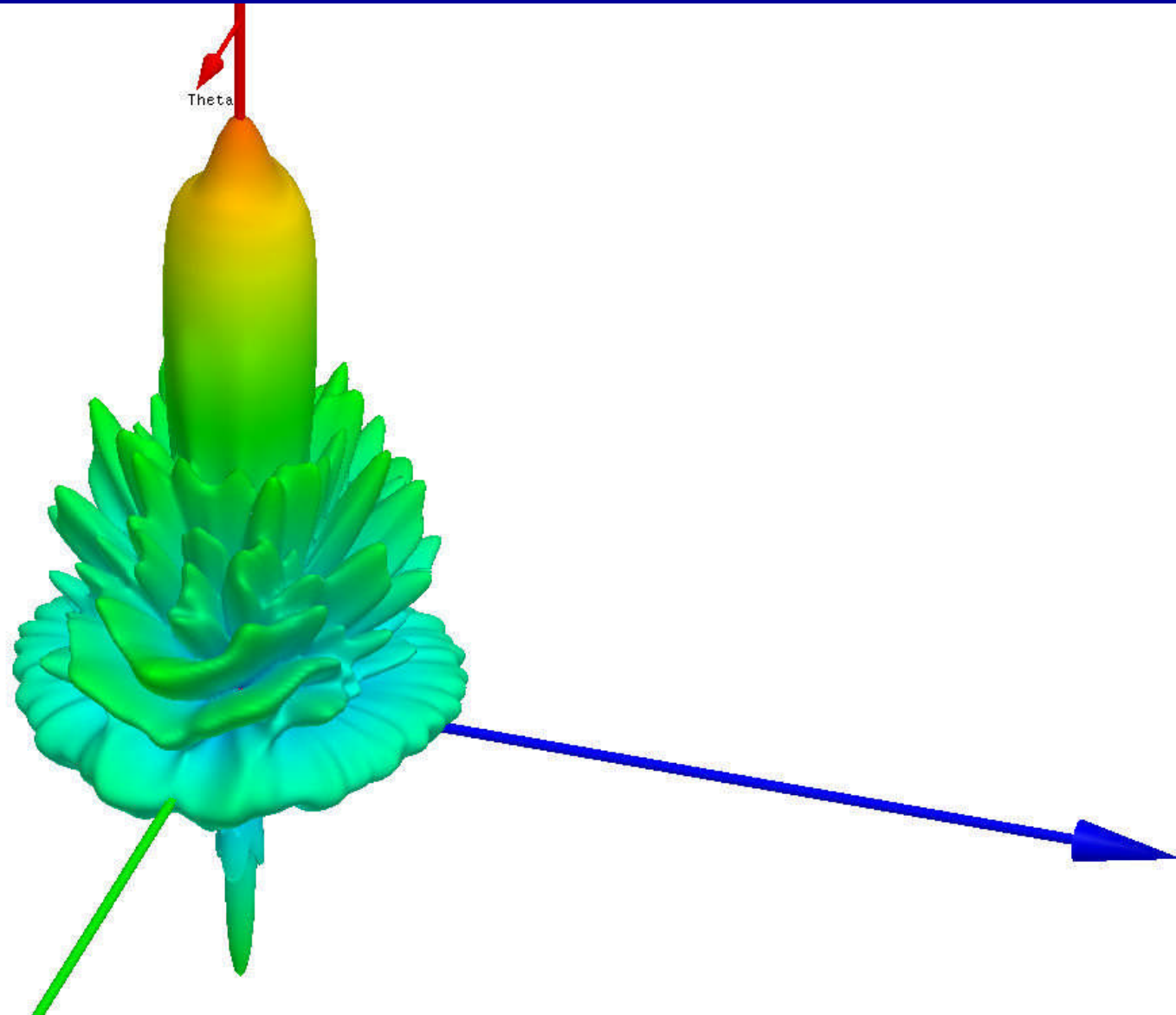
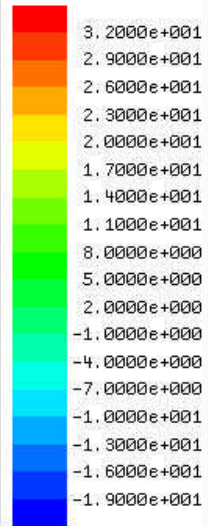
# 0.5 $\lambda$ Closer to Reflector

dB(DirTotal)



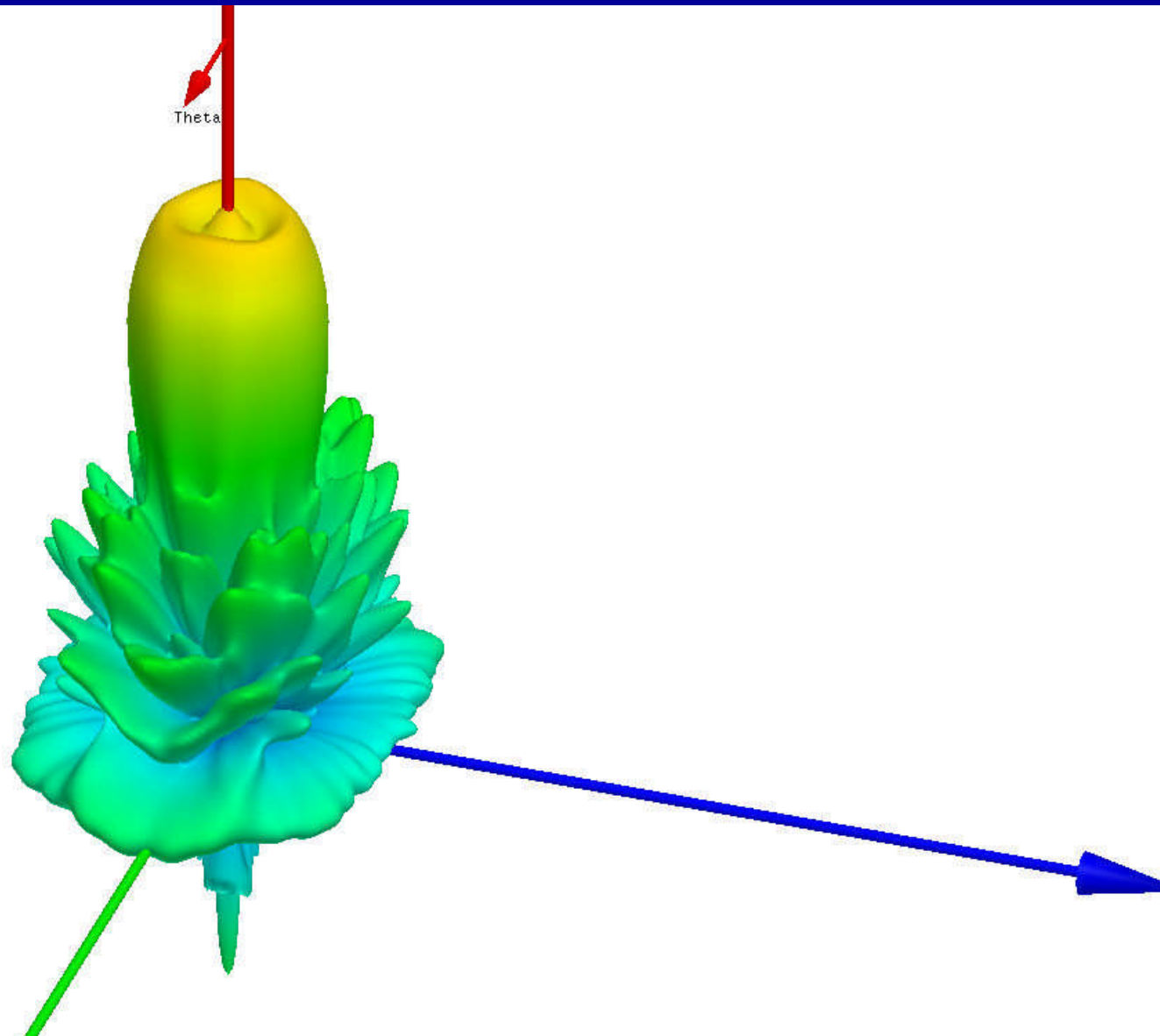
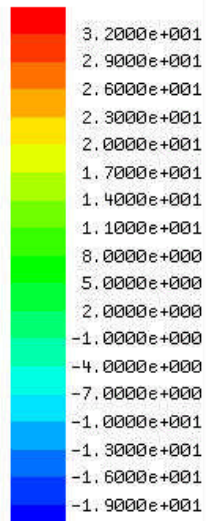
# 0.75 $\lambda$ Closer to Reflector

dB(DirTotal)

