

Designing an X-Band T/R Module Package

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Outline



- Who is Kyocera America?
- What's a T/R Module?
- Package Description & Specs.
- RF Modeling and Results.
- Conclusion

Introduction to KAI



- Owned by Kyocera International Inc. which is part of Kyocera Corporation.
- Opened its San Diego plant in 1971.
- First Japanese corporation with production facilities in California.

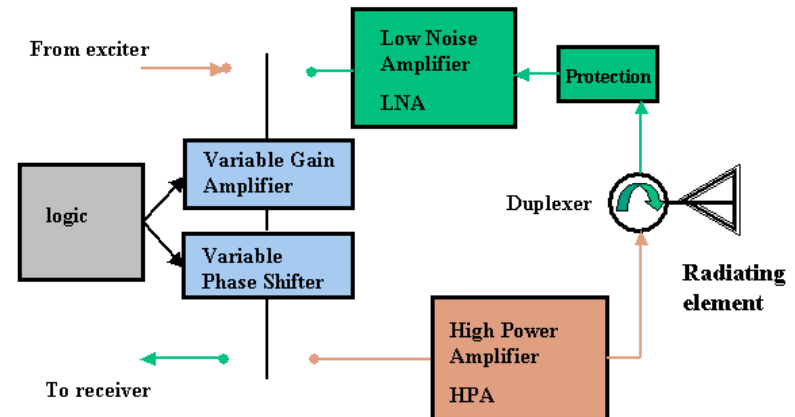
KAI's Products: DC to Light



T/R Module Definition



- T/R stands for Transmit/Receive.
- Provides last Tx amplification stage and first Rx amplification stage for Phased Arrays
- Used in radars and communication systems.
- Usually multi-chip assembly.



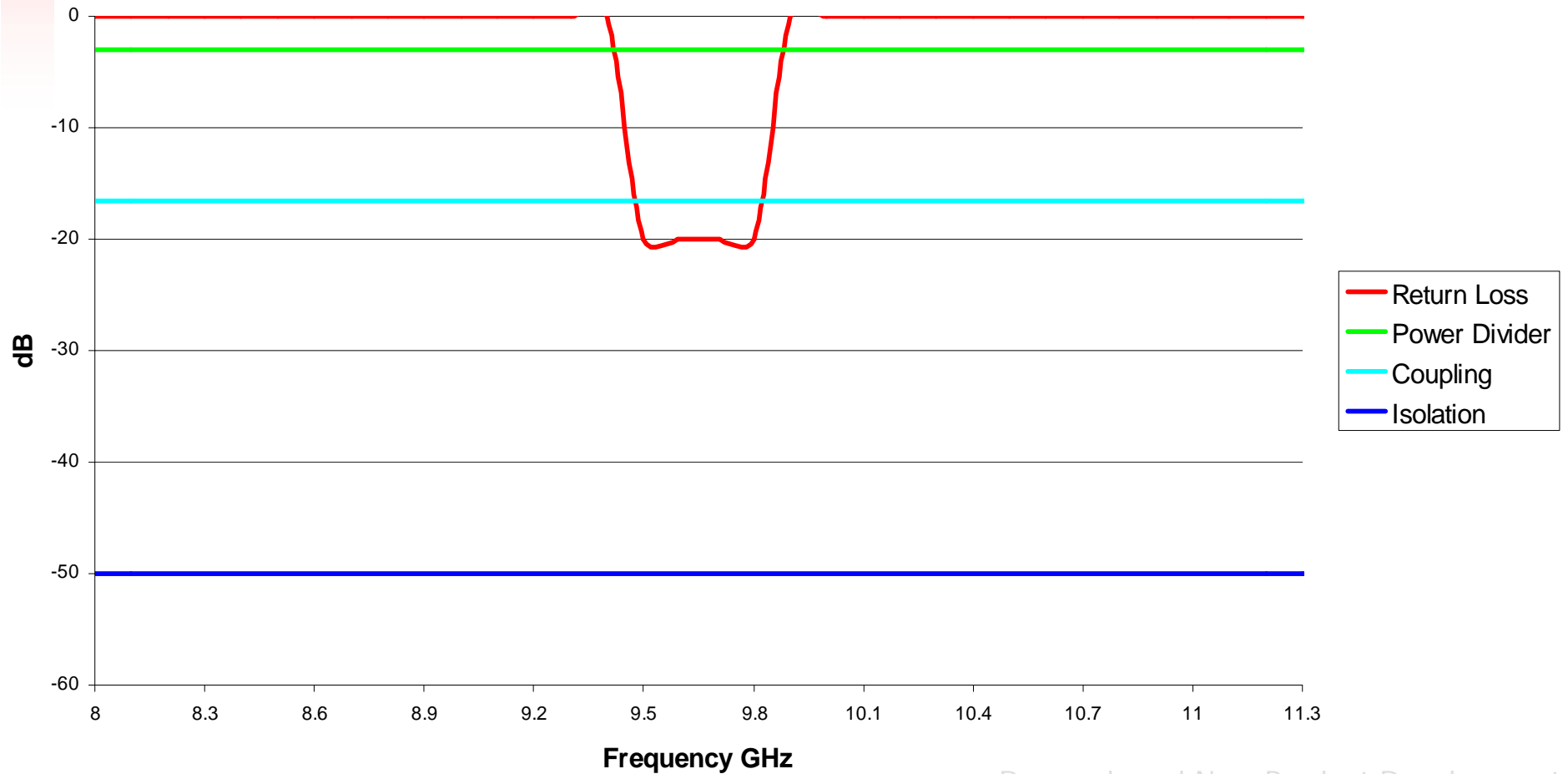
Design Modifications

- Strategies to Improve Layout, Manufacturability, and Performance
 - Shortened RF transitions.
 - Arranged vias and ground to inhibit RF reflections.
 - Re-arranged and shrunk cavities to inhibit resonance.
 - Used coplanar structures for better isolation.
 - Maintained optimum design guidelines throughout package. (via diameter and pitch, trace width and spacing, ceramic tape thickness, etc).

Simulation Targets



Module Desired Performance



Challenges



- Meet electrical requirements in complex 3D transitions and passive structures.
 - Ten different 3D - RF transition models.
 - One 11-port model, which includes power divider and coupler.
- Size constraint on overall physical size.
- Meet manufacturing tolerances.
- Meet customer's assembly tolerances.

RF Modeling Approach

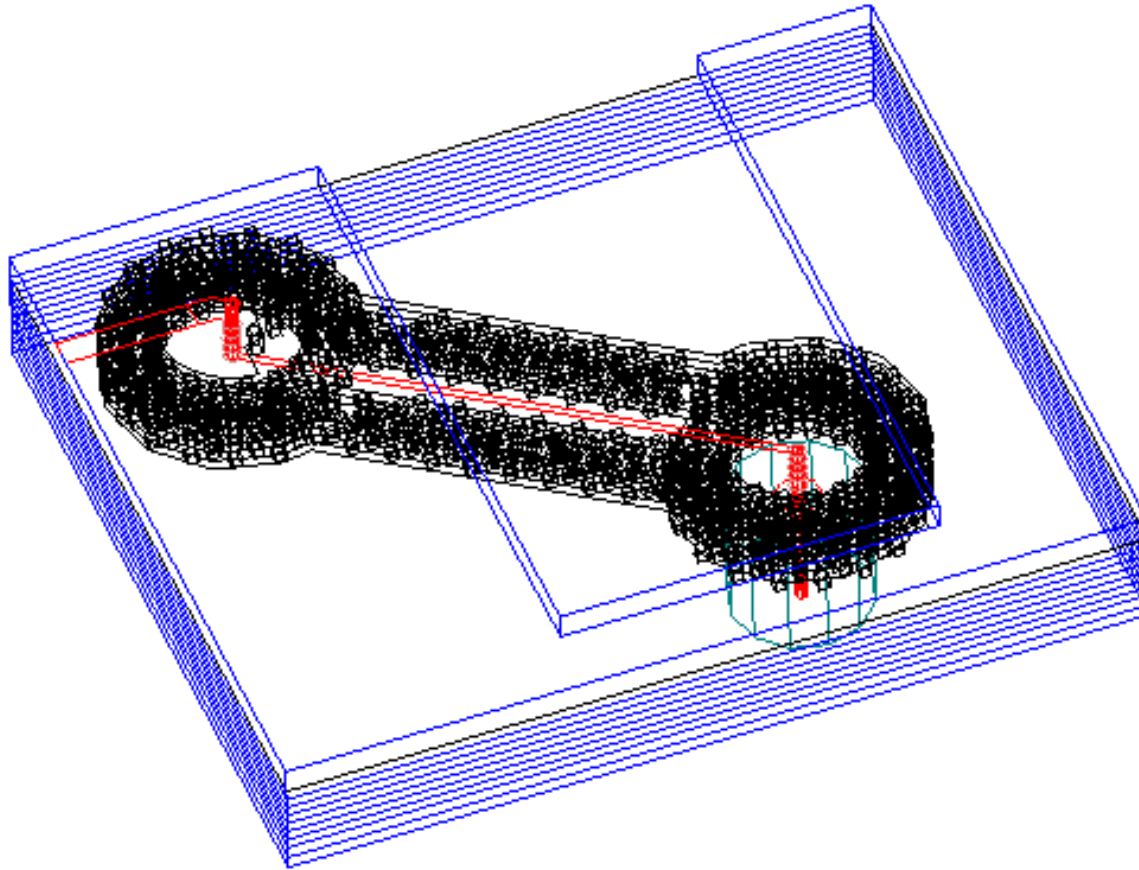


- Break RF routing into a series of independent transitions.
- Use HFSS to model and optimize each transition
 - Break large transitions into sub-models, solve, and optimize.
 - Bring together sub-models and solve the entire transition.
- Reduce model complexity
 - Use square vias instead of cylindrical vias.
 - Use metal blocks instead of large number of vias at non-critical places.

