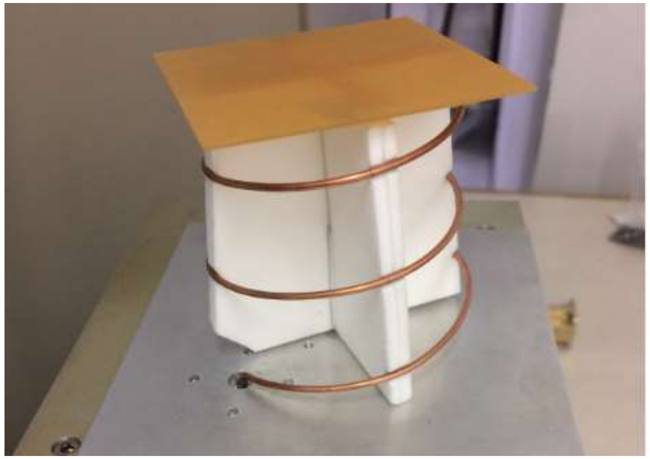
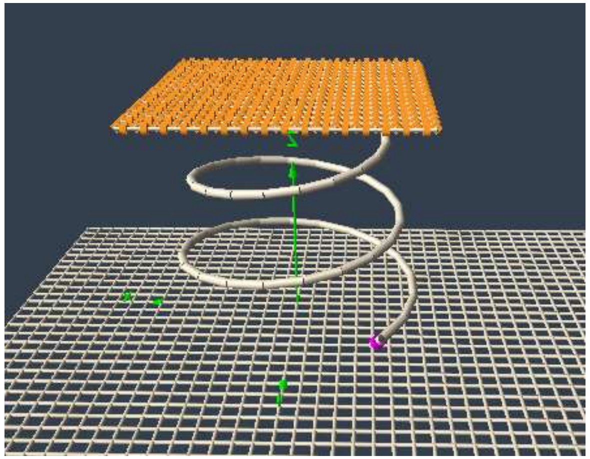
DIELECTRIC FILMS IN NEC2

"The use of dielectrics in NEC2 is not allowed". This is a general topic.

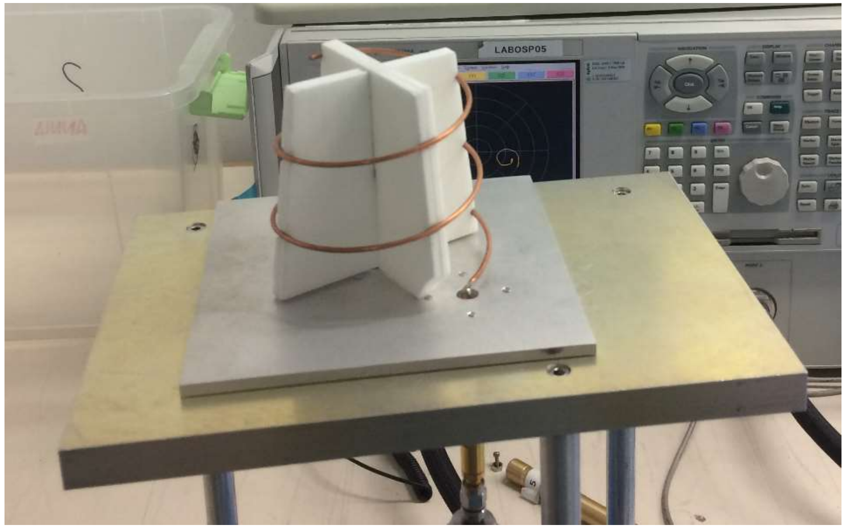
However, this presentation shows how to overcome this limitation in case of dielectric thin films. A film is considered thin if their thickness is < λd/10. Where λd is the wavelength in the dielectric media.