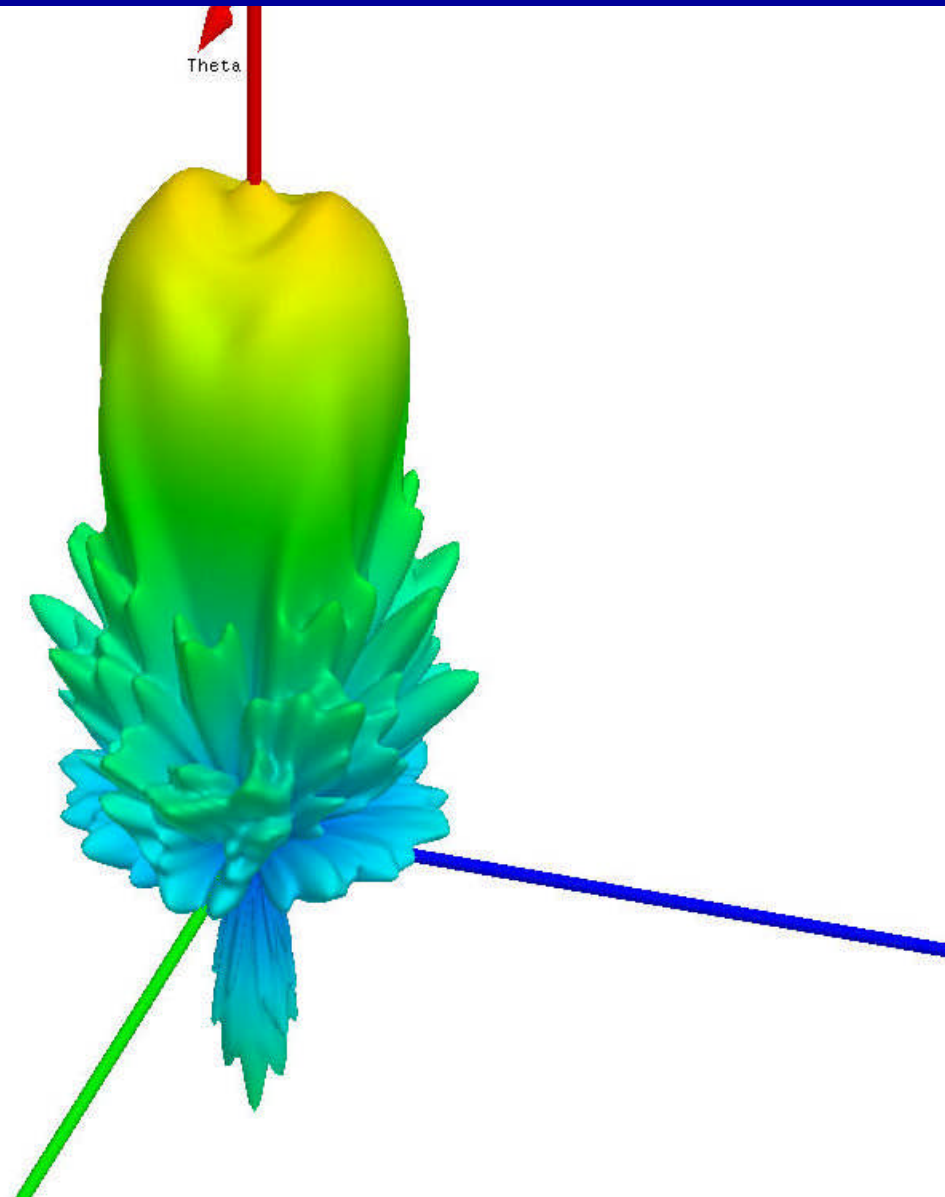
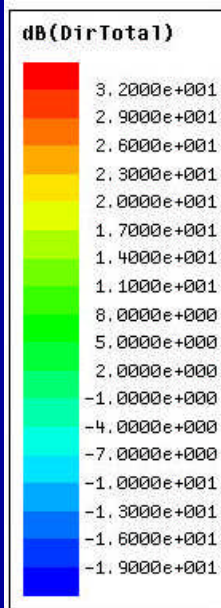


# $1\lambda$ Closer to Reflector

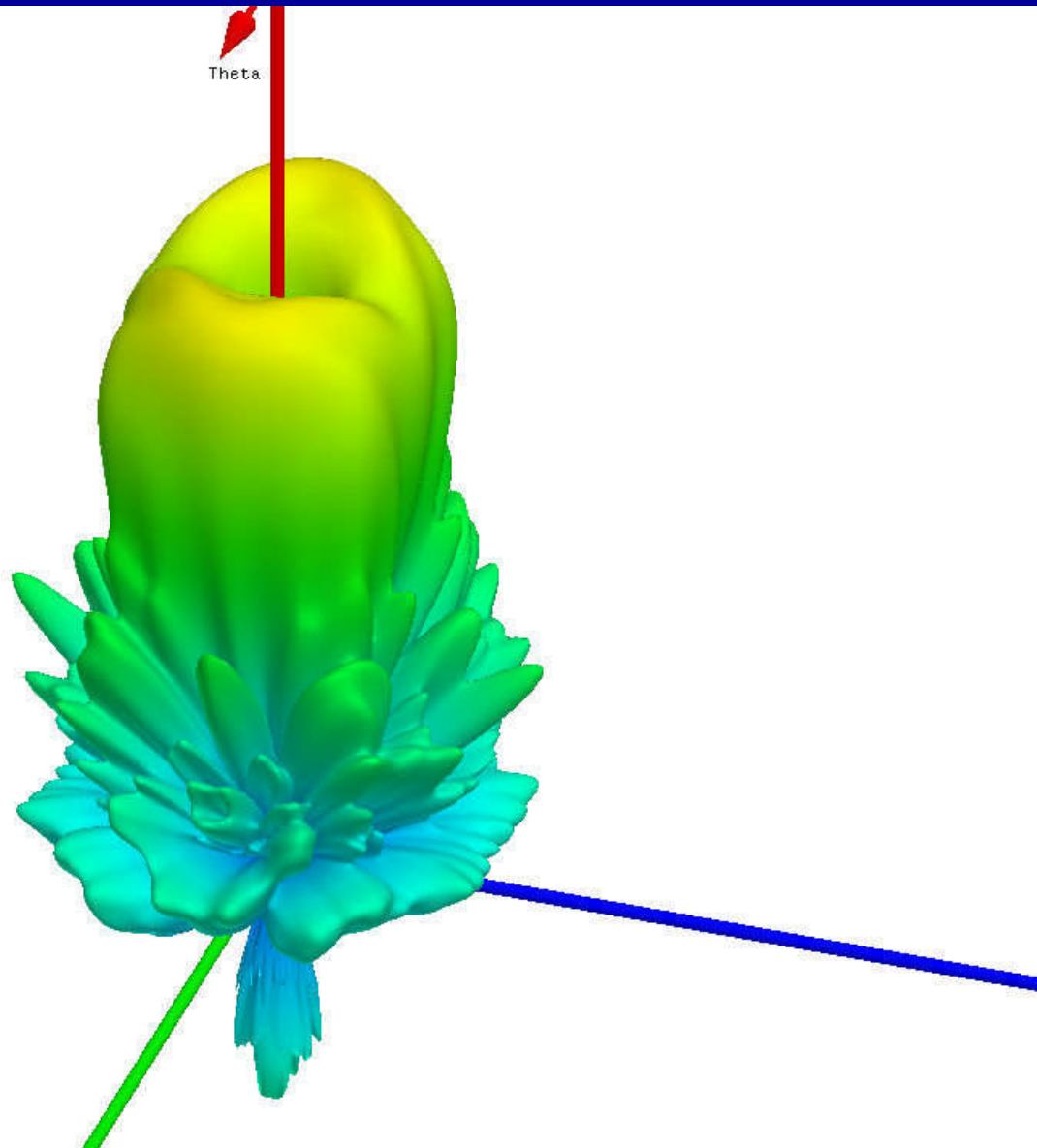
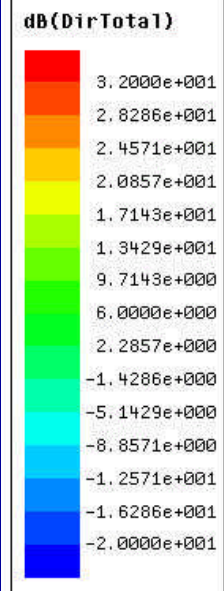
dB(DirTotal)



# 1.25 $\lambda$ Closer to Reflector

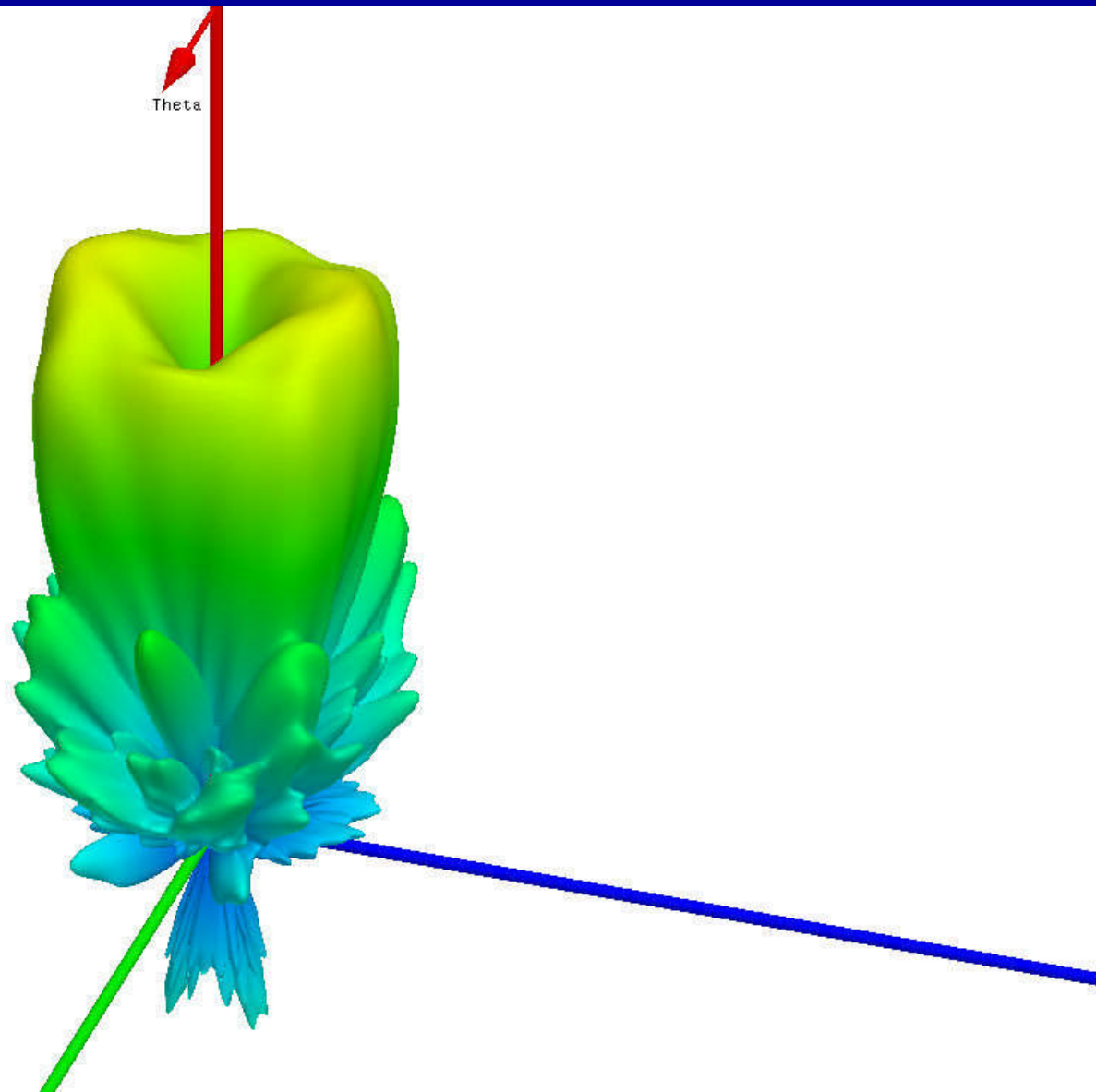
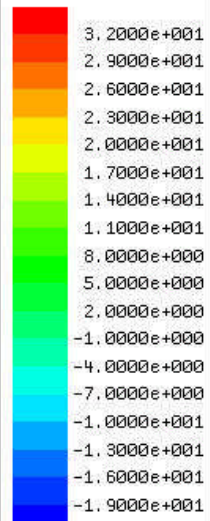


