DESIGNING WAVEGUIDE COMPONENTS USING HFSS

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ANSOFT FORUM

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Contents

- Mmwave Waveguide Polariser and OMT
- Ka-band Polariser
- Higher Order Modes in Ring-Loaded Horn

Mmwave Requirements

- Circular Polarisation
- 1% bandwidth
- Low Return Loss of feed chains
- Good isolation between RX and TX
- Low Axial Ratio

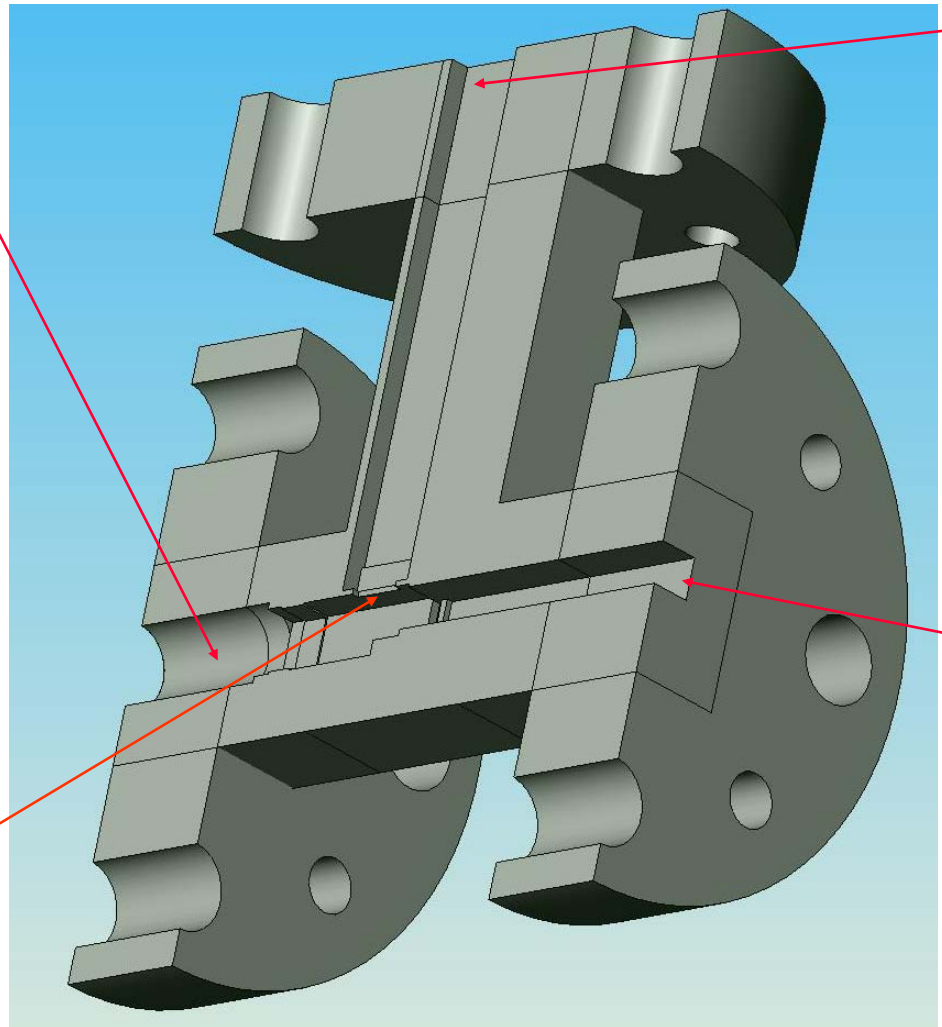
Leads to

- Need for high quality OMT and polariser

Component Tolerancing

- Return Loss affects tolerancing of all components
- Axial Ratio affects tolerancing of polariser.
- Sensitivity analysis carried on all components
- All components electroformed so a mandrel is needed for each component
- Not necessarily true that tolerances can be achieved

