Using Dummy Objects and Seeding to Accelerate Convergence in HFSS

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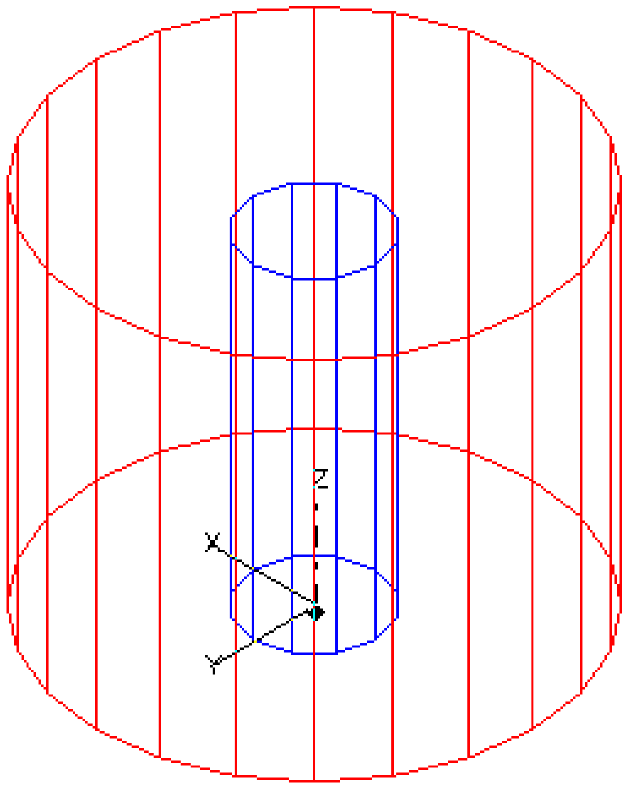
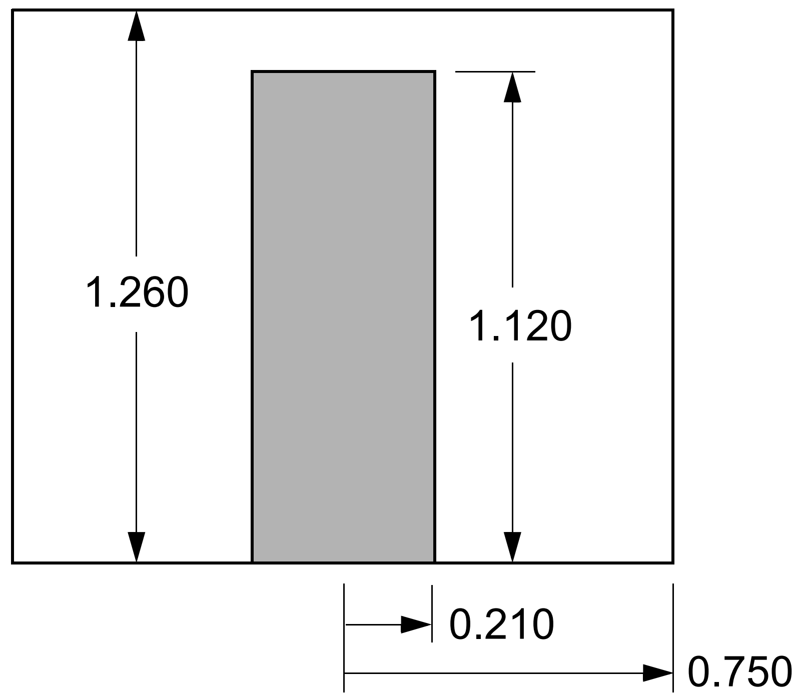
Introduction

- Past meshing strategy:
  - Lambda Refine at $\lambda/3$
  - Large number of adaptive passes: 10 to 20
  - Not the most efficient mesh?
- New meshing strategy:
  - Lambda Refine at $\lambda/20$ to $\lambda/30$
  - Use dummy objects and seeding
  - Limit number of adaptive passes: 6 to 8
- Coaxial resonators using eigen-solver
- Lowpass filters using driven solution

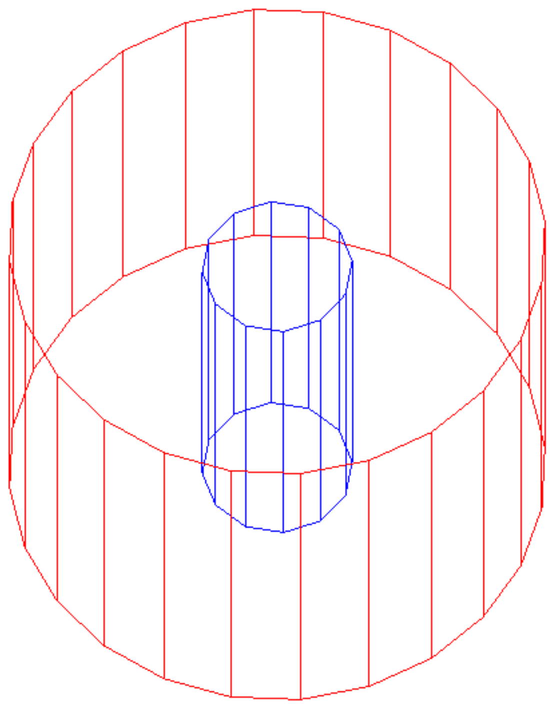
FEM Meshing - Coaxial Resonator



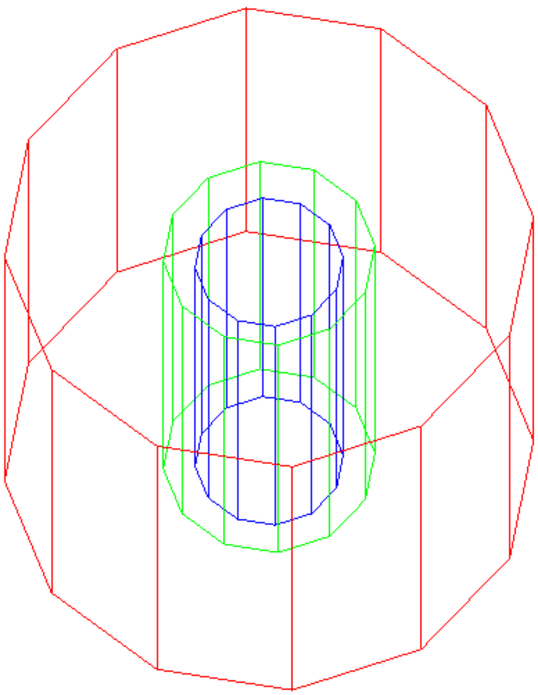


Source	f_0 **(GHz)**	Q_u
Wang	1.87	5592
FlexPDE	1.877	5608

Two Possible Starting Points

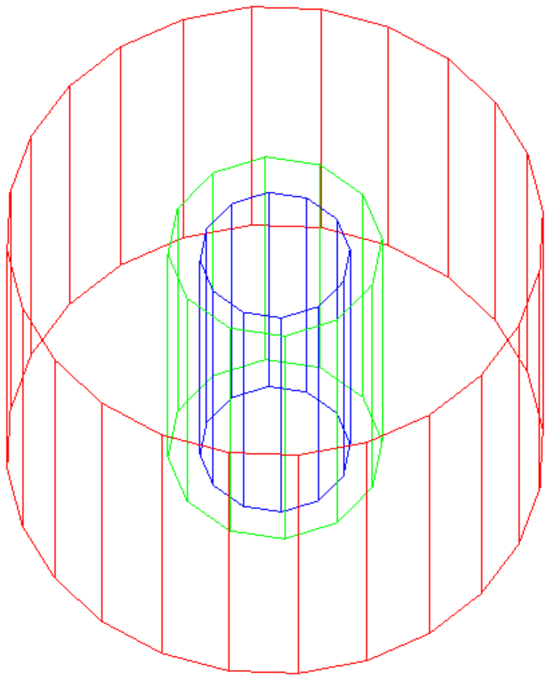


Case 1:
12 segments on post
24 segments on cavity
No seeding or dummy objects

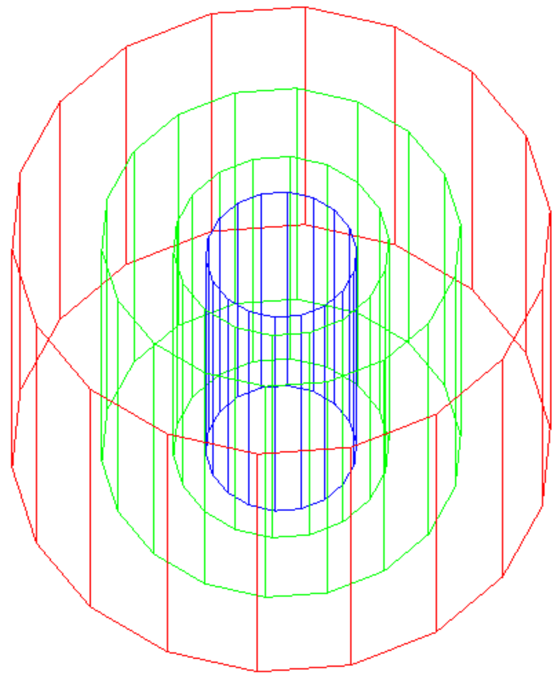


Case 2:
12 segments on all objects
Dummy object around post
Seed dummy at 0.1, max of 2000

Two More Starting Points



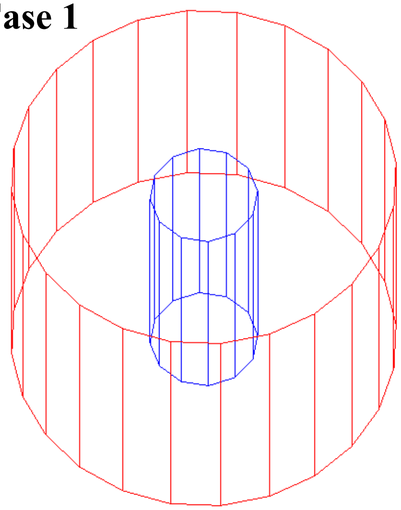
Case 3:
12 segments on post and dummy
24 segments on cavity
Seed dummy at 0.1, max of 2000



Case 4:
18 segments on all objects
Two dummy objects
Seed inner dummy at 0.1, max of 4000

Results for Case 1 and Case 2

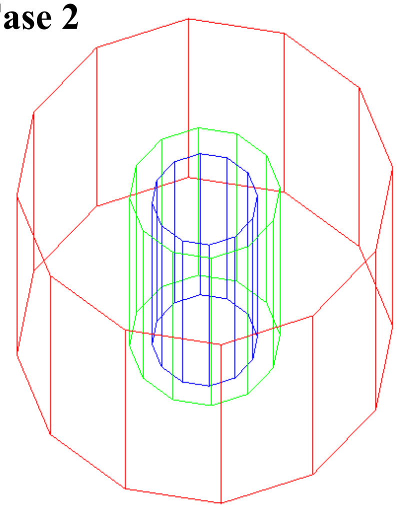
Case 1



12 segments on post, 24 segments on cavity, no seeding or dummy objects

Pass	f_0 (GHz)	Q_u	No. of tets	Δf_0 (%)
1	1.67870	4600	192	N/A
2	1.73039	4588	256	3.02
3	1.76209	1584	377	1.83
4	1.81827	4309	548	3.19
5	1.84973	4354	789	1.73
6	1.86460	4513	1094	0.80