# 1.5 $\lambda$ Closer to Reflector

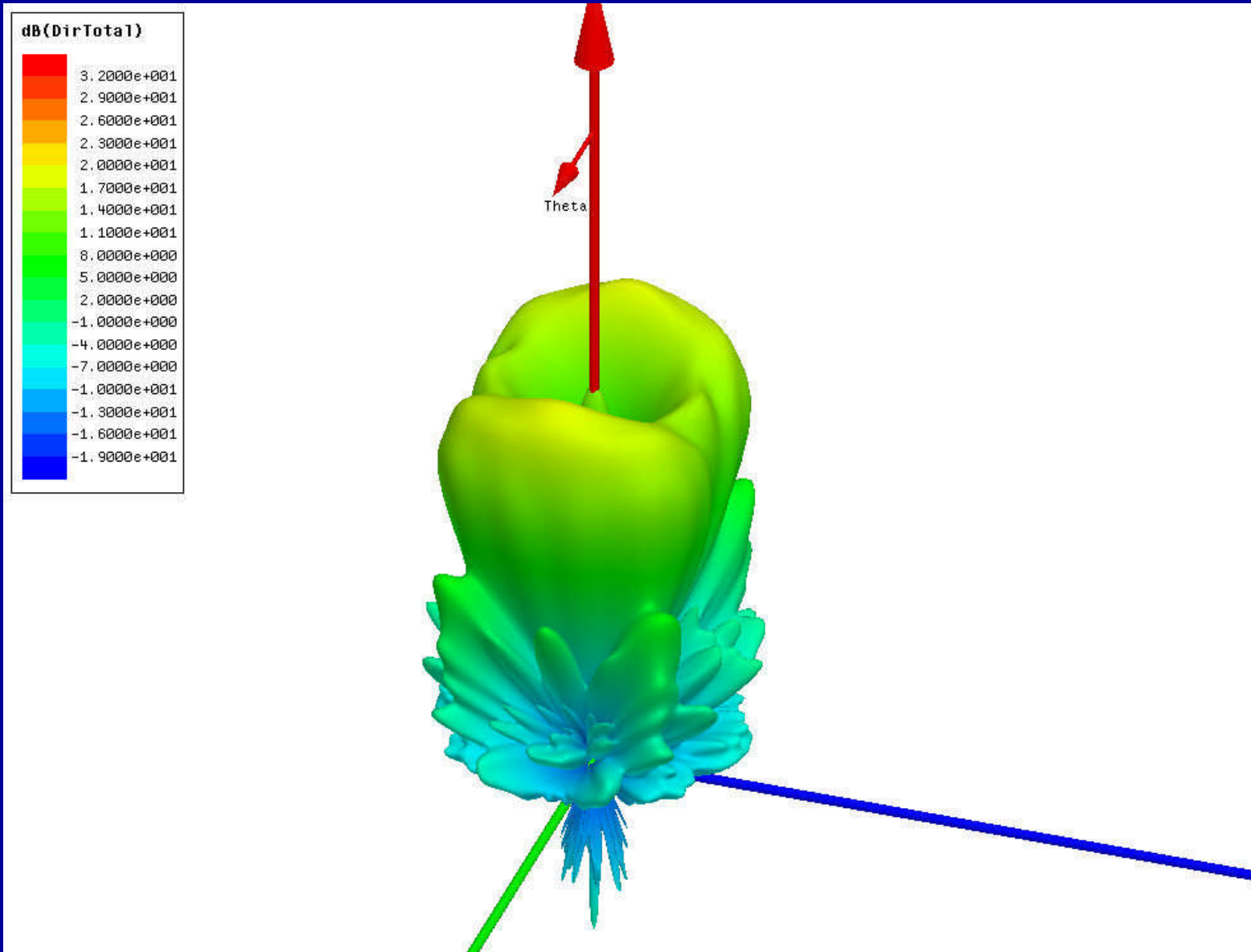


# 1.75 $\lambda$ Closer to Reflector

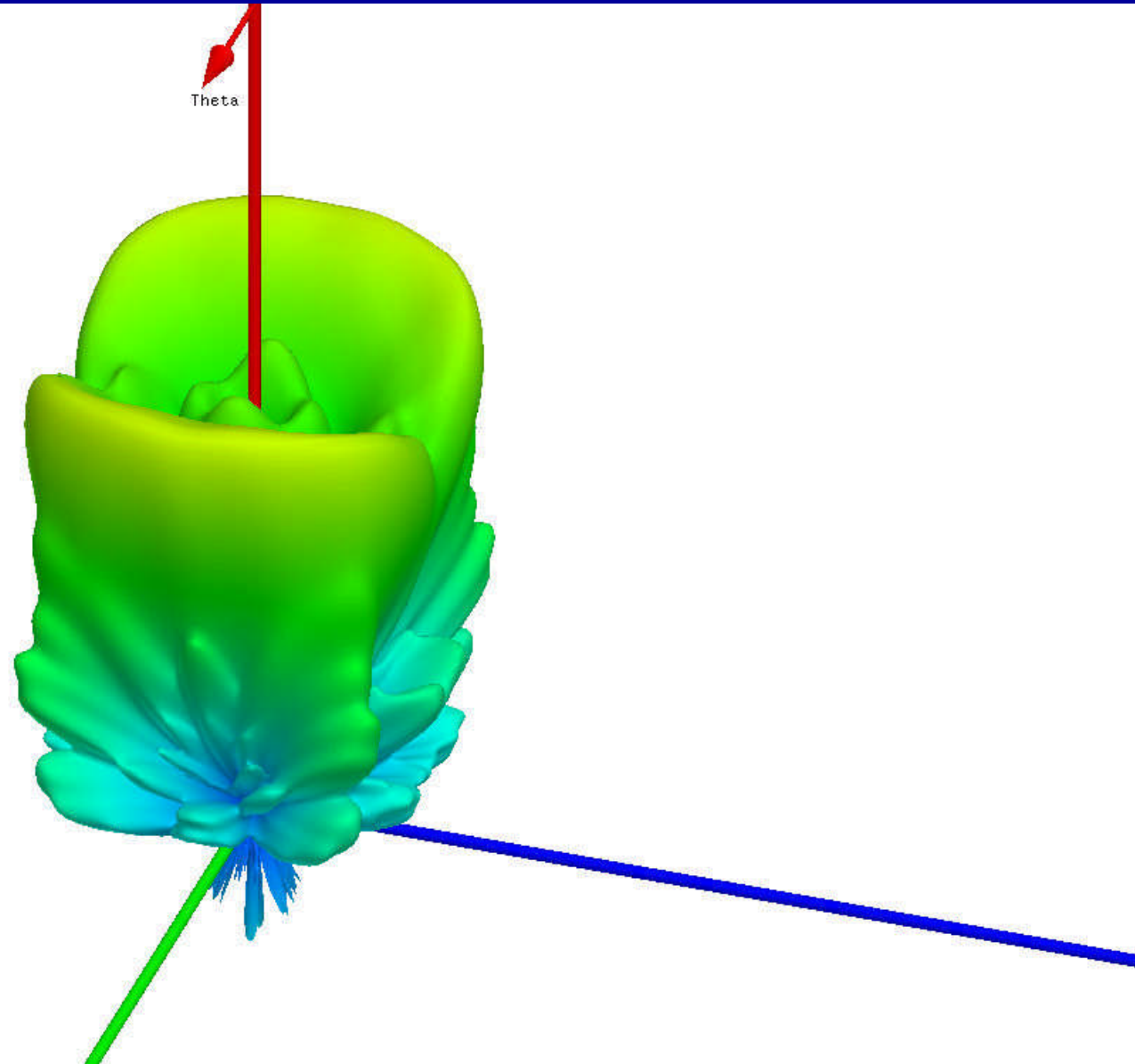
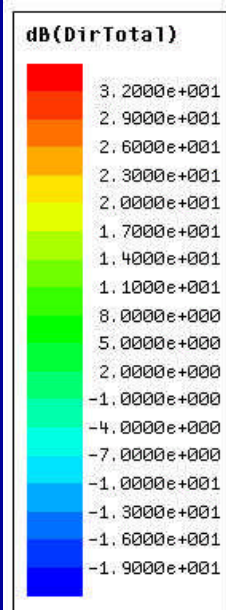
dB(DirTotal)



