Waveguide Tolerances

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Berlin, June 3, 2015

METAS, Bern

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- **Comparison of different numerical solvers (TD, FD) and different discretization schemes (Accuracy comparison)**
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  - Rotation
- **Conclusion**

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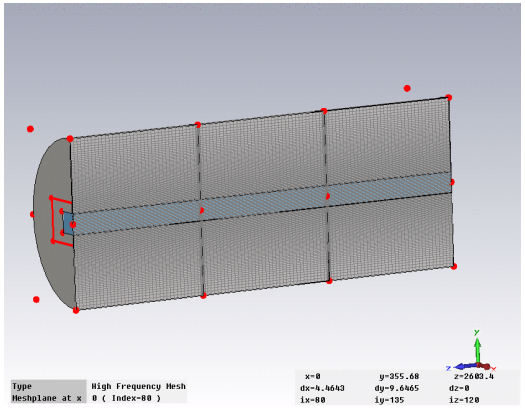
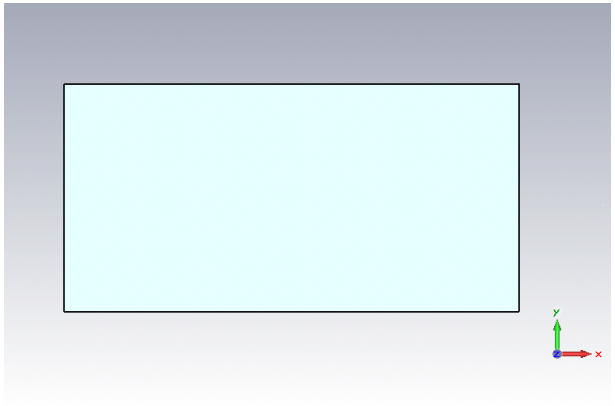
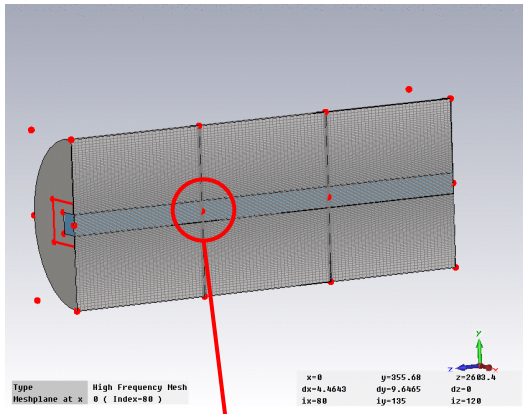
Application in measurement equipments

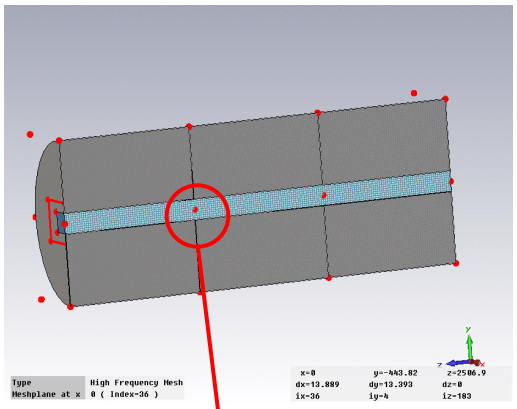
- **Influence in measurement equipments**
  - Measurement equipments using hollow waveguide sections
  - Limitating deteriorations by misalignment or rotation