Case 2

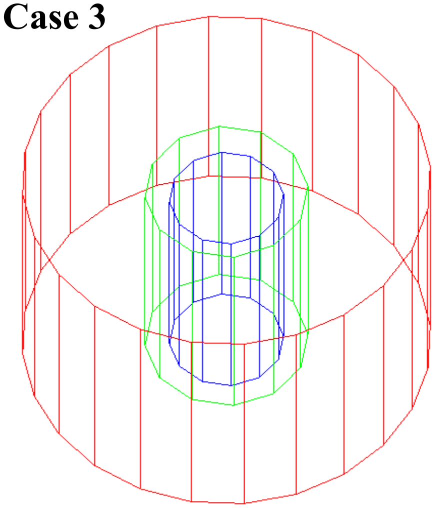


12 segments on all objects, dummy object around post, seed at 0.1, max of 2000

Pass	f_0 (GHz)	Q_u	No. of tets	Δf_0 (%)
1	1.8647	5265	2390	N/A
2	1.8822	5325	3161	0.937
3	1.8863	5346	4240	0.221
4	1.8887	5345	5738	0.144
5	1.8899	5372	7793	0.438
6	1.8904	5378	10644	0.089

Results for Case 3 and Case 4

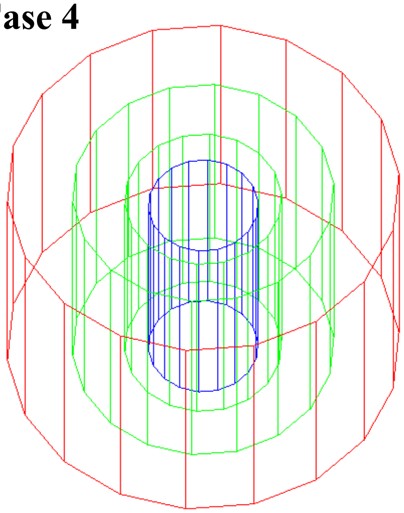
Case 3



12 segments on post and dummy, 24 segments on cavity, Seed at 0.1, max of 2000

Pass	f_0 (GHz)	Q_u	No. of tets	Δf_0 (%)
1	1.8604	5398	2480	N/A
2	1.8716	4762	3471	11.92
3	1.8759	5009	4841	4.71
4	1.8784	5304	6699	5.43
5	1.8796	5184	9234	2.35
6	1.8799	5430	12721	4.49

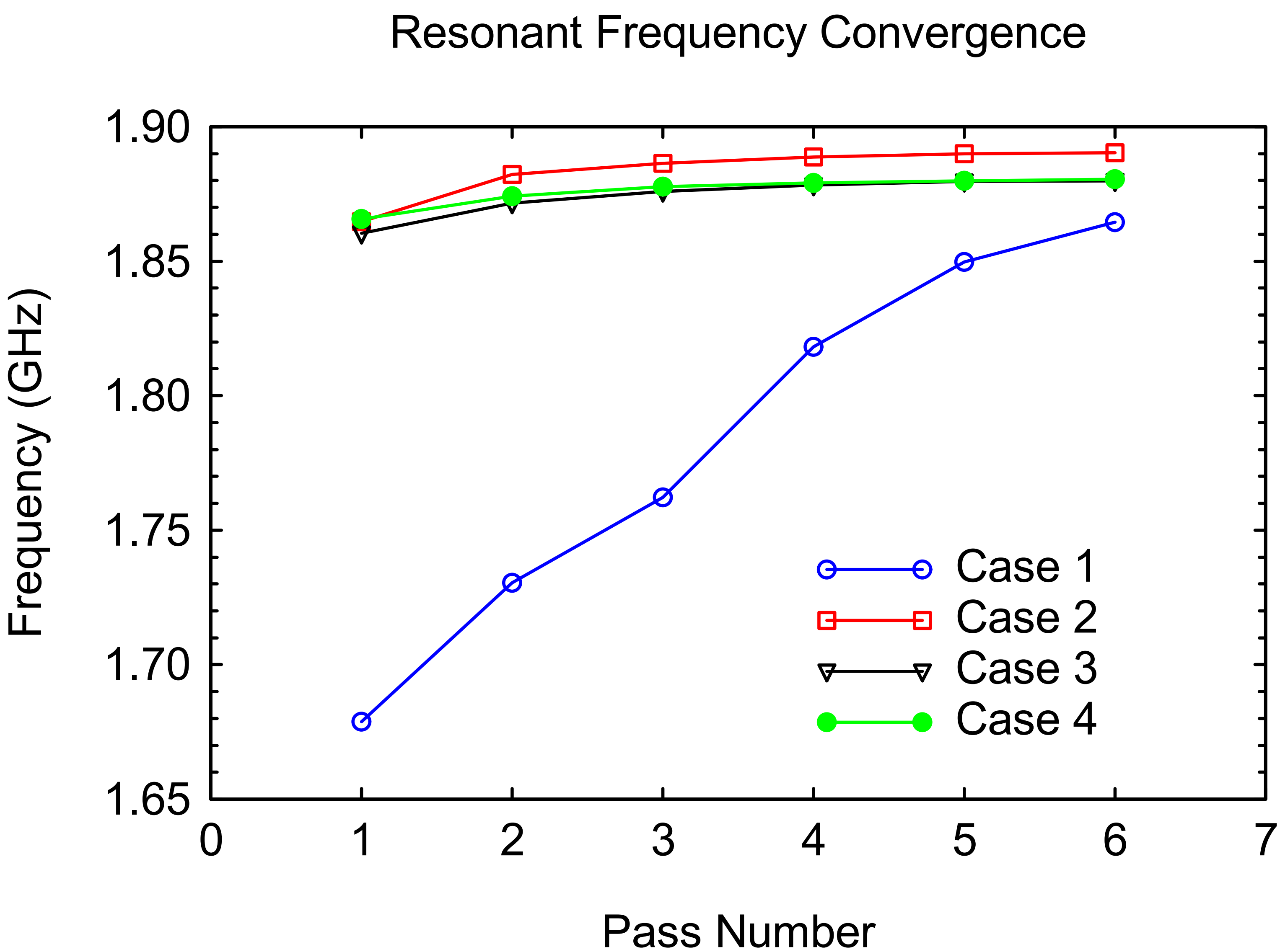
Case 4



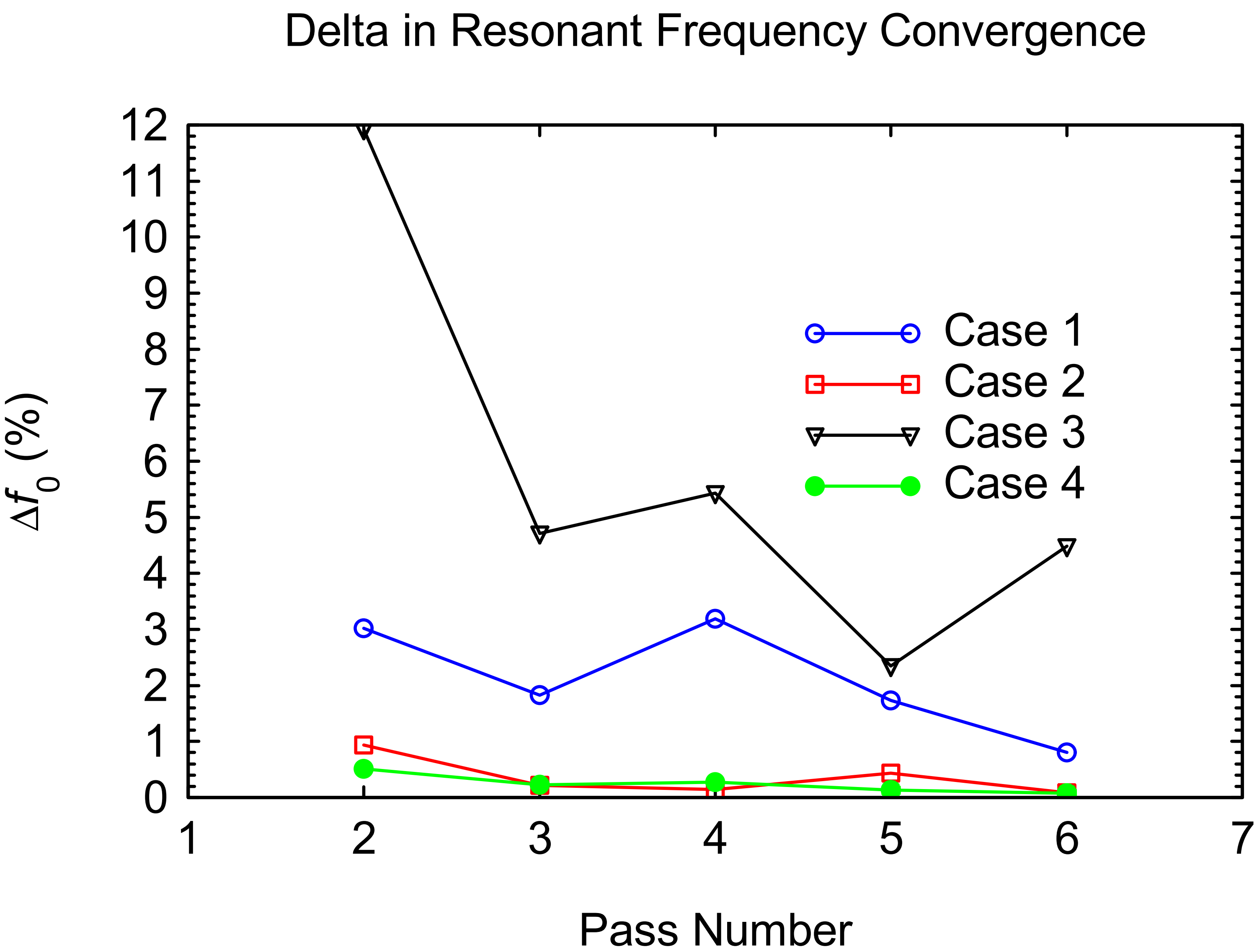
18 segments on all objects, two dummy objects, seed inner at 0.1, max of 4000

Pass	f_0 (GHz)	Q_u	No. of tets	Δf_0 (%)
1	1.86562	5452	4929	N/A
2	1.87419	5449	6631	0.512
3	1.87766	5447	8899	0.224
4	1.87914	5437	12282	0.271
5	1.87998	5447	16832	0.134
6	1.88040	5452	21837	0.075