Transition 1



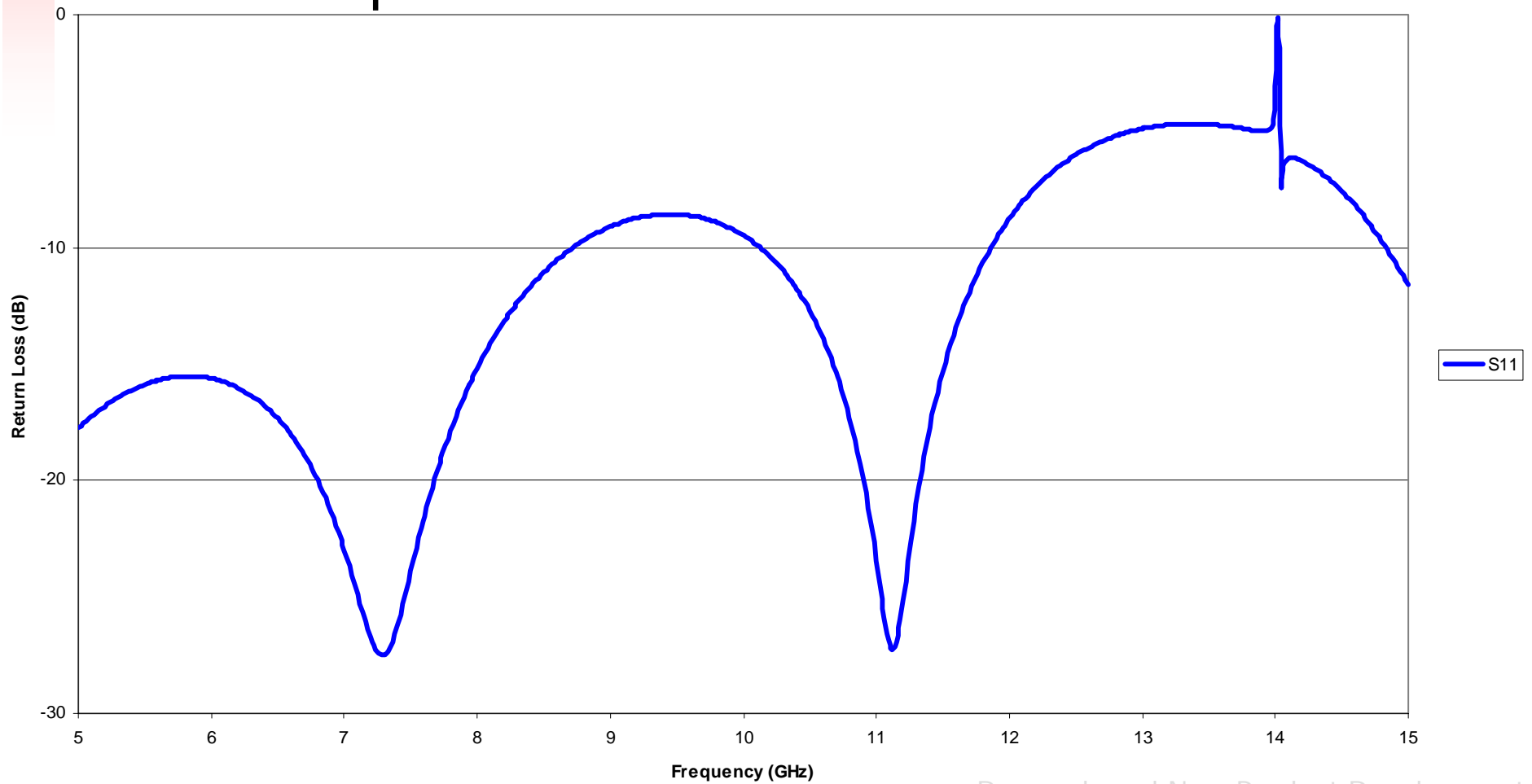
- Cinch to Stripline to Coax to Microstrip



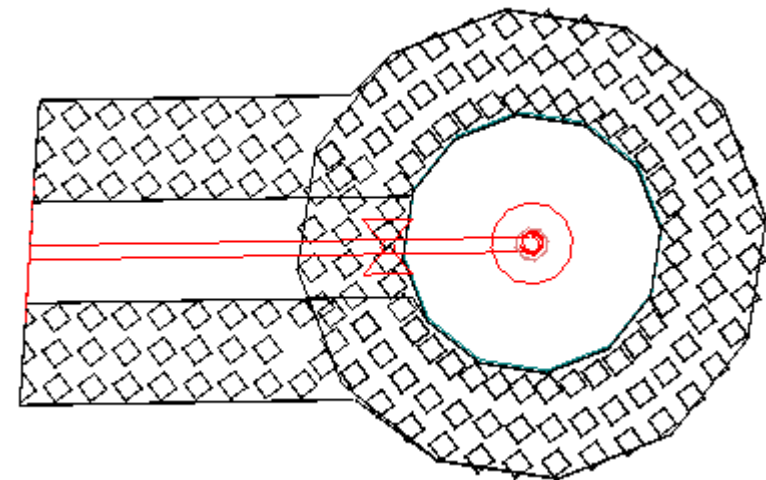
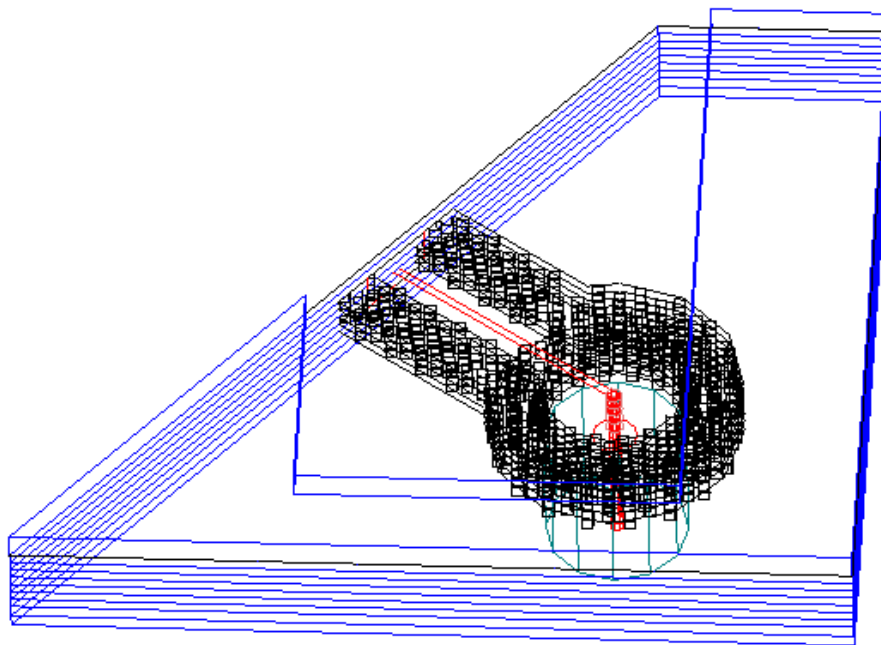
Transition 1