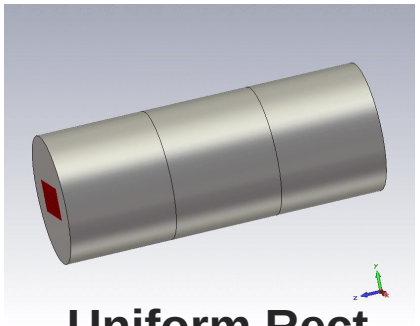




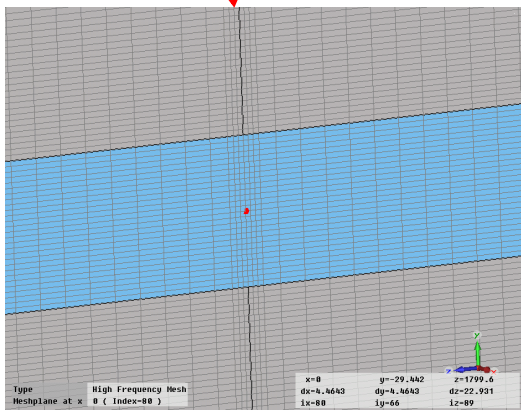
Accuracy Comparison between 3 Cases

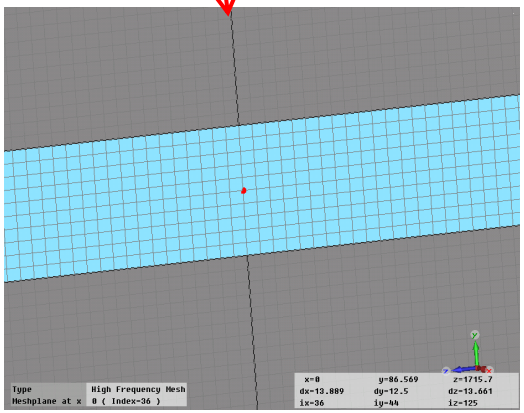


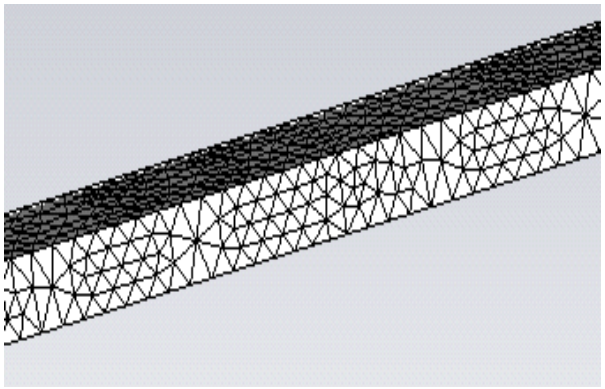




Uniform Rect Waveguide

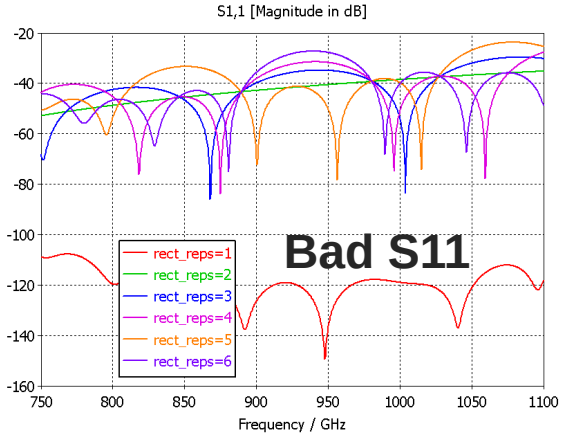


