Wide-band stacked annular-ring dielectric resonator antenna

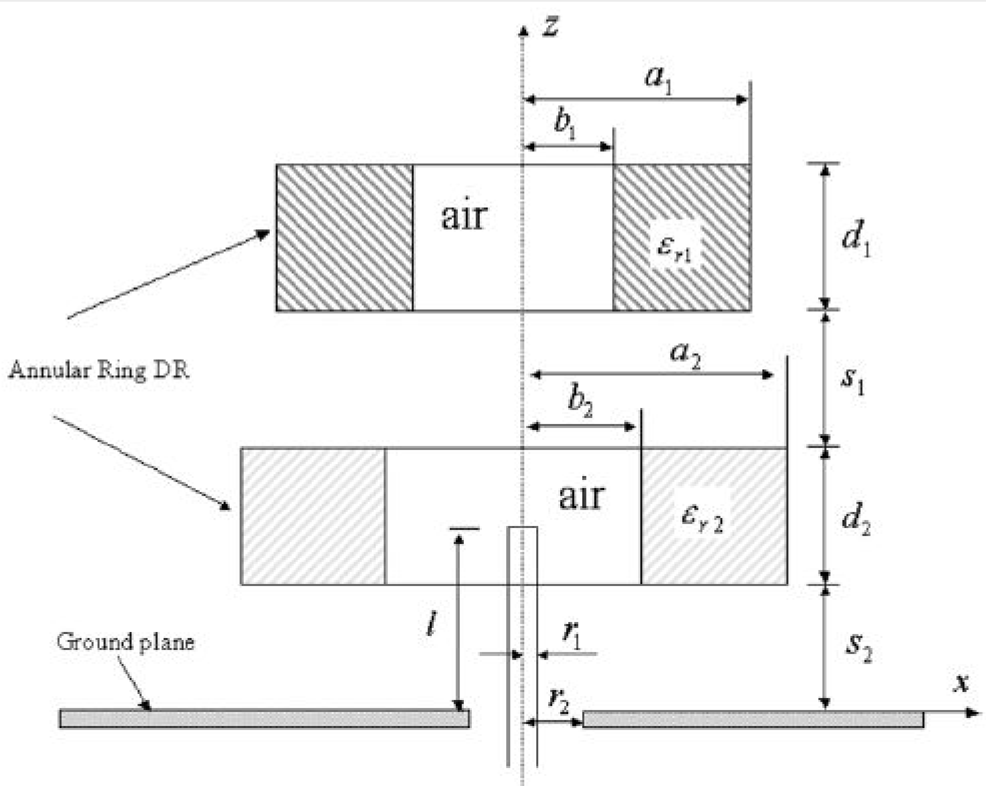
A wide-band stacked annular-ring dielectric resonator antenna is modeled efficiently with the FEM/MOM and 2 planes of magnetic symmetry.

Introduction:

The FEM/MoM is often overlooked as an efficient technique for modeling dielectrics. This is even truer when the model consists of more than one dielectric layer. The traditional MoM method, the Surface Equivalence Principle (SEP) requires that the boundary of each dielectric be meshed into triangles. These triangles contribute a significant part to the computational resources. However, for the FEM/MoM only the outermost surface of the dielectric needs to be meshed into triangles while the inside of the dielectric can be meshed into tetrahedra using a coarser mesh size than the surface.