- Uncompensated S11



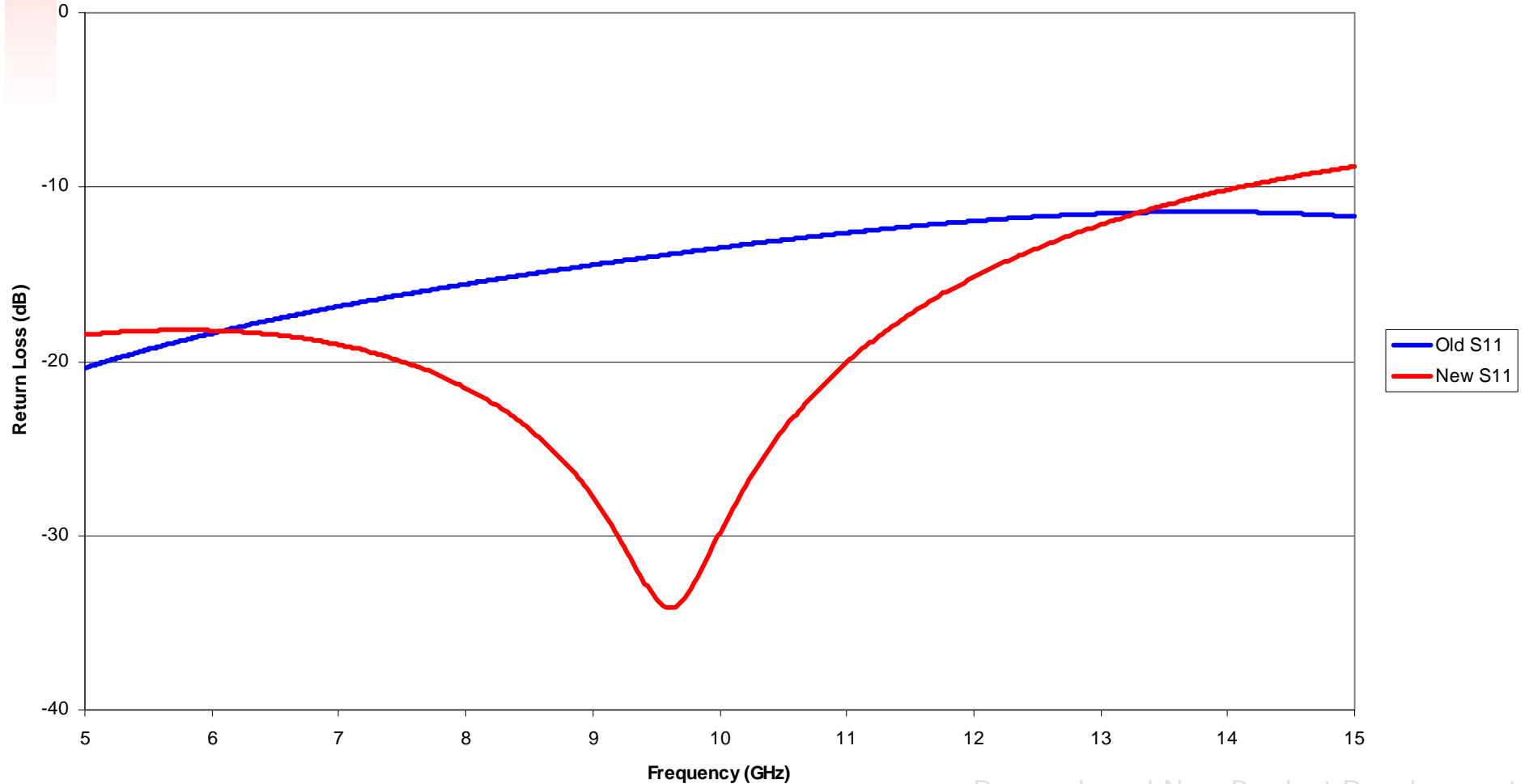
Transition 1 – Submodel 1



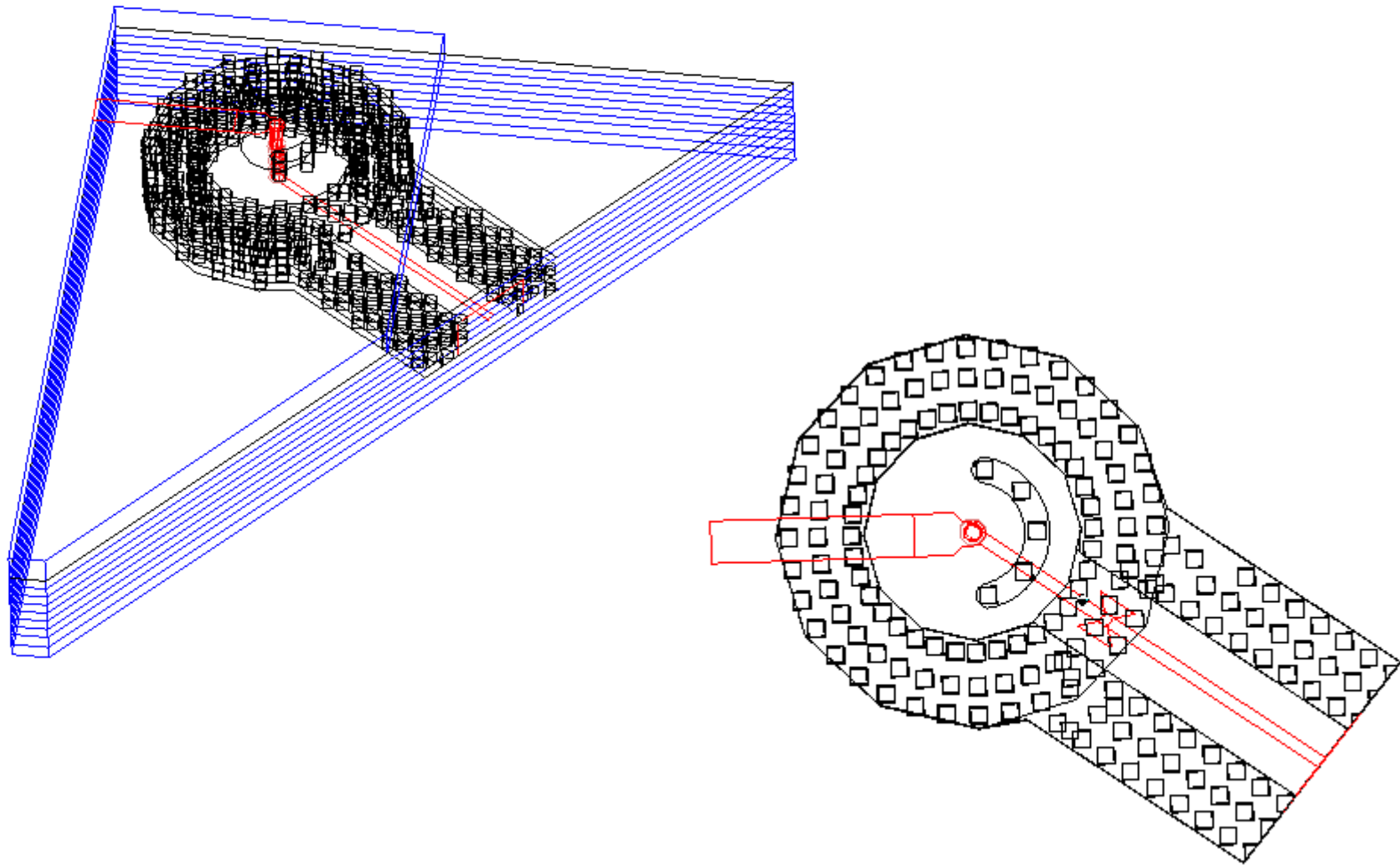
Transition 1 – Submodel 1



- Before & After



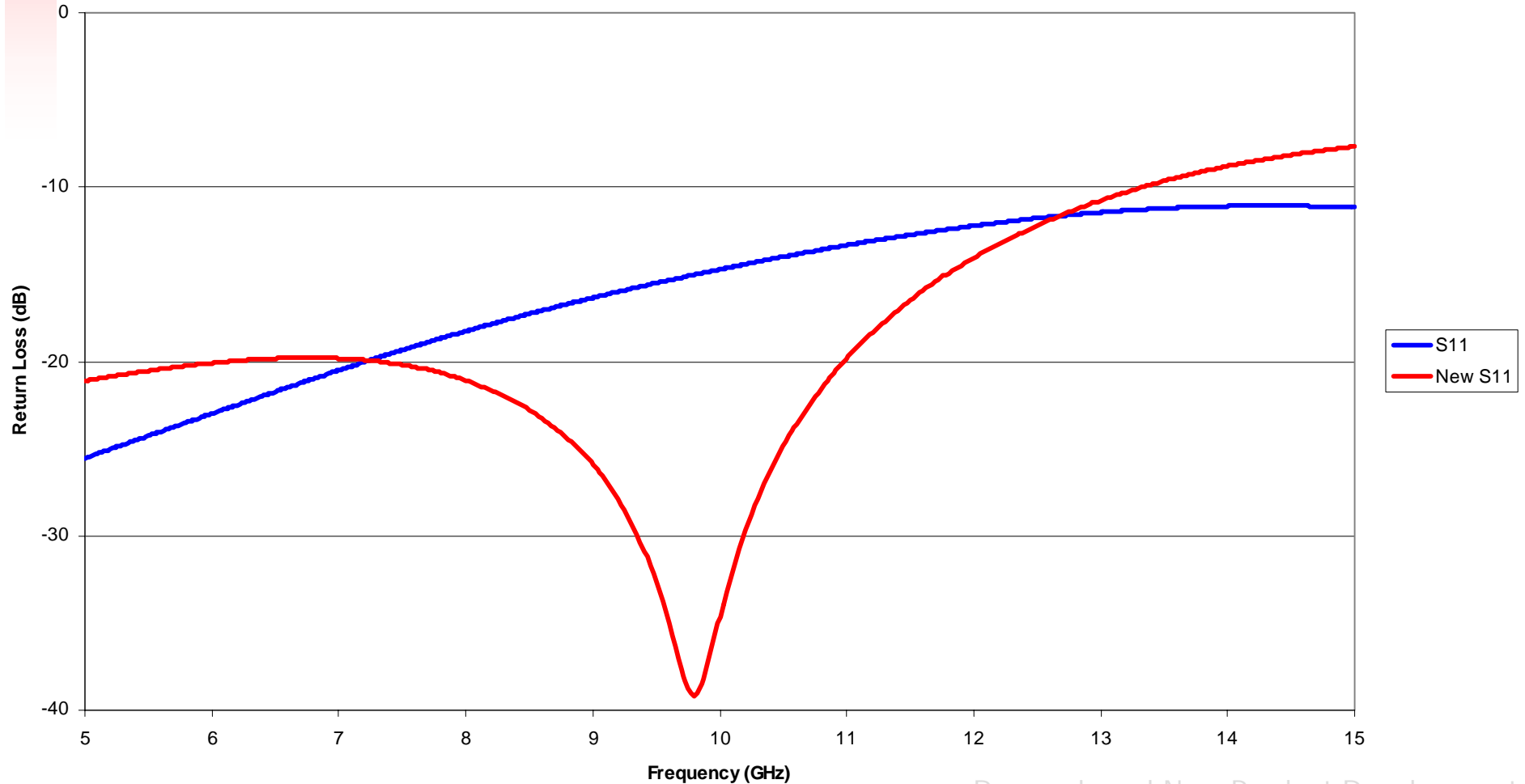
Transition 1 – Submodel 2



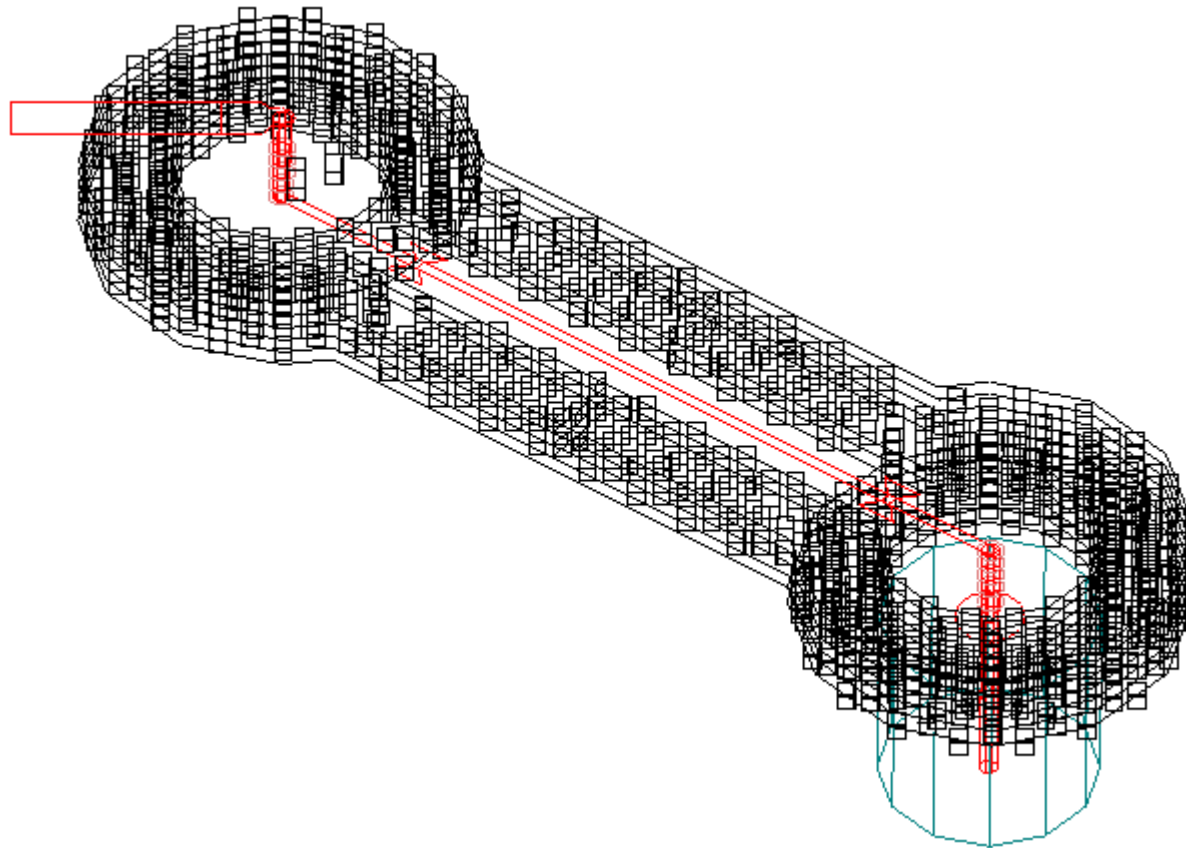