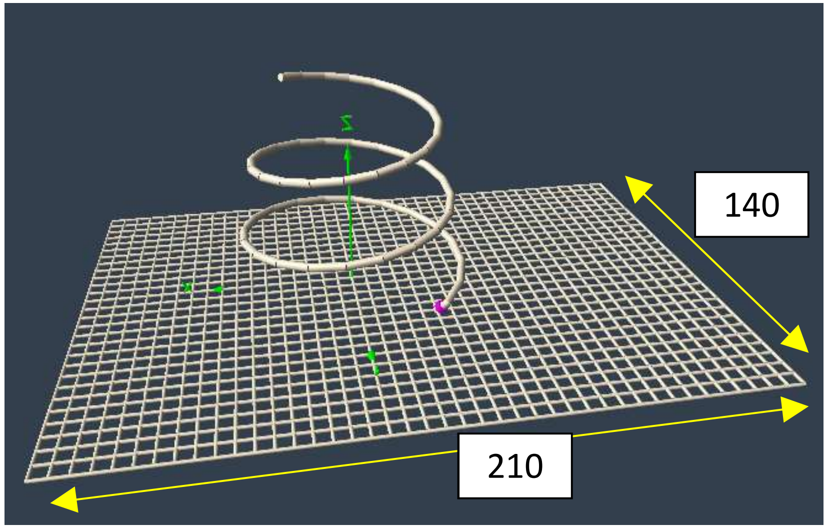
PHYSICAL MODEL (Left) and 4NEC2 MODEL (right) of an helix plus dielectric sheet

