



A Novel Type of Pattern Synthesis Implementation using Corrugated Apertures

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Outline



- **Previous Work**
- **Motivation**
- **Concepts**
- **Challenges**
- **Antenna Design**
- **Conclusions**
- **Future Work**



Motivation



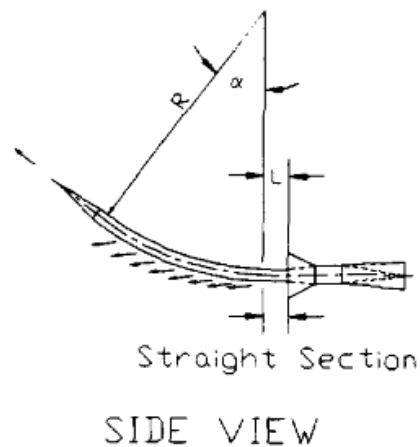
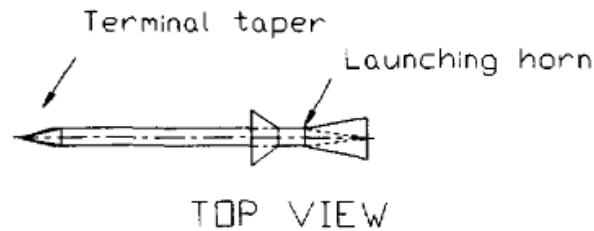
- **Antenna Pattern synthesis implementations**
 - **Amplitude and Phase Synthesis**
 - **Shaped Apertures**



Previous Work

Naftali Herscovici - The Shaped-Beam Polyrod Antenna,
IEEE Antennas and Propagation Magazine. Vol. 36, No.2. April, 1994, pp.55-57.
Antenna Designer's Notebook

R (in)	L (in)	α (°)	Tip Angle (°)	Squint (°)
5.5	0.5	30	20.5	8

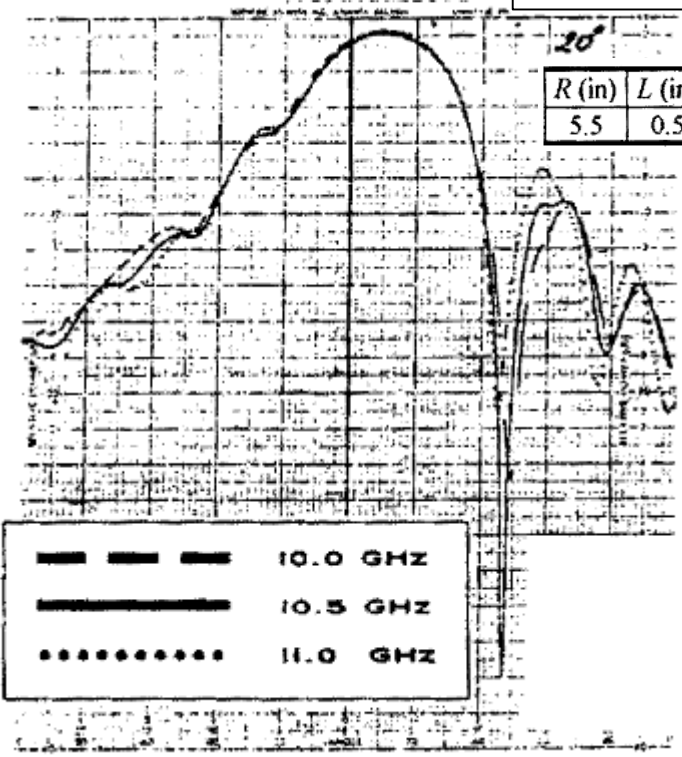


Previous Work

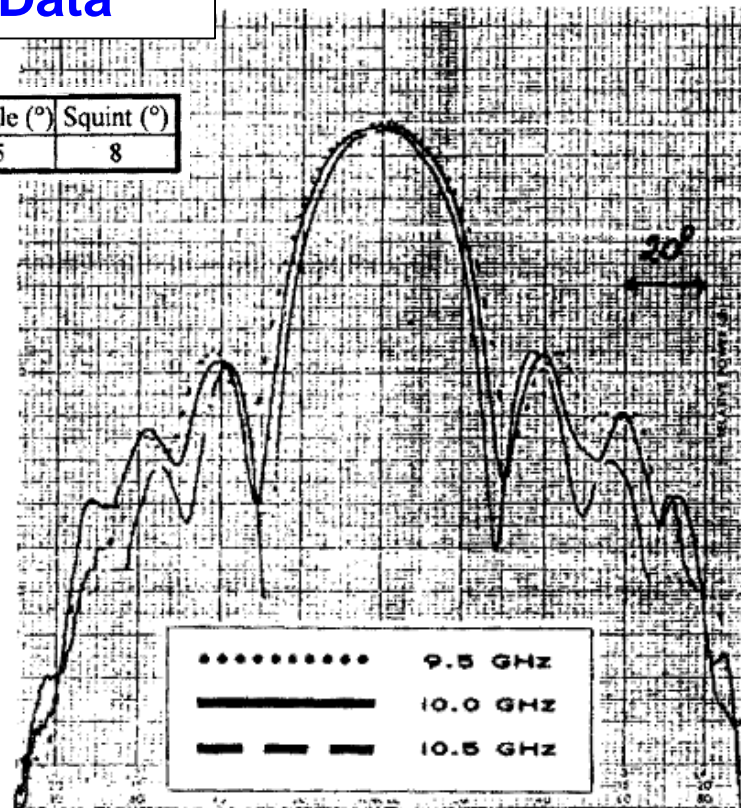
Naftali Herscovici - The Shaped-Beam Polyrod Antenna,
IEEE Antennas and Propagation Magazine. Vol. 36, No.2. April, 1994, pp.55-57.
 Antenna Designer's Notebook