Transition 1 – Submodel 2



- Before & After



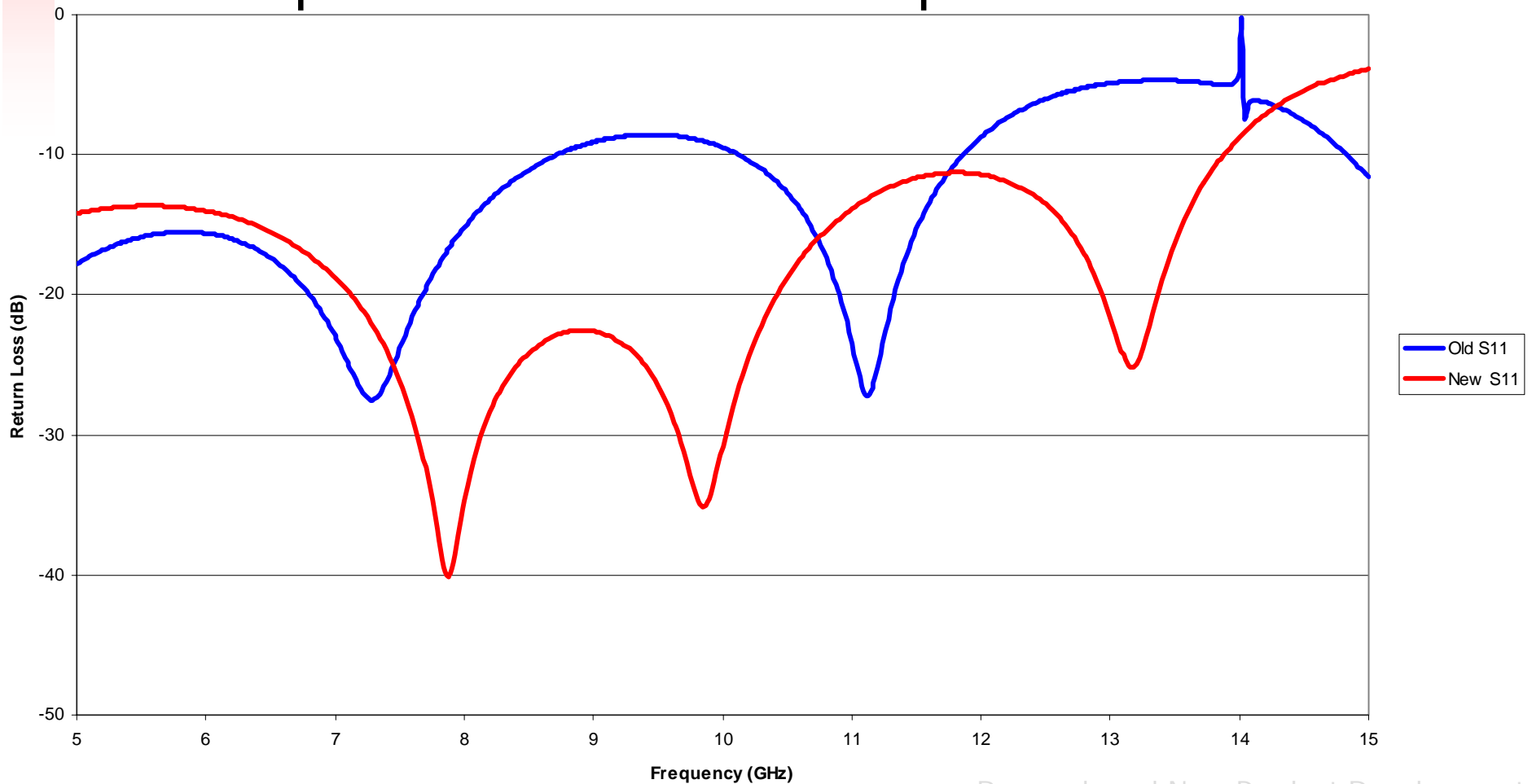
Complete Transition 1



Transition 1



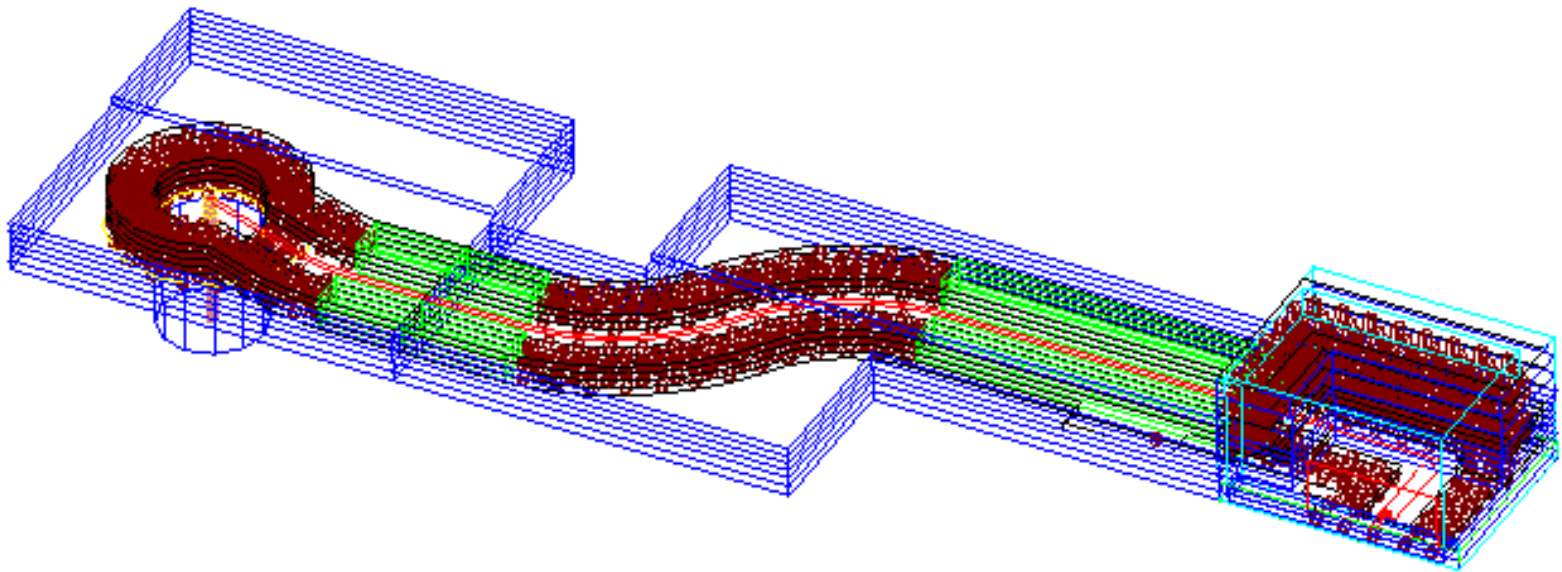
- Compensated vs. Uncompensated



Transition 2



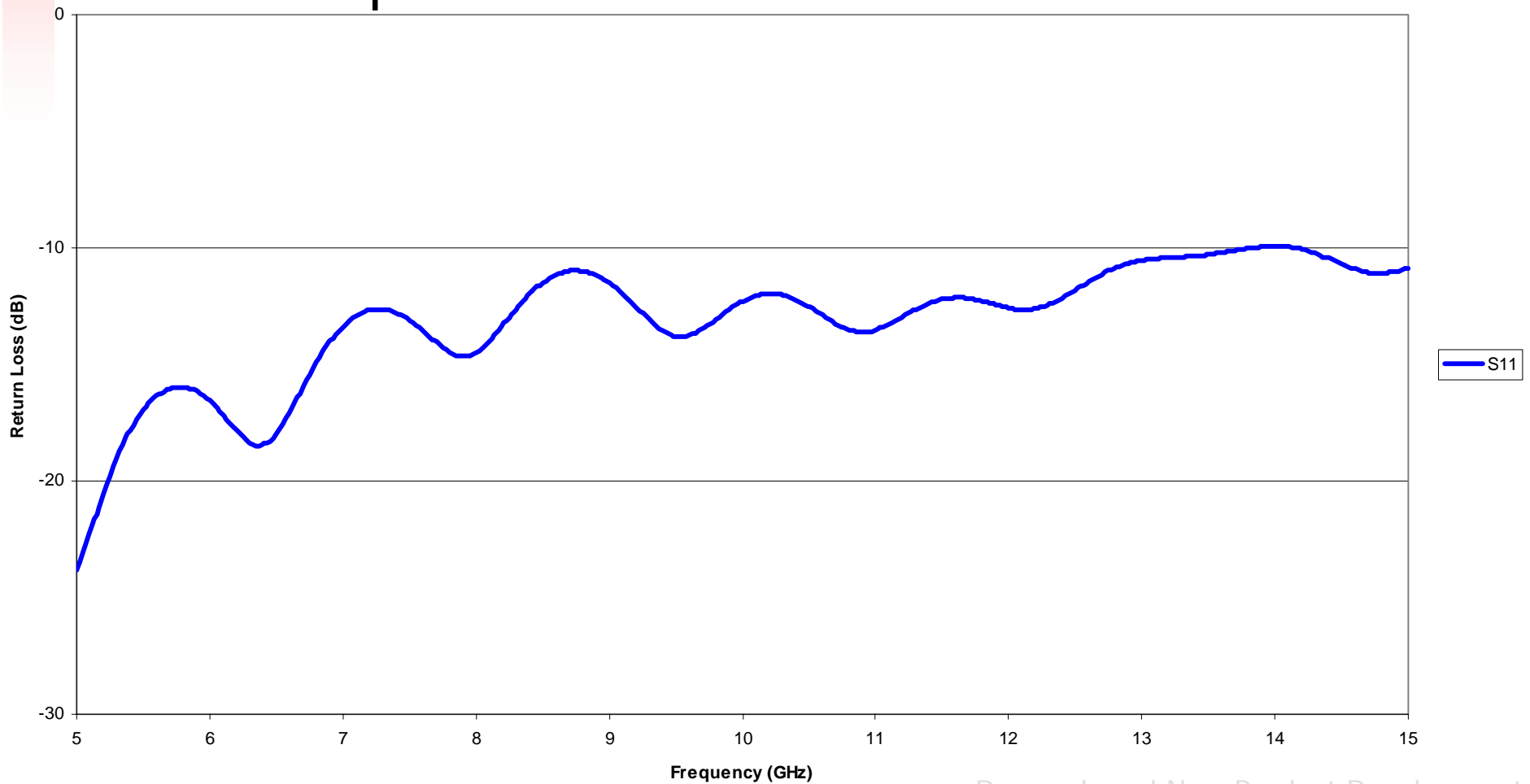
- CINCH to Stripline to CPWG to W/B to MMIC