Coaxial Resonator Results



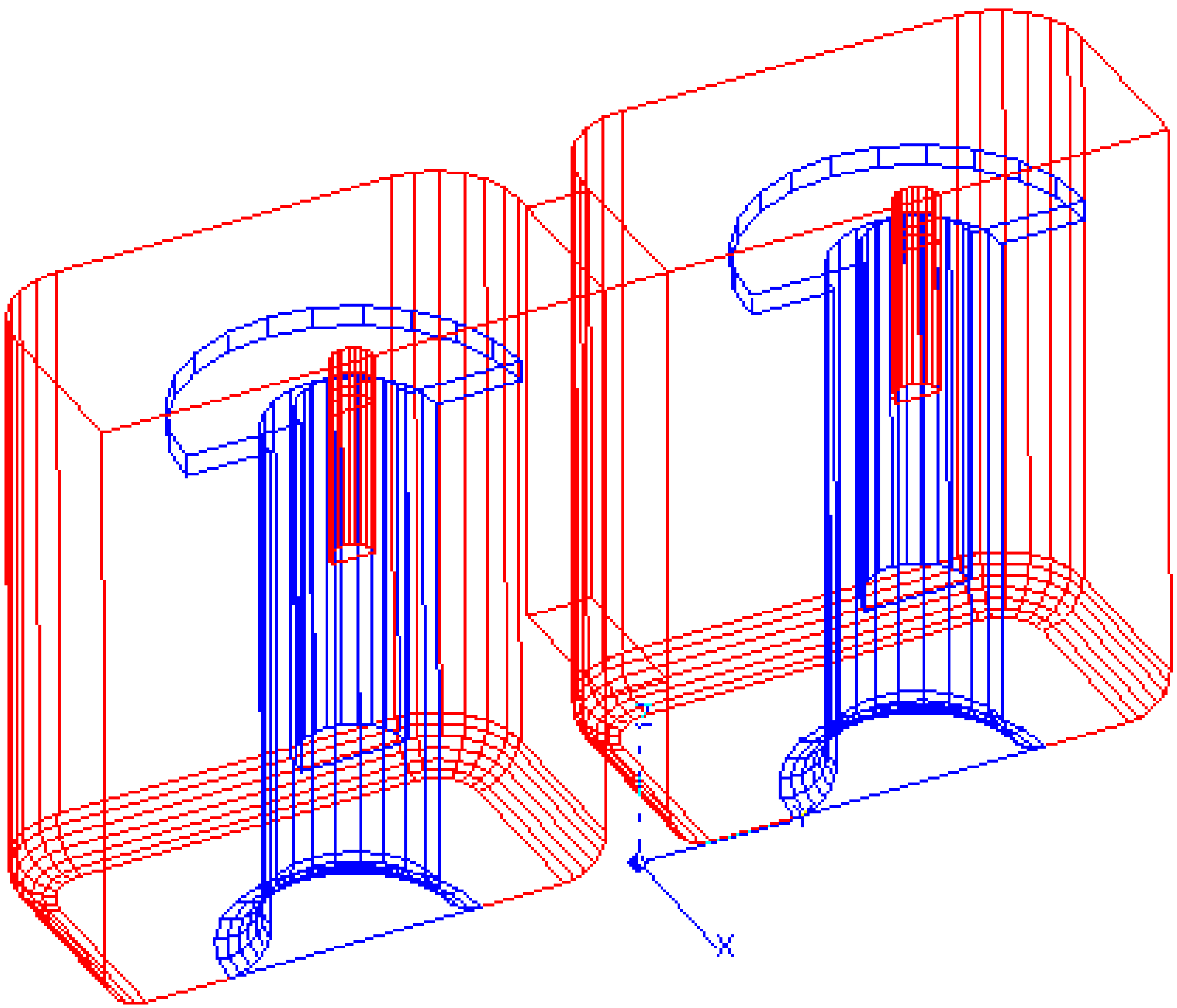
Coaxial Resonator Results



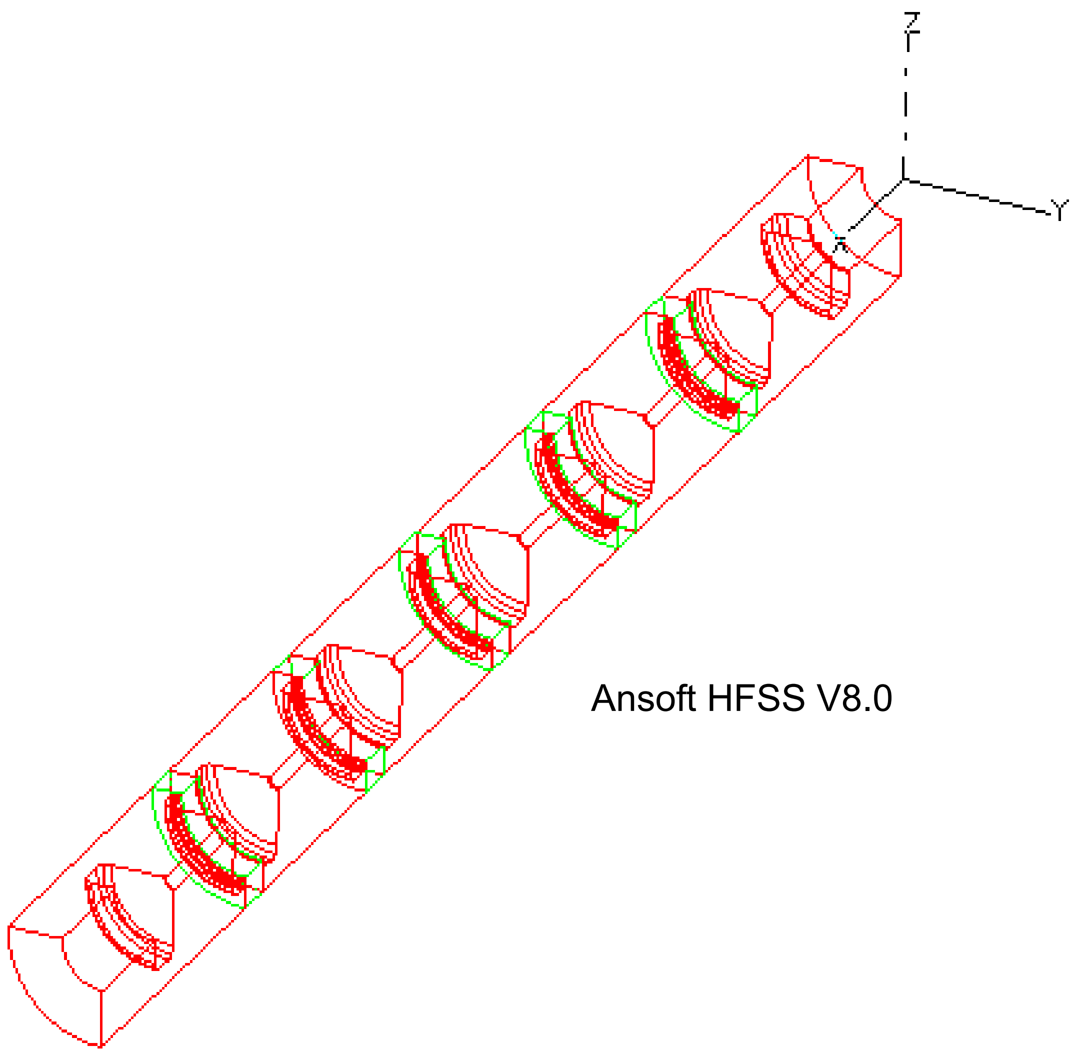
Summary for Coaxial Resonator

- Used default Lambda Refine ($\lambda/3$)
- Tracked convergence of complex frequency
- Eigen-solver may not estimate the starting point correctly
- User must use his or her knowledge of the problem
- Dummy objects and seeding force mesh in critical areas
    - Minimum of 10 cells along resonator
    - Seed high E-field regions in more complicated geometries
- Multiple dummies and seedings are certainly allowed
- Measured data or another trusted solution very valuable