Measured Data

R (in)	L (in)	α (°)	Tip Angle (°)	Squint (°)
5.5	0.5	30	20.5	8

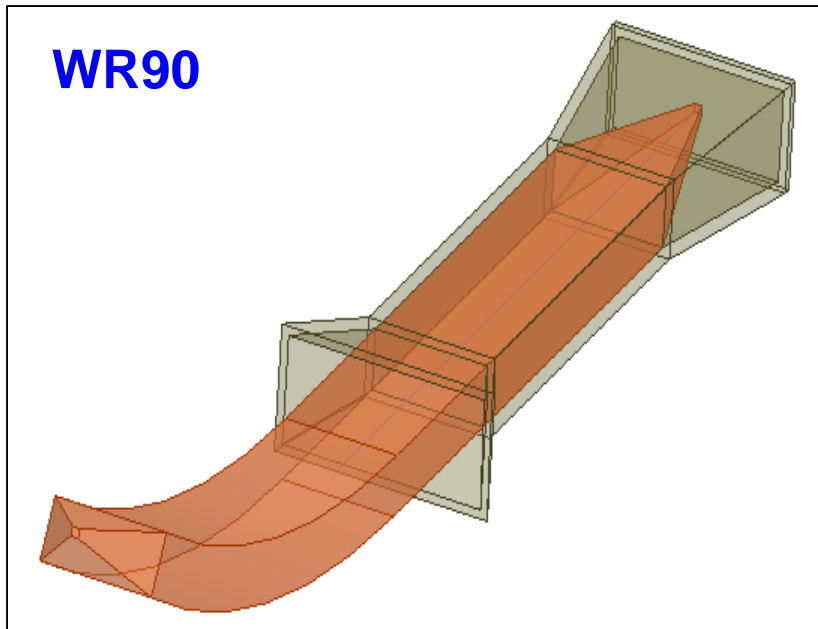


Elevation Patterns

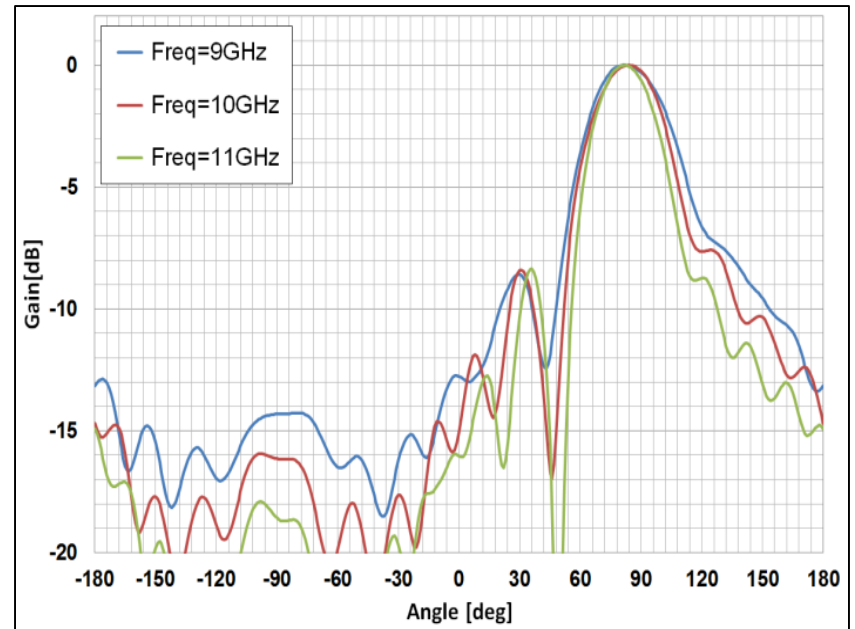


Azimuth Patterns

Validation of the Empirical Design

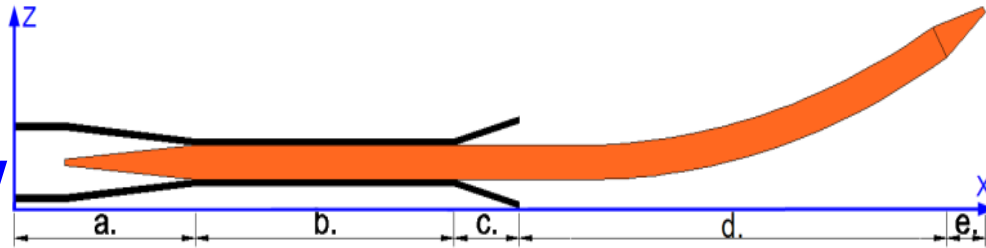


HFSS Model



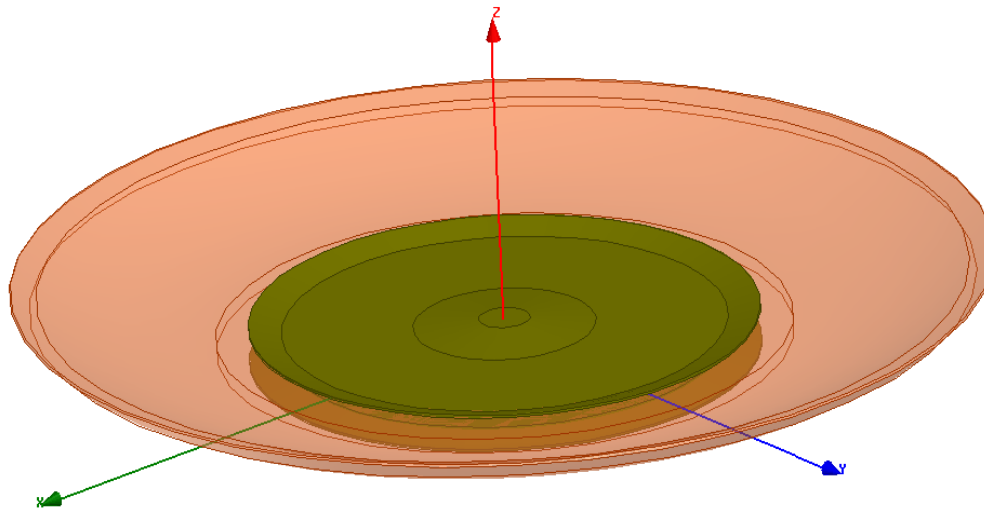
Elevation Radiation Patterns

2D Profile View

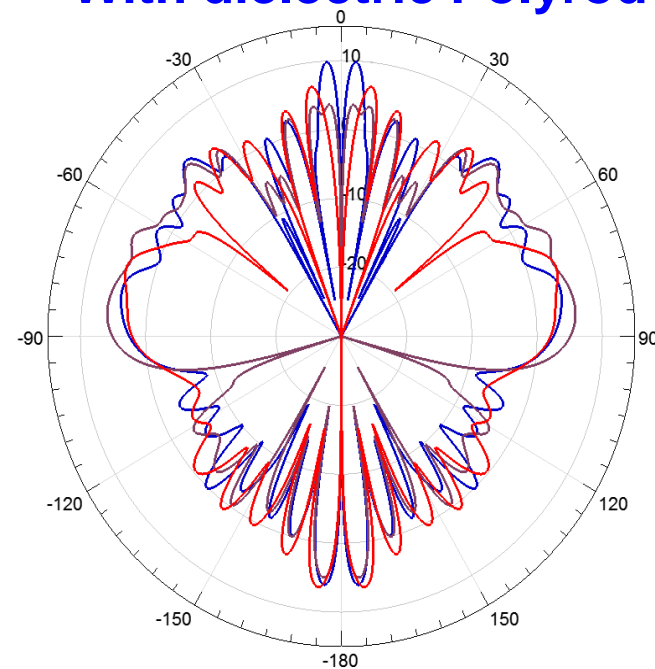
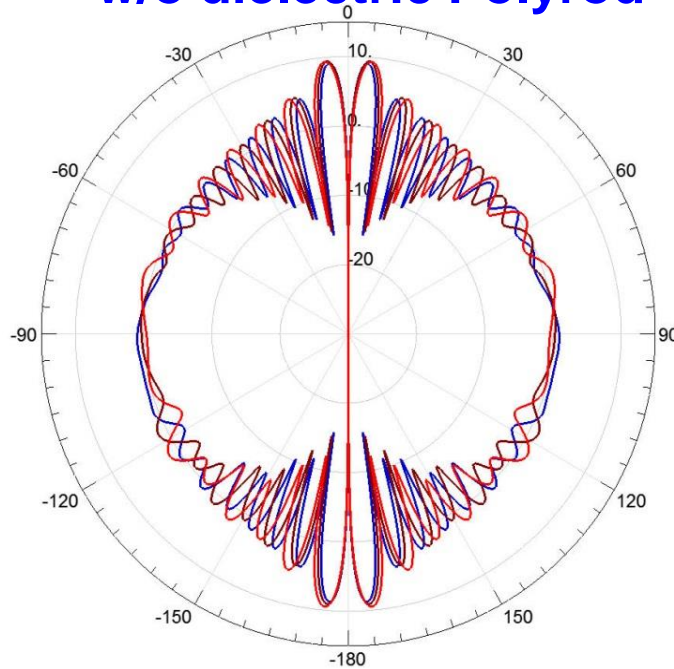


- Major functional parts:
- a. feeding section
 - b. parallel plate waveguide section
 - c. launching section
 - d. shaped Polyrod Antenna
