Workshop EM Signature Radar 2010
Test case #4 : Photonic Radome

Guillaume SYLVAND (EADS Innovation Works)
guillaume.sylvand@eads.net
Bernard AKNIN (MBDA)
bernard.aknin@mbda-systems.com

May 17, 2010

Abstract

The photonic radome is a Frequency Selective Surface (FSS), made of 19 metallic strips placed on the surface of a sphere. We define two configurations with continuous or discontinuous strips, and compute the E field at the center of the sphere created by a plane wave illumination. More specifically, we are interested in the attenuation of this field due to the cuts in the strips.

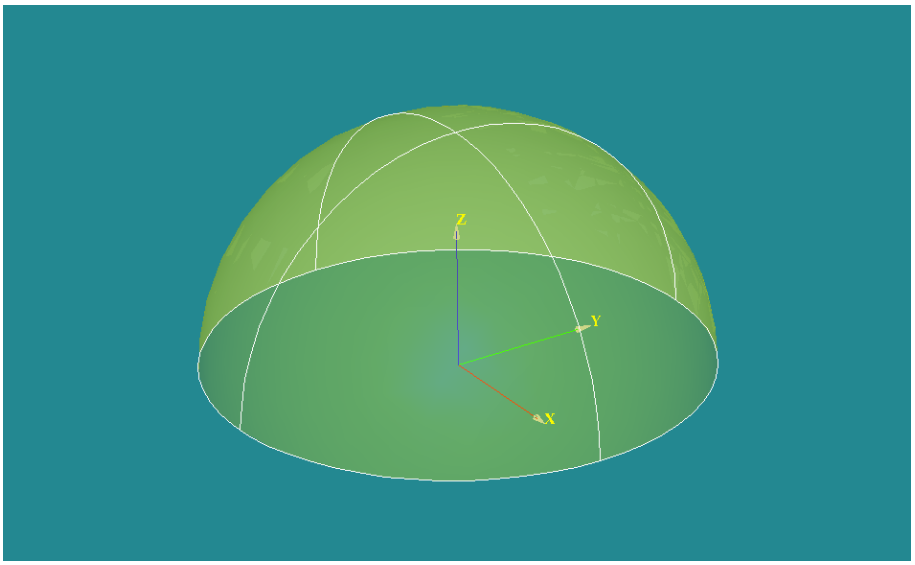
For this test case, we define two structures called *Continuous Strips* (at section 1.1) and *Discontinuous Strips* (at section 1.2). All the structures are made of zero-thickness perfect electrically conductor (PEC) material, placed in empty space.

1 Geometry of the photonic radome

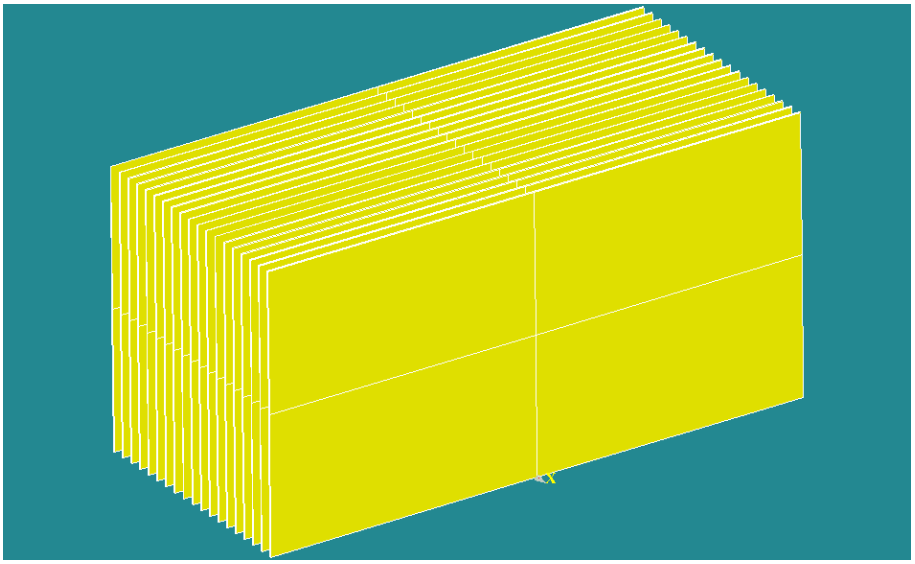
We will give in this section a complete description of the two structures (*Continuous Strips* and *Discontinuous Strips*) used in this test case. The CAD file is available on the workshop's Web site. Nevertheless, if you want to build the geometry with your own tools, the following informations should be sufficient.