More Typical Coaxial Resonator Problem

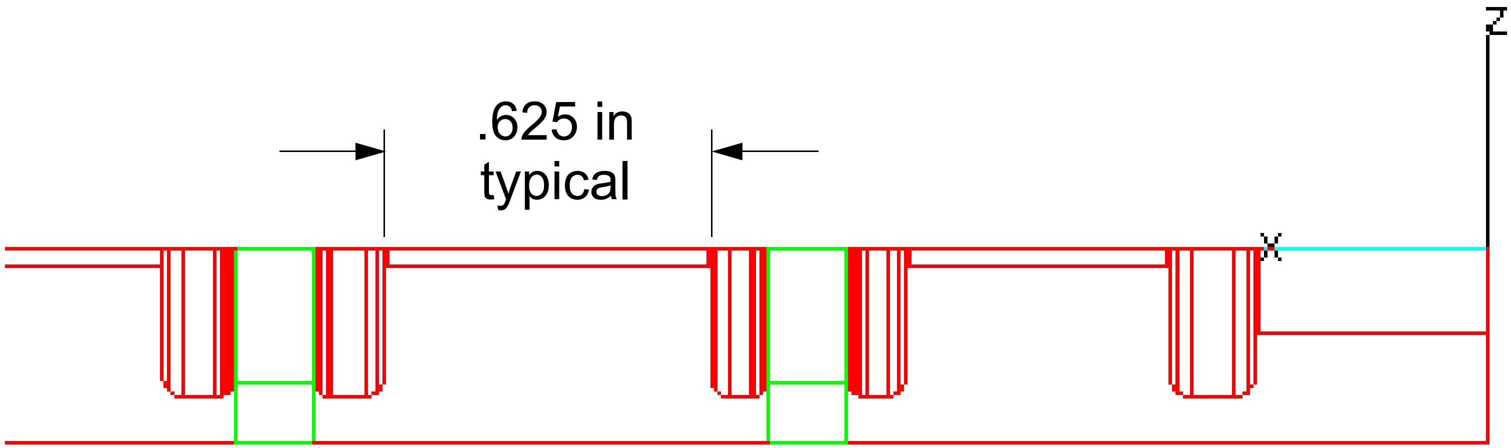


Coaxial Lowpass Filters

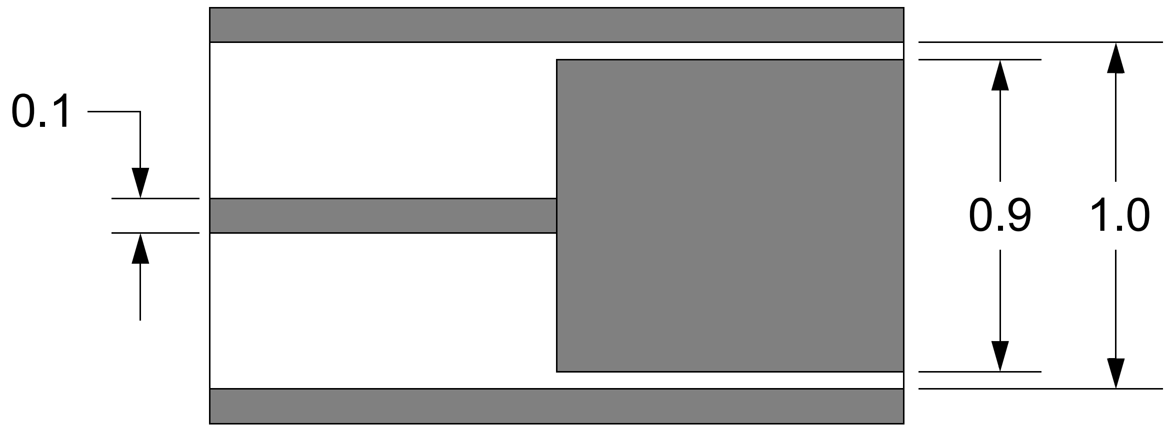


Ansoft HFSS V8.0

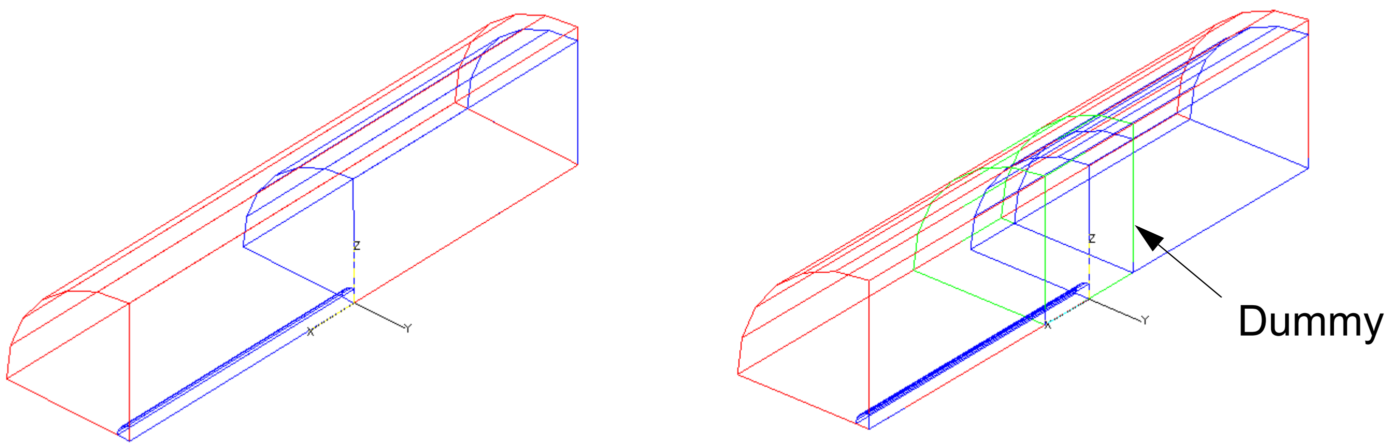
Coaxial Lowpass Filters



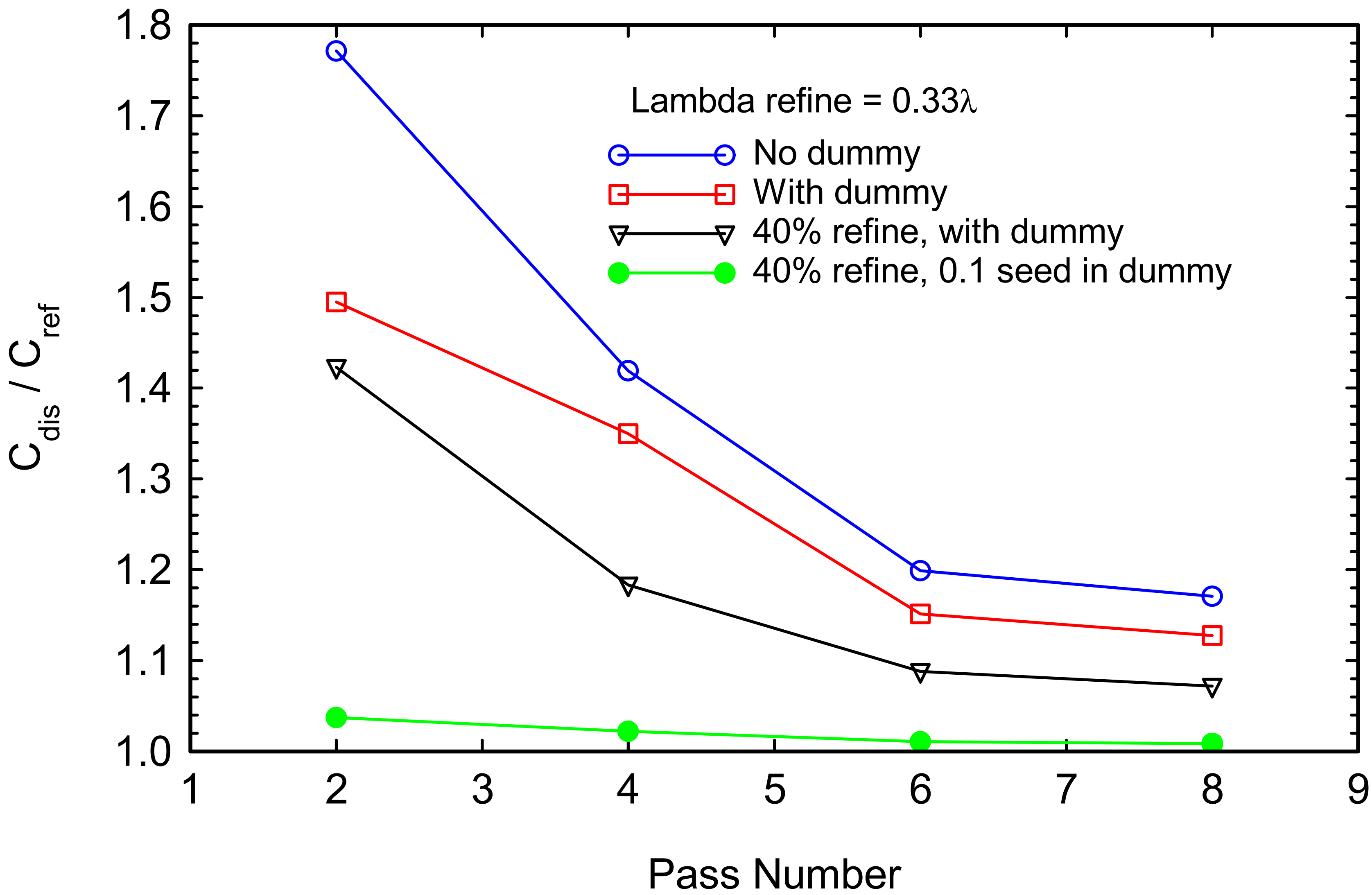
Coaxial Step Convergence Study



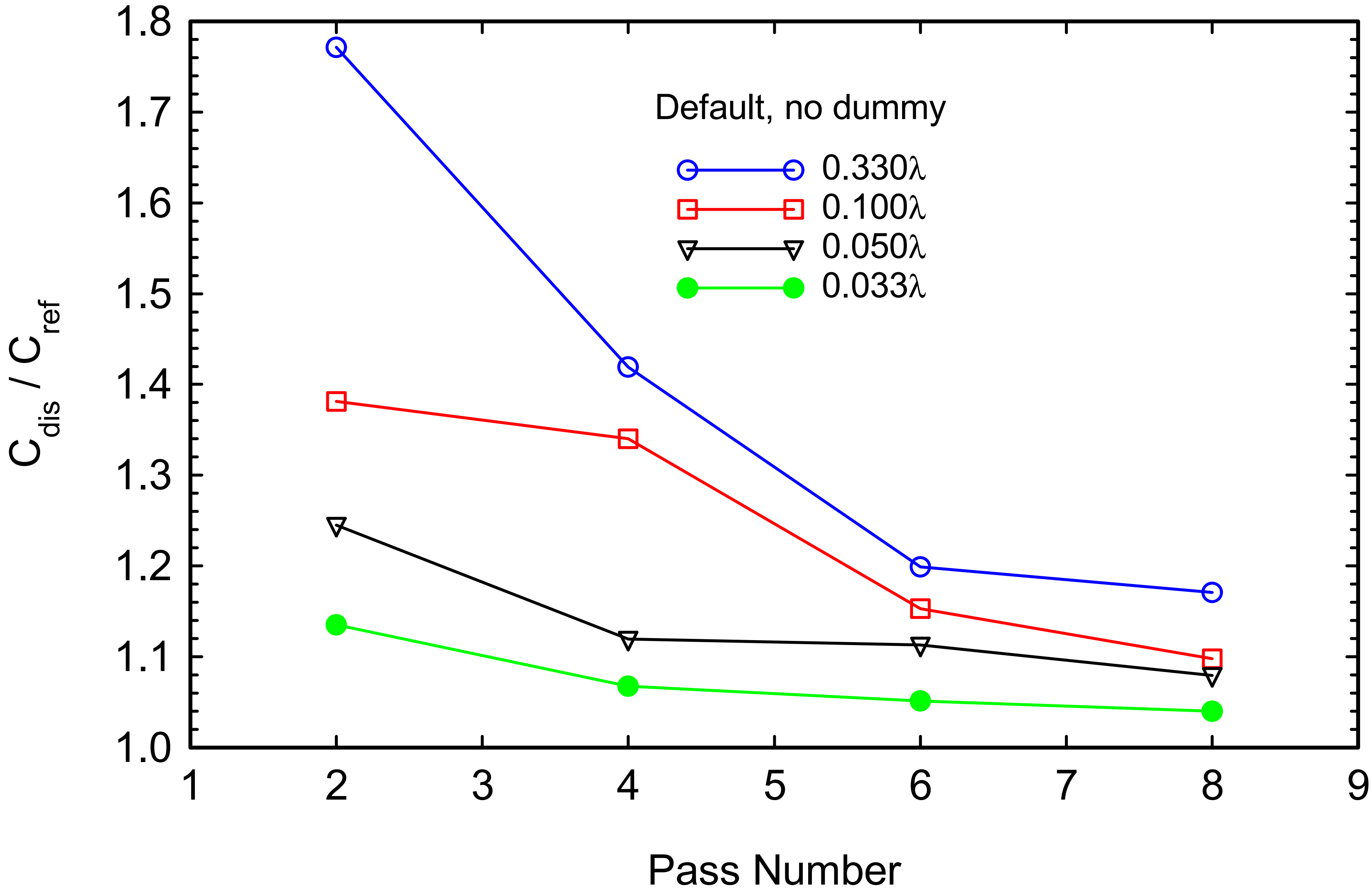
Dimensions are inches



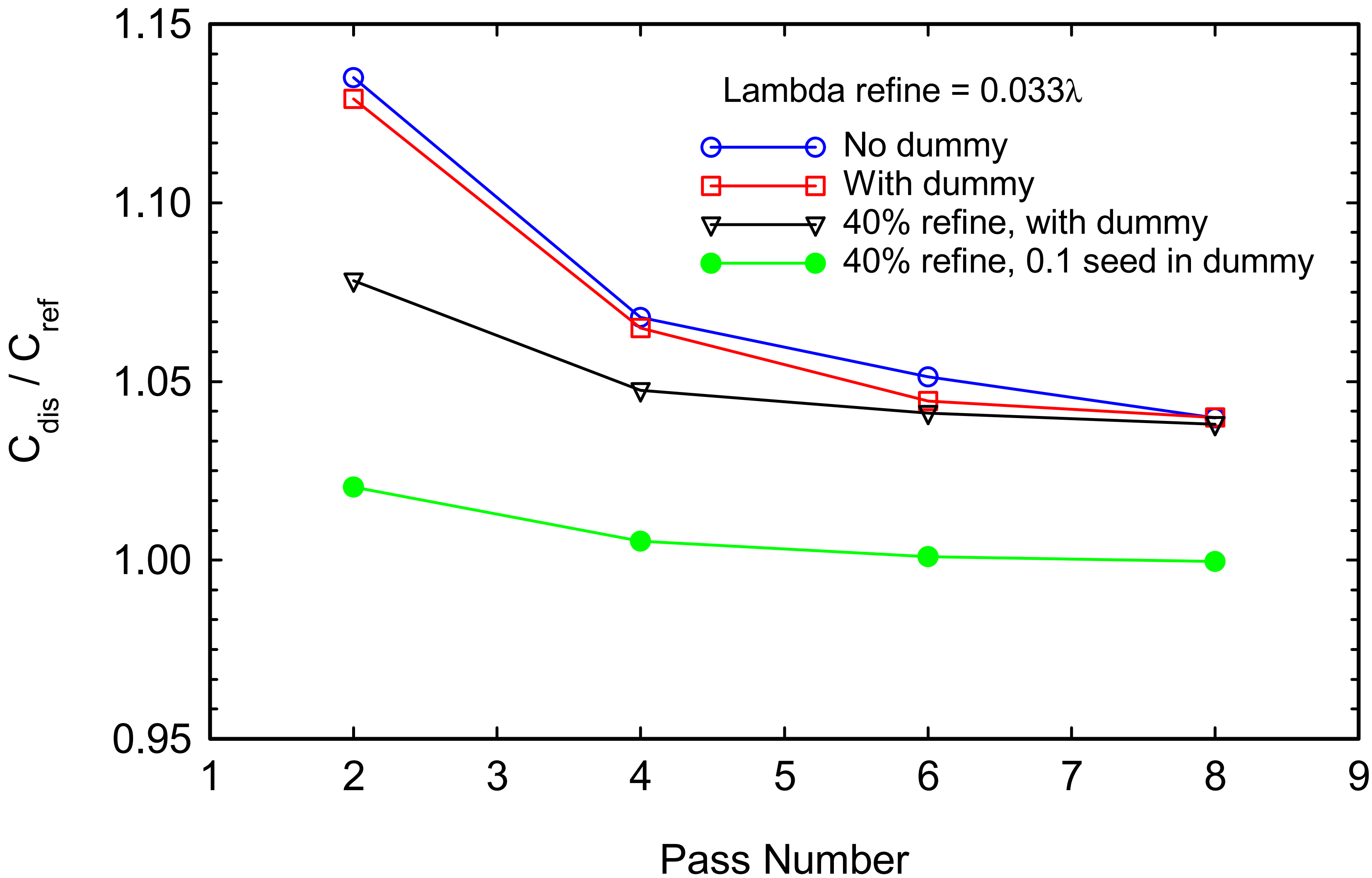
Coarse Lambda Refine - Add Dummy and Seeding



