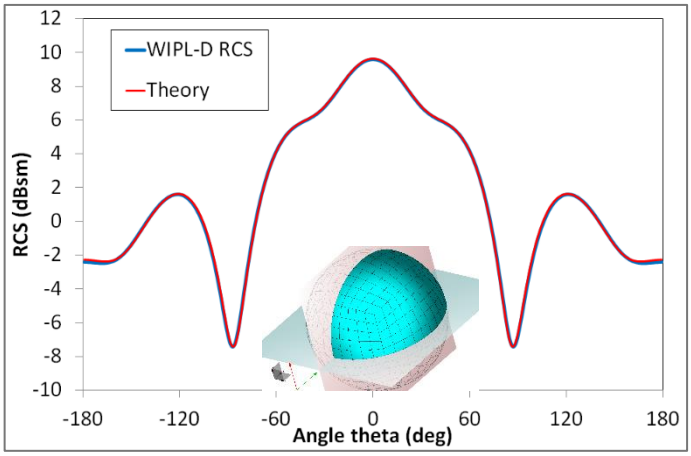
Benchmark Examples (3)

In this paper, we present several benchmarks which were requested by Technical Committee on Electronics Simulation Technology (EST) of the Institute of Electronics, Information and Communication Engineers (IECE) in Japan. WIPL-D simulation results are compared with known solution so that we establish the accuracy of simulation. WIPL-D solution is compared either with analytical results, measured data or results from EM software modules which were also provided by EST tailored especially for the specific problem. Computer used for WIPL-D simulations is Intel® Core™ i7-7700 CPU@3.60 GHz.

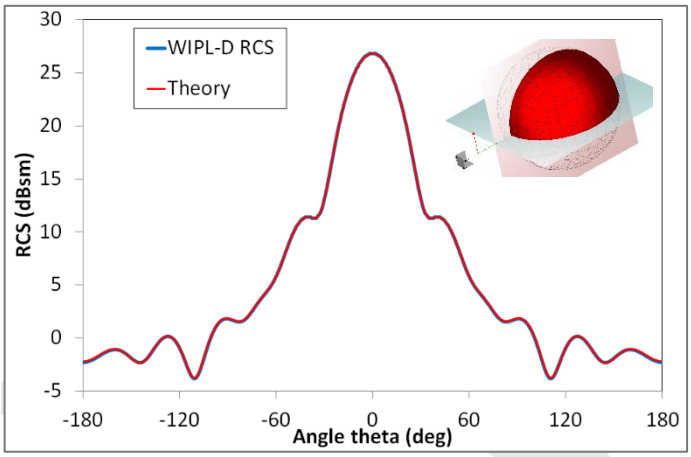
RCS from Metallic/Dielectric Sphere

Bistatic scattering from the metallic sphere was calculated at 721 points. Two symmetry planes were applied. Radius of the sphere is equal to 0.5 wavelengths.

Number of unknowns	Memory	Total simulation time
300	0.7 MB	0.4 sec



Bistatic scattering from the dielectric sphere was calculated at 721 points. Relative dielectric permittivity of modeled dielectric material is 1.777.

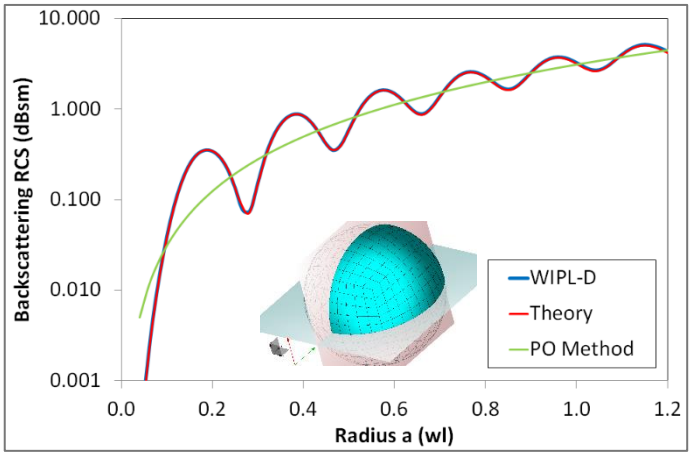


Two symmetry planes were applied. Radius of the dielectric sphere is equal to 1 wavelength.