1.1 Continuous Strips

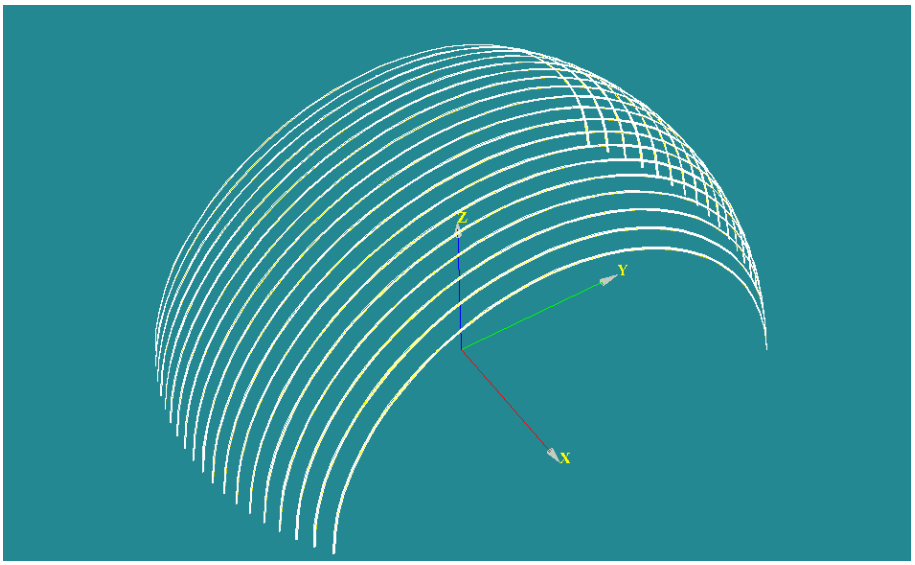
We define a half-sphere $\mathcal{S}$ as the intersection of a sphere of radius $r = 0.165m$ and the half space $z > 0$.

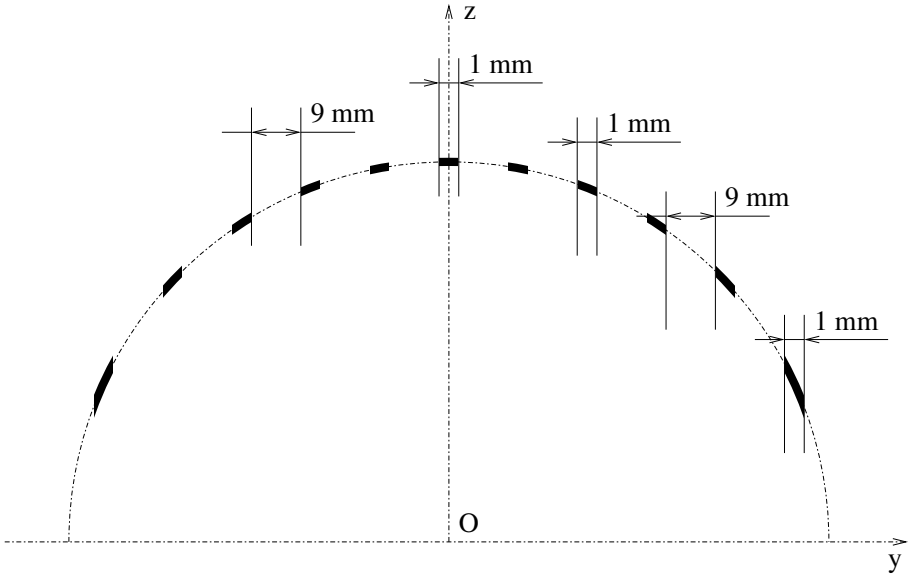


For $i = -9, -8, \ldots, +8, +9$, we define the B_i as 19 semi-infinite boxes normal to (Ox), of width 1 mm in the x-direction, with a space of 9 mm between each. Mathematically, B_i is the set of points M satisfying $x \in [10i - 0.5, 10i + 0.5]$(in millimeters).