# $2\lambda$ Closer to Reflector

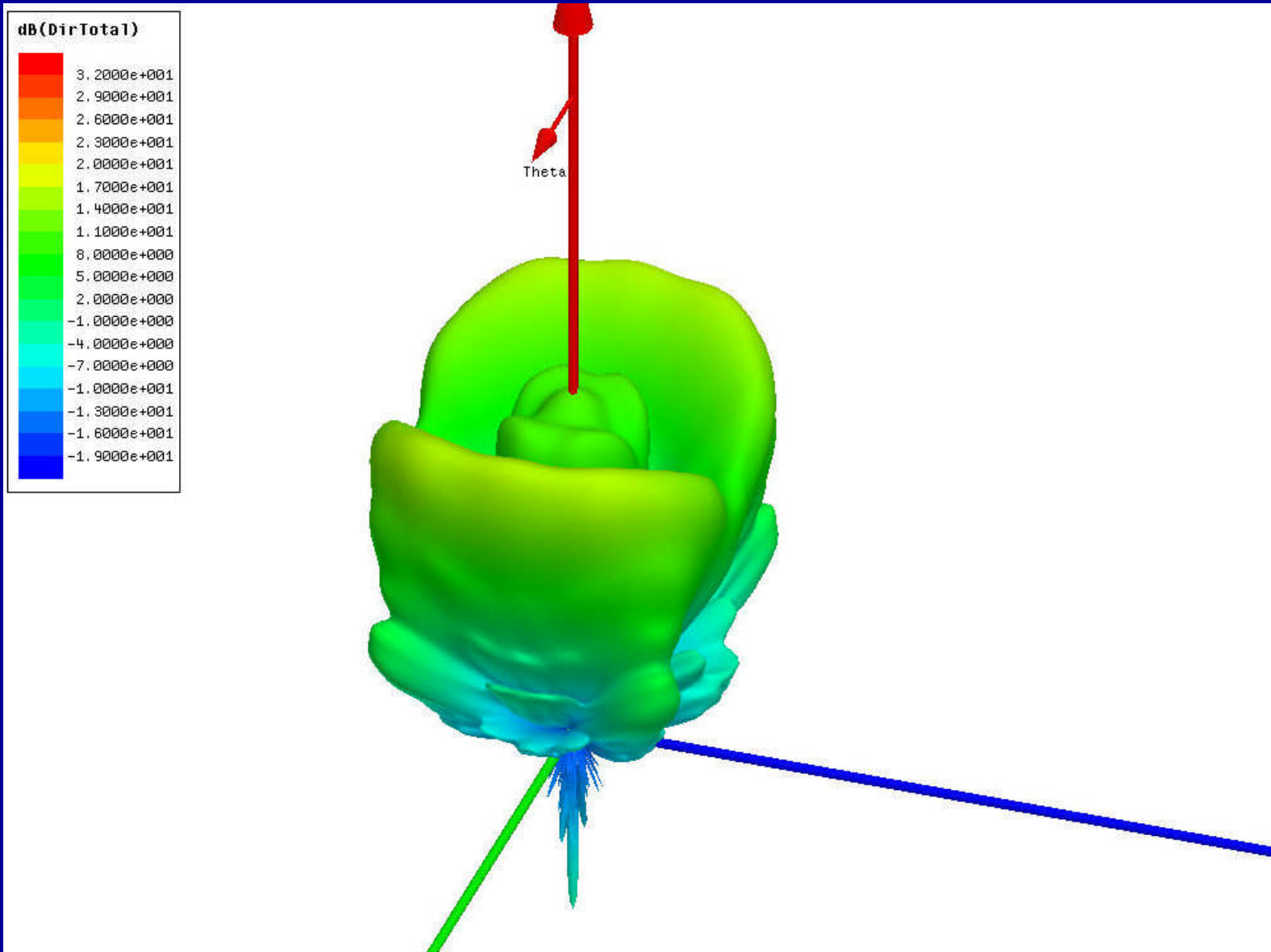


# 2.5 $\lambda$ Closer to Reflector

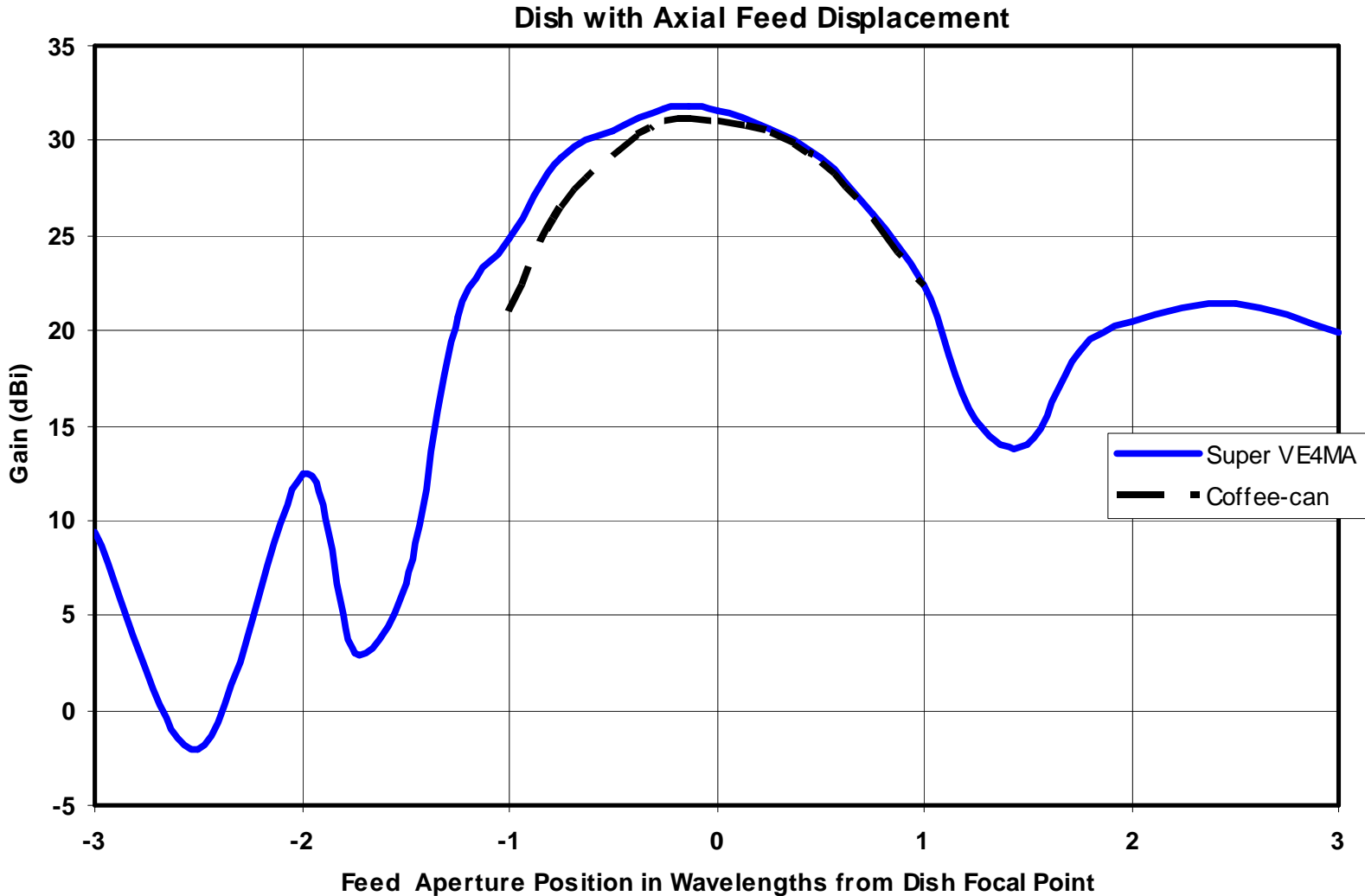




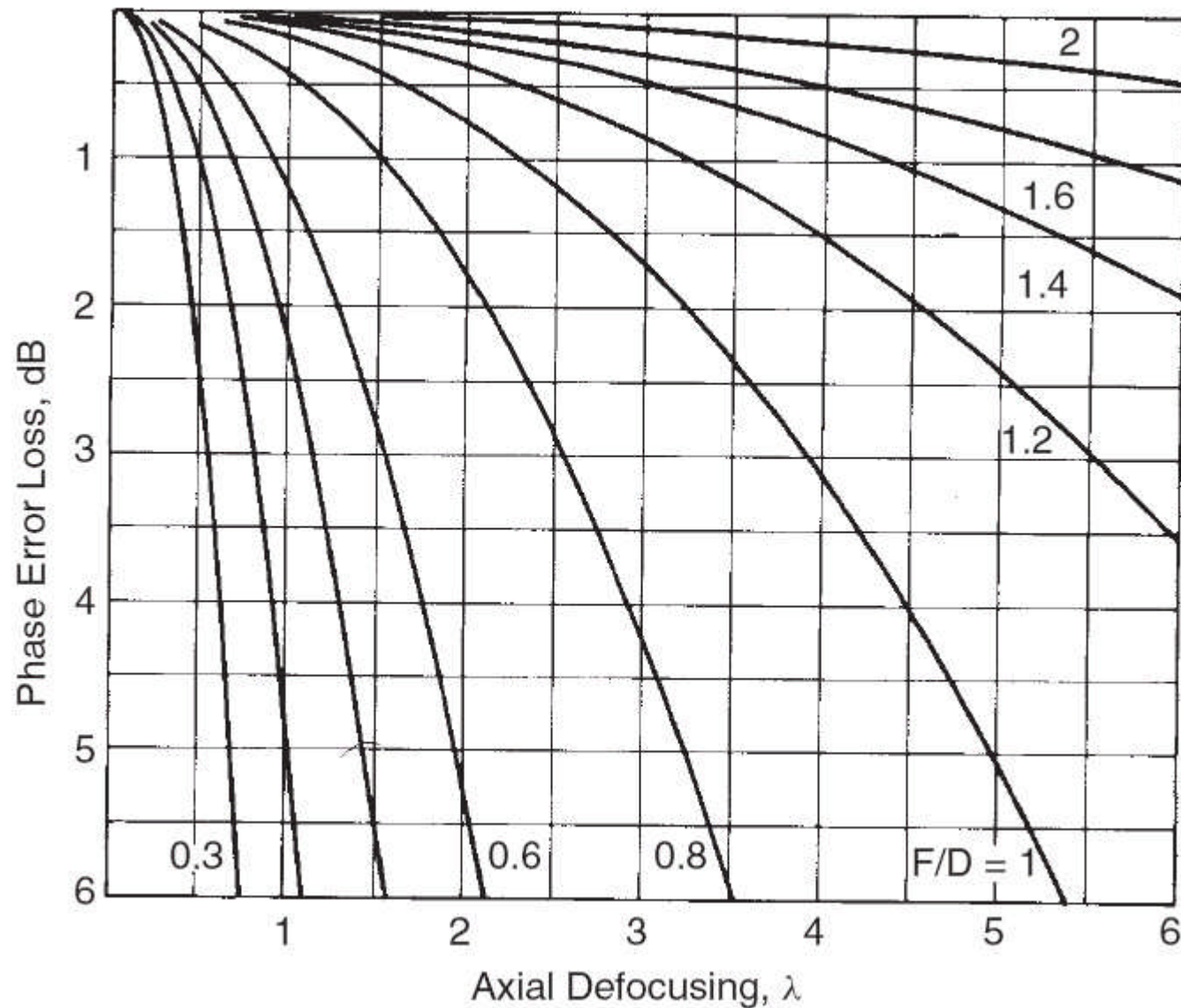
# $3\lambda$ Closer to Reflector



# Plot the gain vs focus shift



# Axial Defocusing Loss



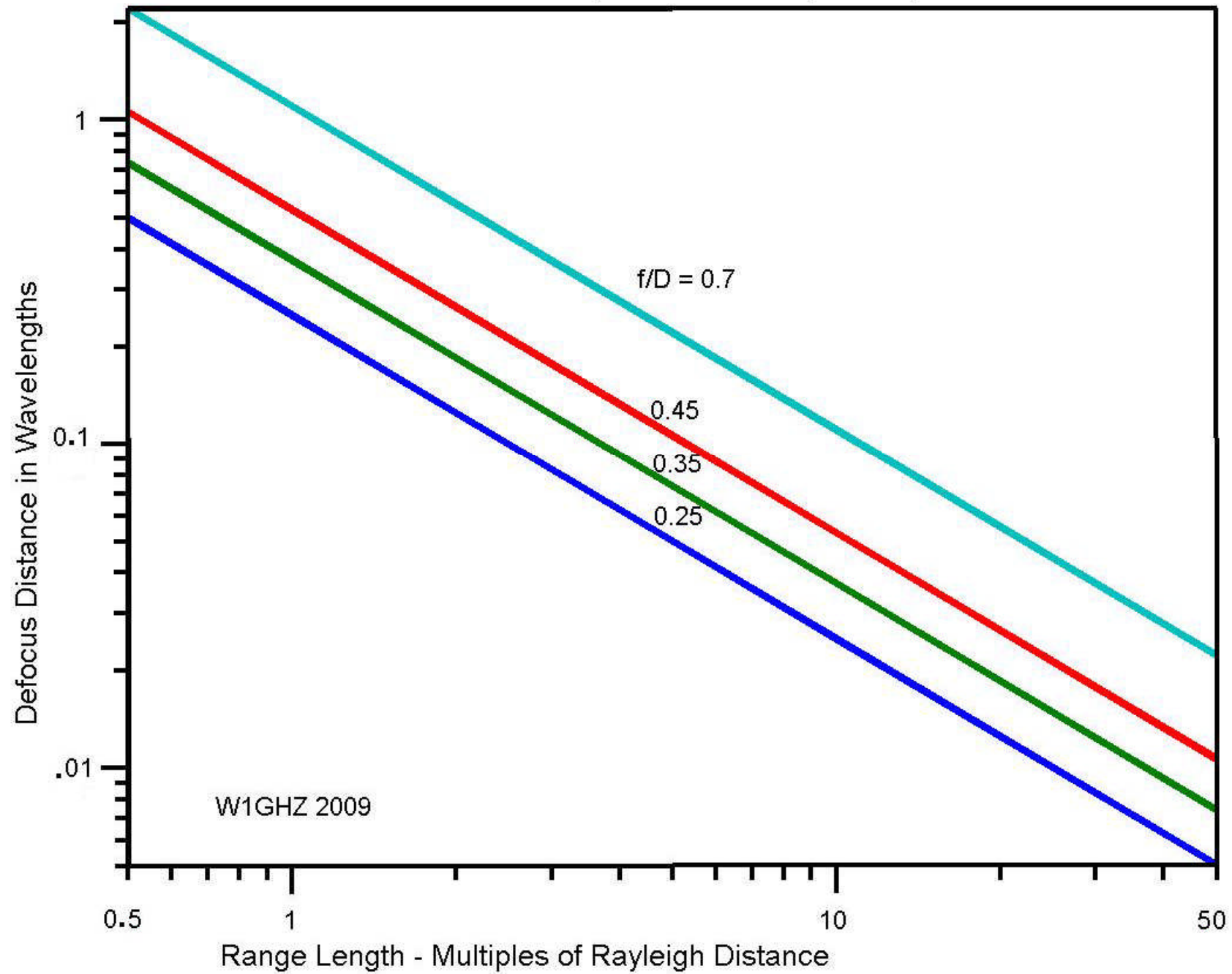
# Focus Summary

- 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 = ~1 dB
  - *For any diameter dish*

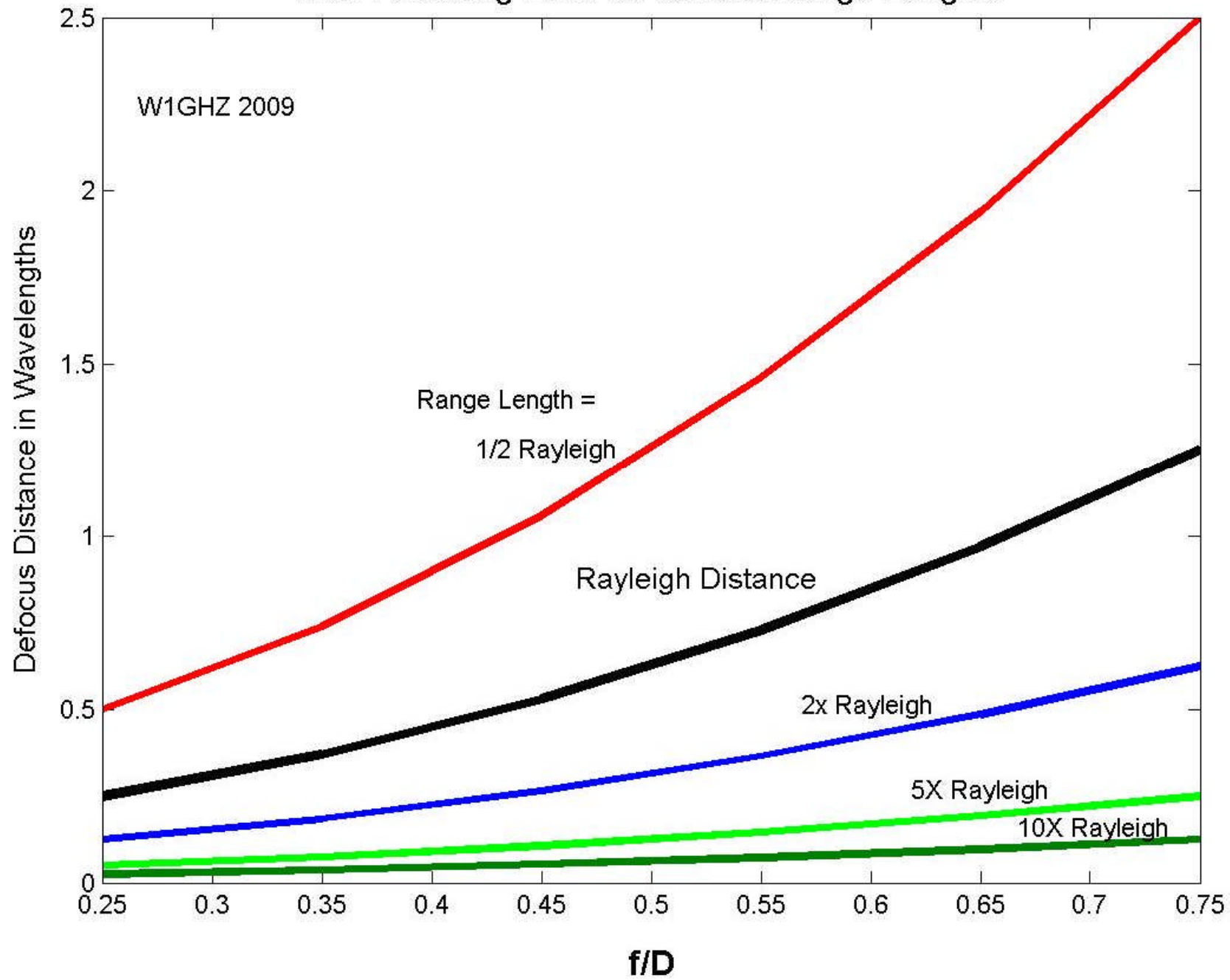