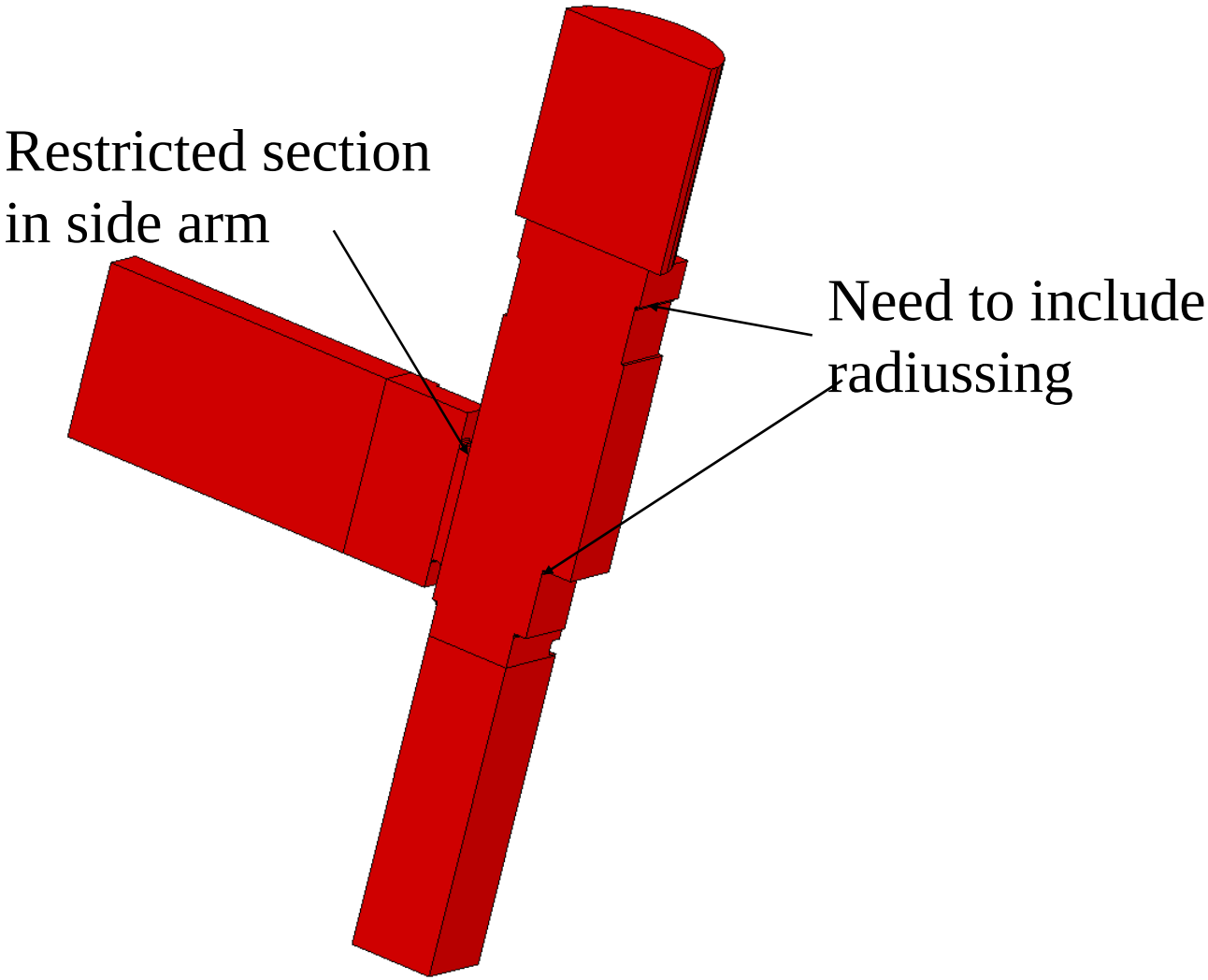
OMT Section


Input arm
Side arm
Through Arm
Problem area in exit to side arm

OMT Model on HFSS V8.5

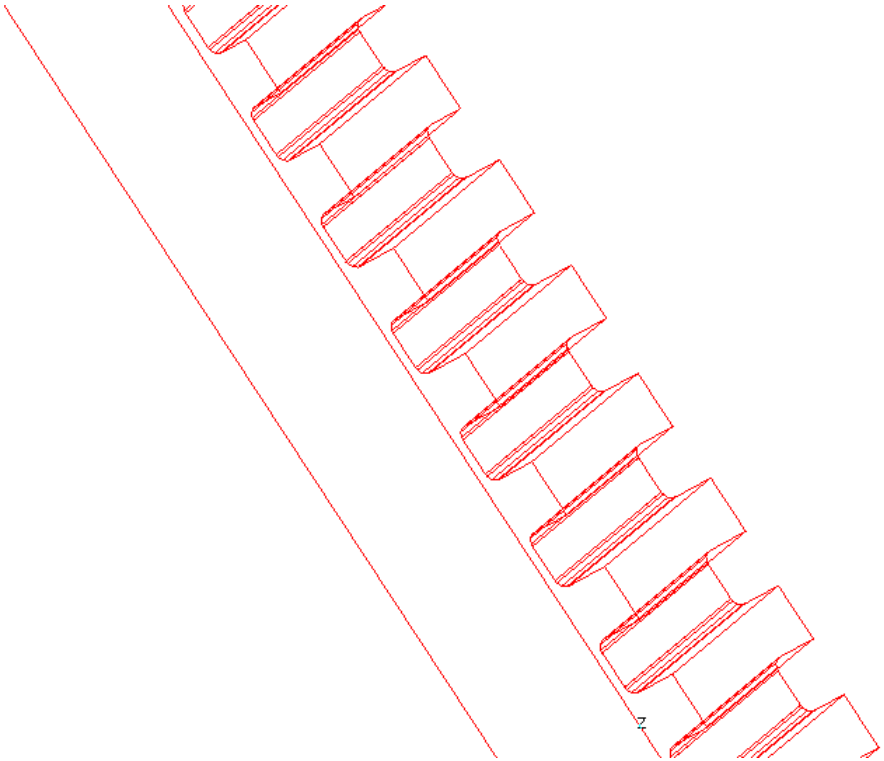
- Run as half model
- Run twice once for each port
- Meshing set up as
  - Side arm iris region 20,000 tetrahedra
  - Rest of side arm 20,000
  - Through body 20,000
- Converged around 90,000 tetrahedra
- Radiussing at 60 micron for internal corners meant re-optimising dimensions
- Runtime 90 minutes for convergence and 8 frequencies 2 Gbytes and 2 GHz

OMT Model on HFSS V8.5



Radiussing

OMT, polariser, transition had radiussing of 60 μ at the corners
Necessary to model this and adjust dimensions accordingly



HFSS model of
corrugated polariser

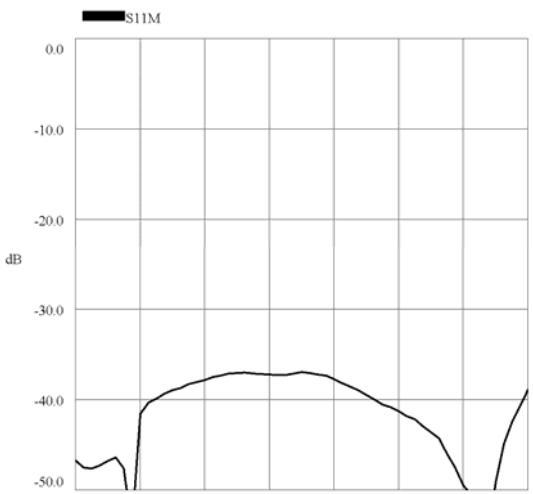
Polariser Model on HFSS V8.5

- Run as quarter model
- Run twice
- Meshing started at 75,000
- Converged around 104,000 tetrahedra
- Radiussing at 60 micron meant re-optimising dimensions
- Runtime 90 minutes for convergence and 6 frequencies (2 Gbytes and 2 MHz)
- Axial Ratio <1.04

Tolerances Required

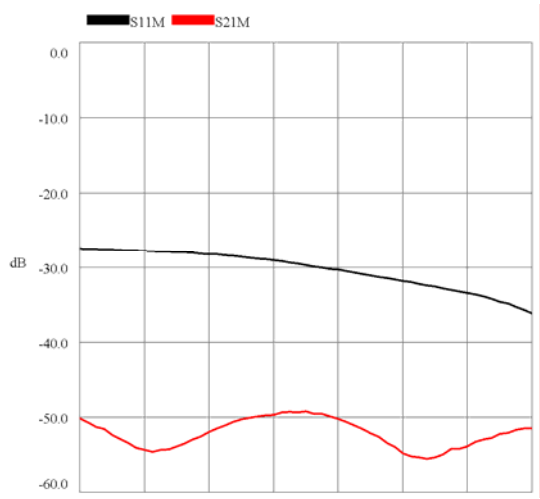
Component	Tolerances Required
Polariser	+/- 8 μ for Return Loss +/- 4 μ for phase
Transition	+/- 10 μ for Return Loss
OMT	+/- 4 μ around exit to side arm +/- 8 μ elsewhere