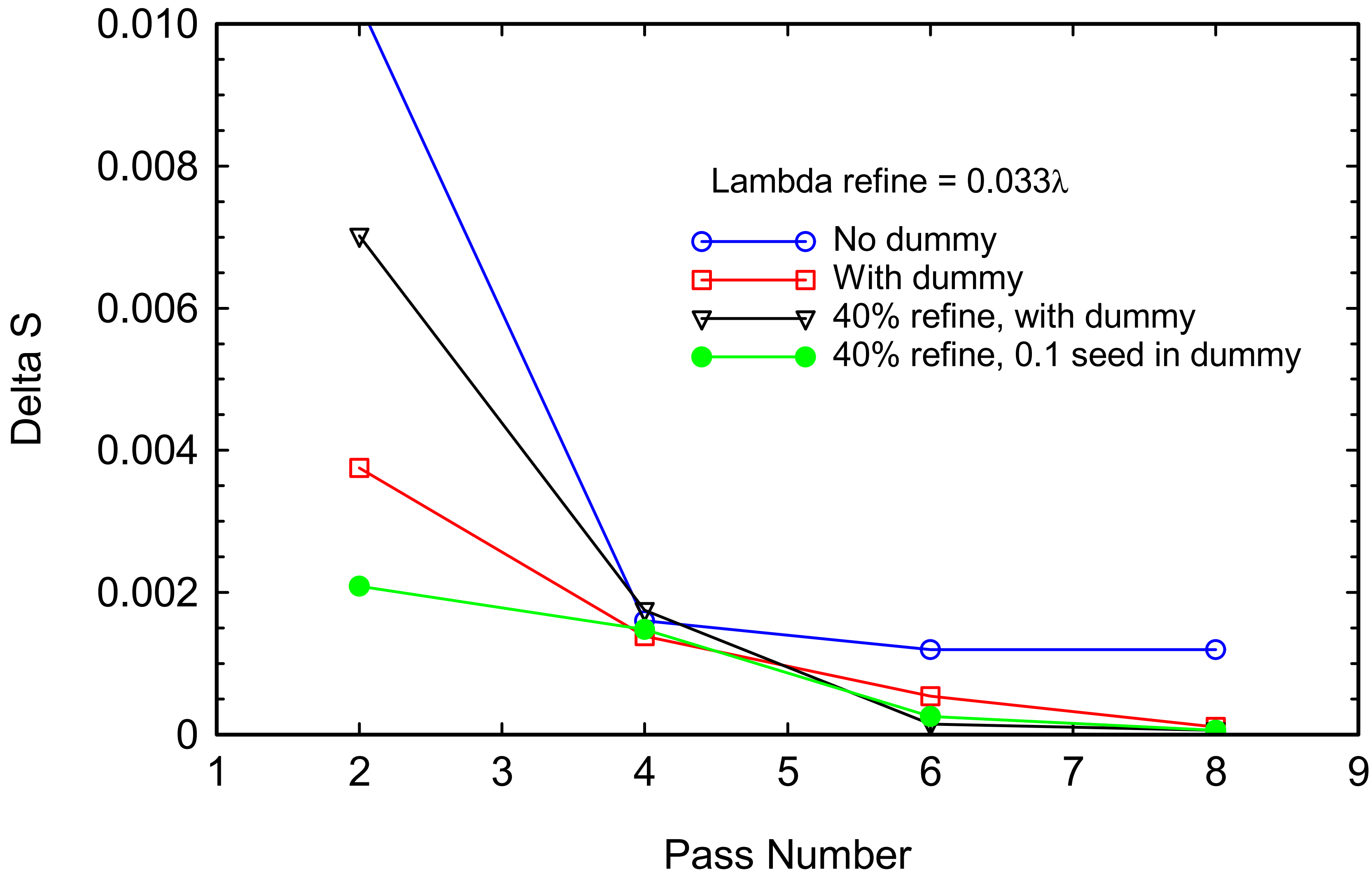
Vary Lambda Refine Only



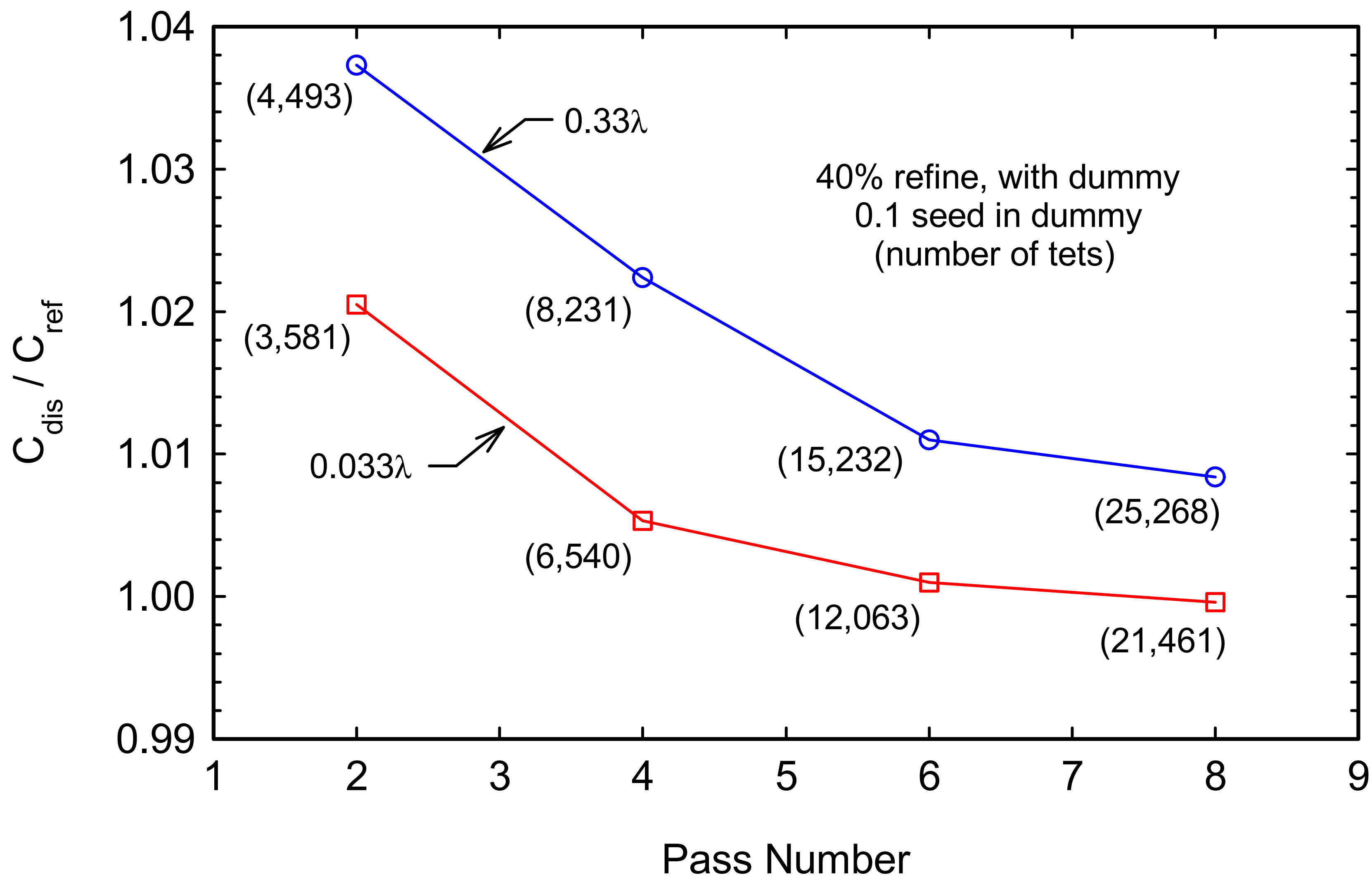
Finer Lambda Refine - Add Dummy and Seeding