Number of unknowns	Memory	Total simulation time
1,536	18 MB	0.8 sec

In addition, the radius of the metallic sphere was swept at 70 points and the backscattering was calculated.

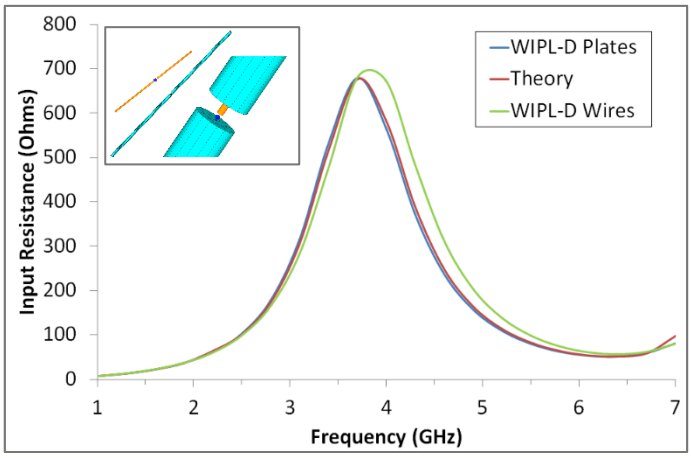
Number of unknowns	Memory	Total simulation time
1,038	8.2 MB	47 sec

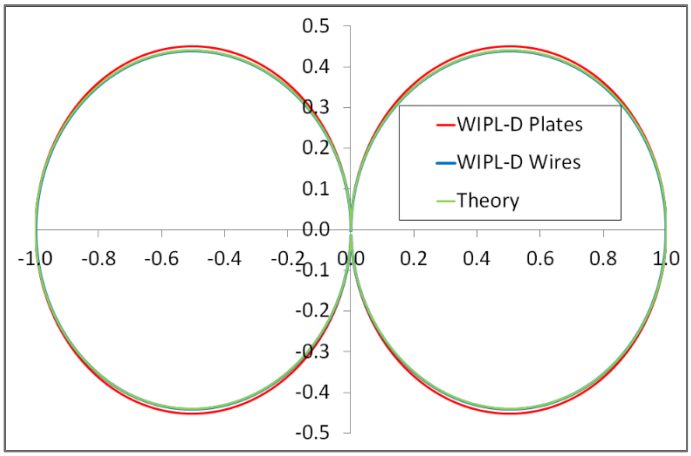


Input Impedance and Gain of the Dipole

Two models (*Wire* model and *Plate* model) of the dipole were simulated. Simulation time does not encompass time required for calculation of the radiation pattern. The dipole was with the length of 60.5 mm and the radius equal to 0.5 mm. The gap between arms appearing in the *Plate* model is 0.5 mm.

Model	Number of unknowns	Memory	Simulation time per frequency
Wires	7	0.4 KB	<0.01 sec
Plates	408	1.3 MB	0.16 sec