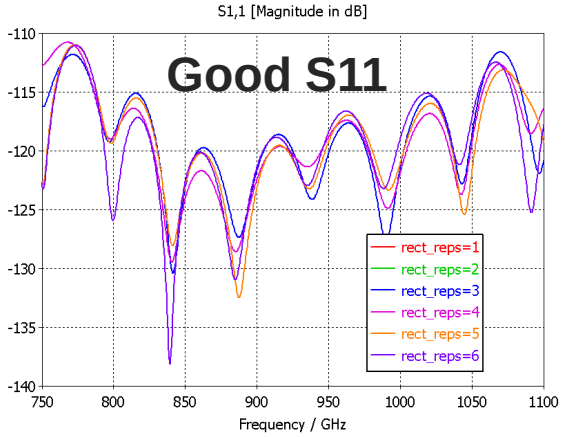


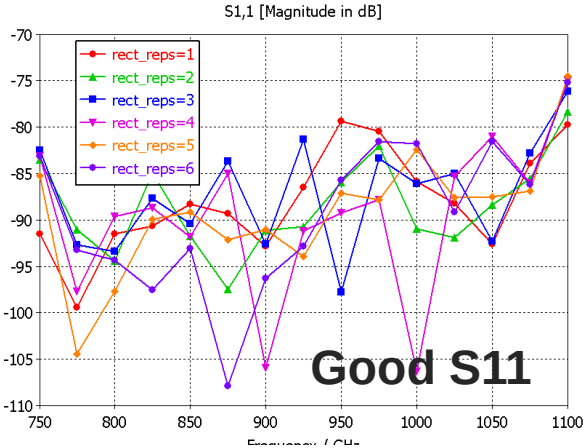


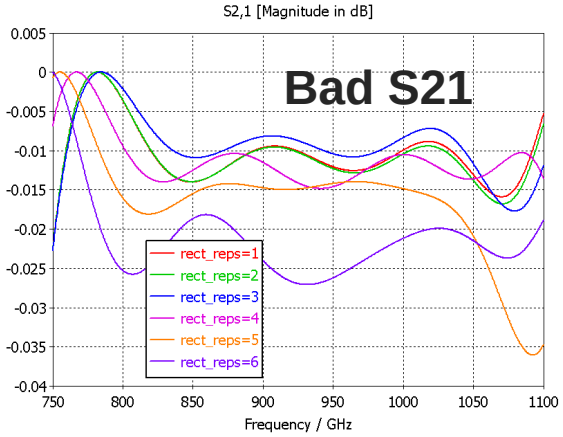
TD, Variable Hex Mesh **TD, Uniform Hex Mesh** **FD, Tet Mesh**

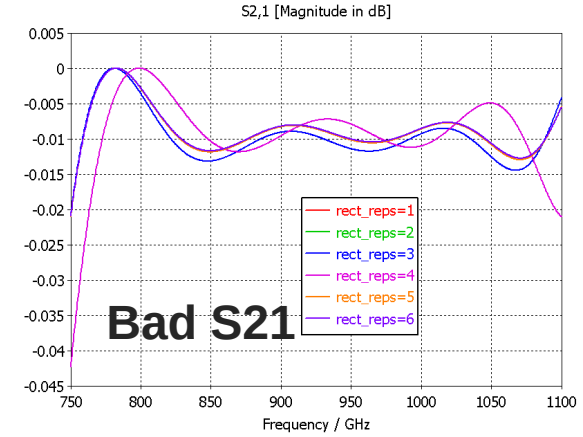
Accuracy Comparison between 3 Cases – WM250