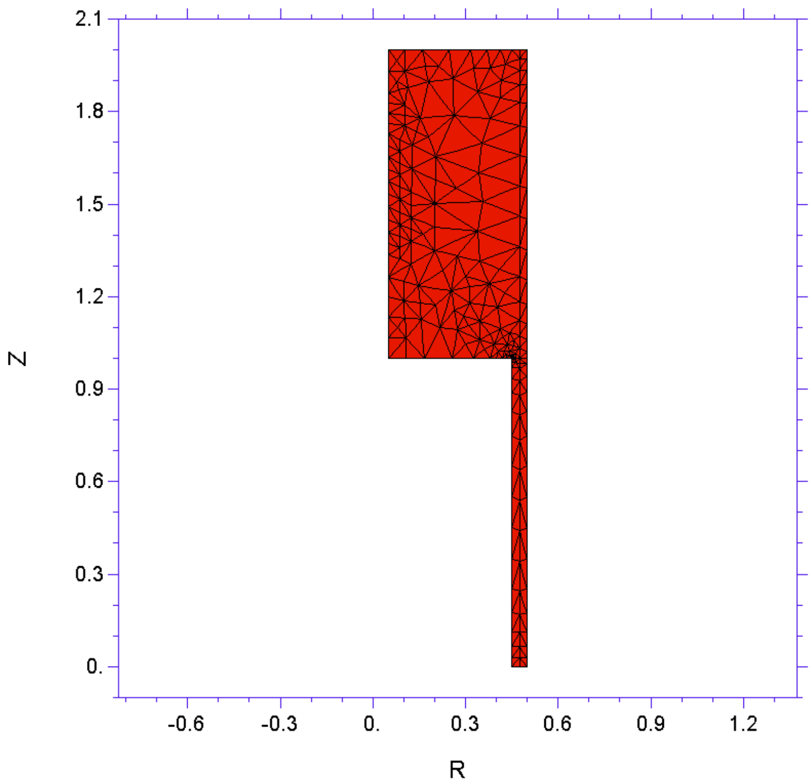
Delta S Behavior

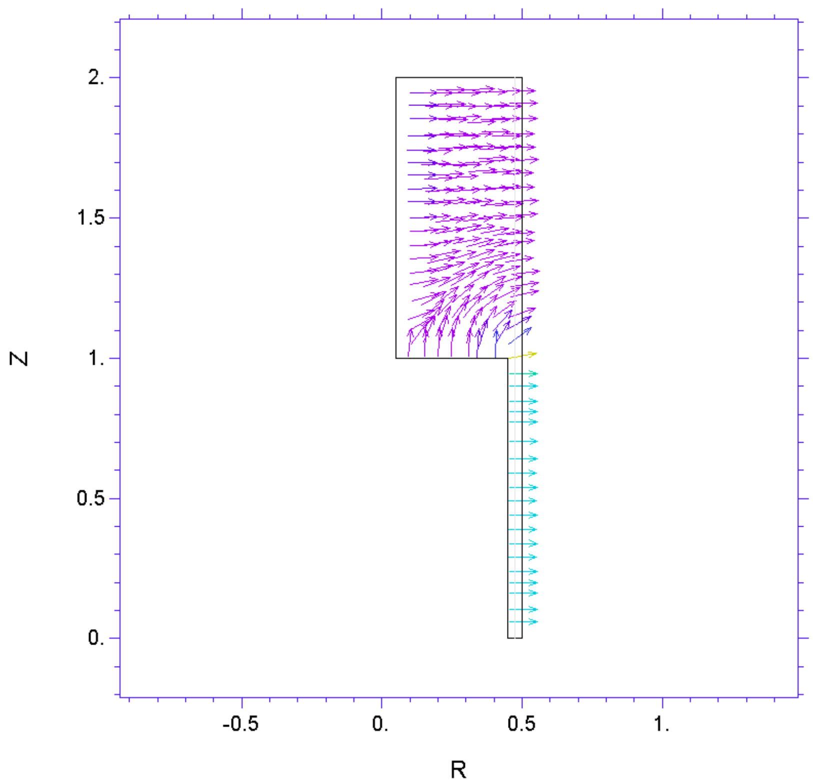


All The Tricks - Change Only Lambda Refine



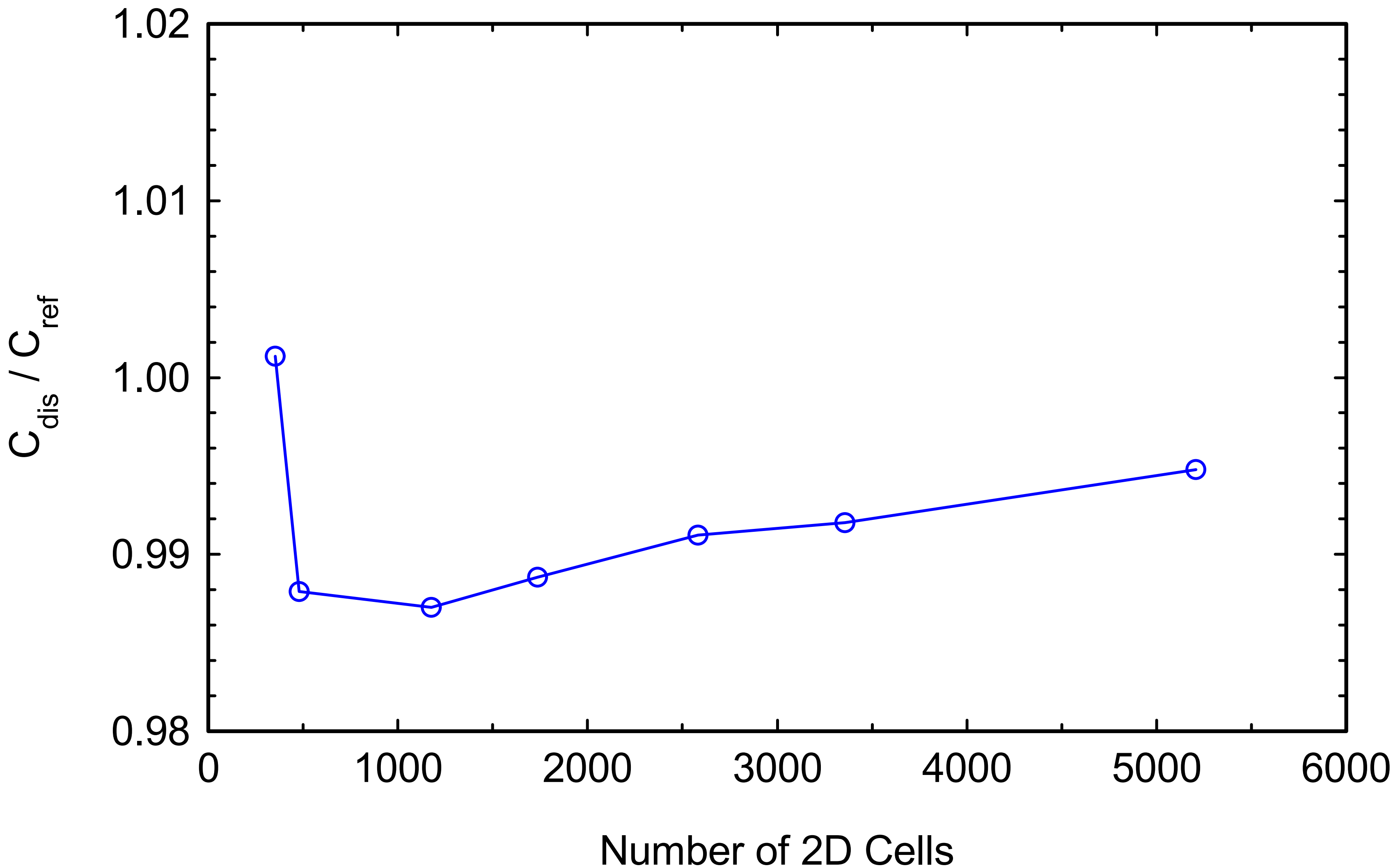
FlexPDE Solution





2D Rotationally Symmetric

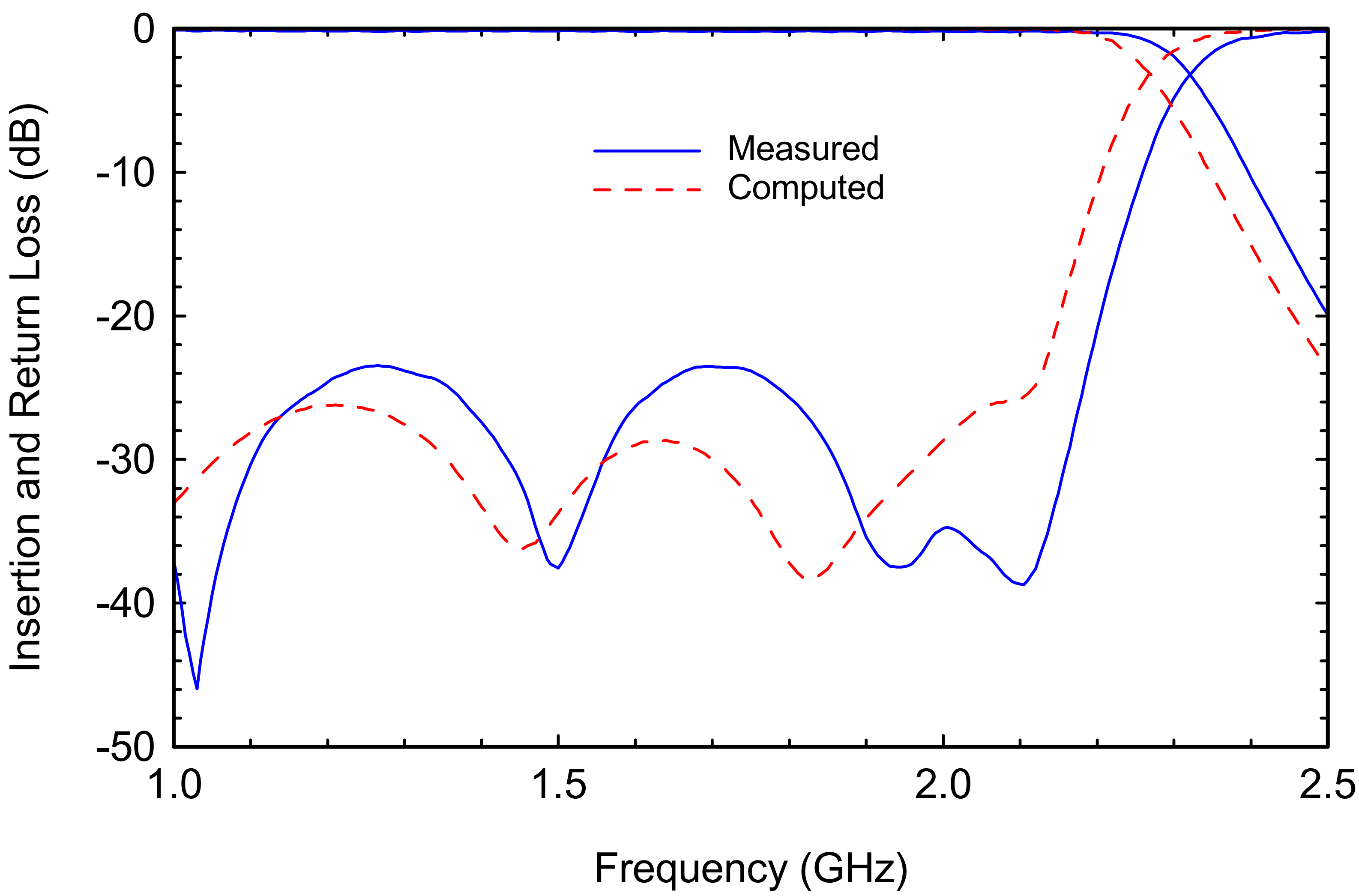
FlexPDE Solution



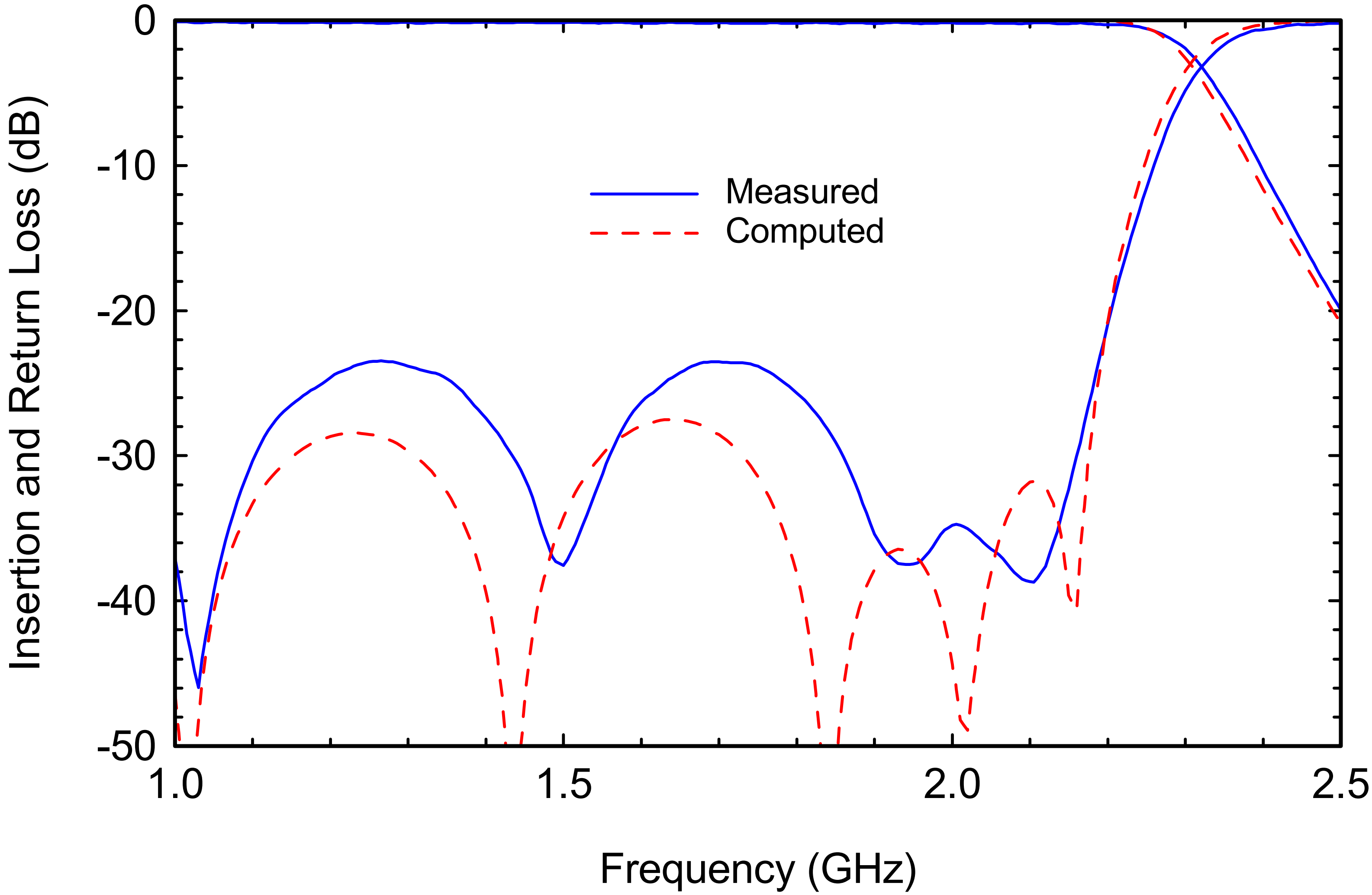
Summary for Coaxial Step Convergence Study