# How to focus accurately

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

### Dish Focusing Error vs Range Length



### Dish Focusing Error at Various Range Lengths

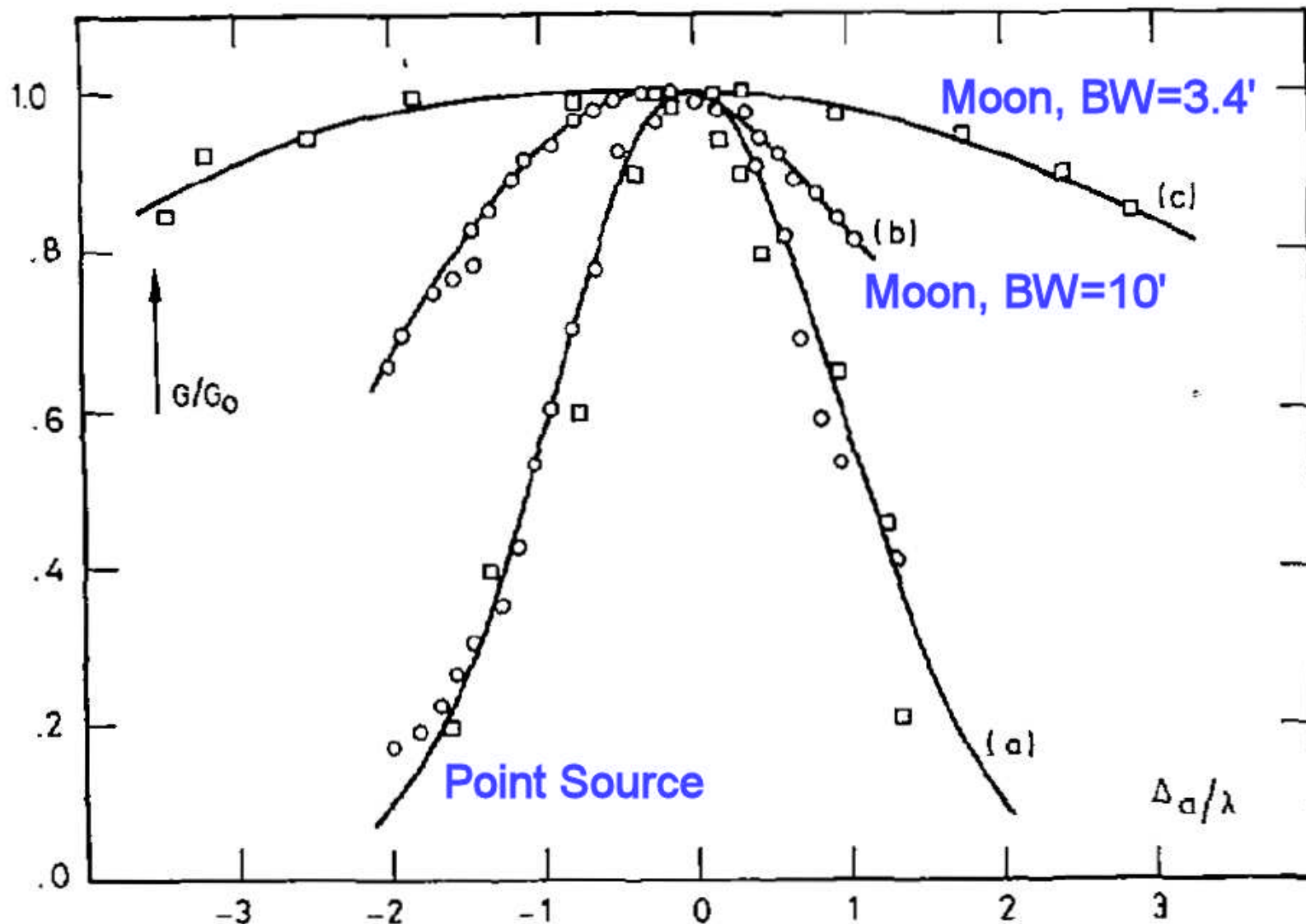


# Practical Focus Error

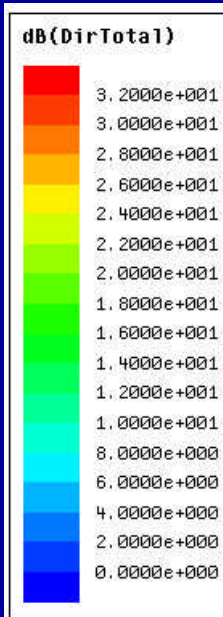
- Normal antenna range  $\approx$  Rayleigh Distance
  - Focus at infinity = measured gain  $\sim 1$  dB low
  - Focus on range = real gain  $\sim 1$  dB low
    - *Feed will be too far from reflector*
- > Focus at 5x Rayleigh Distance = tiny error