Final Results



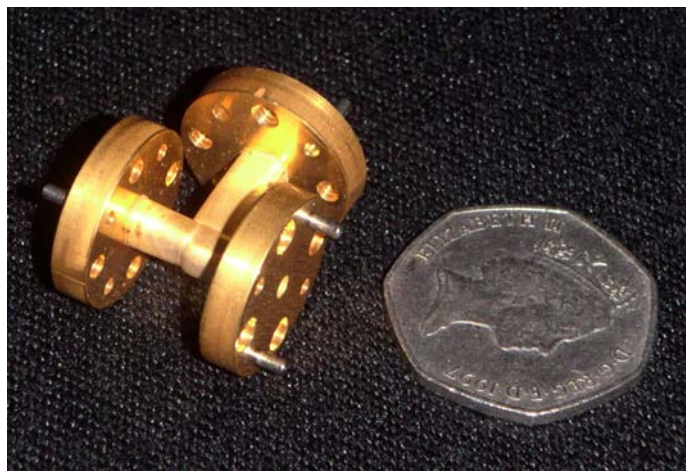
-0.75% +0.75%

Polariser +
2 transitions



-0.75% +0.75%

OMT side arm to thru' arm

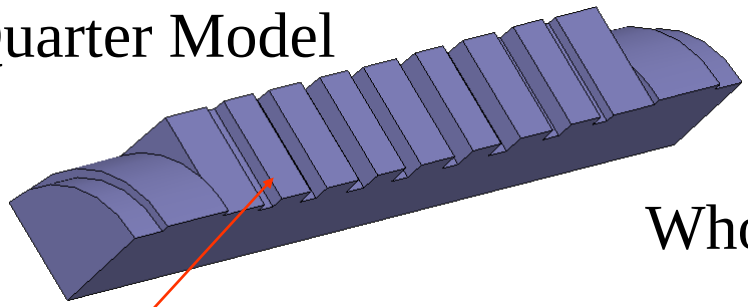


Ka-band Polariser

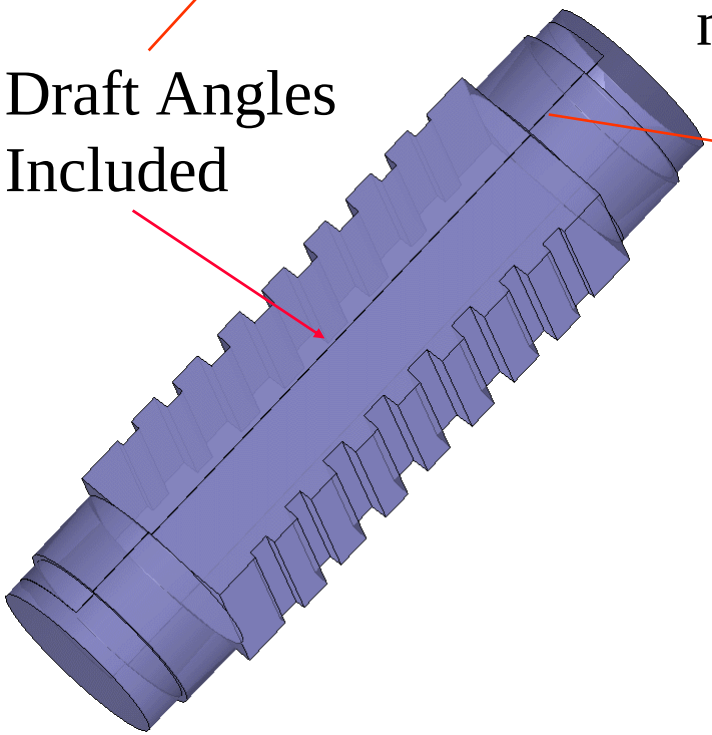
- Dual band
- To be cast
- Tolerances a problem

Polariser Tolerances

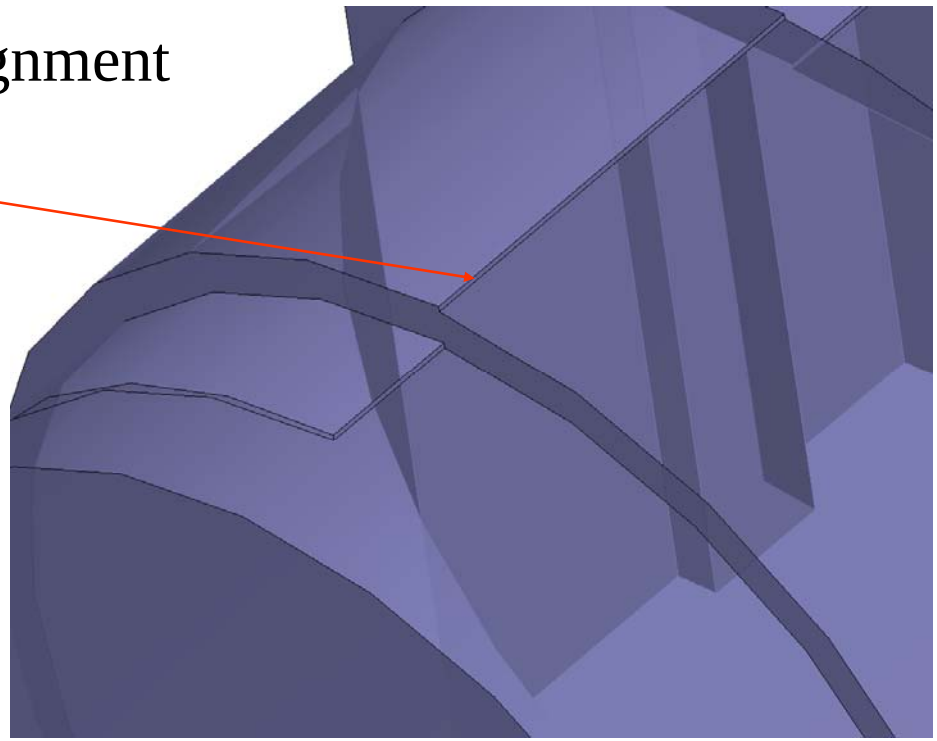
Quarter Model



Draft Angles Included



Whole Model with misalignment



Polariser Optimisation and Tolerances

- Used a Quarter model with 2 symmetry planes - had to run it twice
- Set-up used limits on specified modes. 0.01/0.5 degs on S21, 0.01/1 degs on S11
- Convergence after 2 passes below limit
- Initial mesh set at 45000
- Run on V10, No of tetrahedra between 65000 and 85000. (3 Gbytes and 3.8 GHz)
- Runtime 1 hour for convergence and 11 frequencies