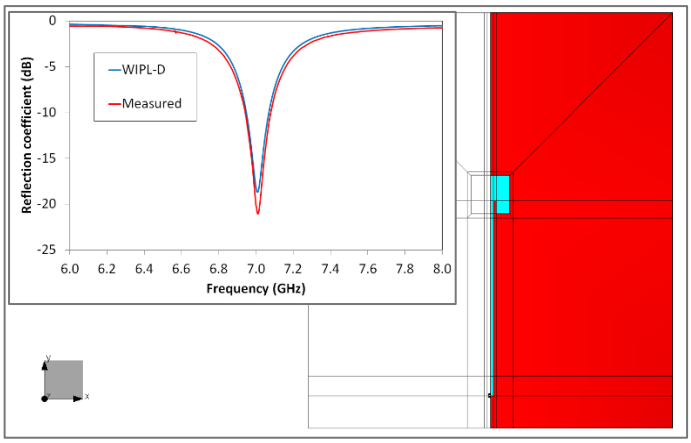


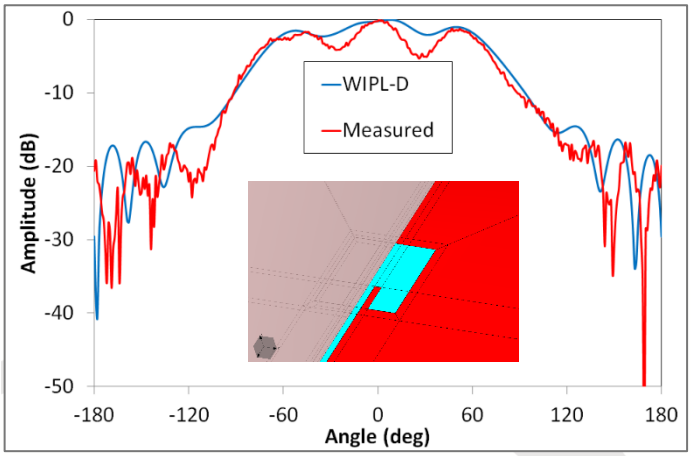


Microstrip Line Fed Patch Antenna

Microstrip line fed patch antenna printed on a 0.8 mm thick substrate with relative dielectric permittivity of 3.274 and metallization thickness of 0.035 mm was simulated. In order to obtain S-parameters, a *De-embedding* procedure was applied. Simulation time (per frequency) encompasses time requested for the antenna simulation and the additional time requested for feeder simulation.

Number of unknowns	Memory	Simulation time per frequency
4,121	130 MB	10.3 sec

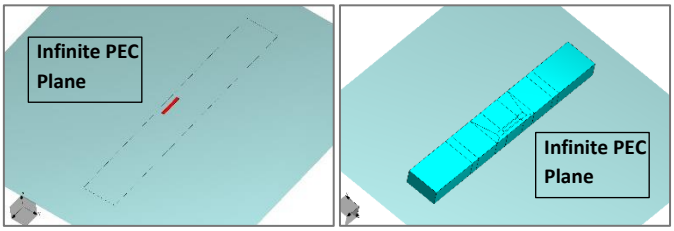


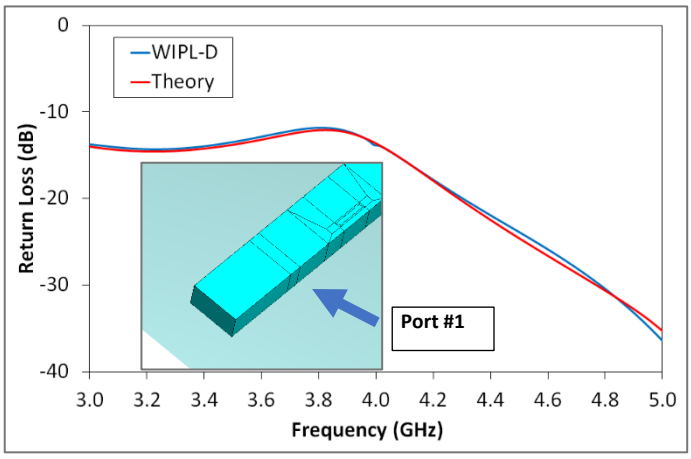


Waveguide Slot Antenna Return Loss

Waveguide slot antenna (slot is in the PEC plane) was modeled and simulated. In order to obtain S-parameter, a *De-embedding* procedure was applied. Simulation time (per frequency) encompasses time requested for the slot antenna simulation and the additional time requested for feeder simulation.