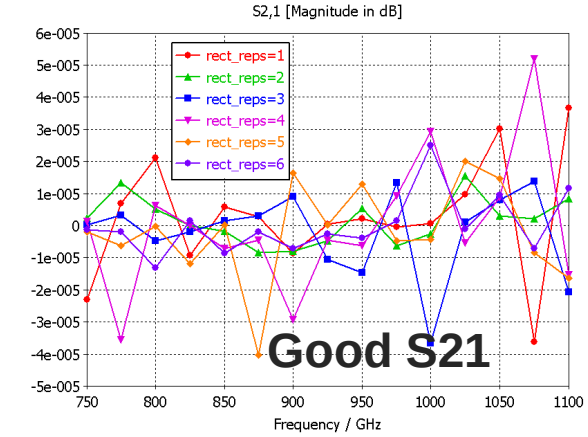




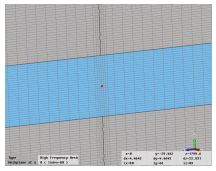




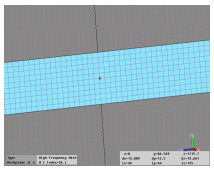




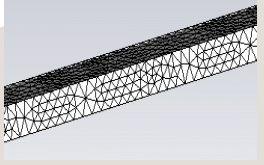
TD, Variable Hex Mesh



TD, Uniform Hex Mesh



FD, Tet Mesh



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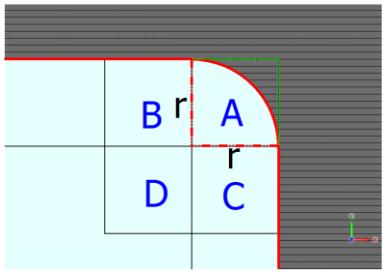
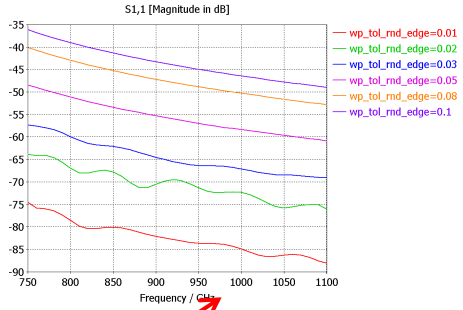
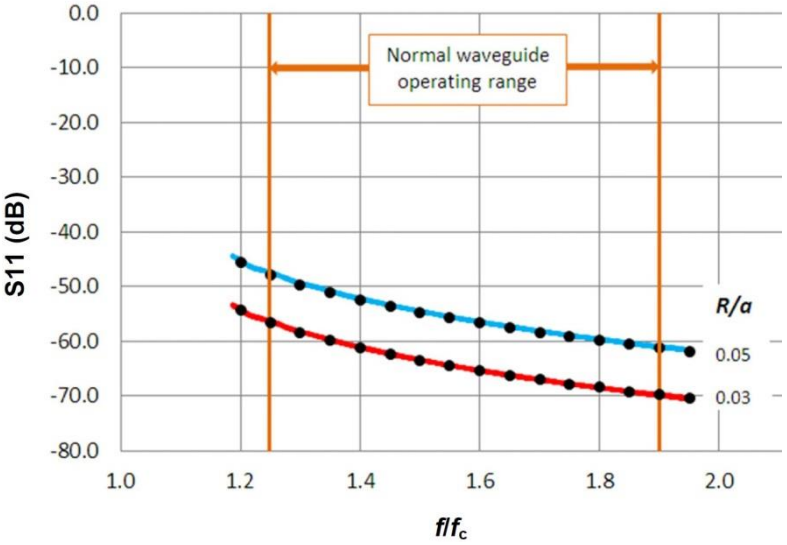
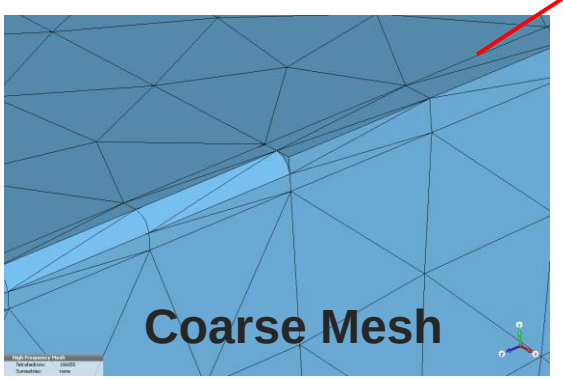
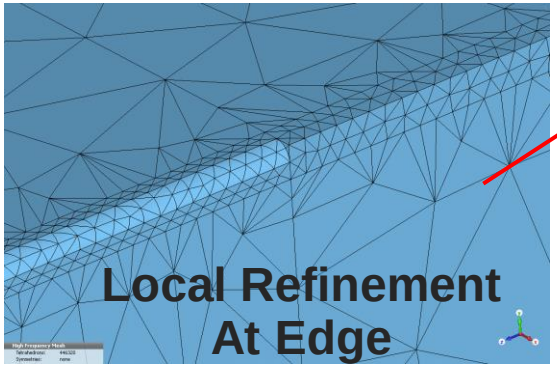
Rounded to Straight Edge – WM250