Polariser Misalignment

- Longitudinal misalignment is worse
- Lateral misalignment is so small that did several runs with increasing misalignment
- Need to clean up model
- Whole model run on V10, 138412 tetrahedra.
- Set-up used limits on specified modes. 0.01/0.5 degs on S21, 0.01/1 degs on S11
- Convergence after 2 passes below limit
- Fixed initial mesh as 80,000
- Runtime 4 hours to converge and run 11 frequencies (3 Gbytes and 3.8 GHz)

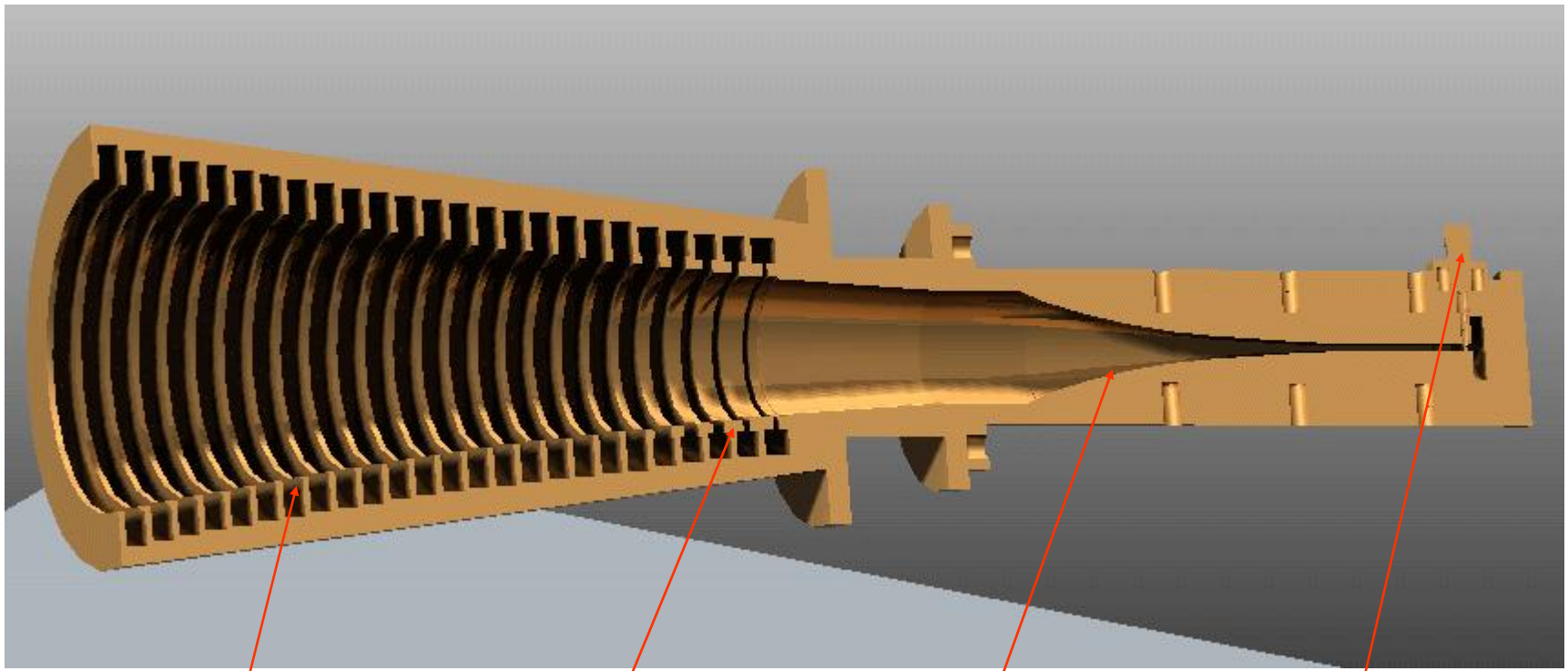
Accuracy

- A large number of different ways of modelling these polarisers tried
- Subdivided model so that could mesh up corrugations more finely
- Forced 120,000 tetrahedra in quarter model
- Variation in phase in S21 was in the range +/- 0.2 degrees

Ring-Loaded Horn

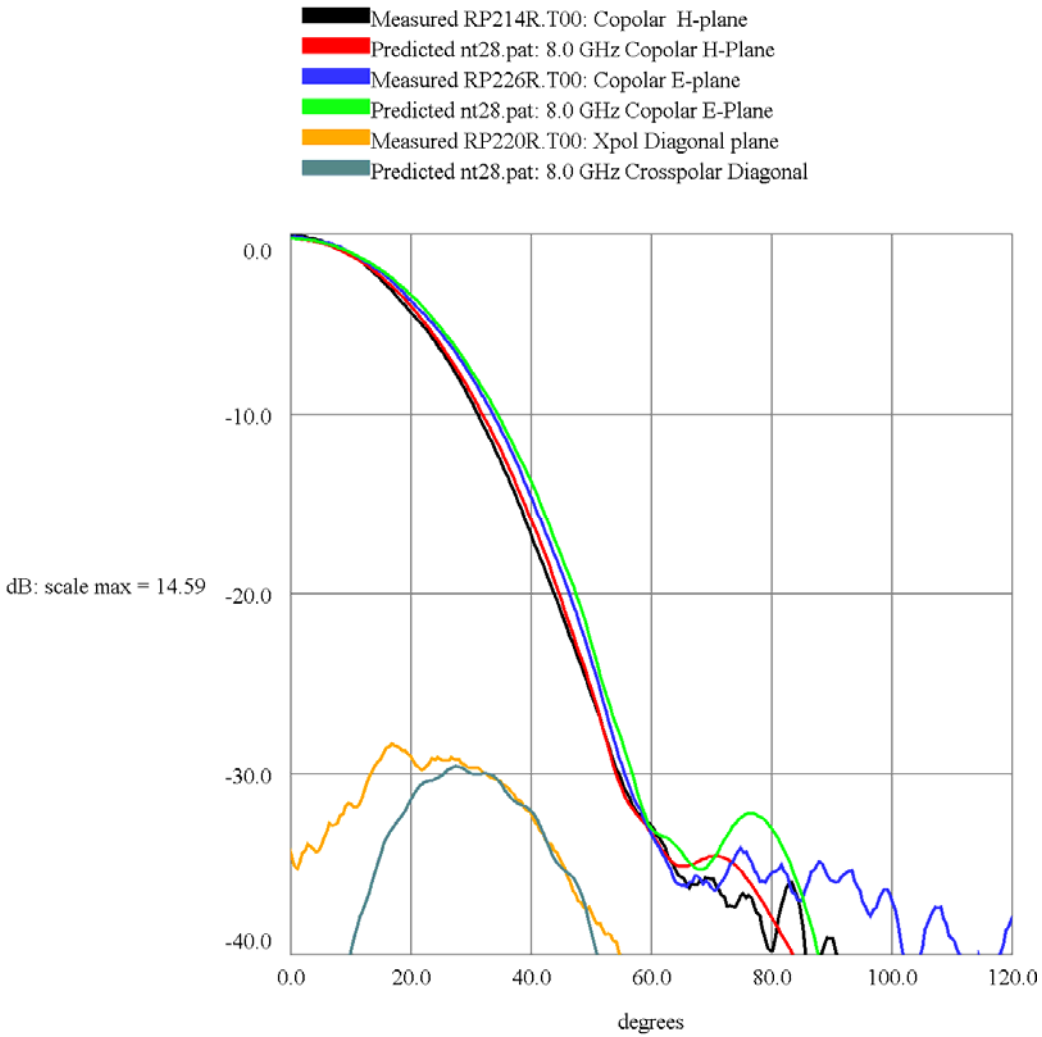
- Ringloaded Horn for 8 to 18 GHz with coaixal output
- Horn designed using modal-matching software, AXIAL. Length 200 mm Aperture 75 mm
- Transition from horn to ridged guide to coax designed using HFSS V8.5
- Whole problem too large for HFSS with only 2 Gbytes RAM