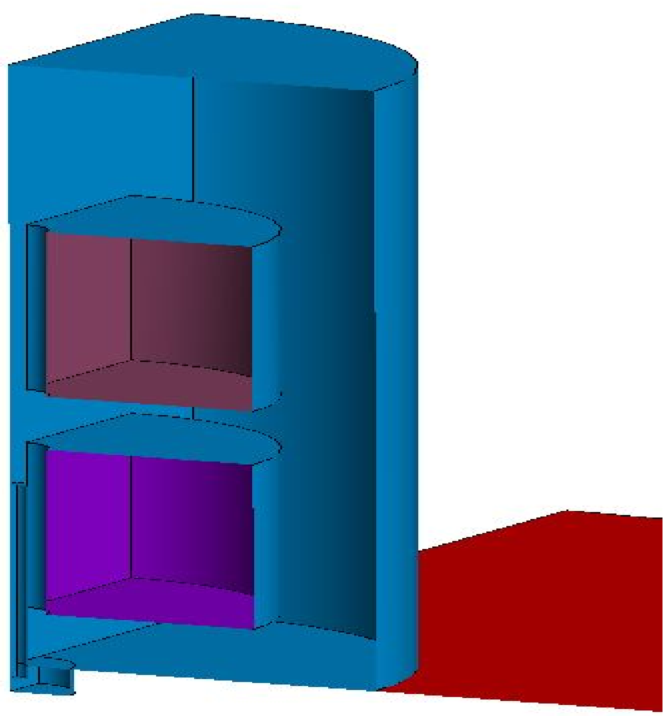
The geometry of the antenna is shown below.

Fig. 1: Geometry of the wide-band stacked annular-ring dielectric resonator antenna [1]



The geometry is constructed in CADFEKO using mainly cylinders of different sizes subtracted from each other as well as circular ellipsoids. As the FEM/MoM is used, a dielectric "air" layer is created that surrounds the antenna. The permittivity of this dielectric is set to 1 and serves to reduce the computational resources as a result of the coarser surface triangles as compared to those of the dielectrics in the intended model.

Fig. 2: Geometry of the antenna in CADFEKO, cutplane and medium colored view of a quarter of the model



A FEM current source is used as the excitation. The end of a coaxial connector is constructed using dimensions consistent with an air dielectric in 50 Ohm coax.

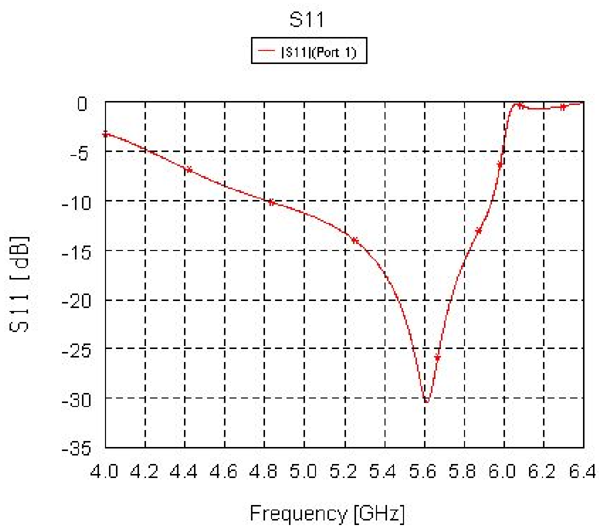
The dielectrics are meshed using a mesh size of 1/6.5 of the wavelength in the dielectric. Finer meshing is used on the feed pin as well as the surface adjacent to the feed pin on the bottom ring. The finer meshing is required for two reasons: firstly due to the small geometry on the pin finer meshing is required to accurately represent the curved surfaces and secondly the close proximity of the pin to the bottom ring implies stronger coupling between the surfaces. It is good modeling practice to use a finer mesh size in areas where the change in the current is greatest.

The FEM current source and frequency loop using continuous sampling is set in CADFEKO and the model is saved after meshing. Magnetic symmetry is added on planes X=0 and Y=0.