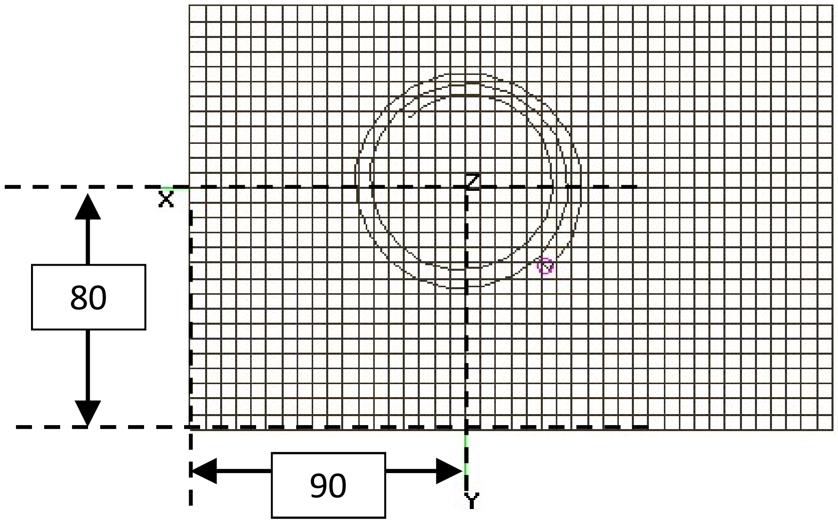




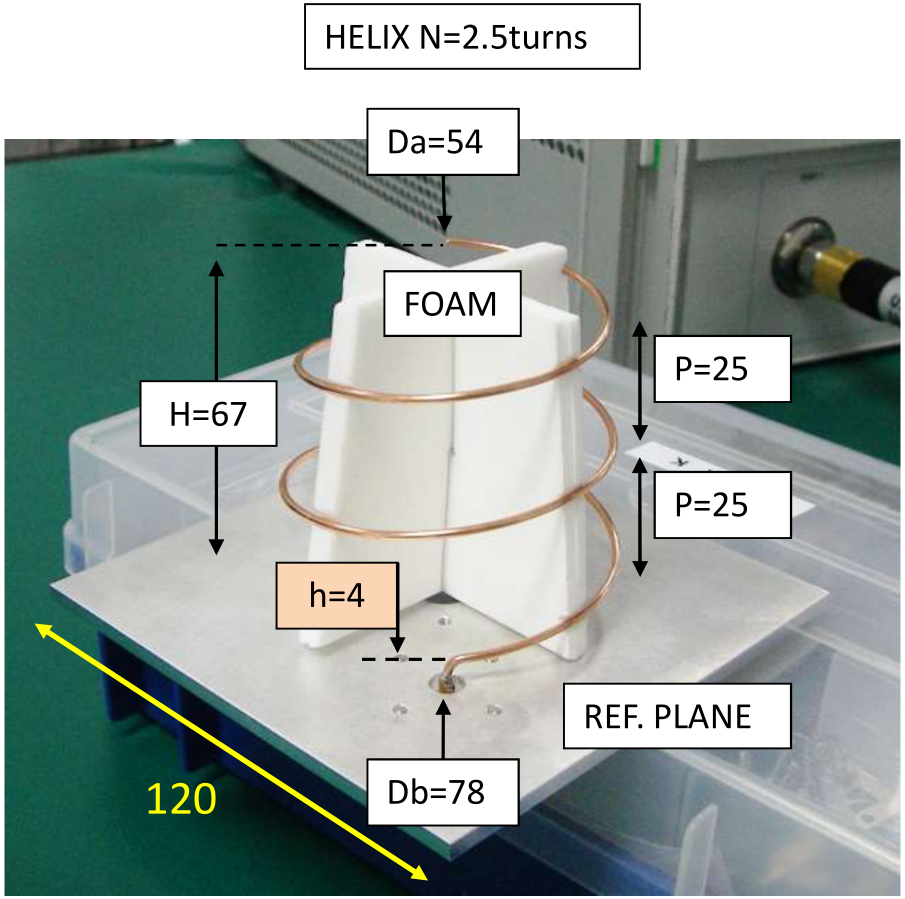
PHYSICAL MODEL AND 4NEC2 MODEL OF HELIX







HELIX GEOMETRY



Da = Diameter at base
Db = Diameter at top

MODELING OF DIELECTRIC FILM

The dielectric plate (80 x 80mm) is modeled by a grid of 17 wires in X-direction and 17 wires in Y-direction. Each wire has 16 segments
Each segment is capacitive loaded by *CD* (LD CARD option 1)

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LD 1 1 1 16 0 0 CAPD
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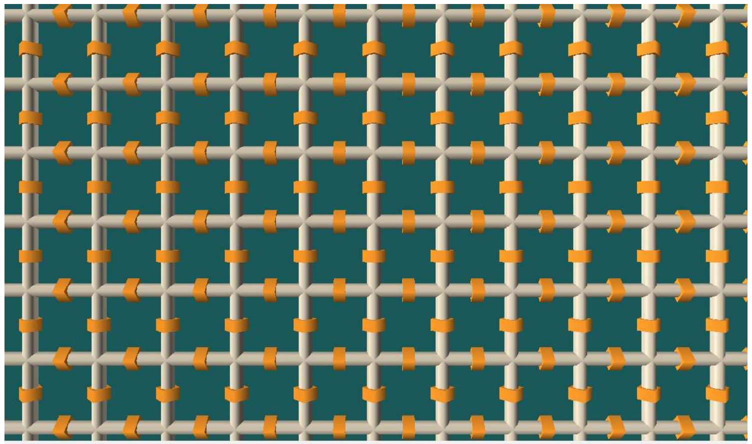
This CARD loads the 16 segments of wire (Tag=1)



- $\boldsymbol{T}$ Thickness of dielectric film
- $\boldsymbol{\Delta}_x$ Grid segment length (x)
- $\boldsymbol{\Delta}_y$ Grid segment length (y)
- ε_0 8.85 e-12 (F/m)
- ε' Relative dielectric constant

$$\mathrm{CD}_X = \varepsilon_0(\varepsilon' - 1)\frac{\boldsymbol{T}*\boldsymbol{\Delta}_x}{\boldsymbol{\Delta}_y} \qquad (\mathrm{F}/\square)$$

Capacitance loading in x-direction.