Cross-Section of Horn



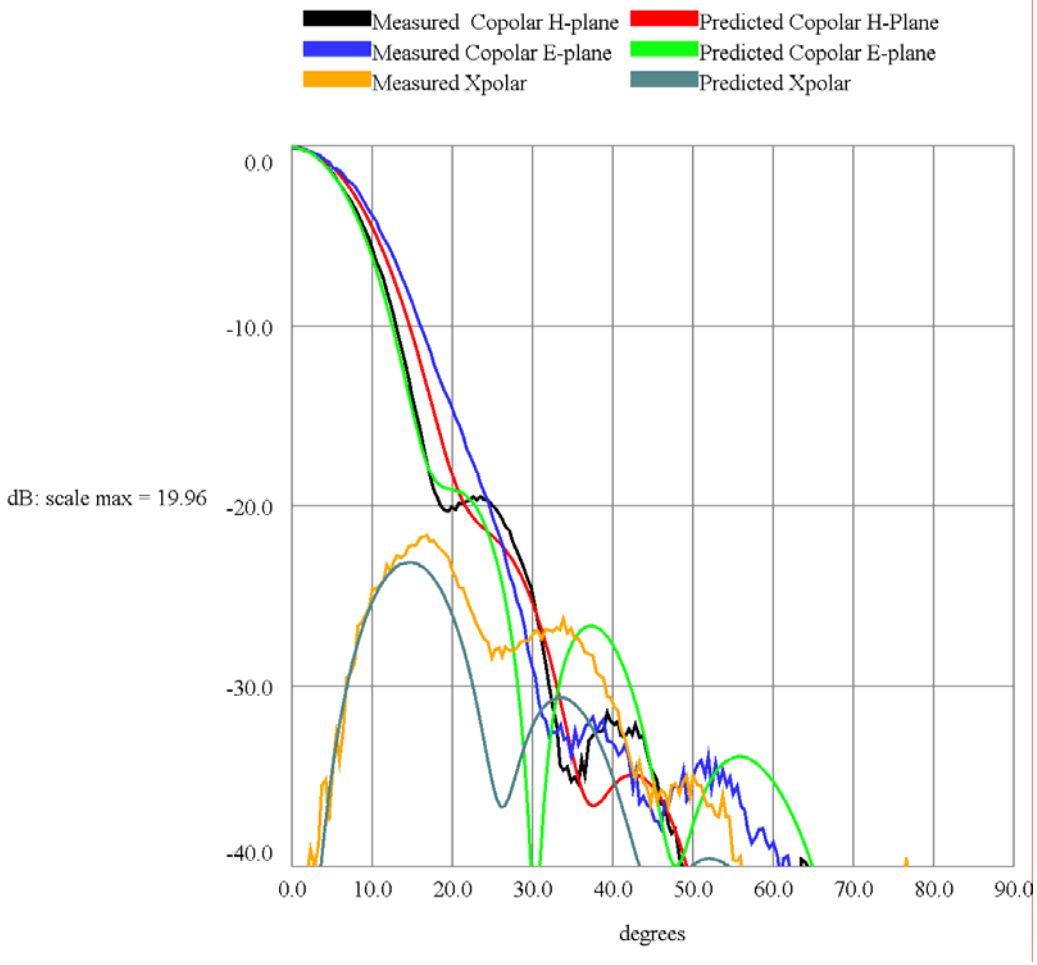
Photograph of Horn

Comparison of Patterns



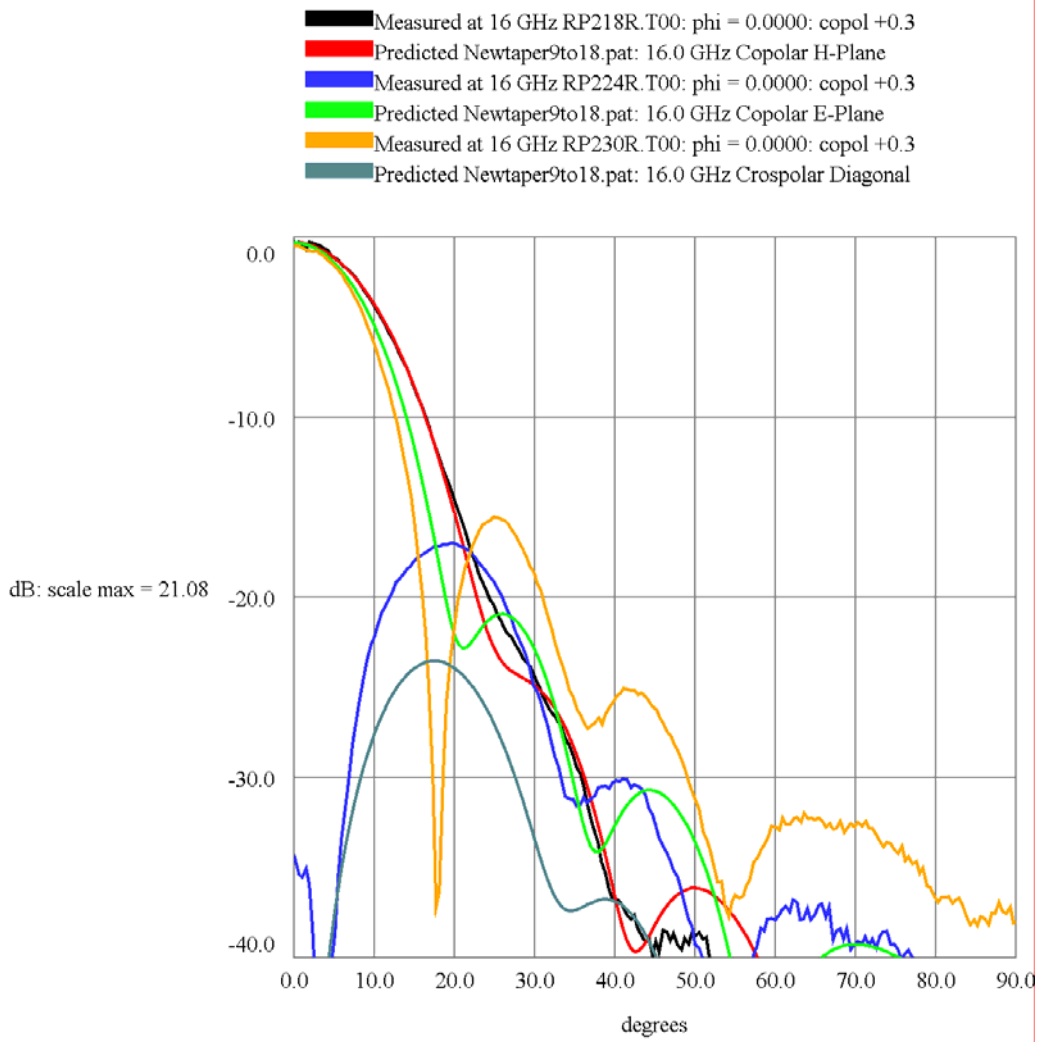
8 GHz

Comparison of Patterns



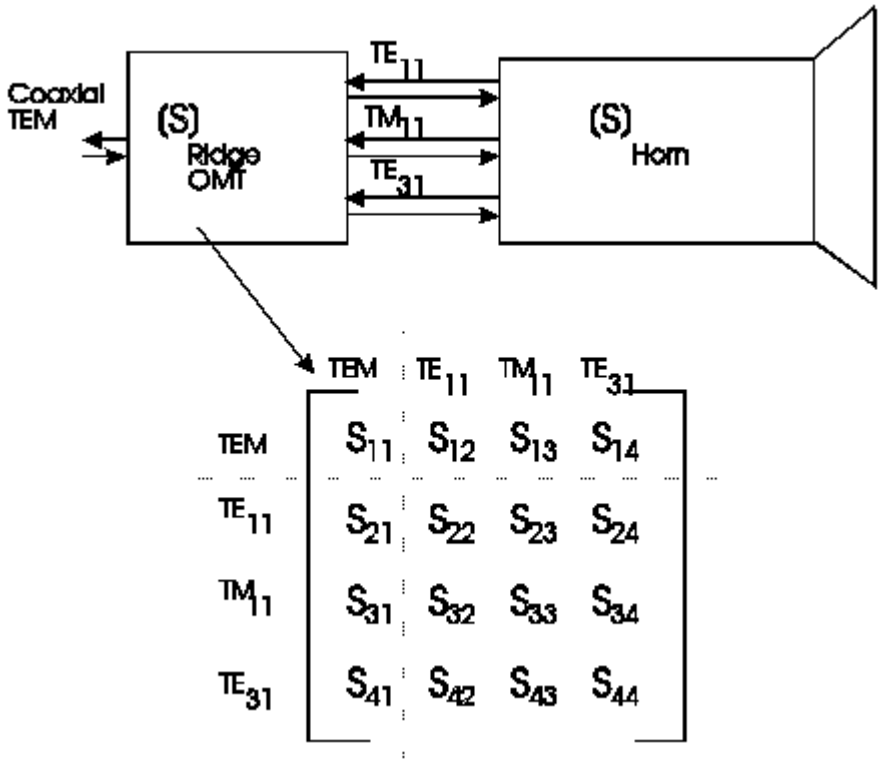
18 GHz

Comparison of Patterns



16 GHz
E-plane sidelobe high
Xpolar high

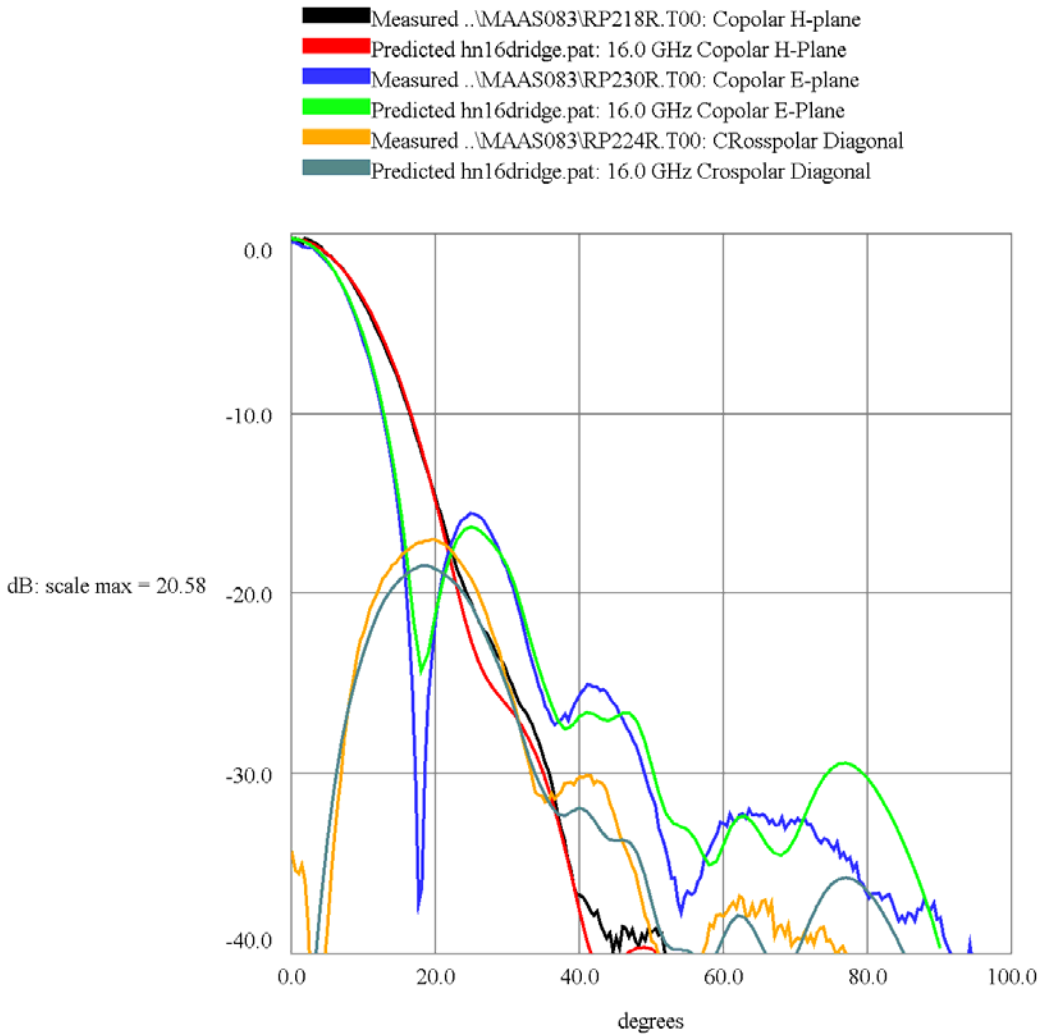
Treatment