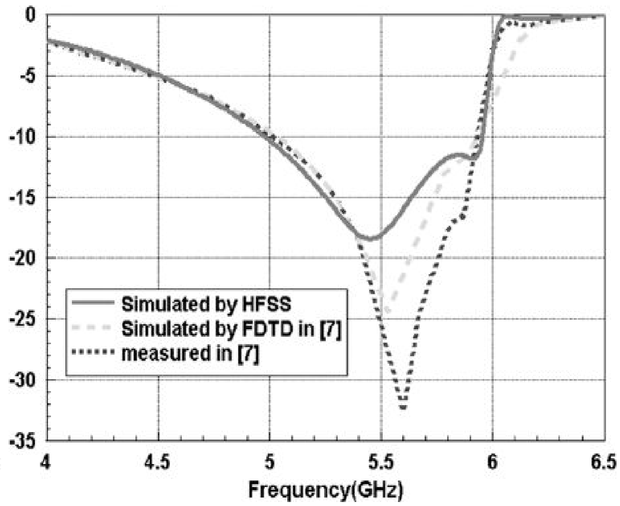
The results for S11 is plotted by clicking on "Add a source data graph" in POSTFEKO and selecting S11 and "Use continuous frequency". Excellent agreement with the reference measurement is obtained.

Fig. 3: Comparing results for S11

(a) S11 results from FEKO



(b) S11 results from the reference



SEP model:

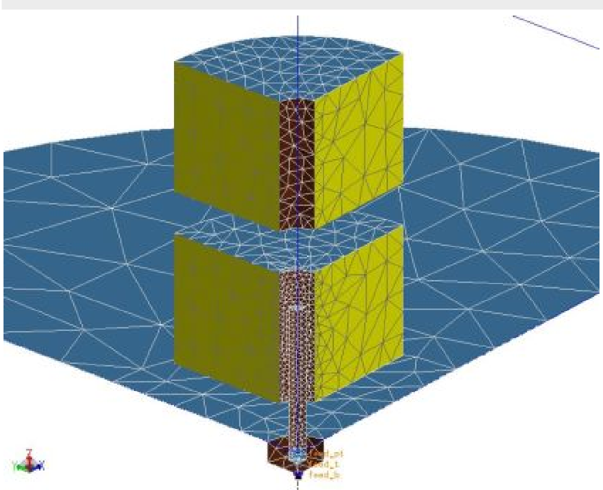
As a matter of interest the SEP model is briefly discussed.

The following points are important for setting up the SEP model:

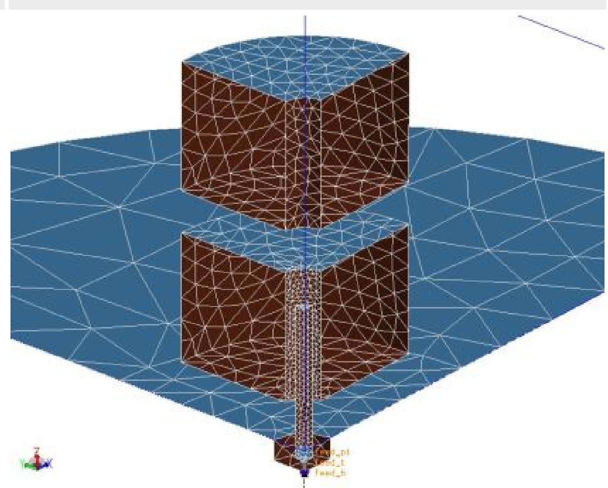
1. The FEM current source can not be used. Instead a wire port is used on a segment connecting the bottom 2 named points.
2. The region around the wire is changed to free space.
3. The surrounding air dielectric must be deleted as it only increases the computational resources for the SEP.
4. All the **meshed** surfaces bordering a free space region and coincident with the symmetry planes must be deleted.