If $\Delta_x = \Delta_y = \Delta$ then, CDx = CDy = CD (isotropic material)

$$CD = \varepsilon_0 * (\varepsilon' - 1) * T \qquad (F/\square)$$

T Thickness of dielectric film in meters (< λ/10)
ε_0 = 8.85 e-12 (F/m)
ε' is the relative dielectric constant

CD (in Farads) is independent of grid density (T < λ/10 and Δ < λ/10)

Figures of pages 9 and 10 shows effectively that the results at 1600 MHz are the same modeling the same dielectric plate with Δ = 5mm or with Δ = 3.2mm and using the same value of CD.

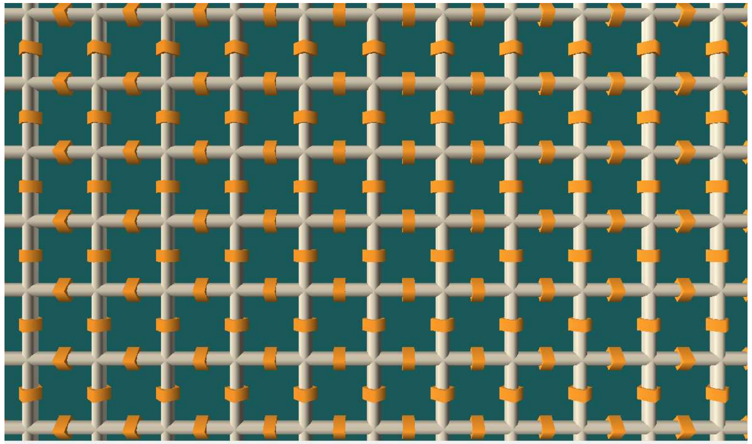
Figures in pages 17 and 18 shows that the results are the same for different thickness of dielectric plate if the product $(\varepsilon' - 1) * T$ is constant.

Non isotropic dielectric materials can also be analyzed. $\Delta_x \neq \Delta_y$

By experimental adjust of Cd to 2e-13 F/□, with a thickness plate of T=7 mm, the relative dielectric constant is estimated. Measured foam effects are negligible.

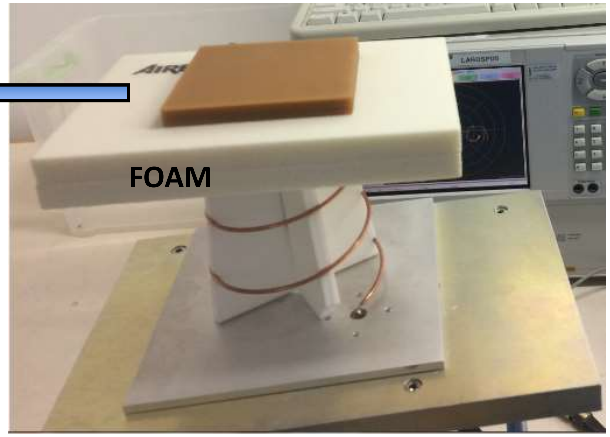
HH is distance of dielectric (at middle) to helix ground plane.