# Focus for BIG Dish

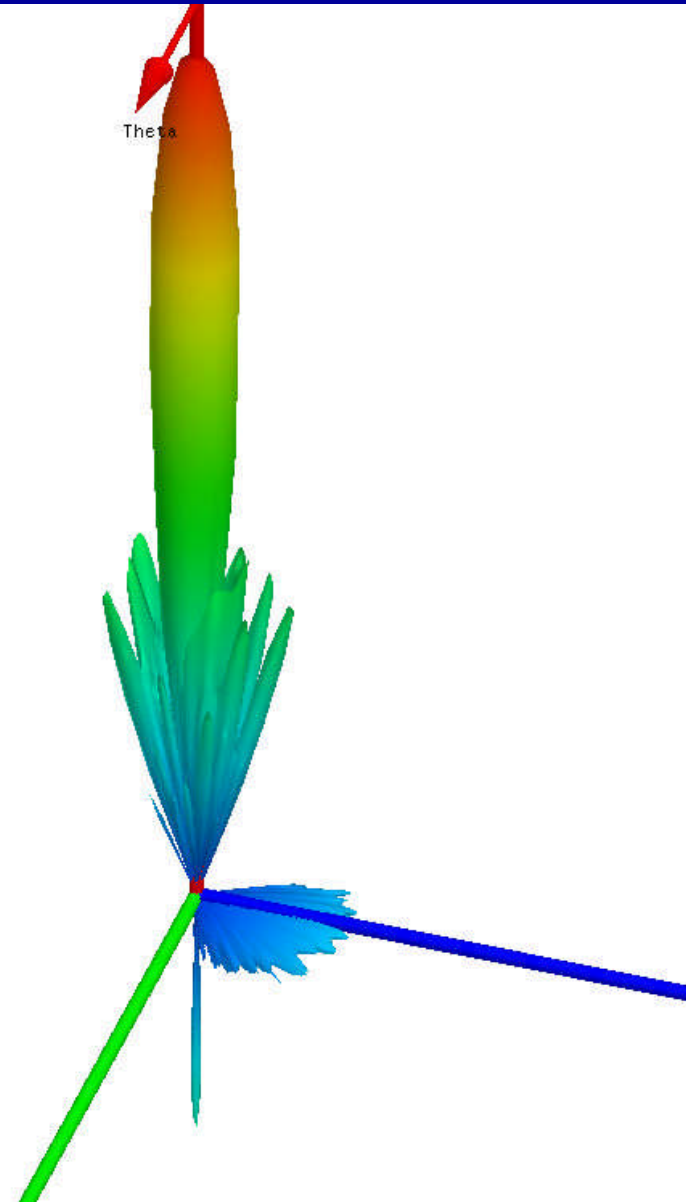


# Offset Dish



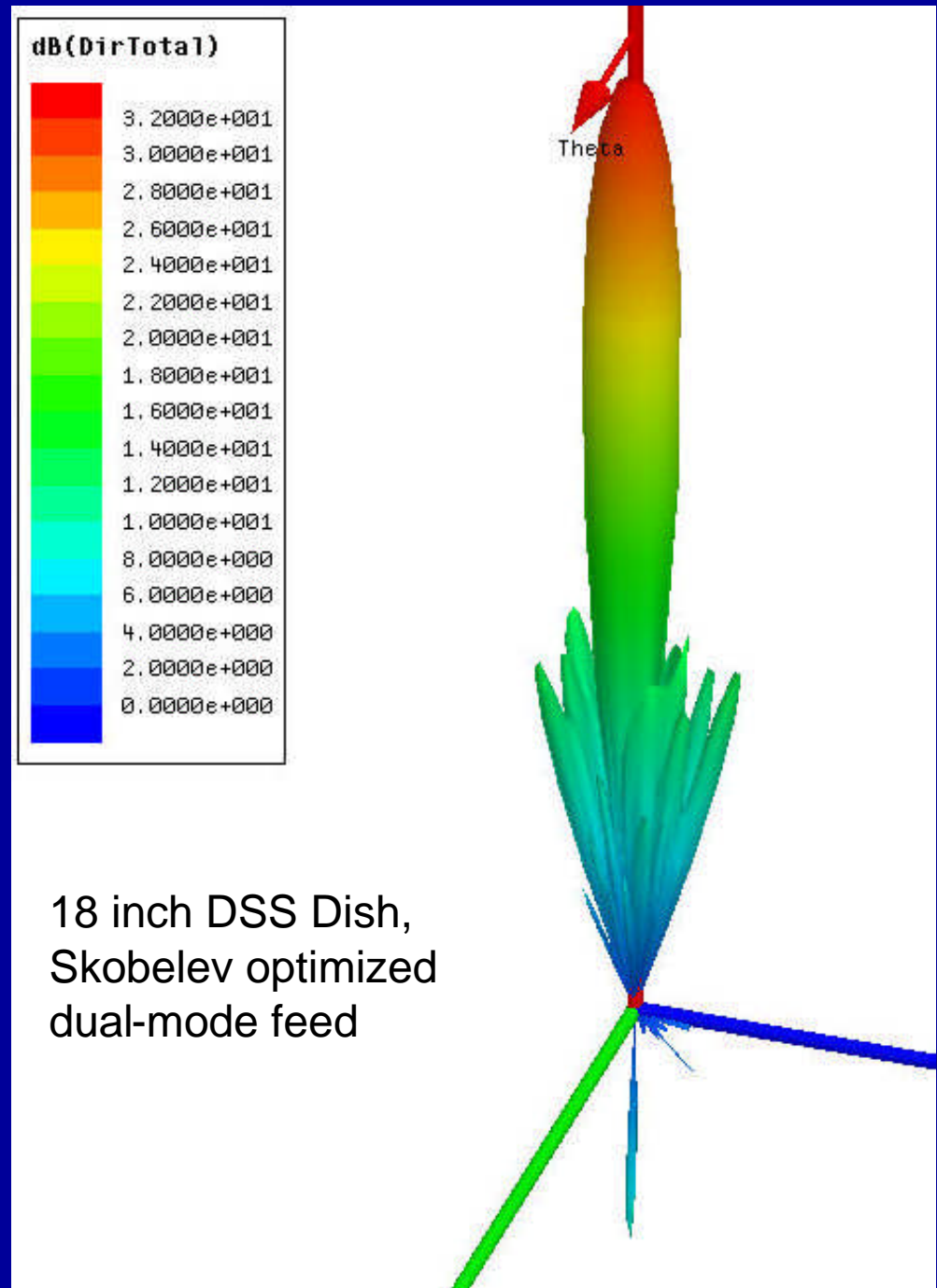
18 inch DSS Dish,  
W2IMU dual-mode feed