Fig. 4: Meshing the SEP model

(a) Meshed surfaces that must not be included in the final model



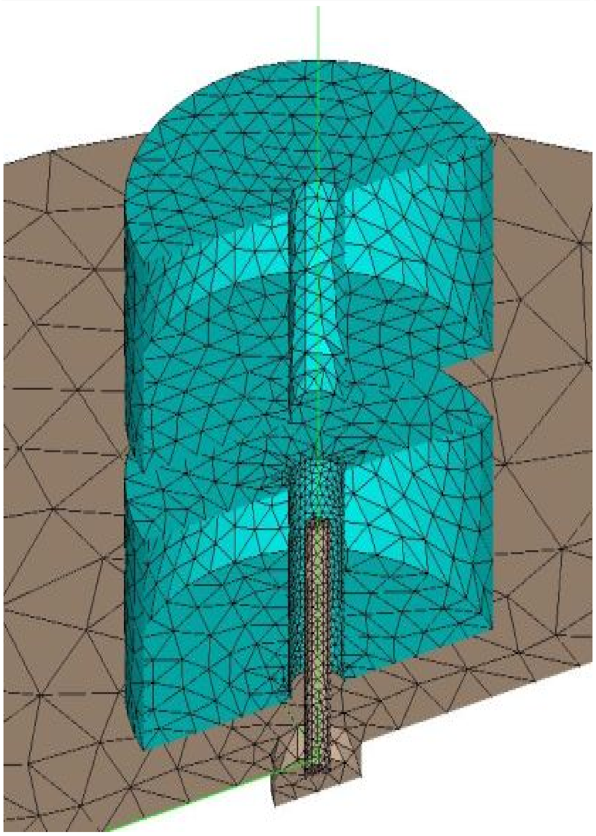
(b) Final mesh



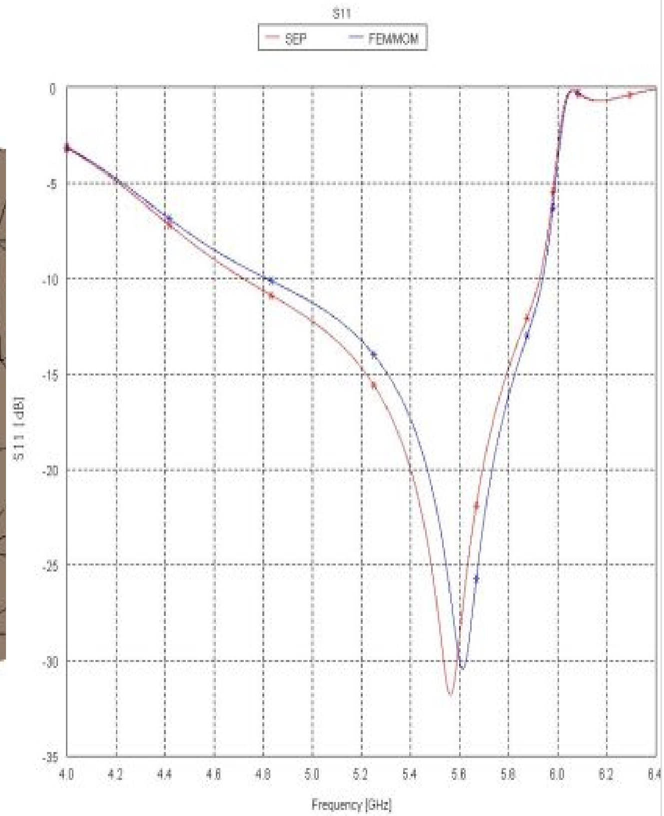
The final SEP model in POSTFEKO is shown below. The comparative results between the SEP and FEM/MOM is also shown.

Fig. 5: Final SEP model (cut-plane view) and comparative results

(a) Geometry of SEP model in POSTFEKO



(b) S11 results comparing the SEP with the FEM/MOM



The computational resources for the FEM/MoM and SEP are compared in the table below

Table1: Comparing computational resources for the FEM/MoM vs SEP

Technique	Runtime	Memory
FEM/MoM	8 minutes	210 MB
SEP	21 minutes	584 MB

It is seen that the FEM/MoM is a more efficient, yet equally accurate technique for solving this problem.

References

[1] Wide-band Stacked Double Annular-Ring Dielectric Resonator Antenna at the End-Fire Mode Operation, Guo, Ruan, Shi, IEEE Trans. AP, vol. 53, no.10, Oct 2005
[2] Stacked Annular Ring Dielectric Resonator Antenna Excited by Axi-Symmetric Coaxial Probe, Shum, Luk, IEEE Trans. AP, Vol. 43, No. 8, August 1995