The strip number W_i is the intersection of $\mathcal{S}$ with B_i. These 19 continuous strips constitute the first configuration of this test case, called *Continuous Strips*.

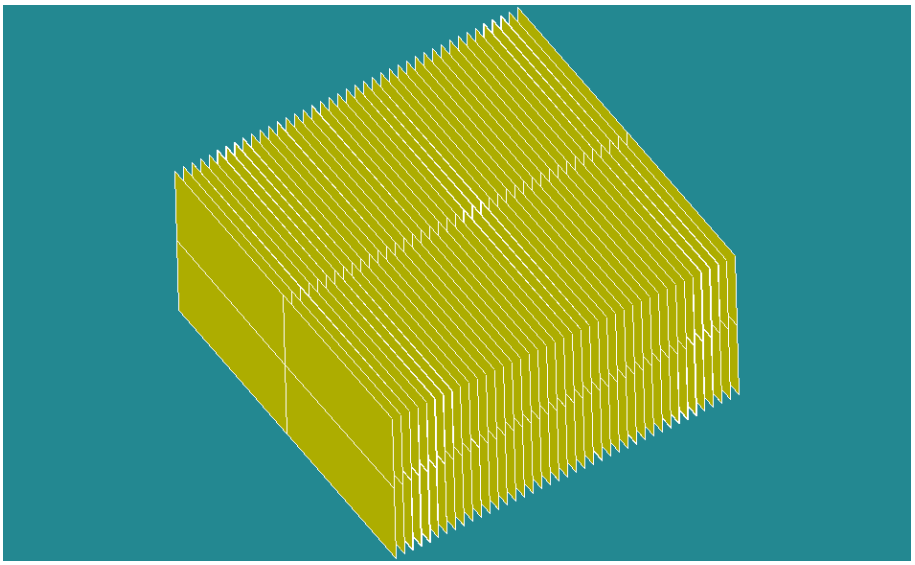




As shown on the picture above (a simpler view, with less strips than in the real case), when projected on the (xOy) plane, the strips have a 1 millimeter width, and the space between two strips is 9 millimeters.

1.2 Discontinuous Strips

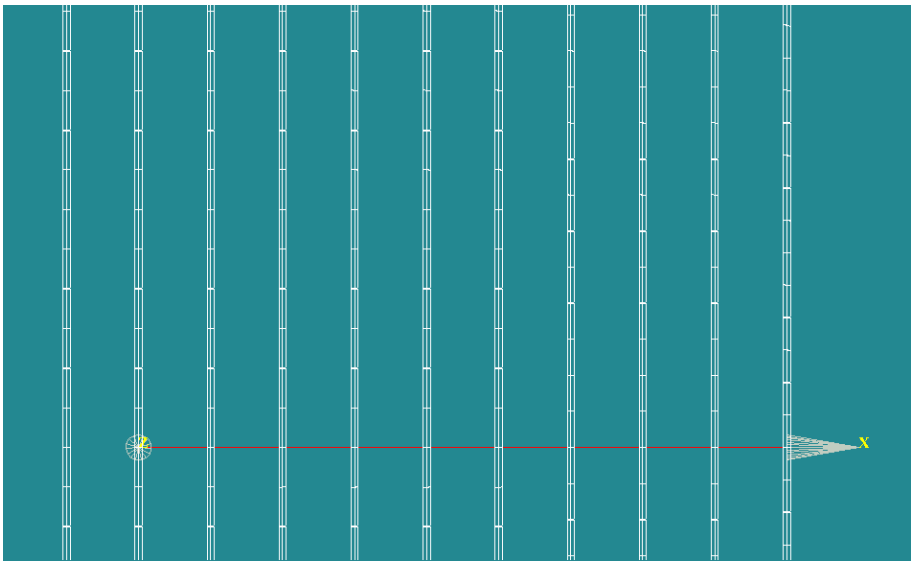
We will cut these strips with semi infinite boxes C_j normal to (Oy), defined as the set of points M satisfying $y \in [pj - 0.05, pj + 0.05]$ for $j \in \mathbb{Z}$ (in millimeters) and p is the period of the cut. The width of the cut is 0.1 millimeter.