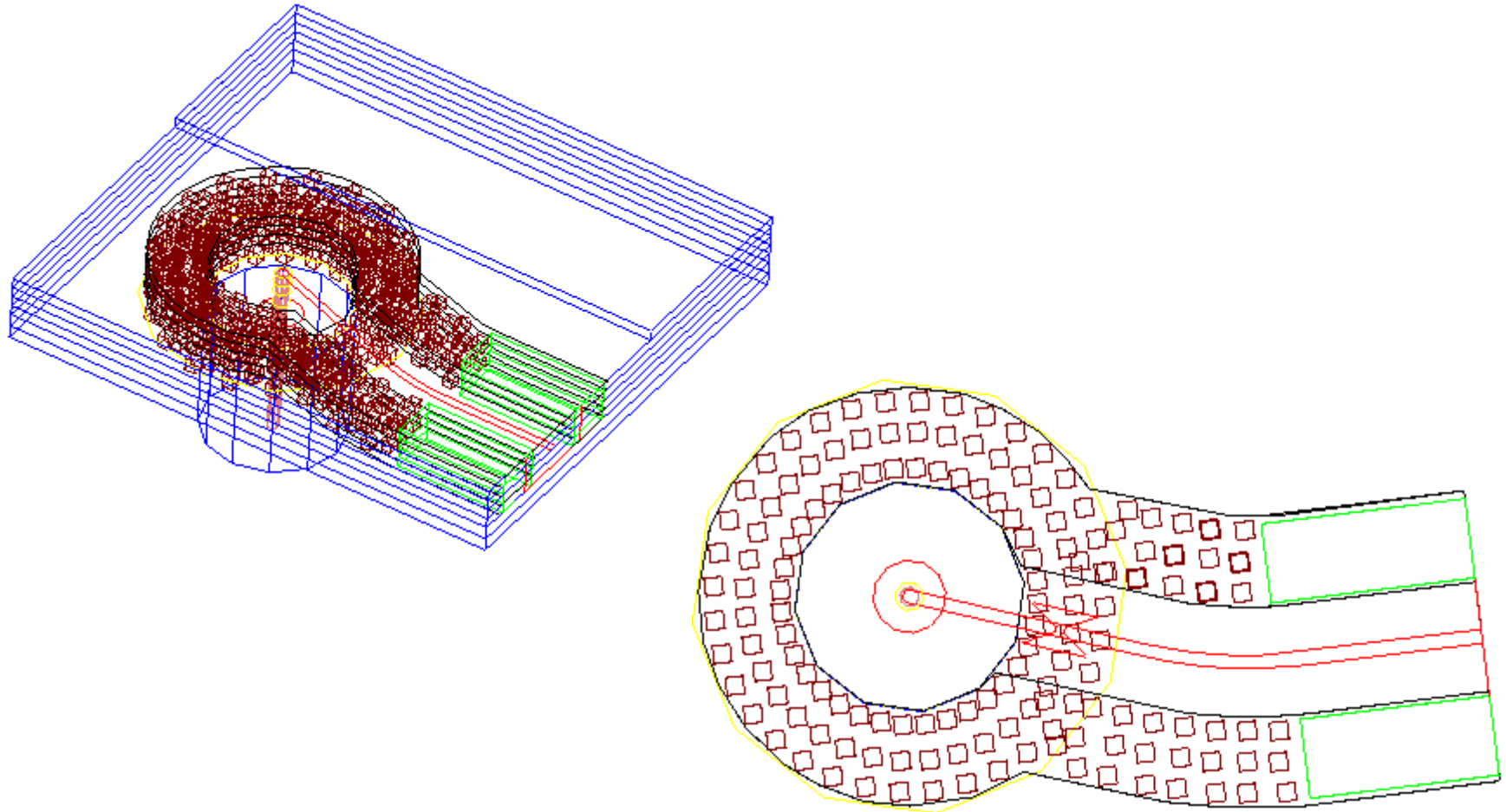
Transition 2



- Uncompensated S11



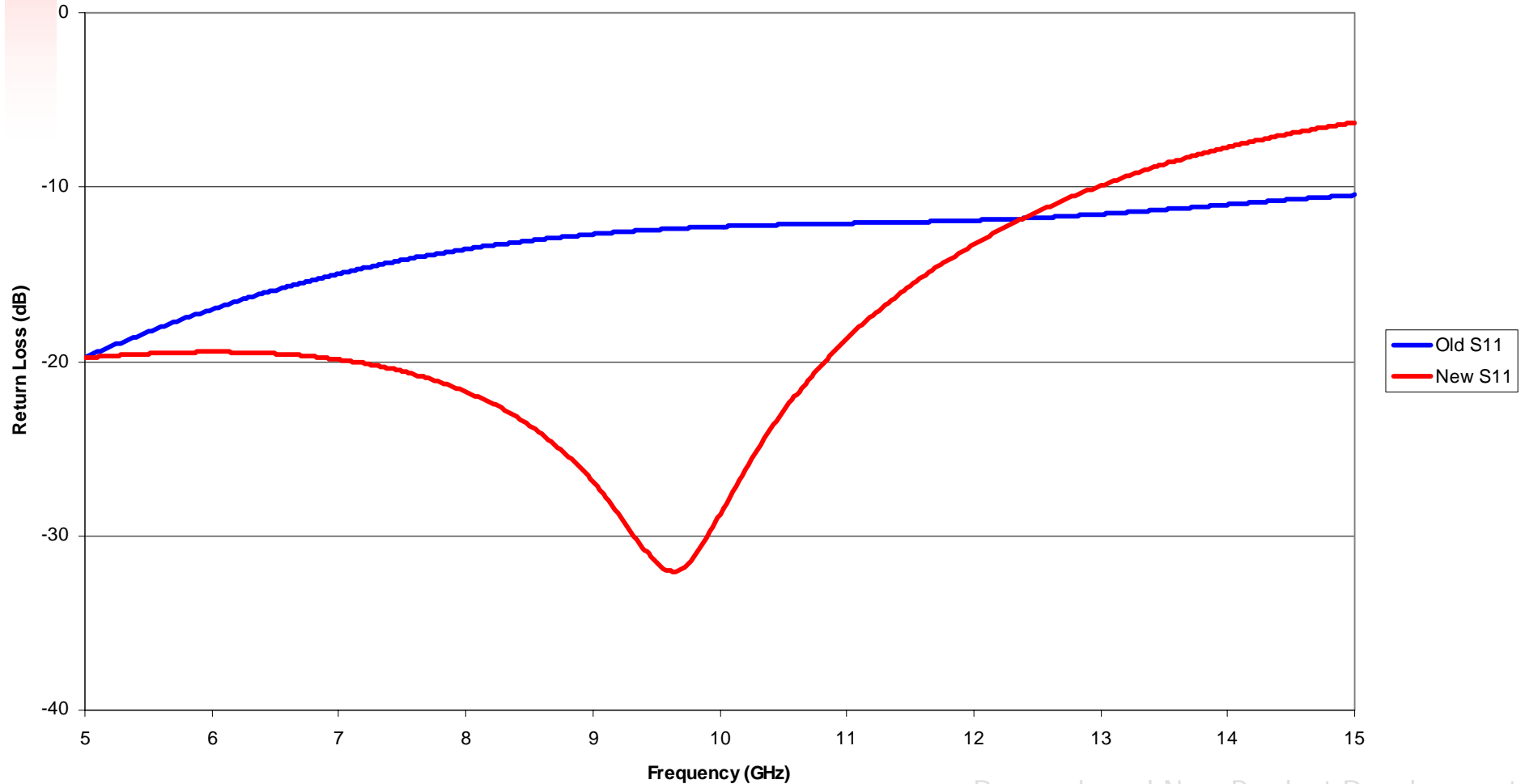
Transition 2 – Submodel 1



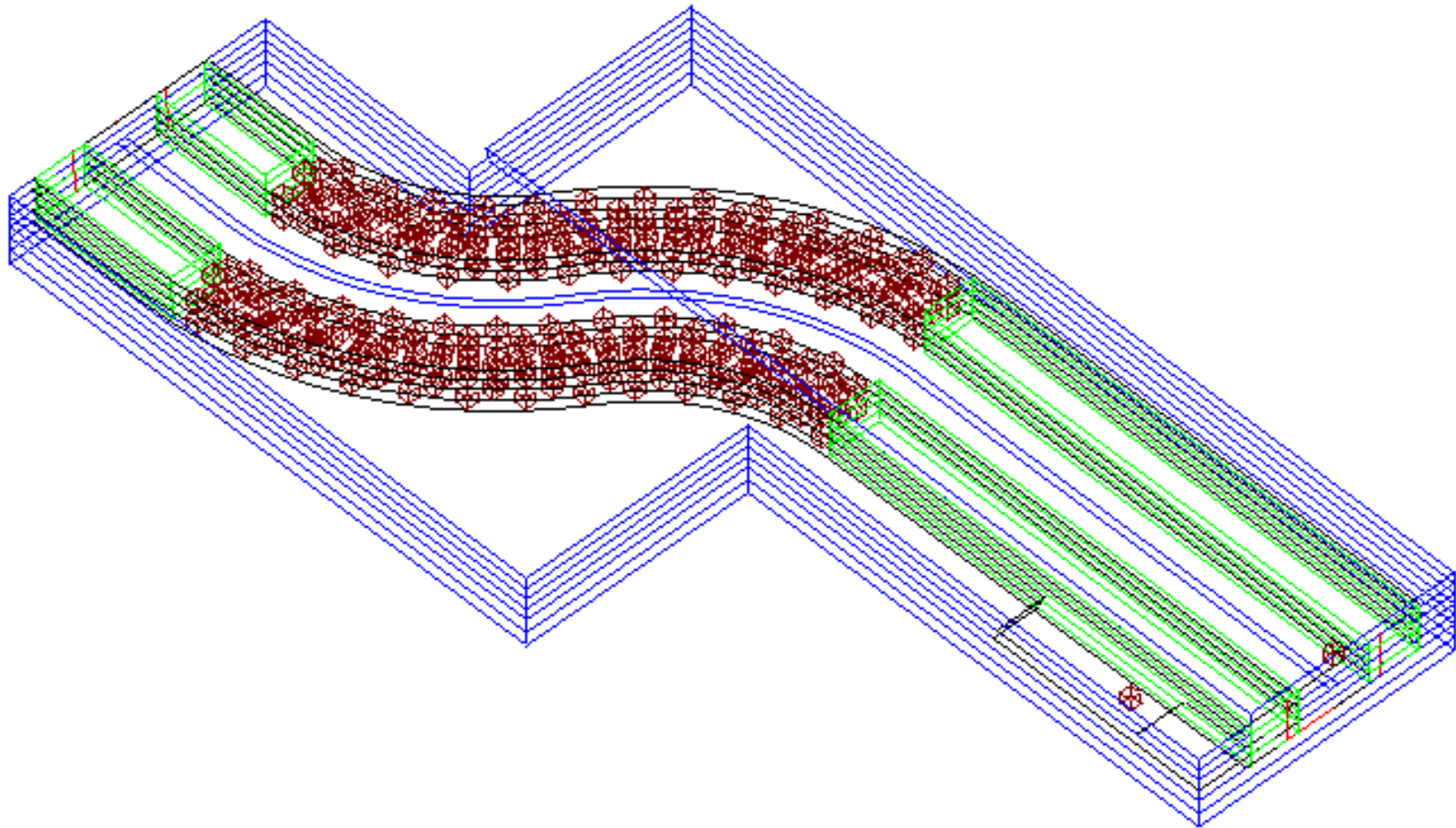
Transition 2 – Submodel 1



• Before & After



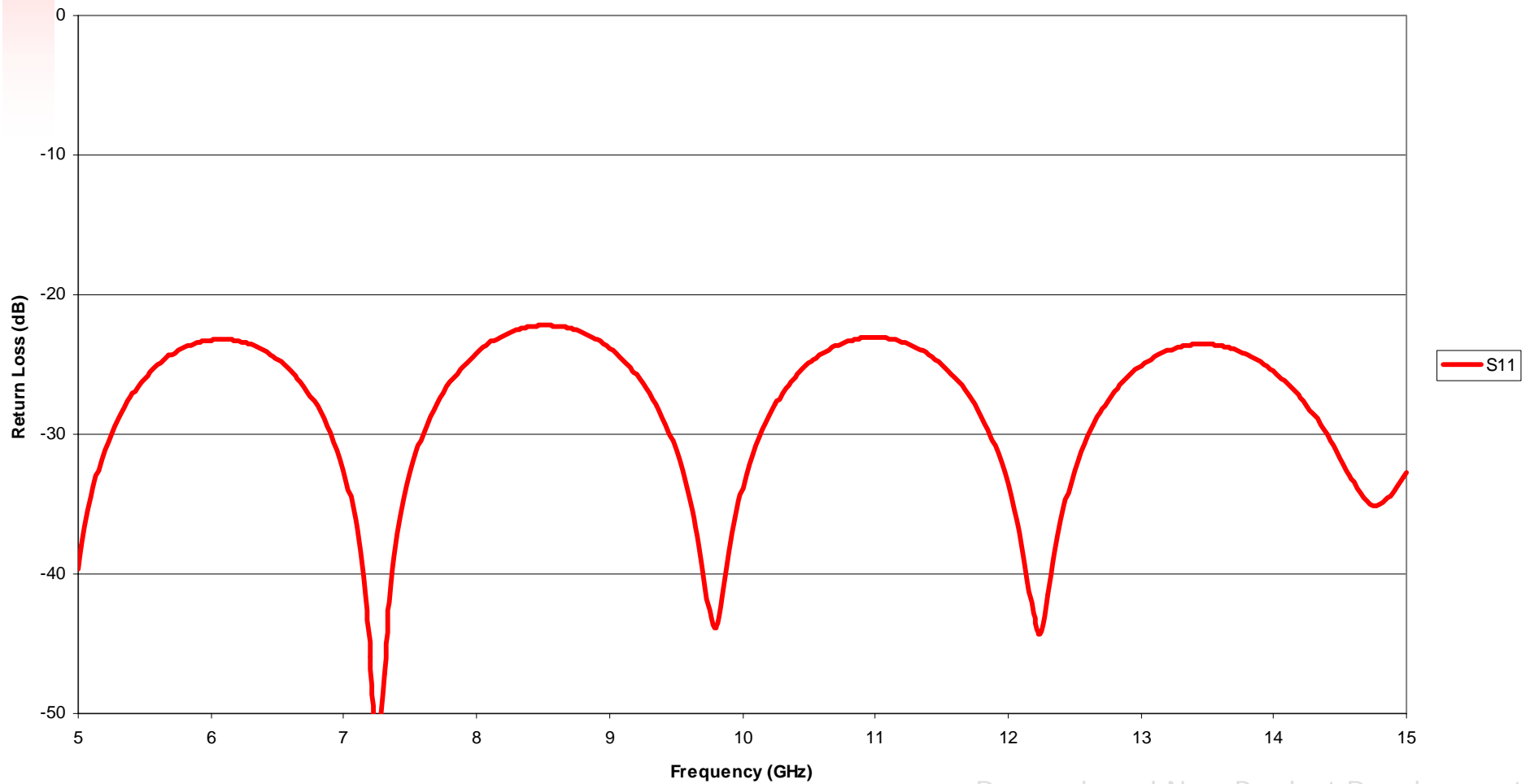
Transition 2 – Submodel 2



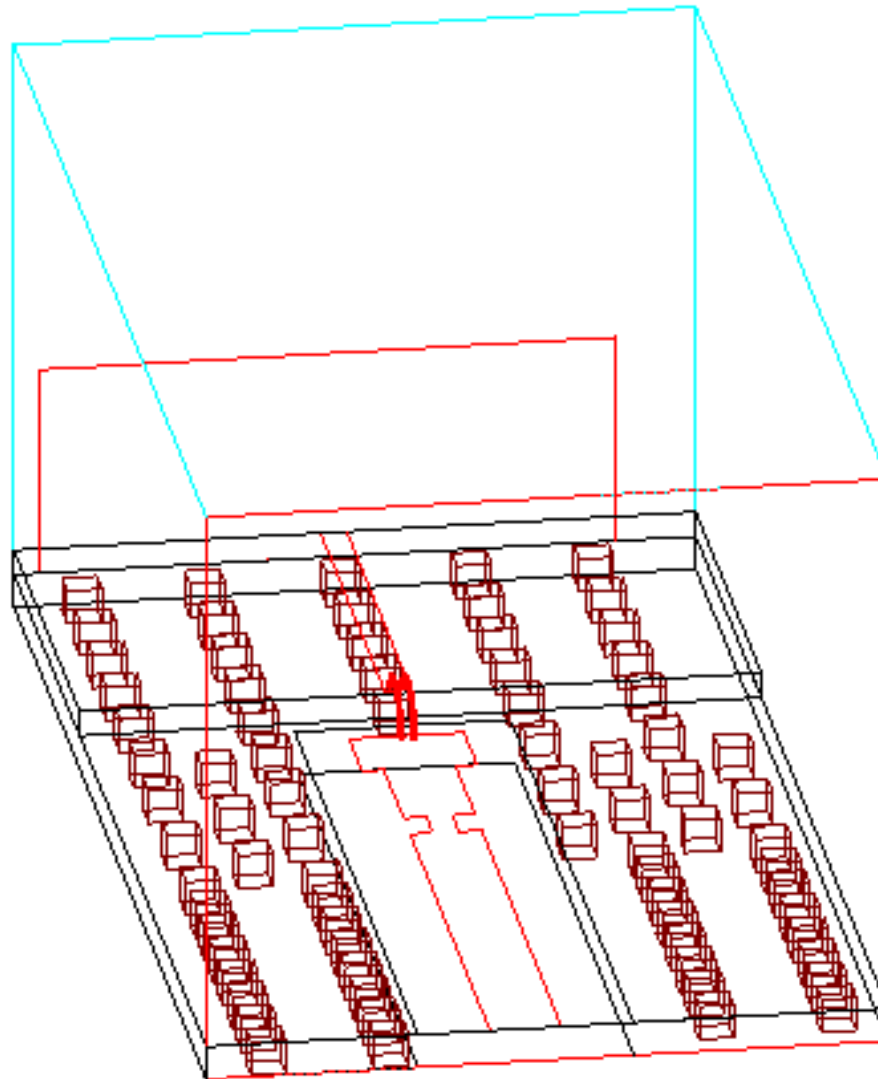