Suspect higher order modes generated in ridged section and propagating in horn

Output of S-parameters from HFSS used as excitation of modal-matching program

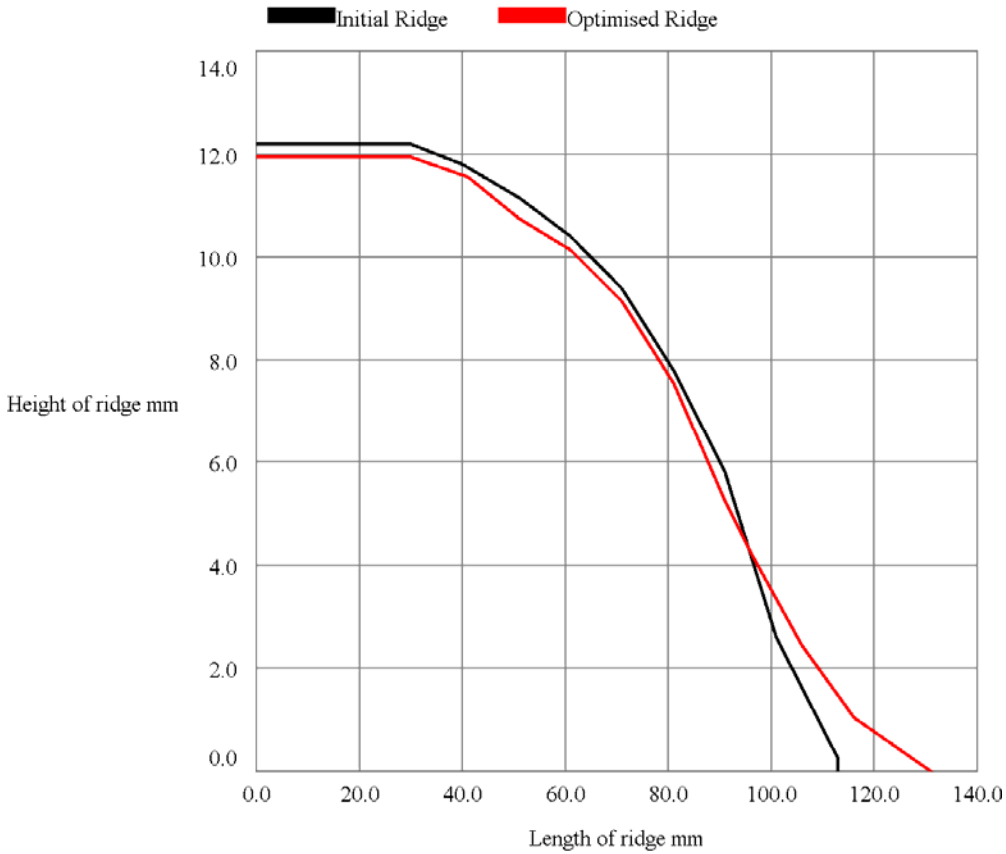
Treatment



16 GHz

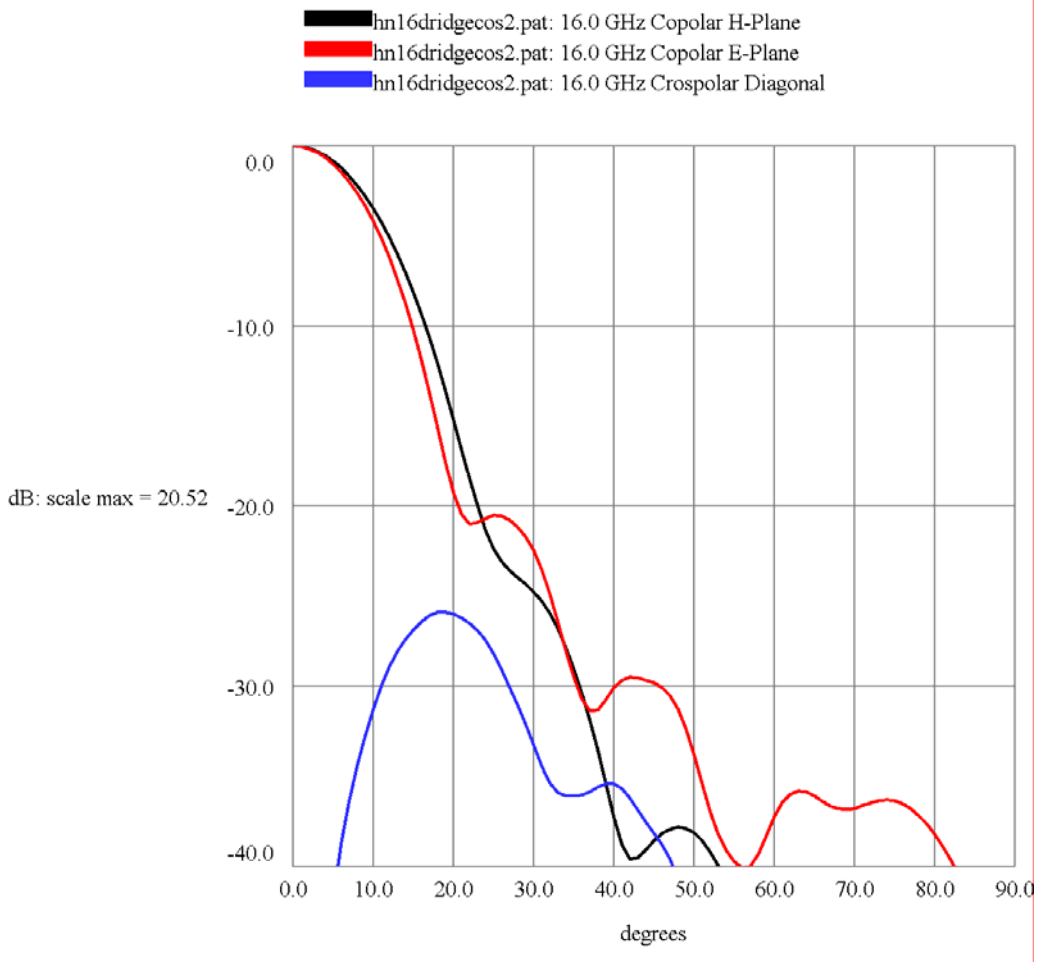
Using higher order modes from HFSS as input to AXIAL gives good agree-ment for sidelobes/xpolar

Horn Improvement



Can optimise ridge shape to give lower level of higher order modes