- Simple structure for convergence study
- Data available in the literature, 3D validation structure?
- Spatial wavelength important near the step
- More efficient strategy:
  - Set Lambda Refine to $\lambda/30$
  - Seed dummy near step - 10 samples across diameter
  - Only 4 to 8 adaptive passes
- Delta S-parameters may not track absolute convergence

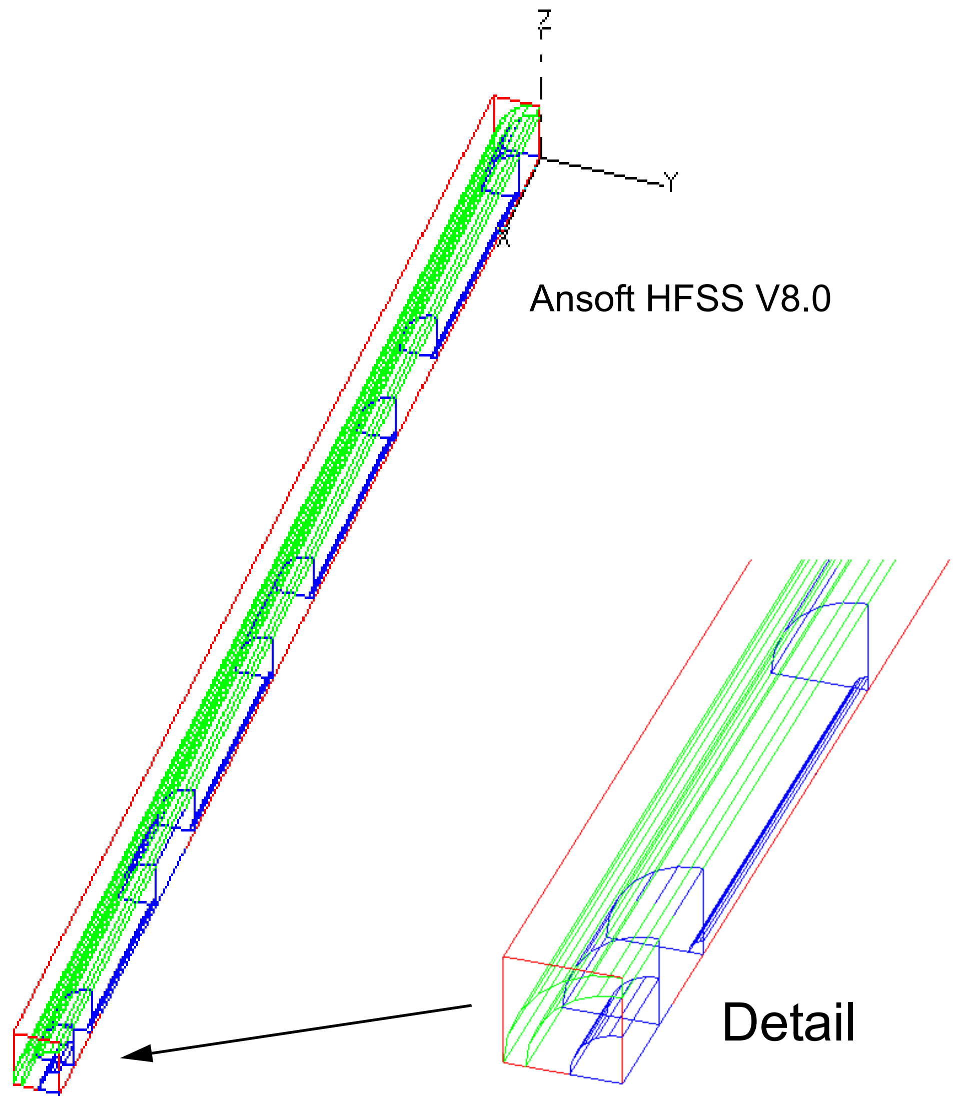
Results Using Default Meshing Strategy



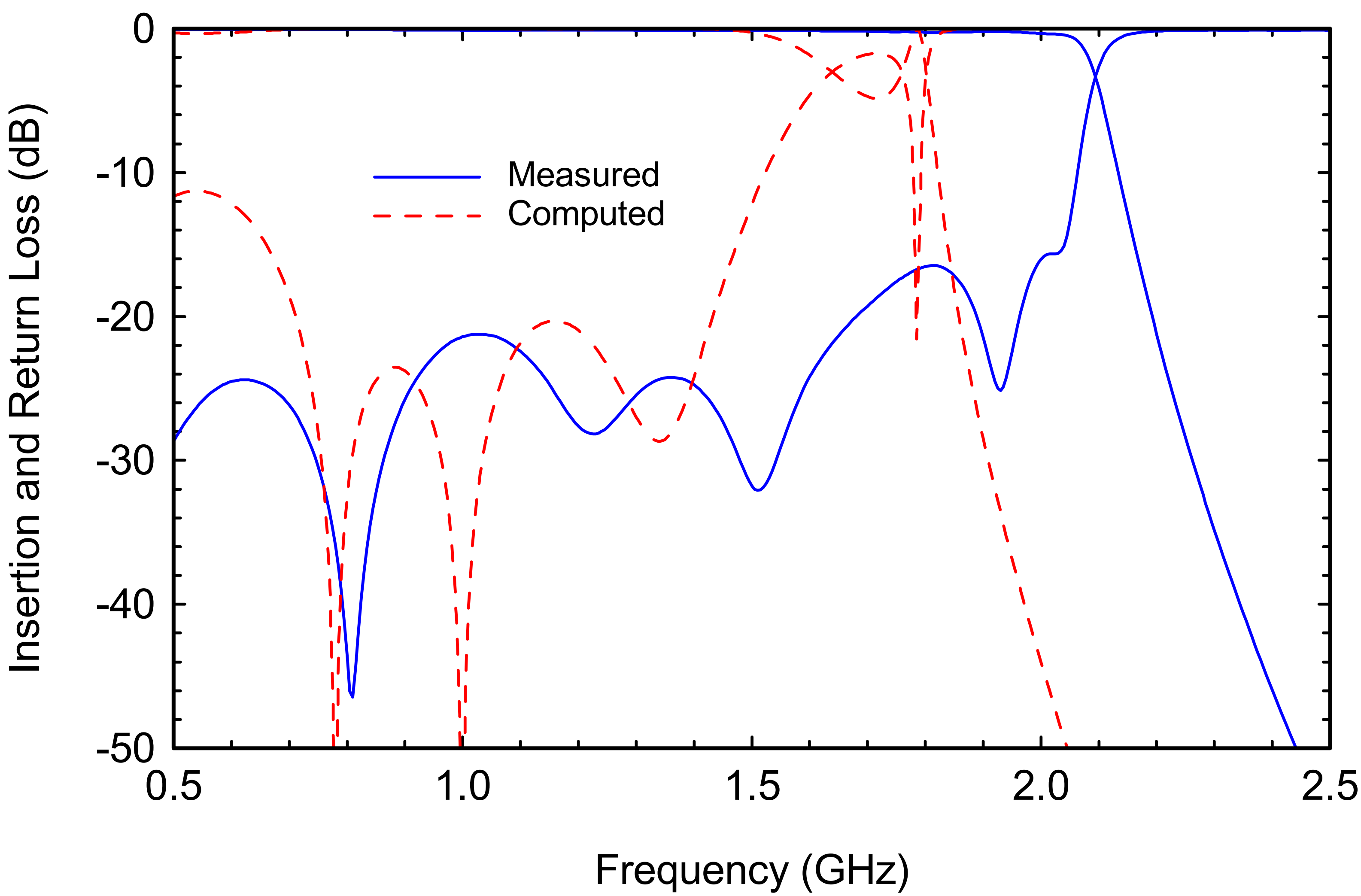
Results Using Dummy and Seeding



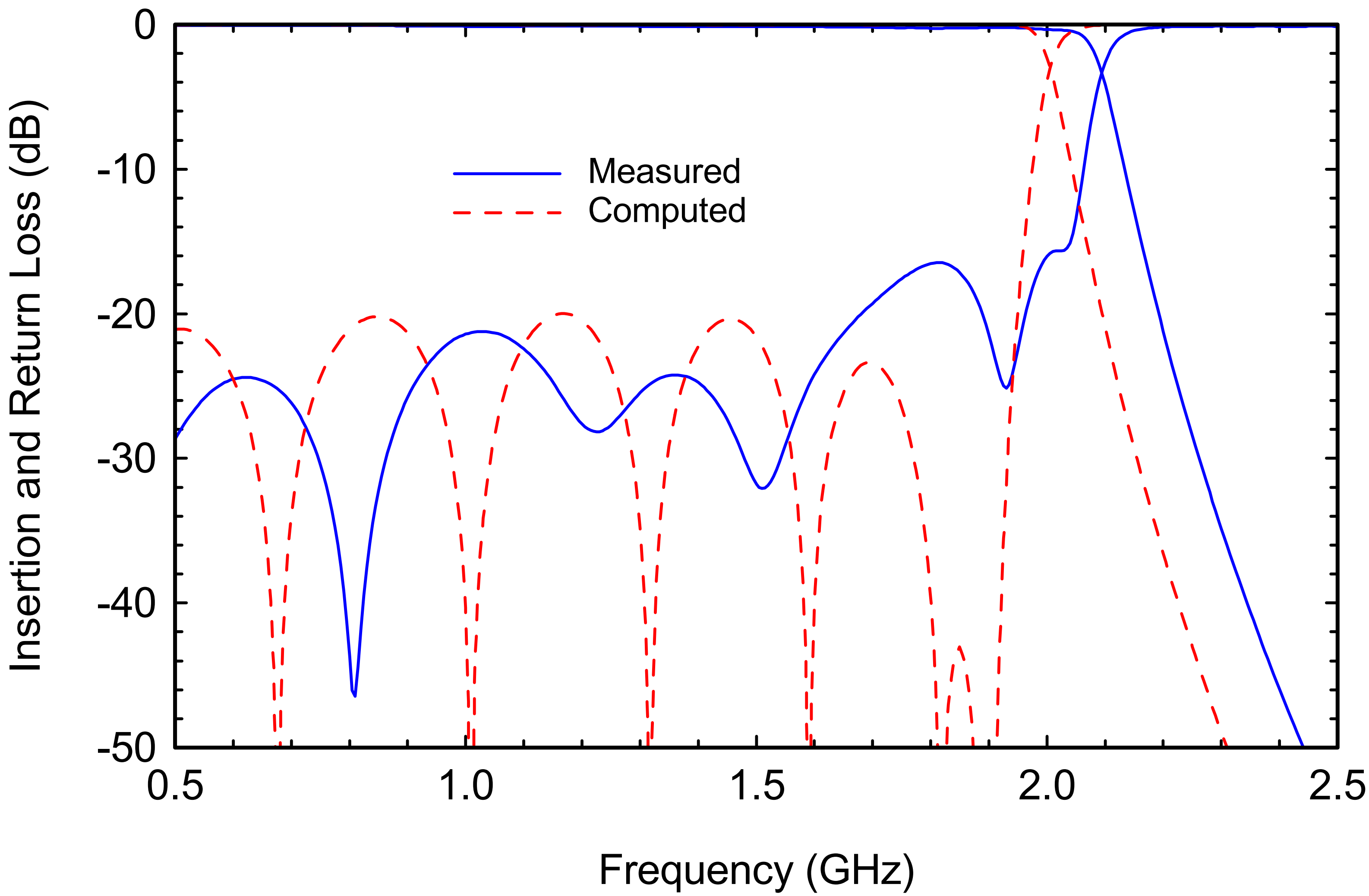
Coaxial Lowpass Filters - Example II



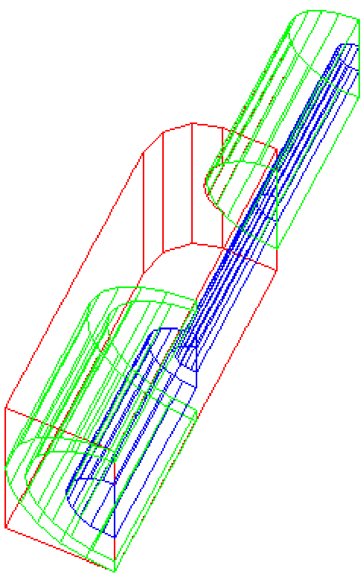
Results Using Default Strategy

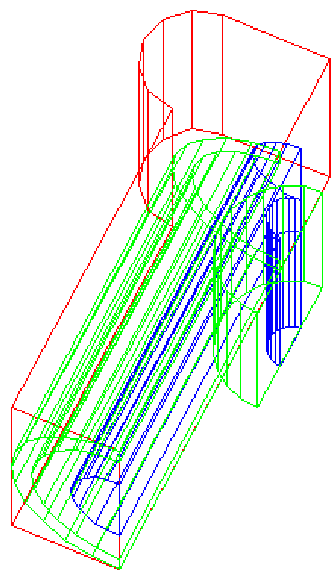