Number of unknowns	Memory	Simulation time per frequency
1,782	24.2 MB	11 sec

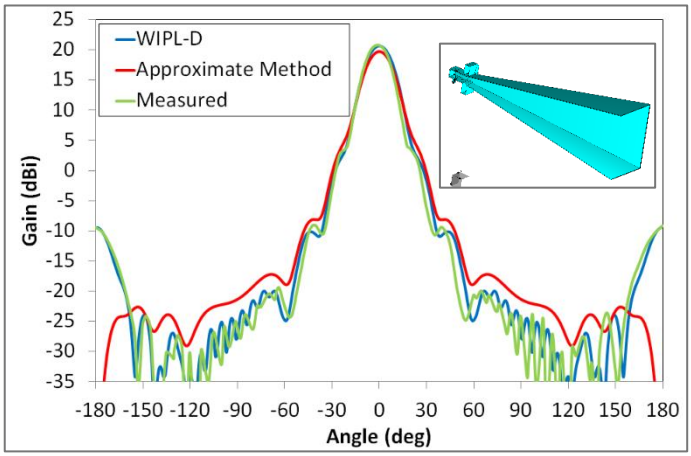




Standard Gain Horn

Standard gain horn with wall thickness was modeled and simulated. One symmetry plane was applied.

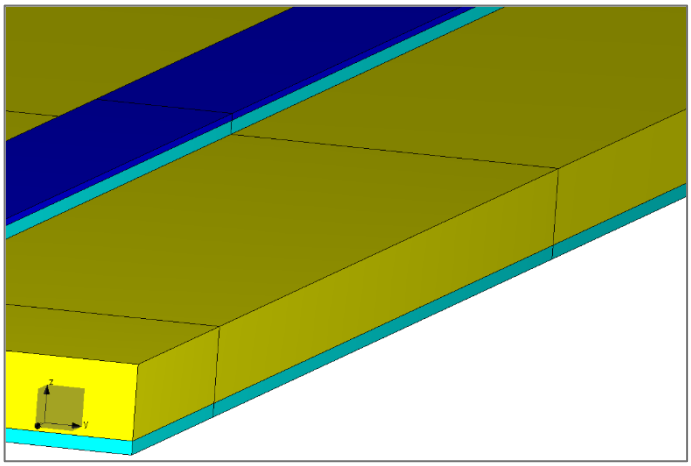
Number of unknowns	Memory	Total simulation time
3,876	115 MB	9.7 sec

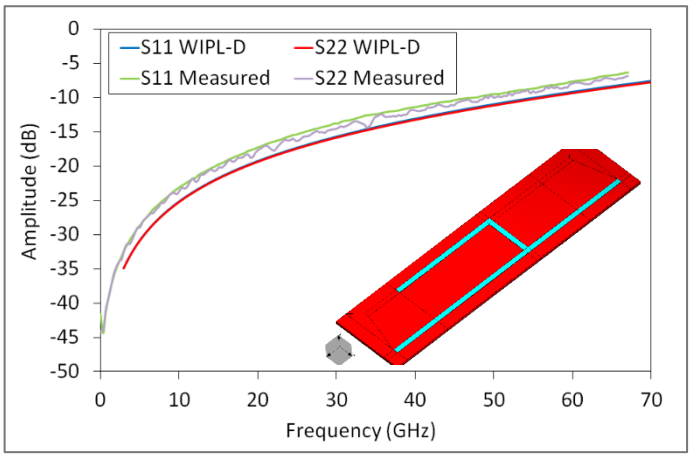


Microstrip Stub

A microstrip stub with two dielectrics was simulated. Relative permittivity of the first dielectric is equal to 4 (substrate), while the relative primitivity of the second dielectric is 8 (dielectric printed above the metallization). The substrate thickness is 0.0055 mm. Thickness of the metallization is 0.001 mm. In order to obtain S-parameters, the *De-embedding* procedure was applied. Simulation time (per frequency) encompasses time requested for the stub simulation and the additional time for the feeder simulation.

Number of unknowns	Memory	Simulation time per frequency
1,256	12 MB	10 sec





Microstrip Capacitor

Similar as presented in the *Microstrip Stub*, a microstrip capacitor with two dielectrics was modeled and simulated. Relative permittivity of the first dielectric is equal to 4 (substrate), while the relative primitivity of the second dielectric is 8 (dielectric printed above the metallization). The substrate thickness is 0.0055 mm. Thickness of the metallization is 0.001 mm. In order to obtain S-parameters, the *De-embedding* procedure was applied. Simulation time (per frequency) encompasses time requested for the capacitor simulation and the additional time for the feeder simulation.

Number of unknowns	Memory	Simulation time per frequency
2,912	65 MB	32 sec