15.7 wavelengths

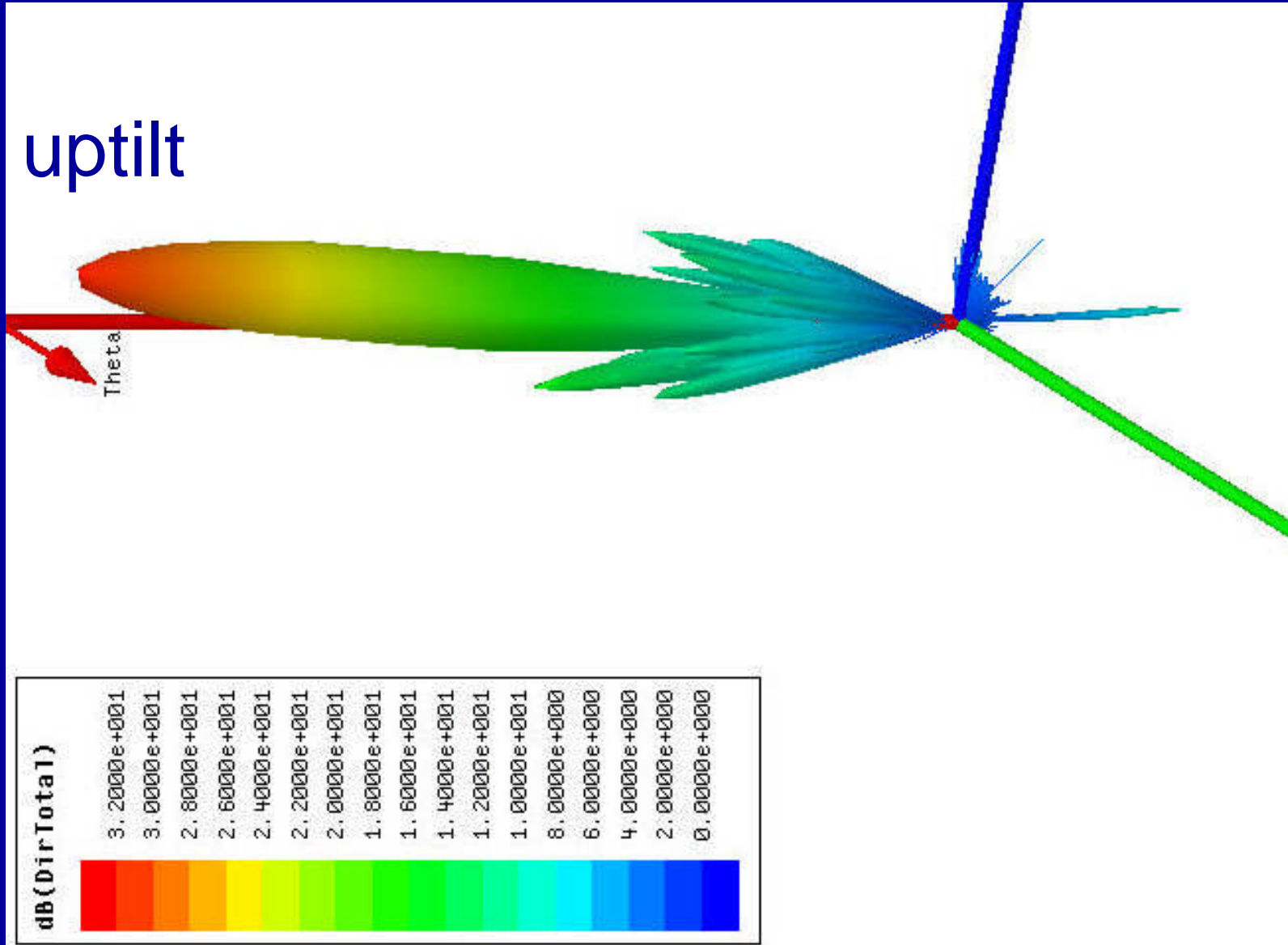


# Better Feed

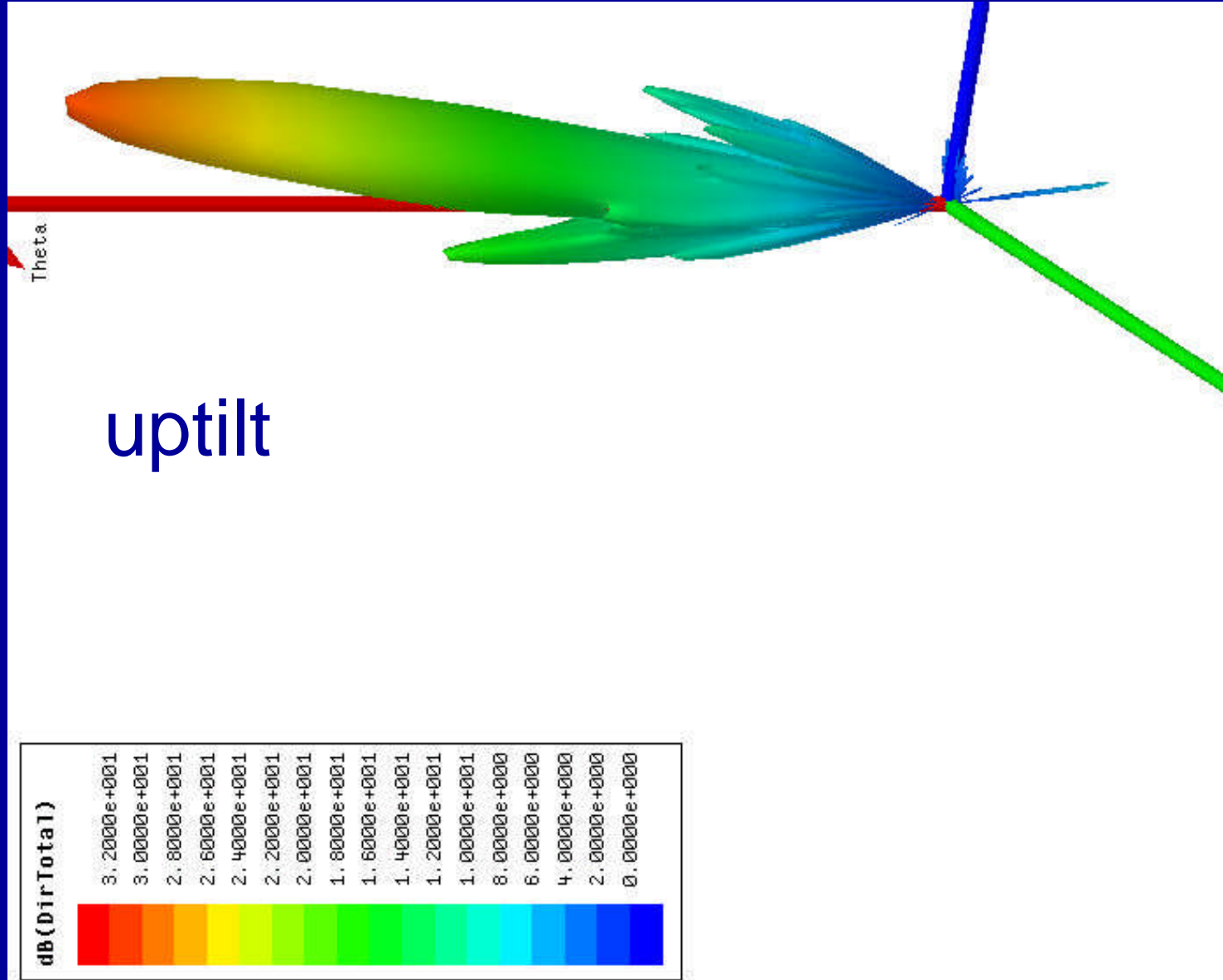
- More gain
- Smaller sidelobes
- Same beamwidth



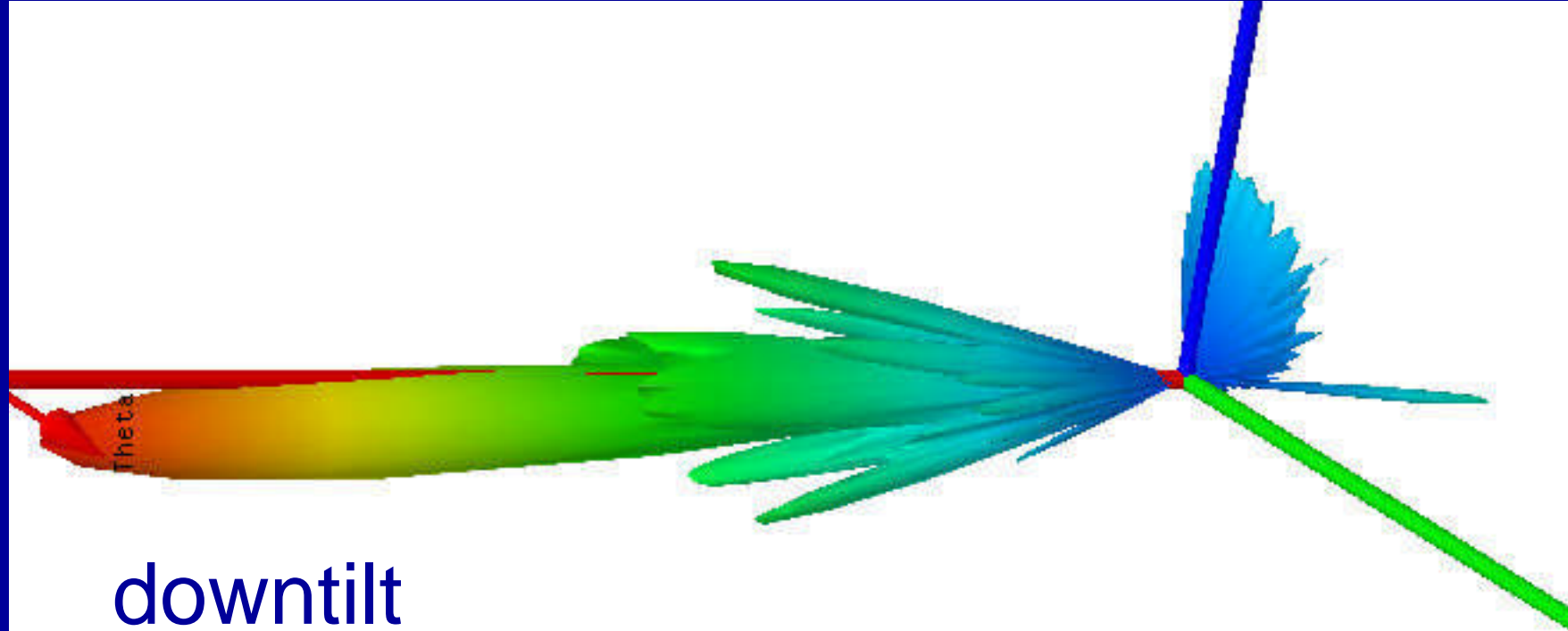
# Feed $0.83\lambda$ closer to reflector



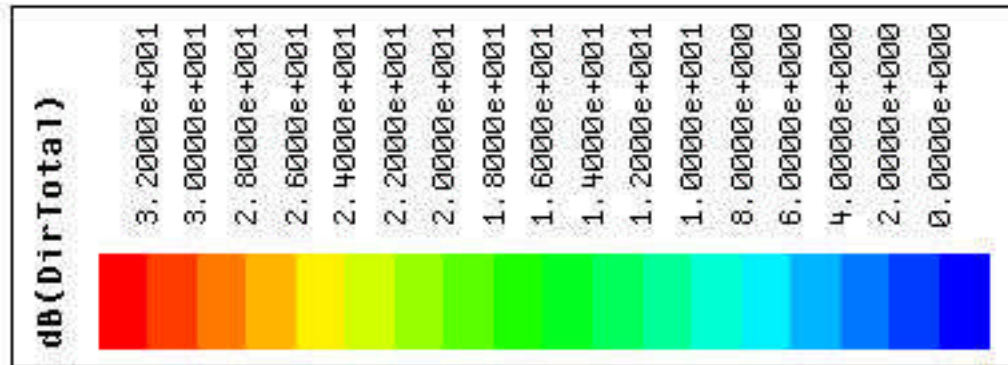
# Feed $1.66\lambda$ closer to reflector