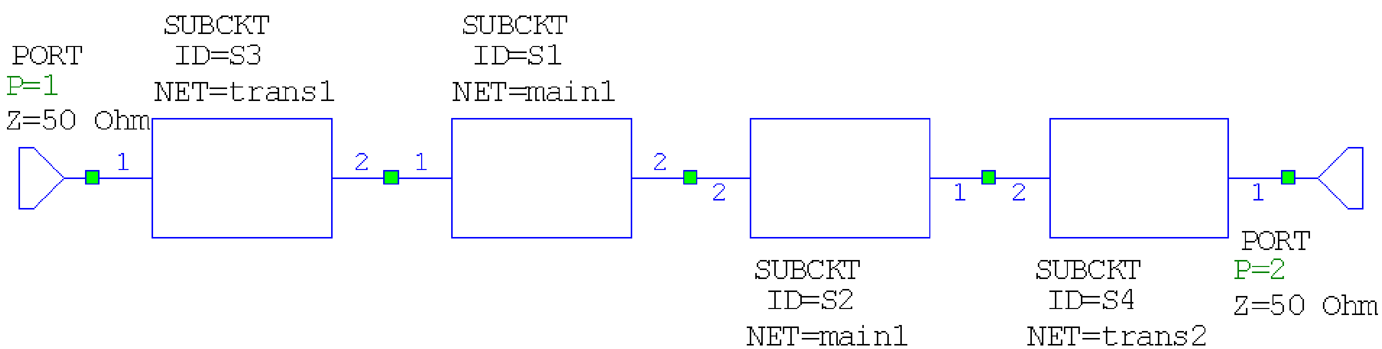
Dummy and Seeding - Missing Detail at Ends



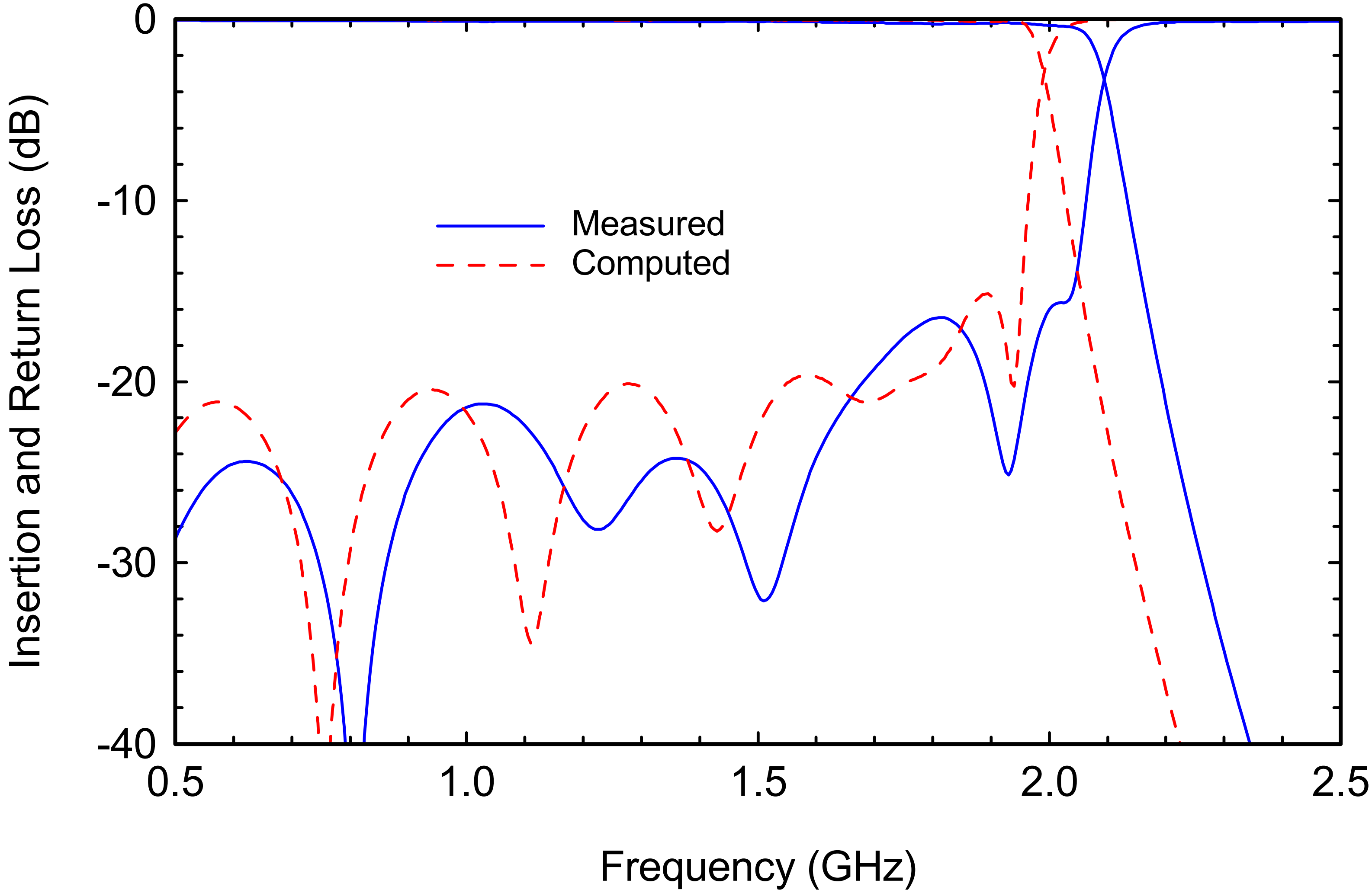
End Termination Details



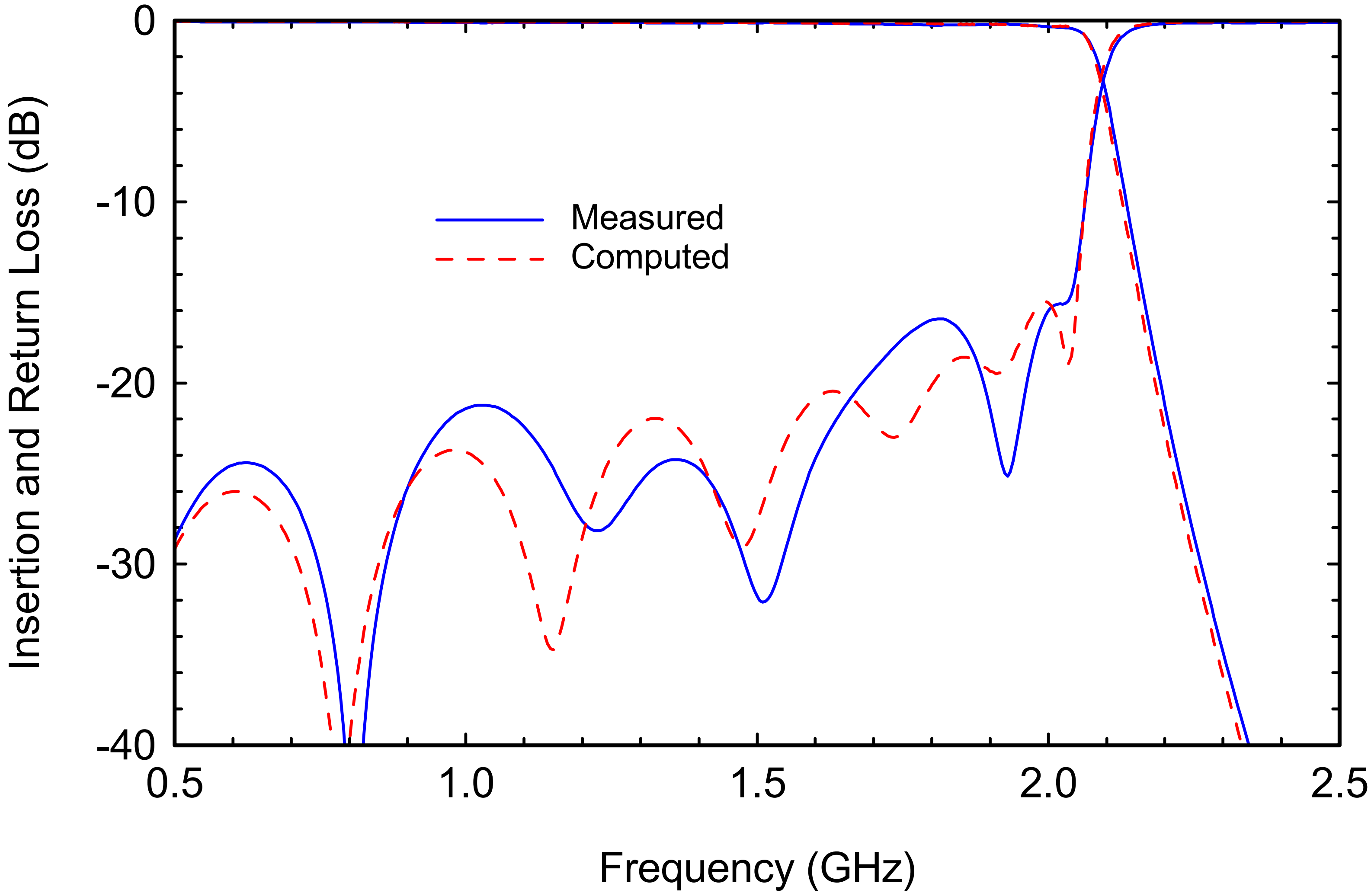




Dummy and Seeding - With Termination Detail



Tolerance Analysis - Add Air Gaps



Summary for Coaxial Lowpass Filters

- Study the key discontinuity first, then the complete filter
- Filters make auto mesh refinement more difficult
  - High reflection at ports in stopband
  - May not get good “connection” between input and output
  - Mesher tends to concentrate on ports, ignores interior
- Seed and mesh near passband
- Refine mesh at low frequency with lambda based starting mesh
- Tolerance analysis required on second example