 - e. matching tip

3D View



Frequencies: 9.5 , 10.0 and 10.5 GHz
w/o dielectric Polyrod With dielectric Polyrod



Challenges

- Beam approaches cosecant shape, but requires more systematic work to approach the cosecant square shape.
- Sidelobes near the axis of symmetry ($\vartheta=0^\circ$ & $\vartheta=180^\circ$) are too high.



Optimization Challenges

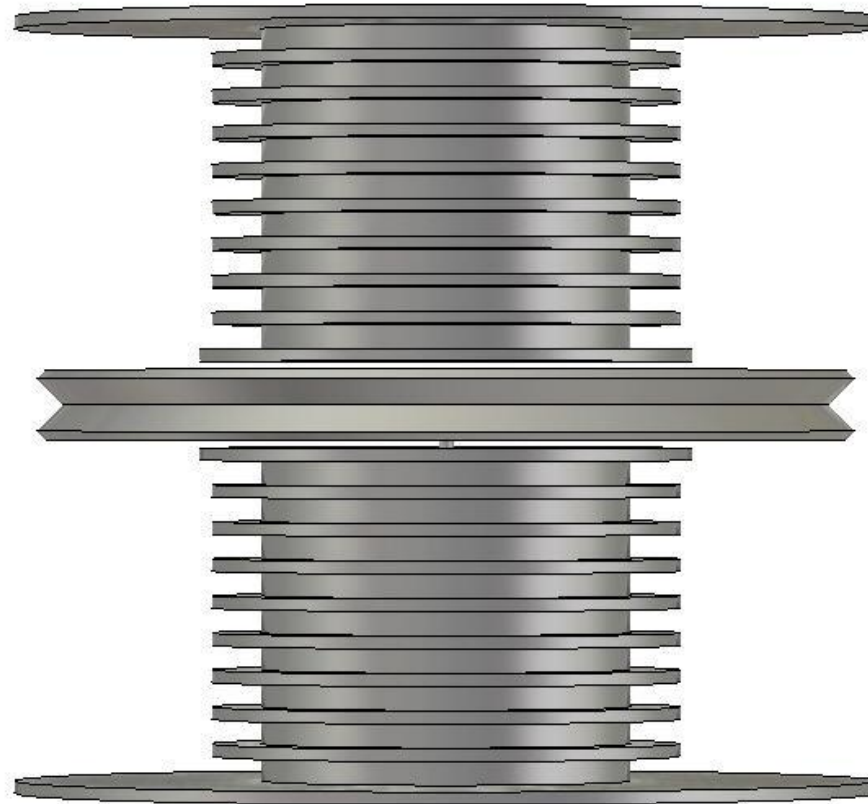


- Many design parameters
- Assess and prioritize various parameter impacts
- Implementation limitation
- Use discrete parameters for optimization
- Large Computational Volume

Use Cylindrical Symmetry (BOR)