We substract the boxes C_j from to strips W_i to obtain the discontinuous strips.

- The strips $i = \pm 9$ are cut with period $p = 9mm$;
- The strips $i = \pm 8, \pm 7, \pm 6$ are cut with period $p = 10mm$;
- The strips $i = -5, \ldots, 5$ are cut with period $p = 11mm$.

These 19 discontinuous strips constitute the second configuration, called *Discontinuous Strips*.



The picture above shows the structure seen from above. One can see that the period of the cuts p depends on the position of the strip : large p for the center strips, smaller p for the strips on the border.

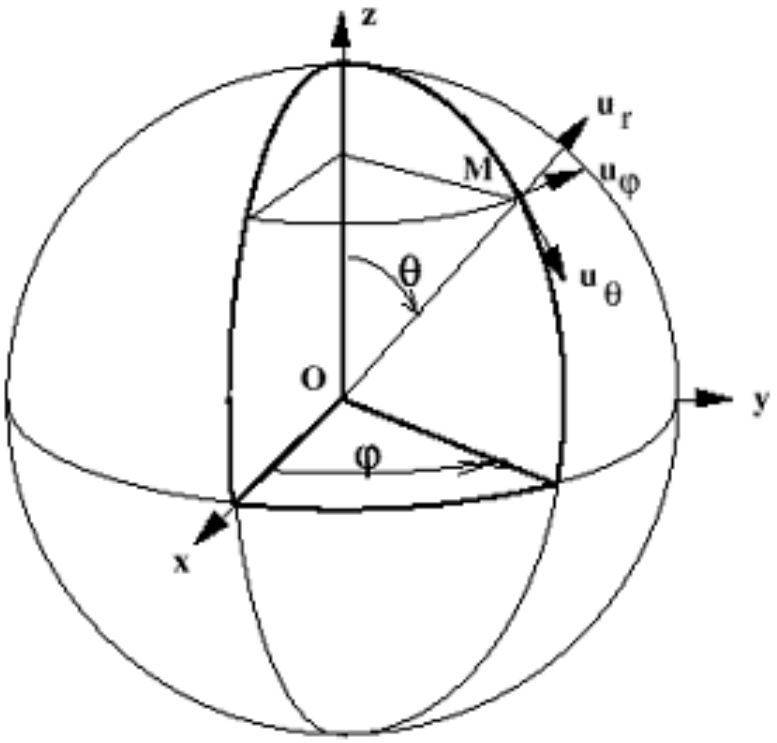


Figure 1: Definition of the angles

2 EM parameters

2.1 Case 1

The frequency range is $F \in [2, 18]$ GHz. The frequency step is left at the operator's choice, considering it is part of the numerical technics, the criteria is the smoothness of the curve obtained.

The illumination is an EM Wave *coming from* $\theta = 0$ and $\phi = 0$ in ϕ polarization : incident electric field $\vec{E}$ is colinear to (Oy).

We look at the total $\vec{E}$ field (incident + diffracted) at the center of the sphere (the origin) for both configurations. We call them :

- $\vec{E}_{cont}$ for the *Continuous strips* configuration ;
- $\vec{E}_{disc}$ for the *Discontinuous strips* configuration.

We compute and draw the attenuation

$$10 \log_{10} \frac{|\vec{E}_{cont}|}{|\vec{E}_{disc}|}$$

1 ascii file is expected, with name ending with `_case1.txt` The file must have two columns : frequency (in Hz), and field attenuation (in dB).

2.2 Case 2

We do an angle sweep for $\theta \in [0, 50]$ (in degrees). The angle step is left at the operator's choice. The other parameters are unchanged.

1 ascii file is expected, with name ending with `_case2.txt` The file must have three columns : frequency (in Hz), illumination angle (in degrees), and field attenuation (in dB).