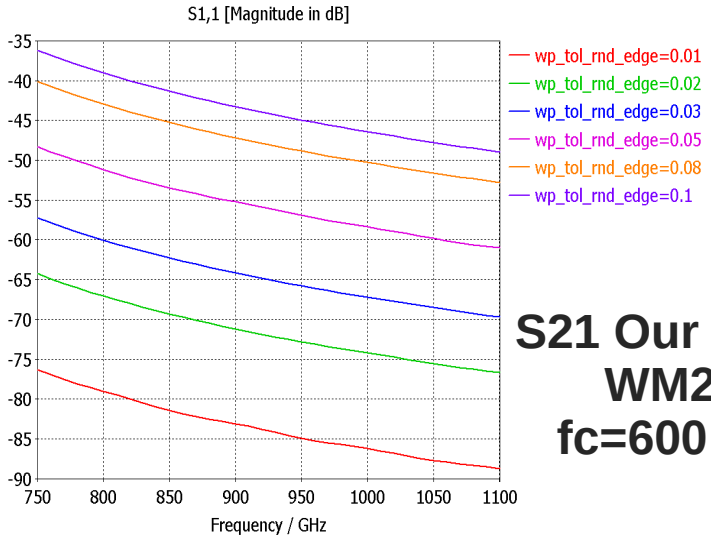








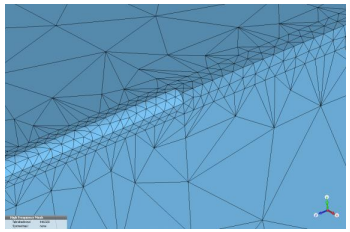


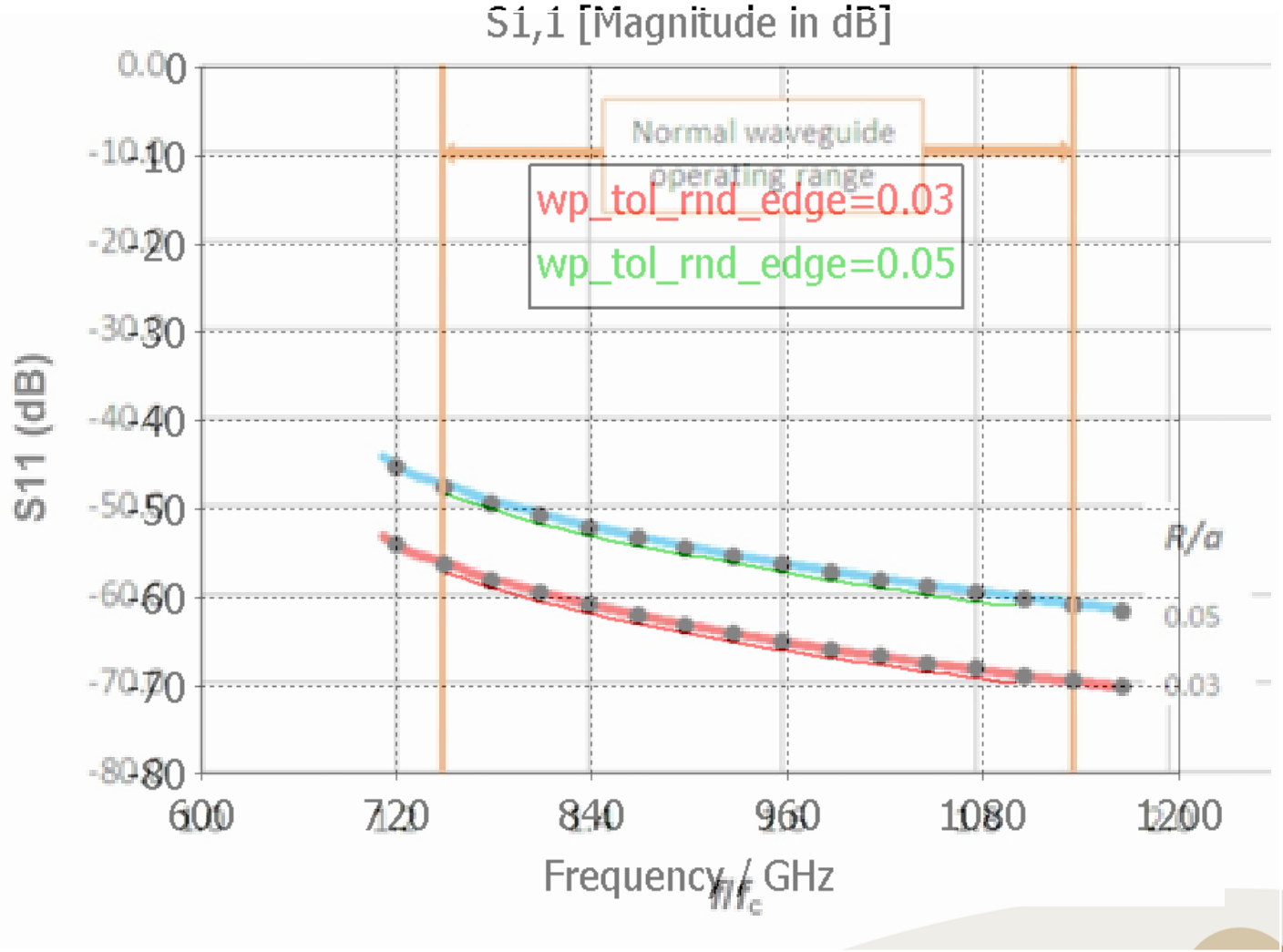


S21 IEEE Result

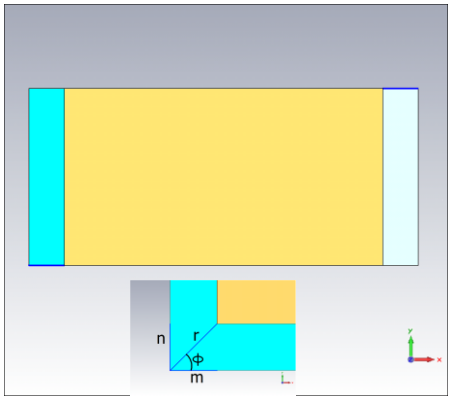
S21 Our Result WM250 fc=600 GHz

Rounded to Straight Edge – WM250





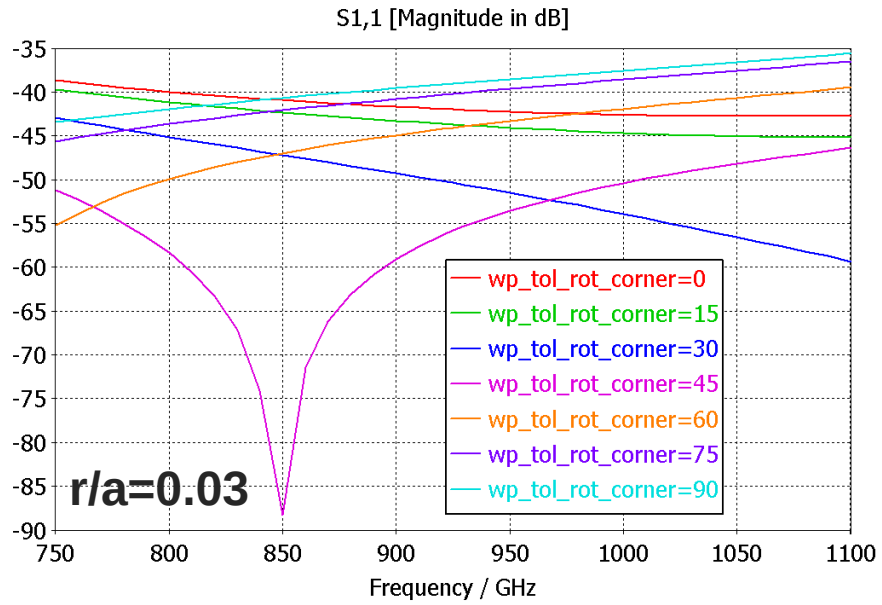
Shift – WM250

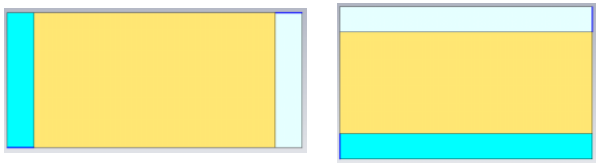


2 Parameters

- **Shift radius**
- **Shift angle**

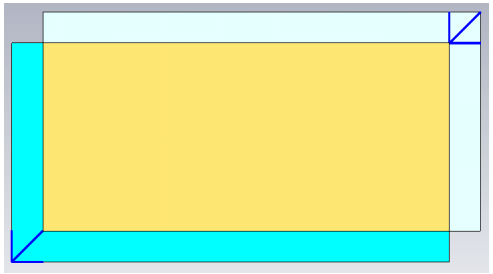
Overlap=Yellow





Low overlap happens with

$\phi \approx 0°, 90°$



High overlap happens with

$\phi \approx 45°$

Shift (r/a)	Max. Reflection (dB)
0.01	-50
0.02	-40
0.03	-35
0.05	-25
0.1	-15

Result:

S11 only depends on the overlap area

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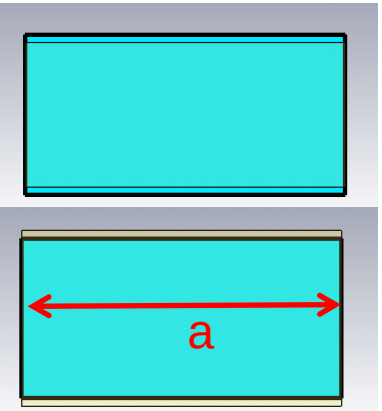
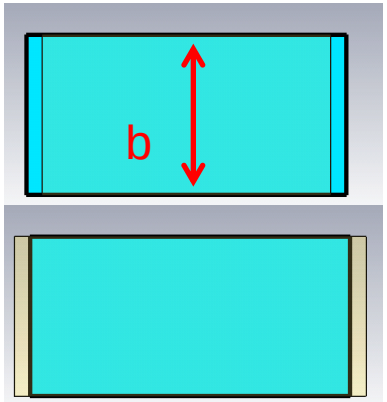
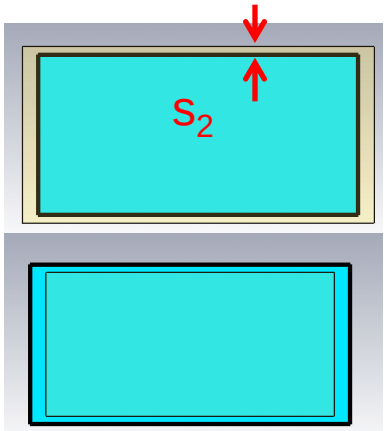
Size Variation – WM250



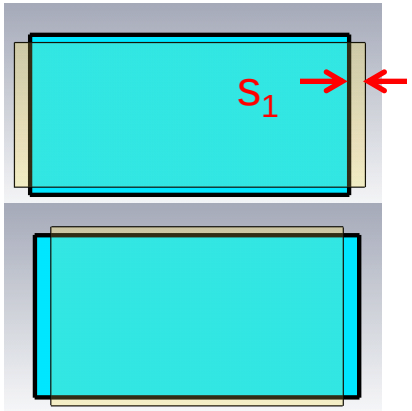
Group G1
a=unchanged
b=varies



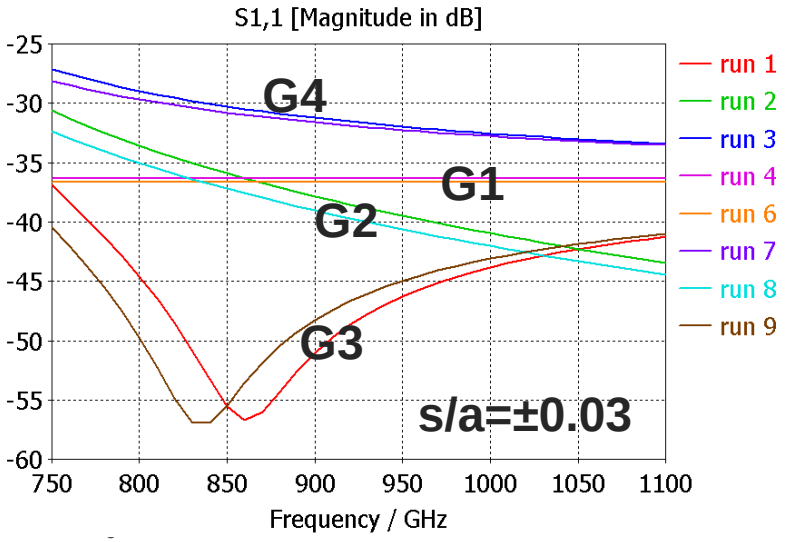
Group G2
a=varies
b=unchanged



Group G3
Both a and b either increases or decreases



Group G4
(a= increases, b= decreases) and viceversa



Size Change (s_1/a) or (s_2/a)	Max. Reflection (dB)
±0.01	-35
±0.02	-30
±0.03	-25
±0.05	-20
±0.1	-15