# Feed $0.83\lambda$ 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

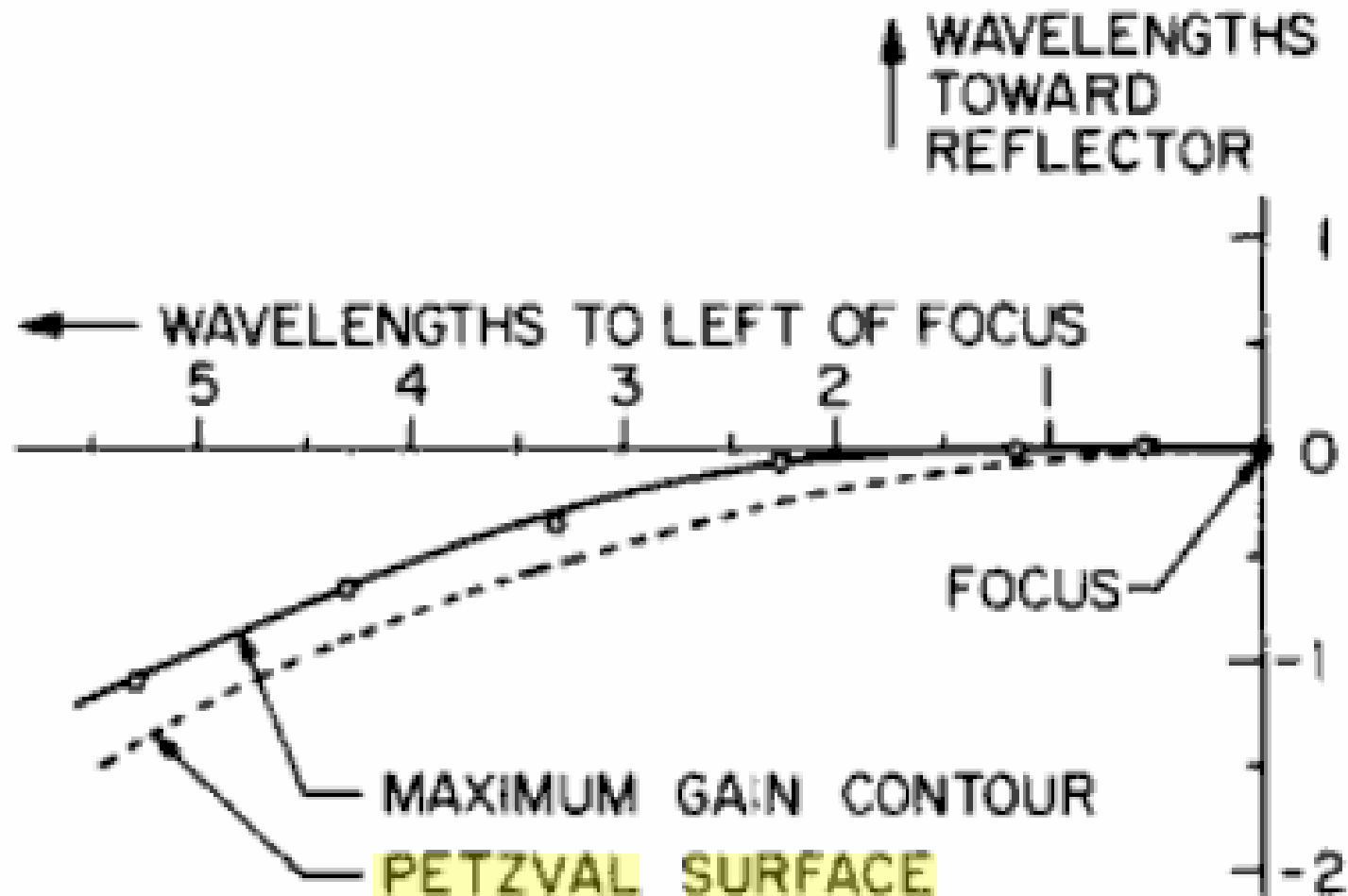
- Beam Scanning
- Multiple feeds – several bands
- Lateral Feed shift causes beam shift in opposite direction



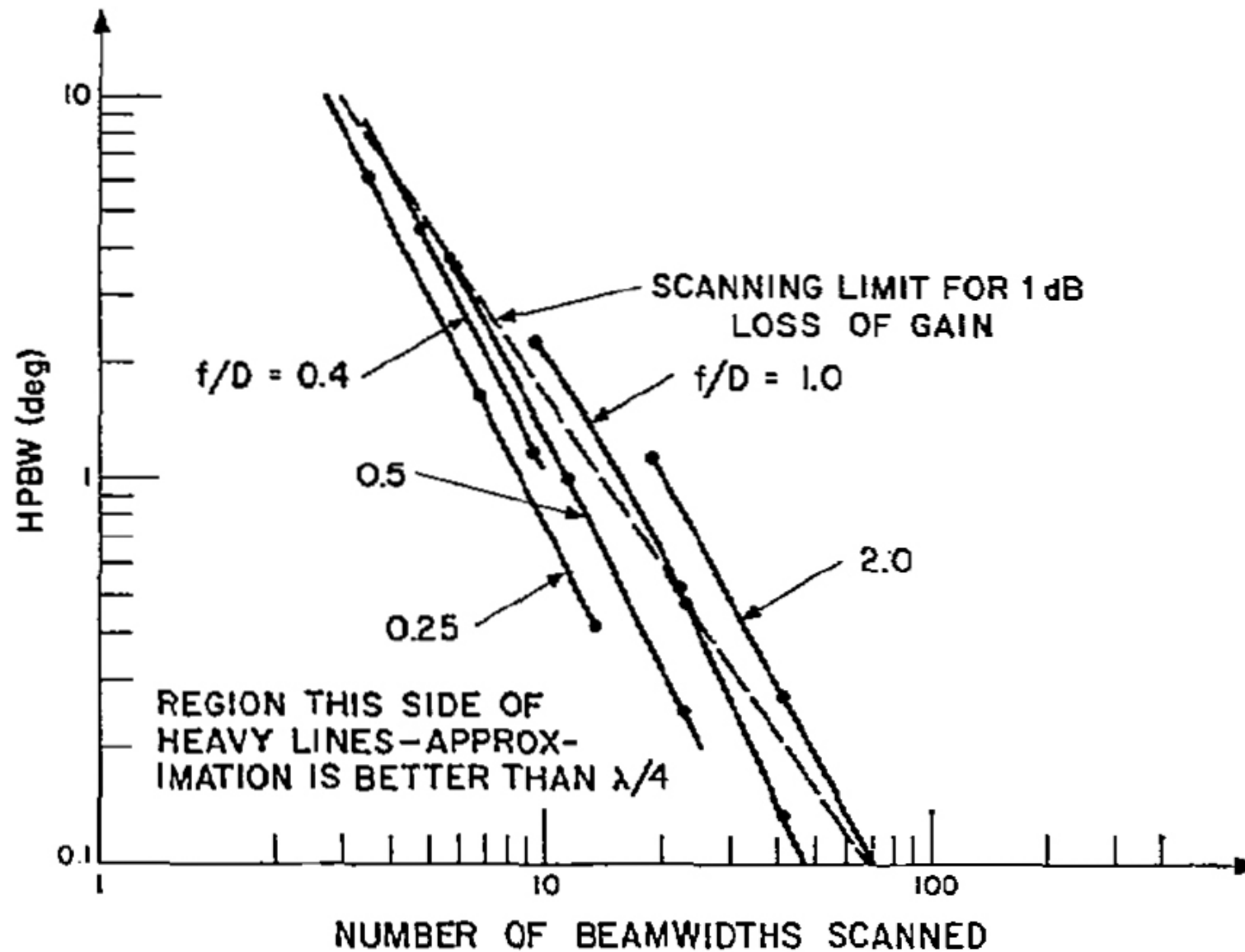
# Lateral Feed Shift - Focus

- Shifted Focus follows Petzval Surface
  - Parabola with  $\frac{1}{2}$  radius of curvature
  - Tangent to focal plane at focus
- Shifted Focus farther away from reflector
- Adjust for Maximum Gain

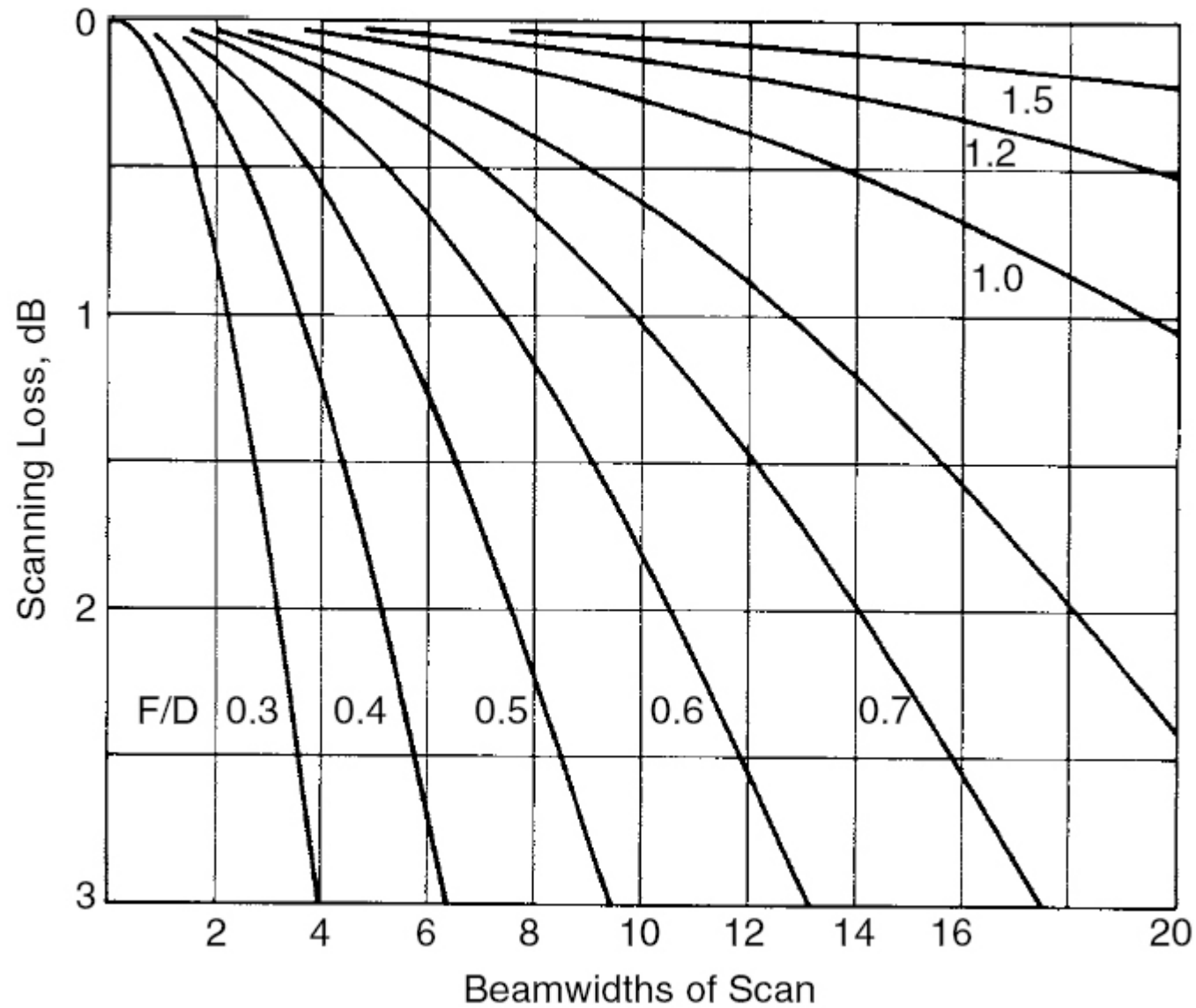
# Shift - Maximum Gain Contour



# Scanning Limit (1 dB Loss)



# Feed-scanning Loss





# 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  $\frac{1}{2}$  beamwidth
  - For 4 degree beam, move in 2 degree steps

# Tilt

- 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](http://www.w1ghz.org)

W1GHZ --> Vermont