Length is increased by 20 mm

Horn Improvement



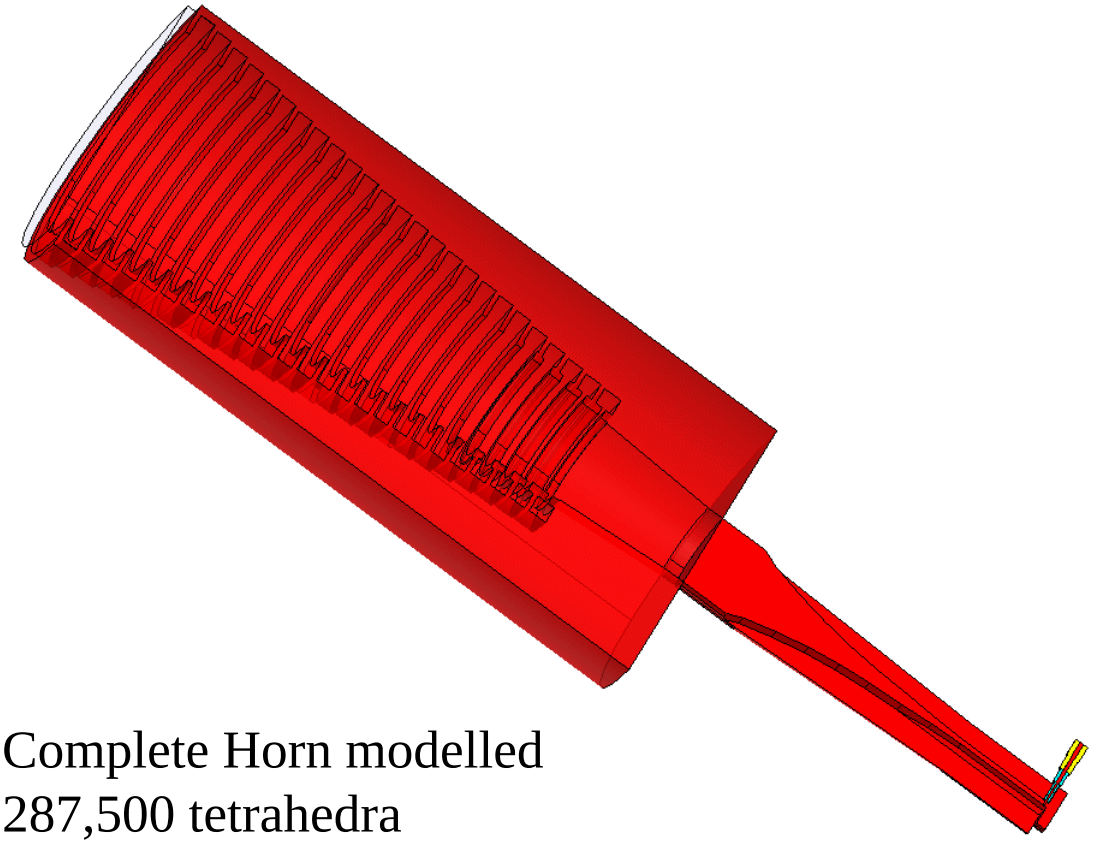
Xpolar reduced from -17.1 to -25.9 dB

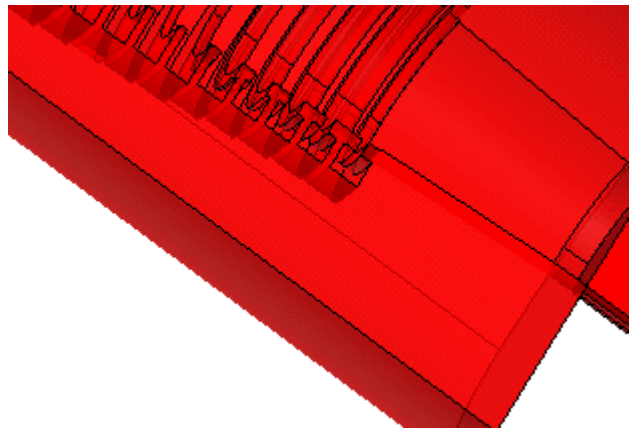
Sidelobes reduced from -15.7 to -20.5 dB

Conclusions

- Radiation patterns of the complete structure can be examined in the design phase
- Output of ridged section can be optimised for modal content
- The input section may need to be lengthened
- This method can be applied to other wideband horns where the use of ridged waveguide plus coaxial output is required.
- Examples are wide-band dielectric loaded horns and high gain ridged horns

AfterWord





Complete Horn modelled
287,500 tetrahedra
42 minutes per freq
3 Gbytes RAM
3.8 GHz machine

Gave same results!!