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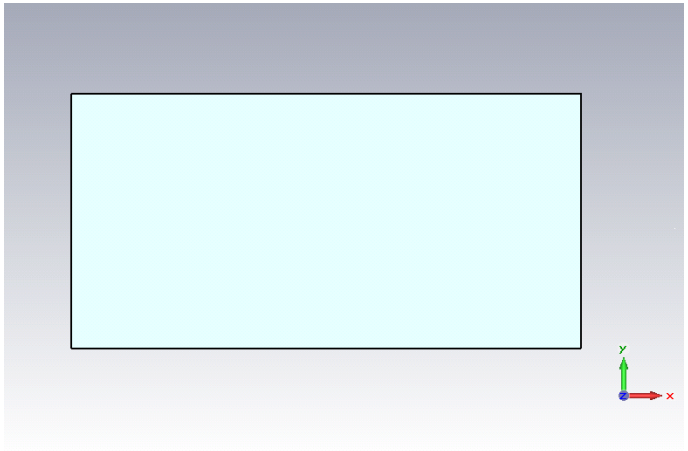
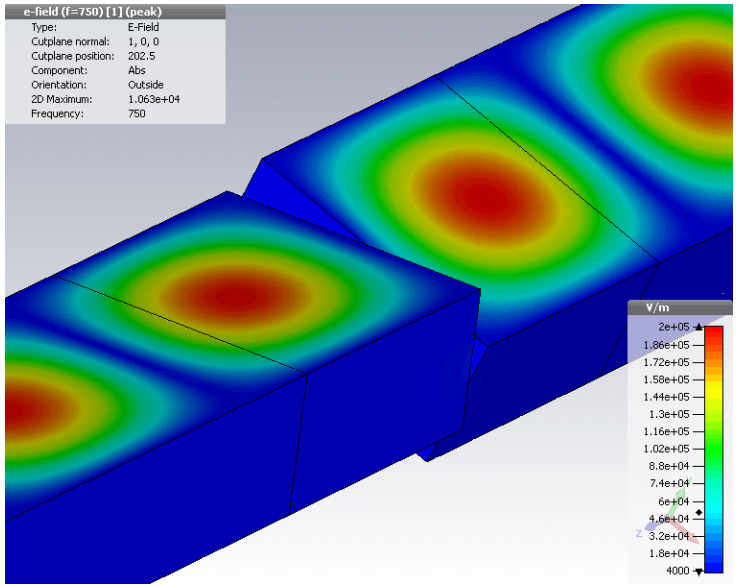
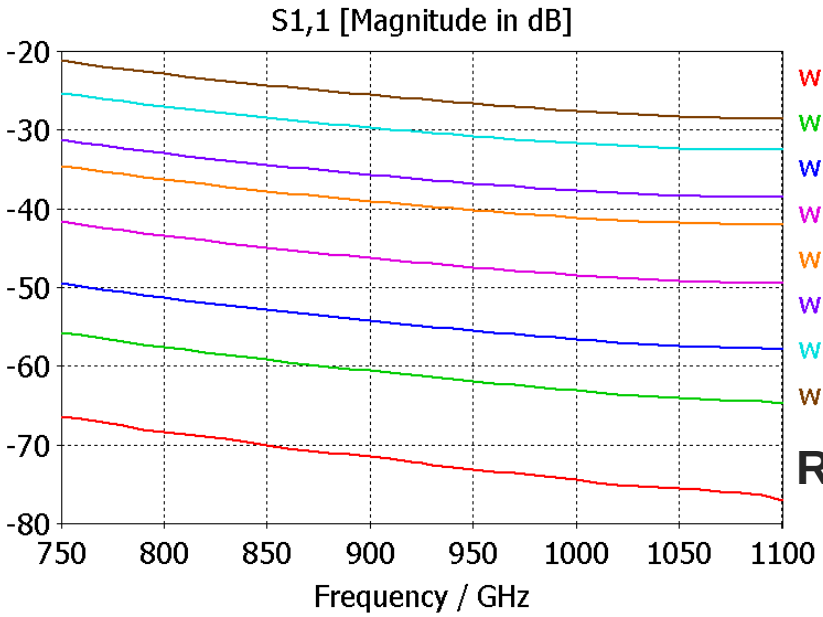
Rotation– WM250







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wp_tol_rot_center=20

Rotation angle In degrees

20^0 degree rotation
Field inside waveguide

Conclusion

- **Simulation difficulties**
  - In both cases, surface roughness and waveguide misalignment TD and FD solvers provide different accuracies in the result.
  - High accuracy necessary, but only achievable with FD.
  - Proper tuning of the mesh is highly recommended – high mesh density necessary.
  - Still very small details cannot be included.
- **Waveguide Tolerances**
  - Eg.: waveguide WR-250 with a bandwidth from 750...1100 GHz (cutoff 600 GHz).
  - Various configurations simulated.
  - Very good agreement for rounded edge in comparison to IEEE result.
  - Already small misalignments and rotations can result in critical influence.

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