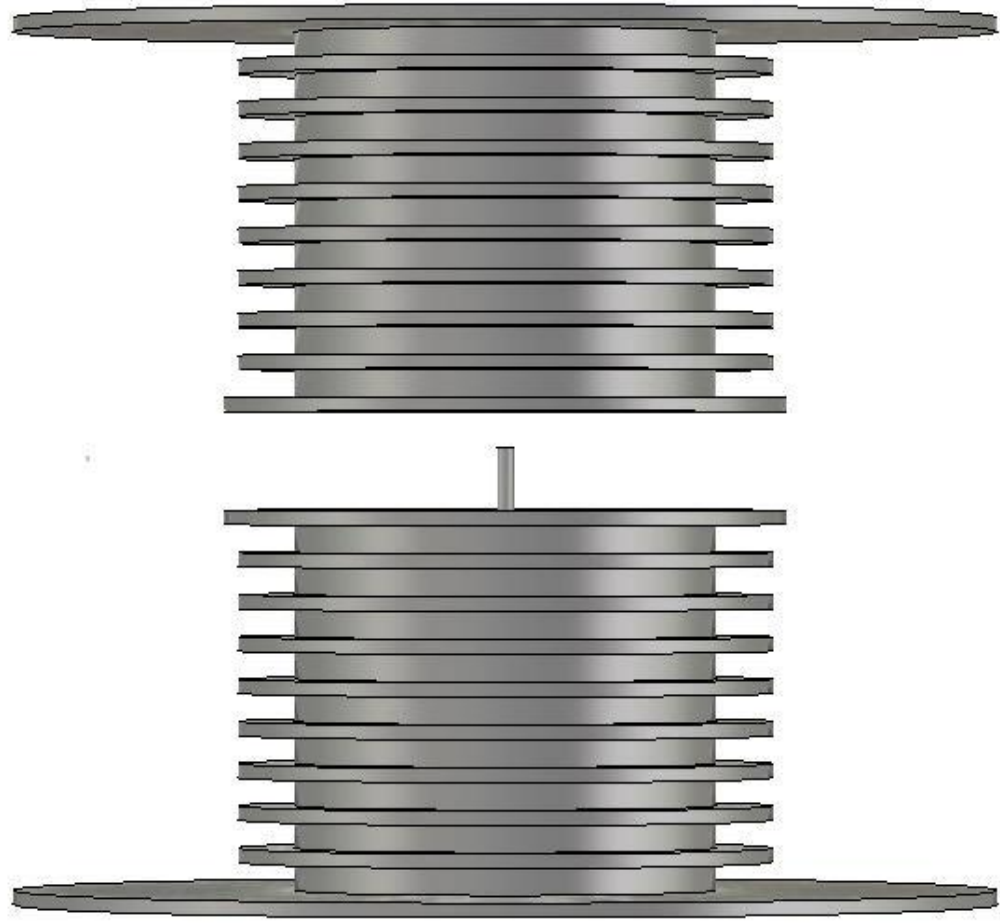


Case Study – Cylindrical Short Backfire Antenna





Case Study – Cylindrical Short Backfire Antenna



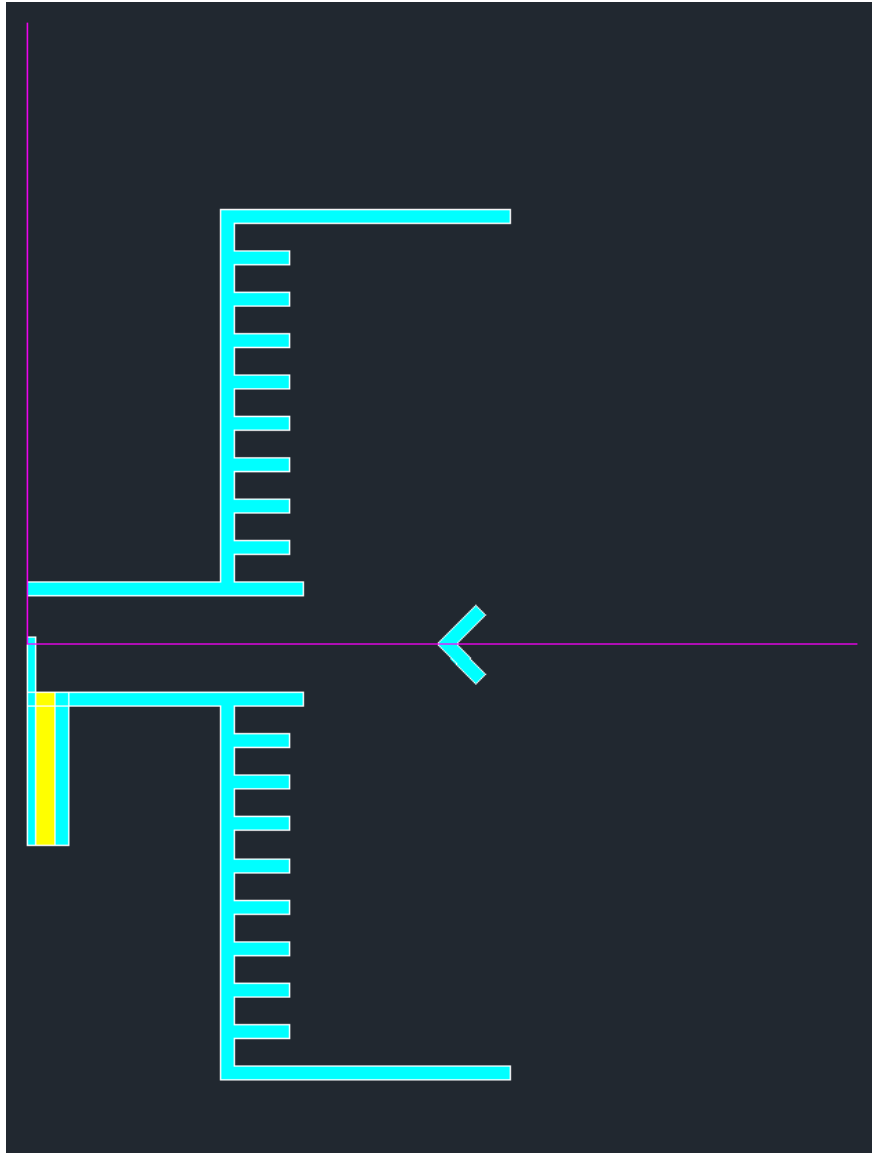


Body of Revolution Method (BOR) Transforms a 3D Problem into a 2D problem

The screenshot displays the COMSOL Multiphysics interface for a model titled "20160816_0804_Omni_Parallel_plate_Corrugated_SUB_COMSOL_Conference_OPT.mph". The software is set to the "Electromagnetic Waves, Frequency Domain (emw)" physics interface. The "Model Builder" tree on the left shows the hierarchy: Global Definitions, Parameters, Materials, Component 1 (comp1), Geometry 1, Materials, Electromagnetic Waves, Frequency Domain (emw), Mesh 1, Study 1, and Results. The "Properties" window for "Geometry 1" is open, showing the "Units" section with "mm" selected for length and "Degrees" for angular units. The "Advanced" section shows "Automatic rebuild" checked. The "Graphics" window displays a 2D cross-section of the corrugated parallel plate structure on a coordinate system. The structure is centered at x=0 and extends from x=0 to x=150. The y-axis ranges from -120 to 120. A red vertical line at x=0 is labeled "r=0". The "Messages" window at the bottom right provides details about the finalized geometry: "COMSOL 5.2.0.220", "Opened file: 20160816_0804_Omni_Parallel_plate_Corrugated_SUB_COMSOL_Conference_OPT.mph", "Formed union of 10 solid objects and 2 curve objects.", and "Finalized geometry has 16 domains, 131 boundaries, and 117 vertices." The status bar at the bottom indicates "725 MB | 893 MB".