Transition 2 – Submodel 2



- Result



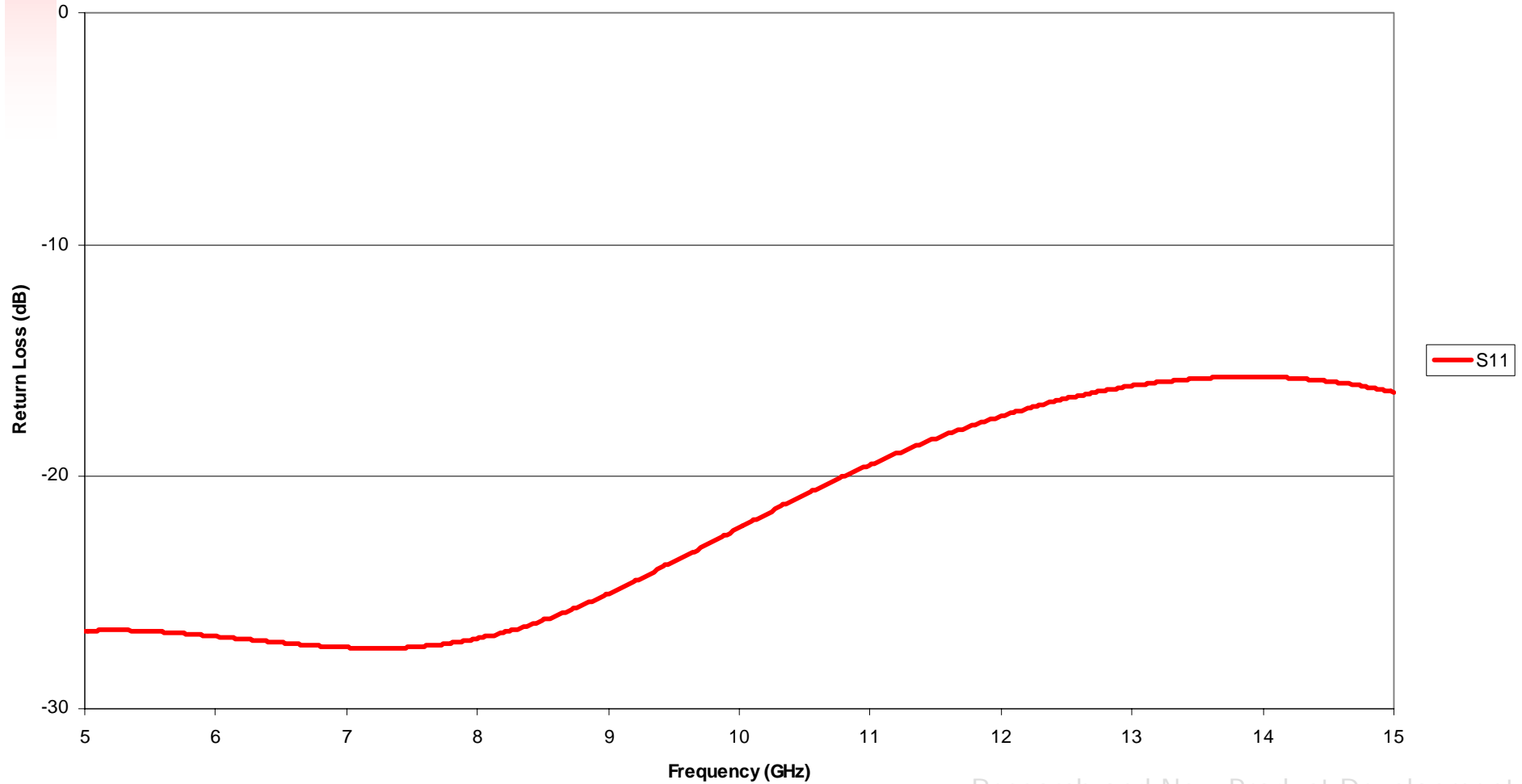
Transition 2 – Submodel 3



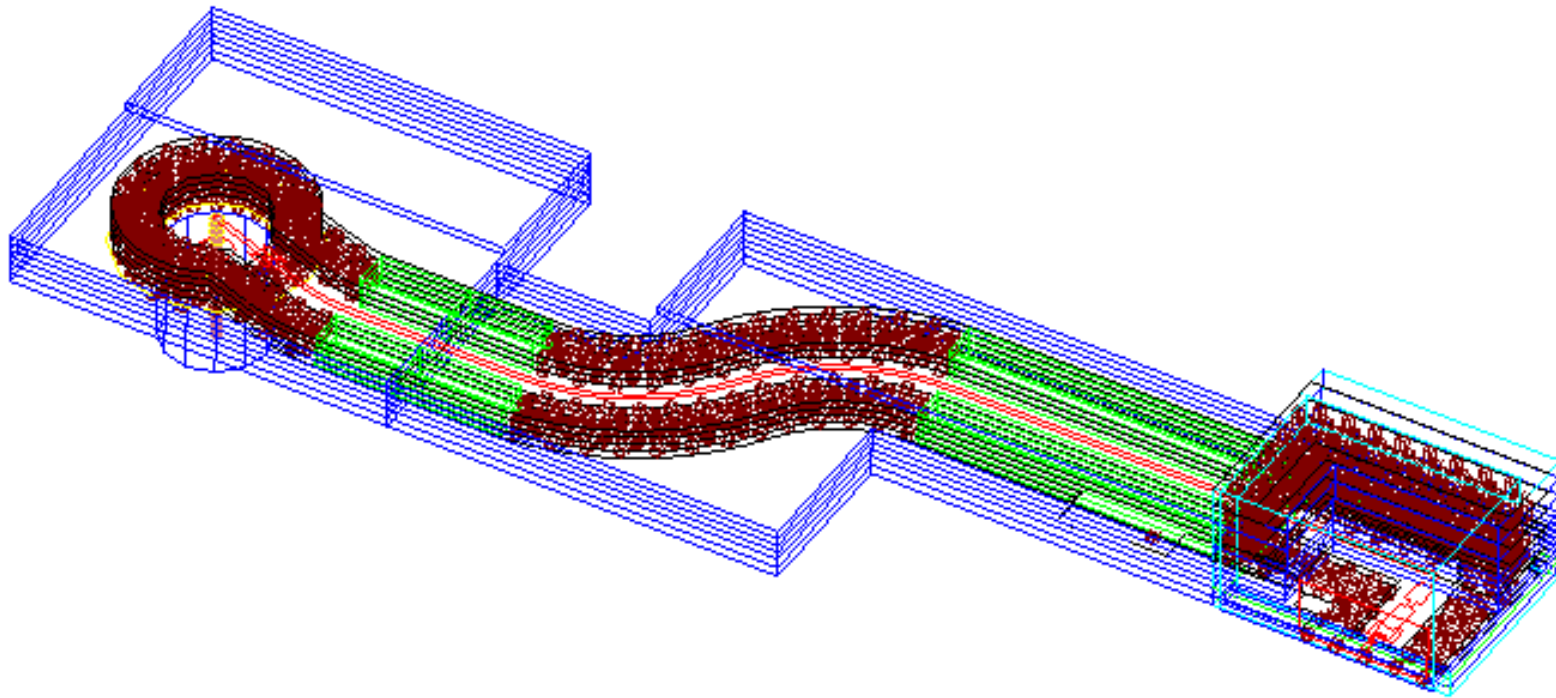
Transition 2 – Submodel 3



- Result



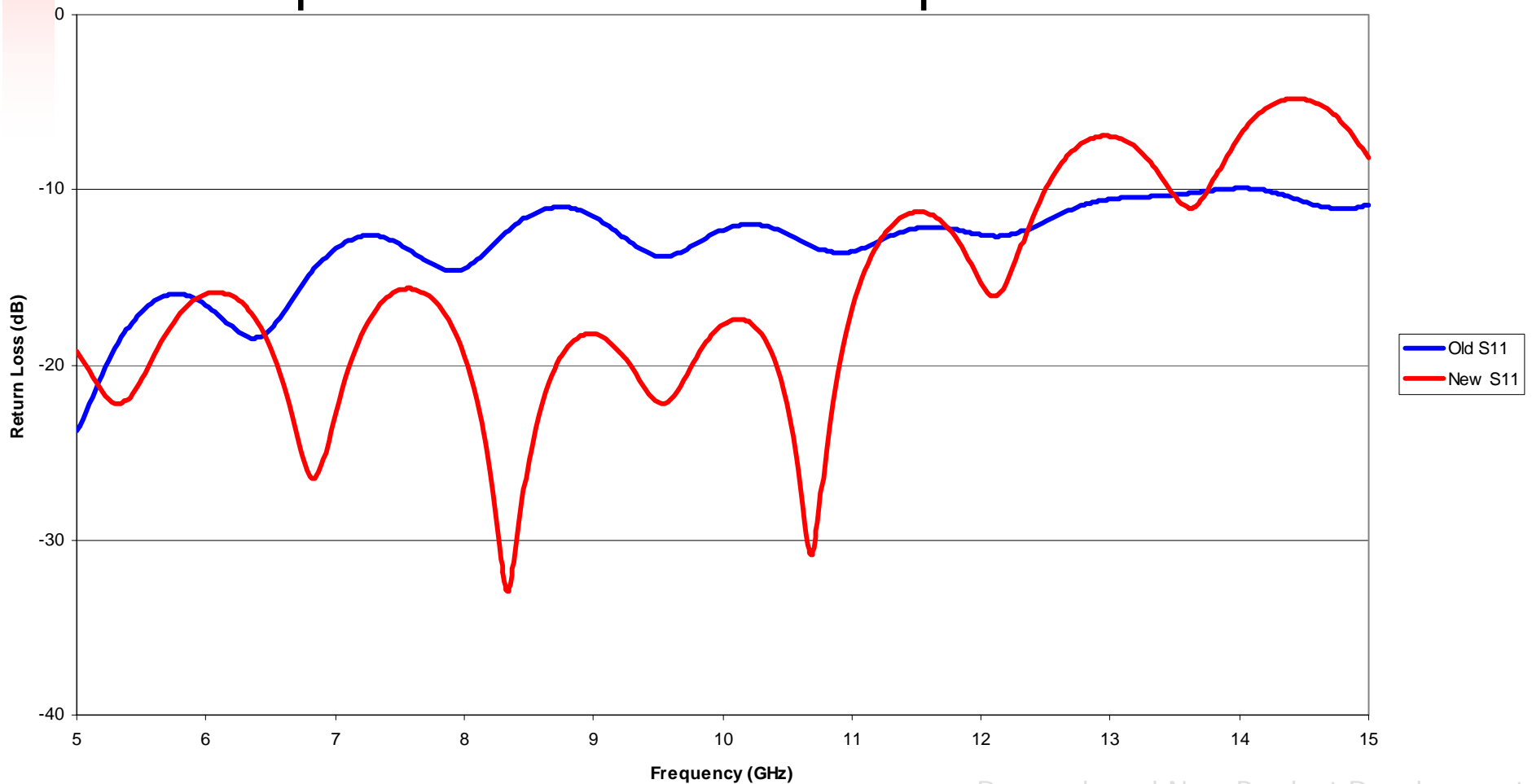
Complete Transition 2



Transition 2



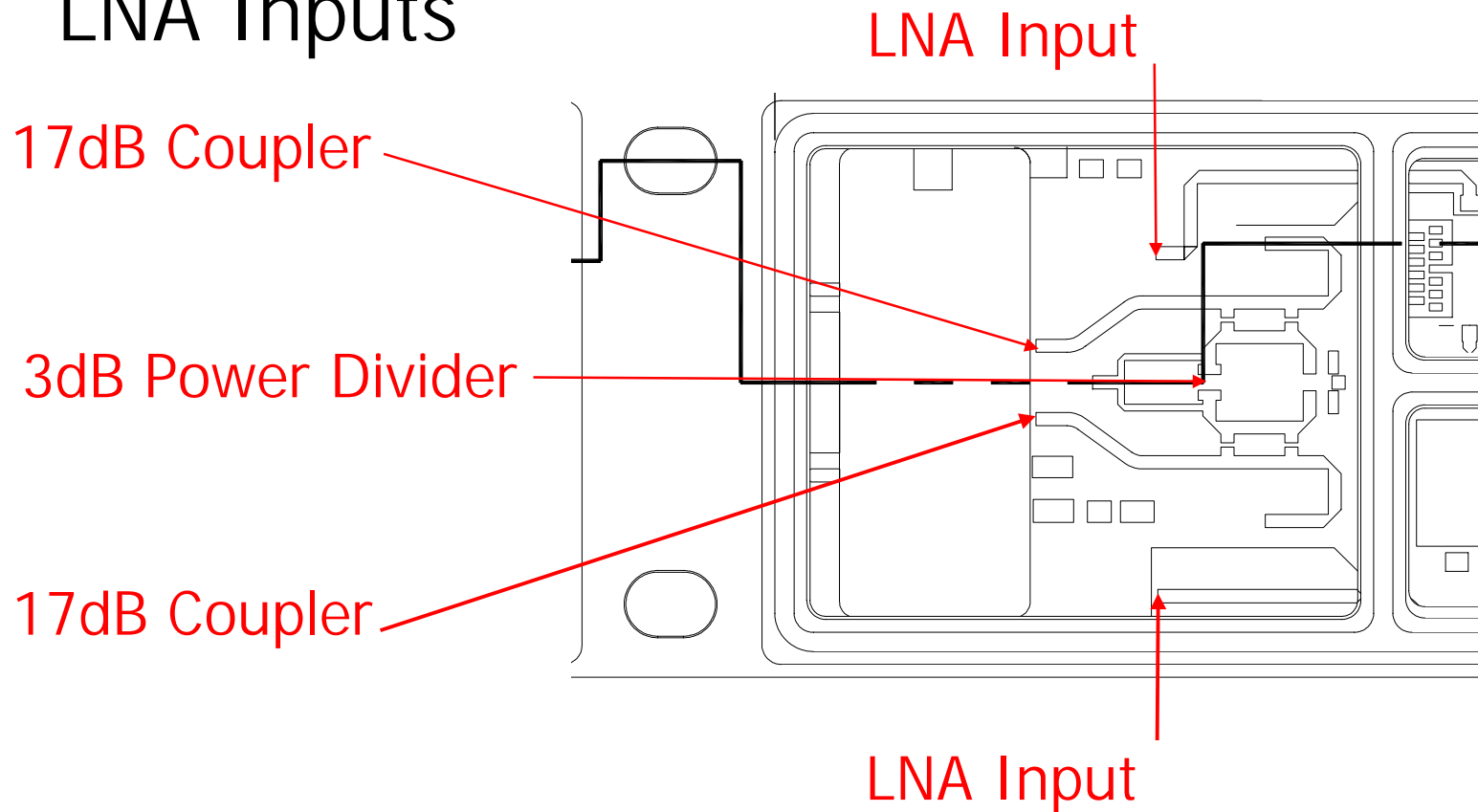