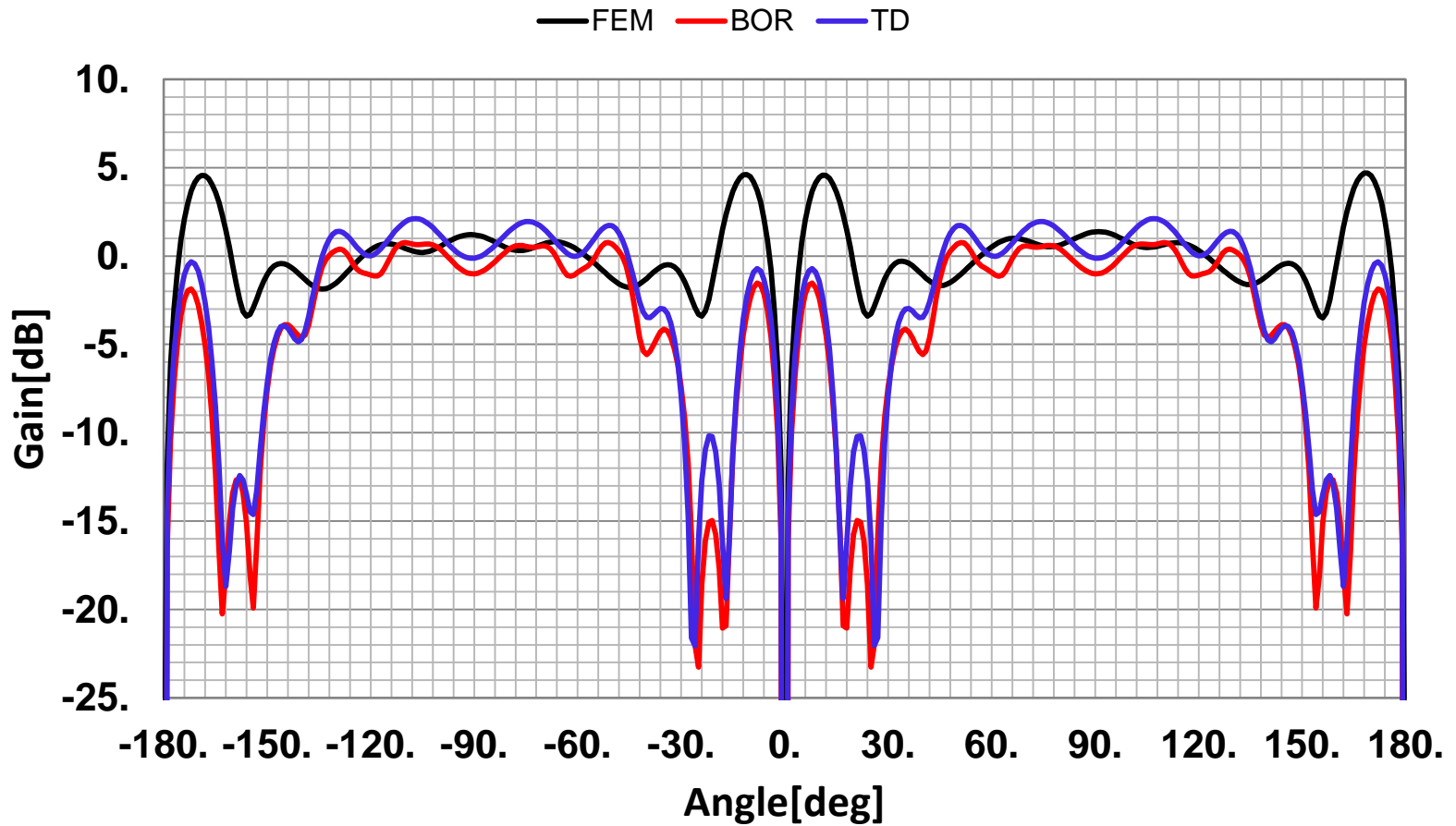


COMOSOL ANTENNA MODEL



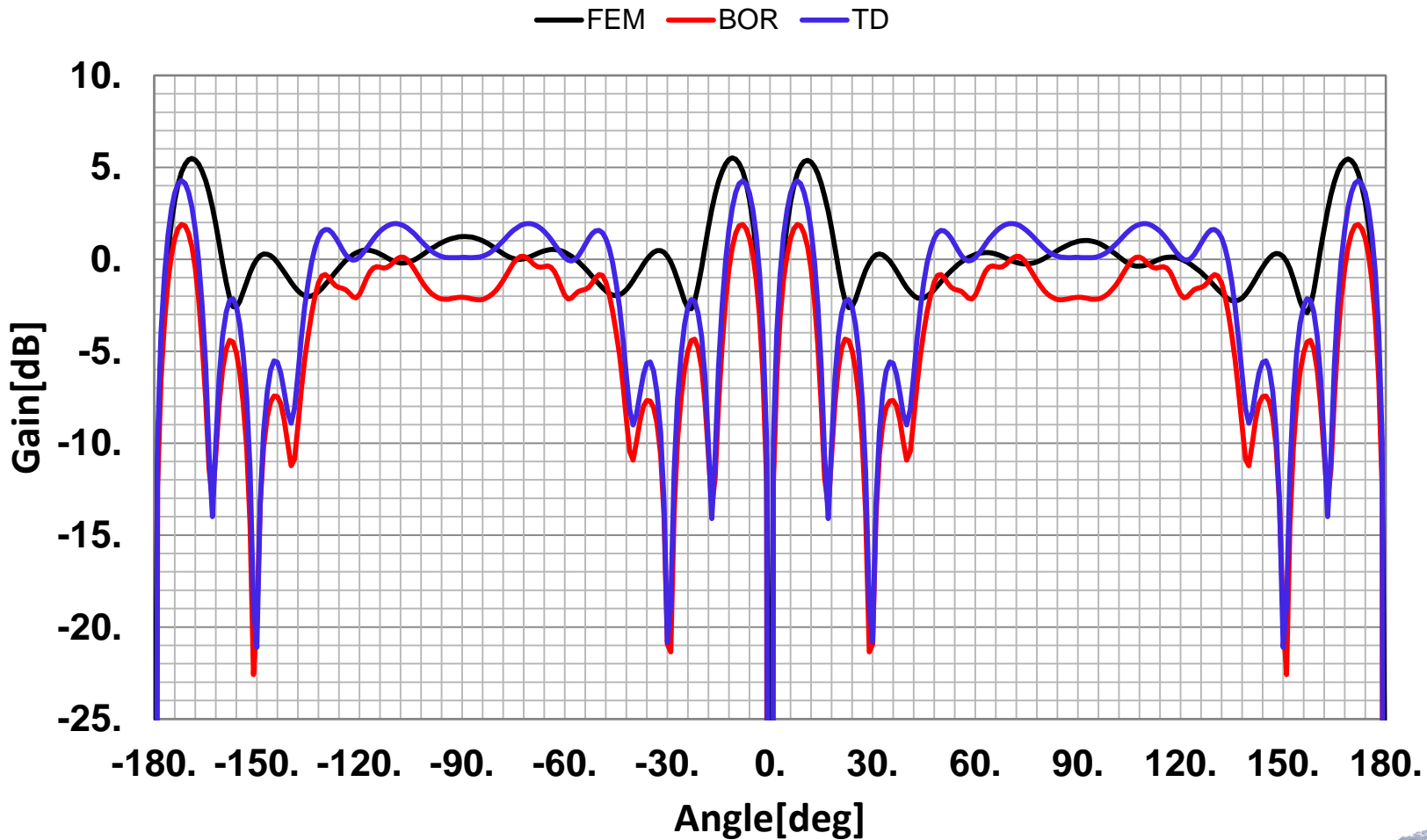


3D FEM,TD vs BOR - 14.4GHz



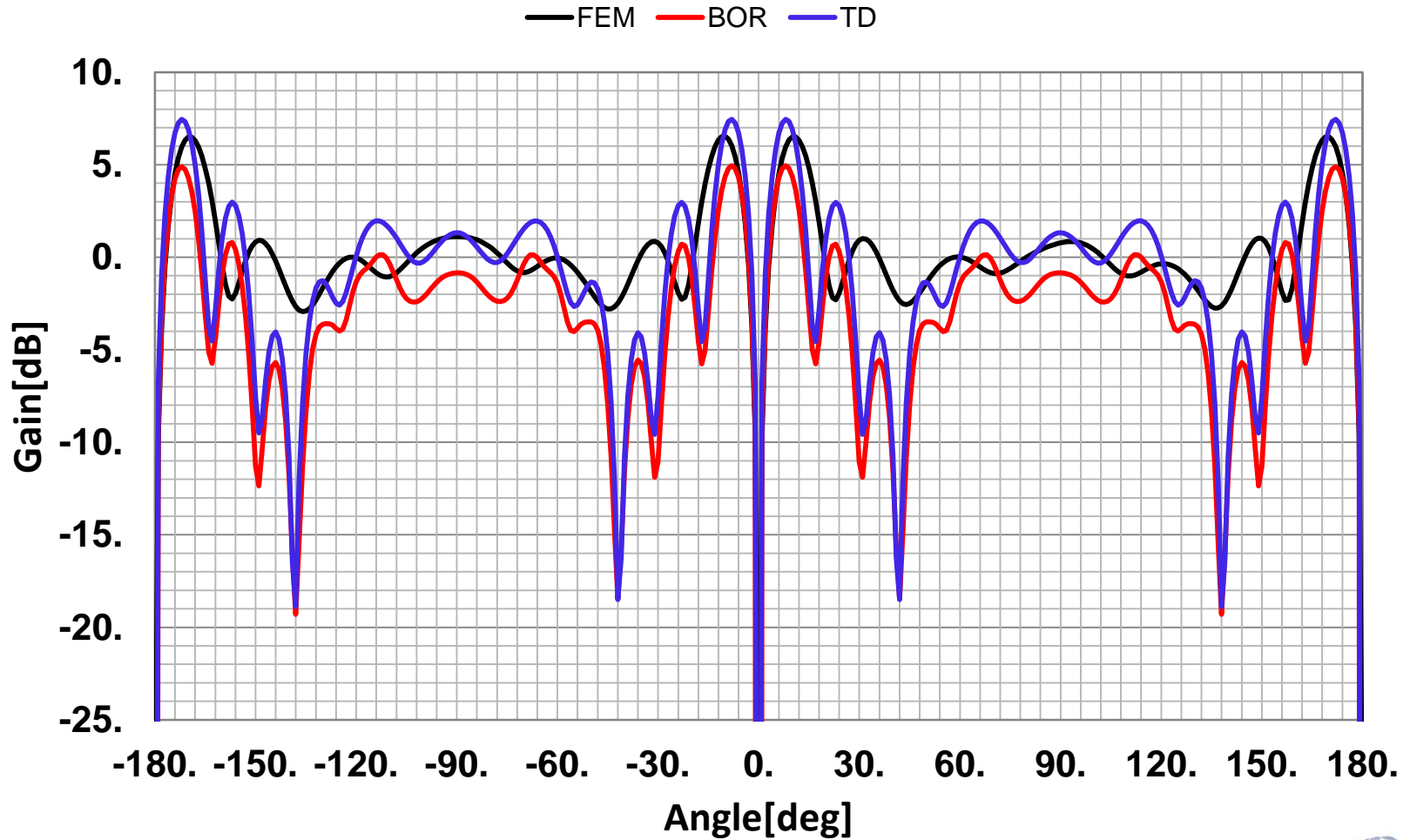


3D FEM,TD vs BOR - 14.9GHz



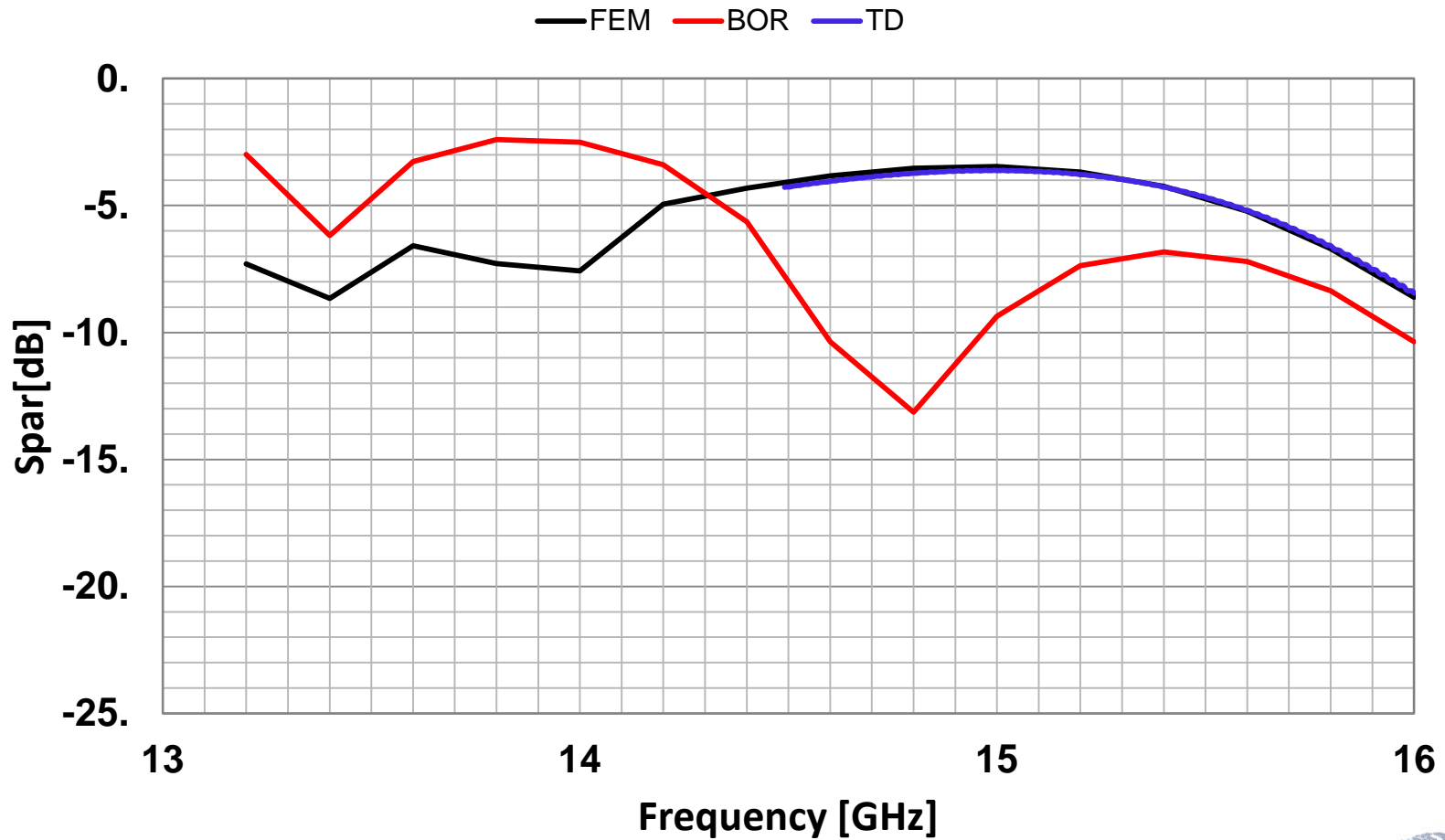


3D FEM,TD vs BOR - 15.4GHz



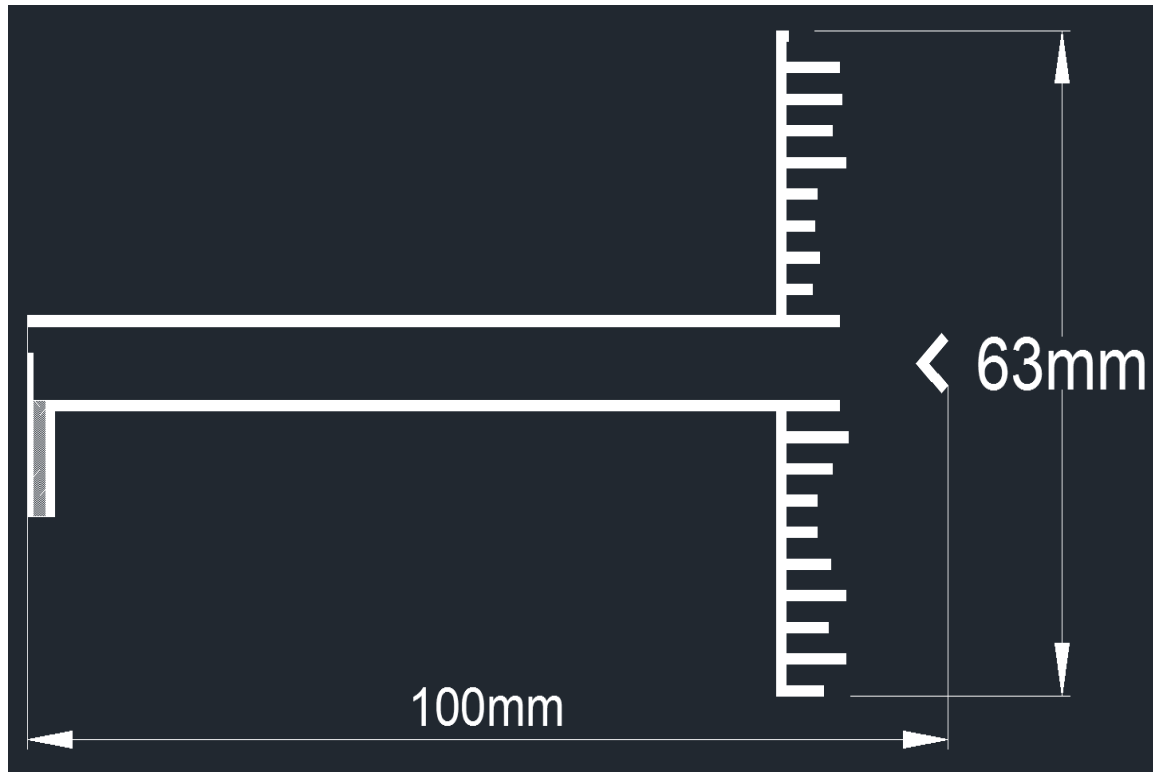