- Compensated vs. Uncompensated



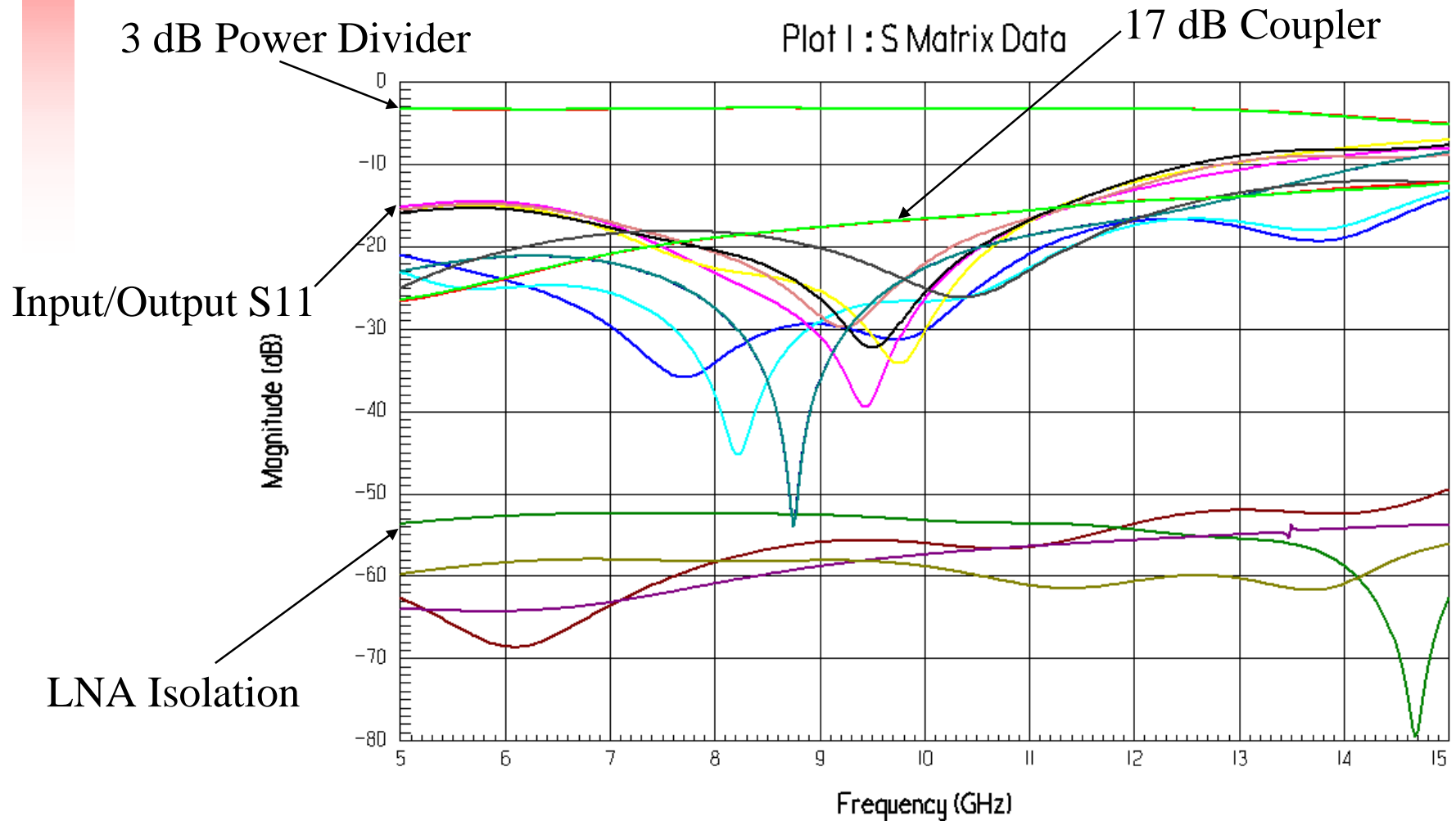
Divider & Coupler Section



- Achieve 50 dB or Better of Isolation at LNA Inputs



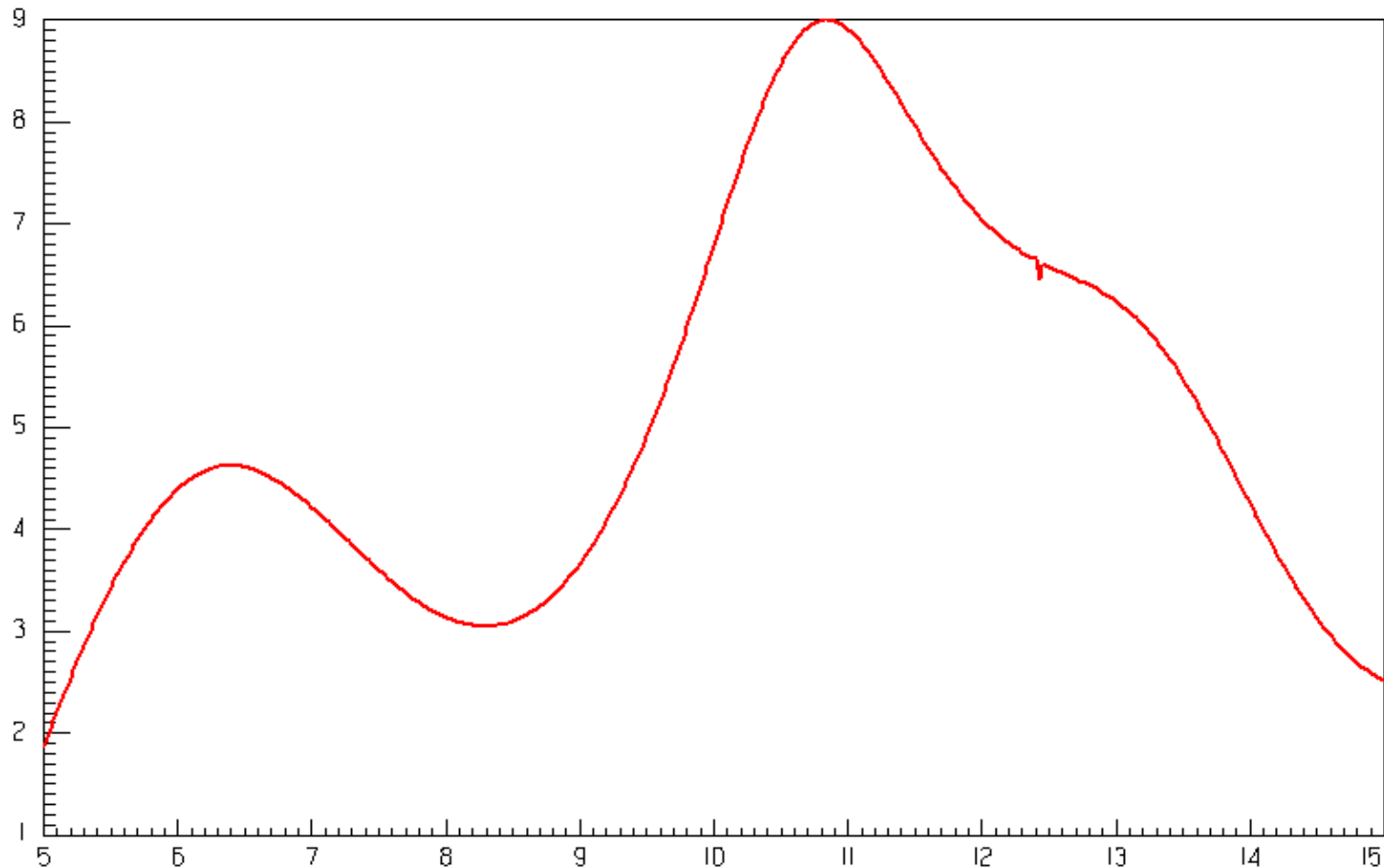
11 Port Model Results



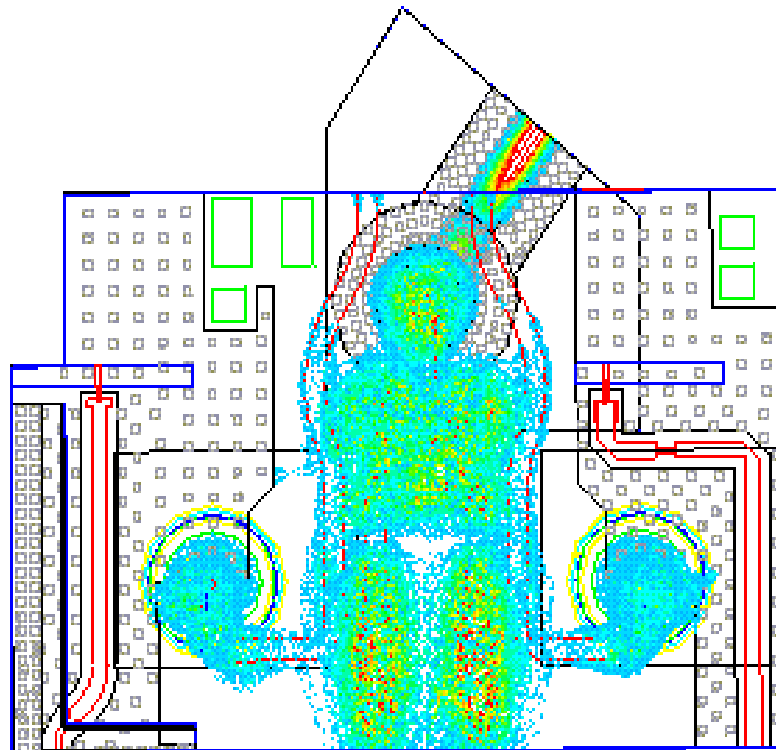
Determining Coupler Directivity



— s16sl7.dat:R_1 : S[port1:ml, port7:ml] (mag) - s16sl7.dat:R_1 : S[port1:ml, port6:ml] (mag)



Animations



Conclusion



- Mechanical layout met manufacturing criteria.
- RF transition models exhibited excellent electrical performance.
- Demonstrated the capability to provide an integrated manufacturable design.
- Demonstrated the importance of HFSS as a tool in designing ceramic packages.