3D FEM,TD vs BOR - Return Loss





COMSOL Optimized BOR Geometry

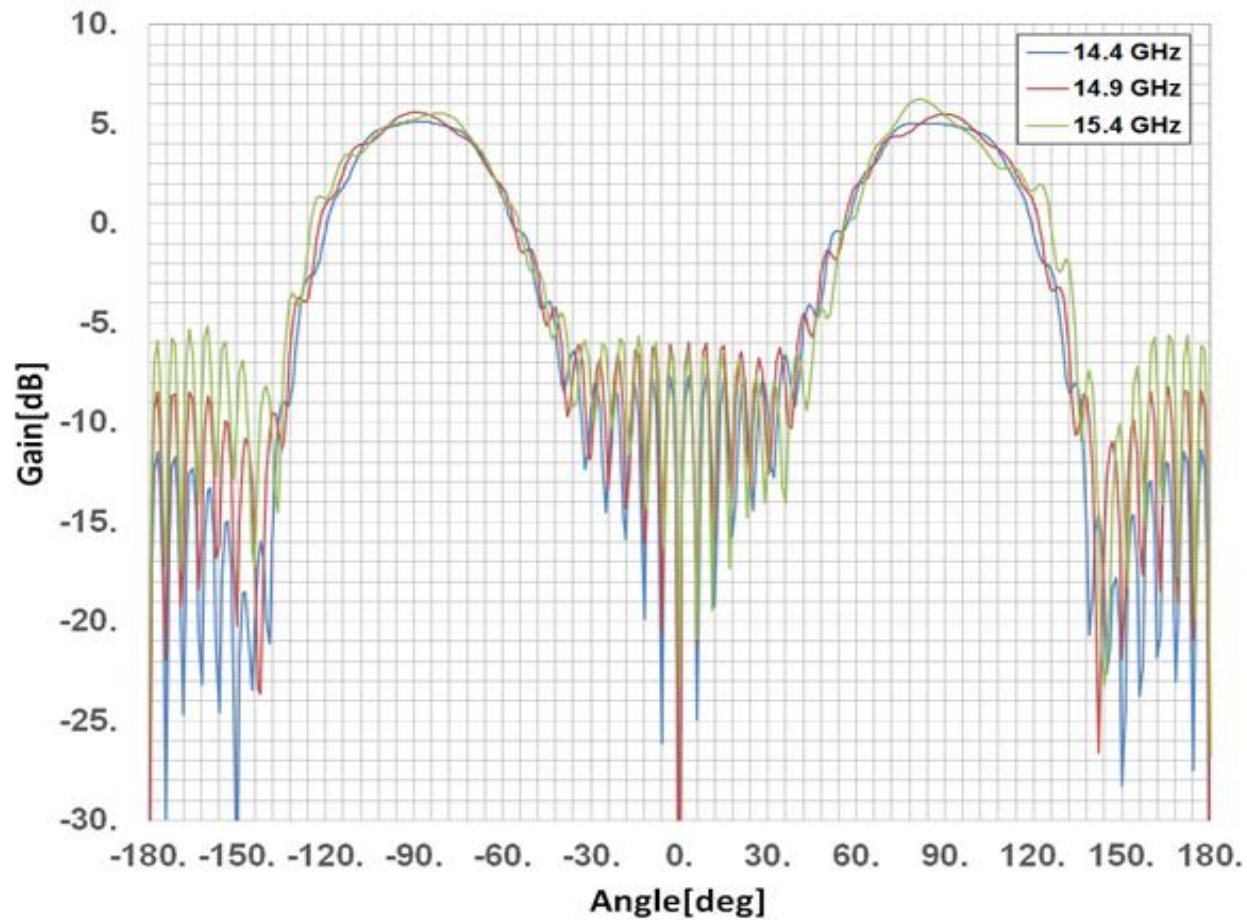




Shaped Beam Cylindrical Array Optimization Results

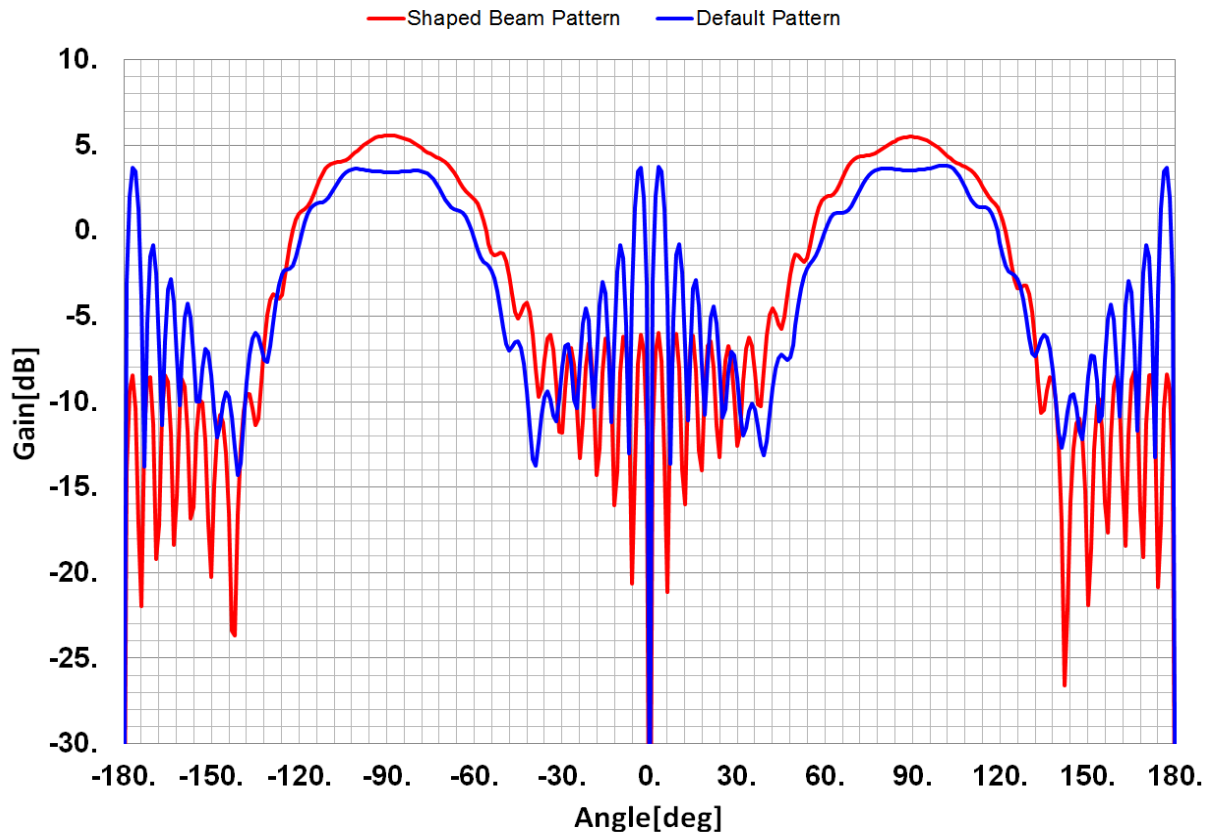


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Shaped Beam Cylindrical Array Comparison between the initial geometry and the optimized results





Conclusions



- **Optimization the performance of shaped beam antennas using COMSOL BOR module was performed.**
- **The optimization results produced an antenna with higher beam efficiency (Higher Gain and lower sidelobes)**
- **The corrugated ridges were proved to be an efficient tool for pattern shaping.**
- **The COMSOL BOR module was validated to be an appropriate method to be used in the optimization process.**



Future Work



- **Optimize the performance of shaped beam antennas using COMSOL BOR for Cosec² pattern in elevation.**
- **Investigate possibility for broadband behavior.**