$\boldsymbol{\Delta} x \leftrightarrow$



$\updownarrow \boldsymbol{\Delta} y$

HH=94 ; T=7



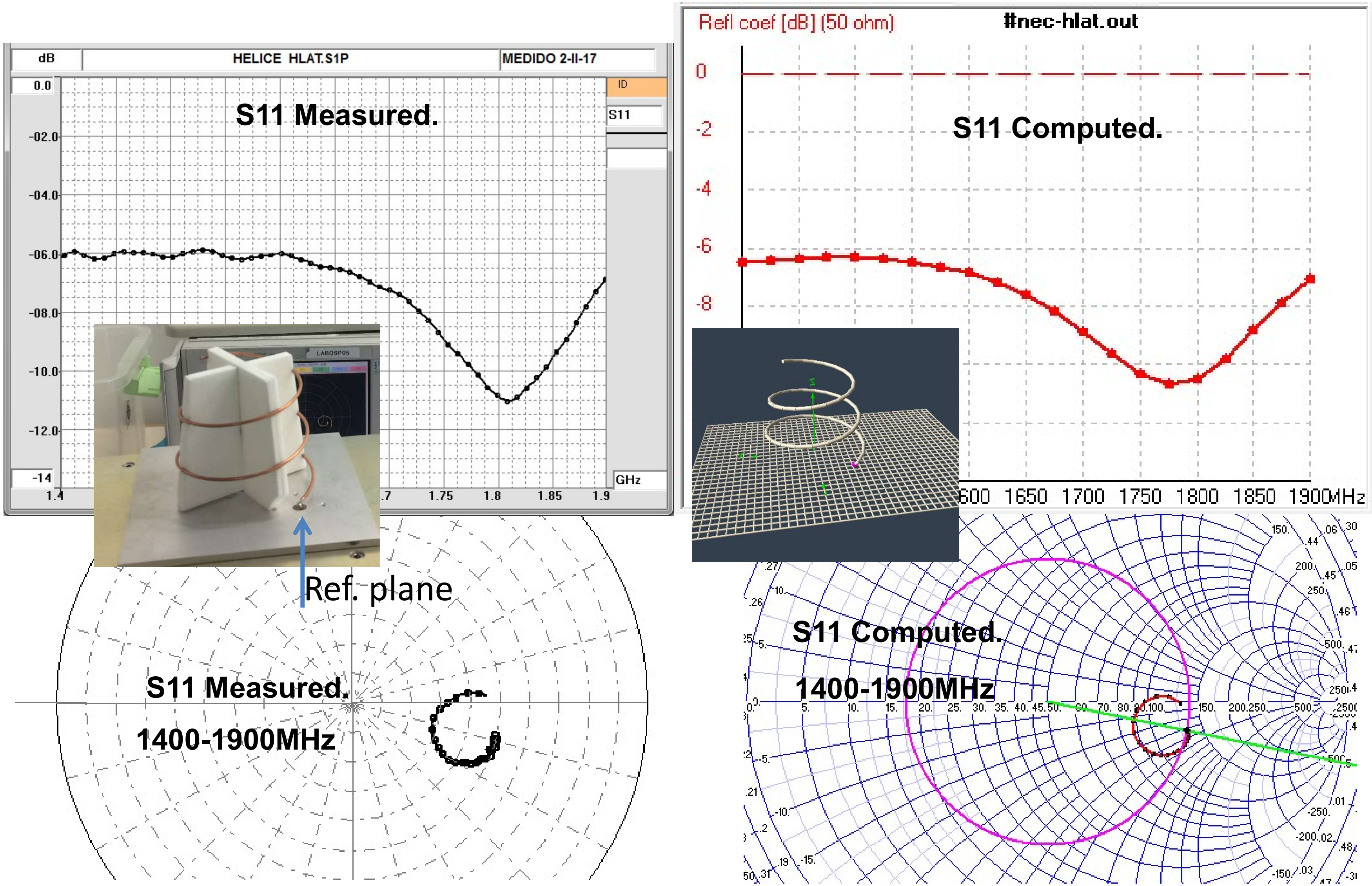
$$\mathrm{Cd}_x = \varepsilon_0(\varepsilon' - 1)\frac{\boldsymbol{T} * \boldsymbol{\Delta}_x}{\boldsymbol{\Delta}_y} \qquad (\mathrm{F}/\square)$$

$\boldsymbol{\Delta}_x = \boldsymbol{\Delta}_y = 5\text{mm}$

$$2\text{e-}13 = (0.885\ \text{e-}11) * (\boldsymbol{\varepsilon}' - \mathbf{1}) * 7\text{e}{-3}$$

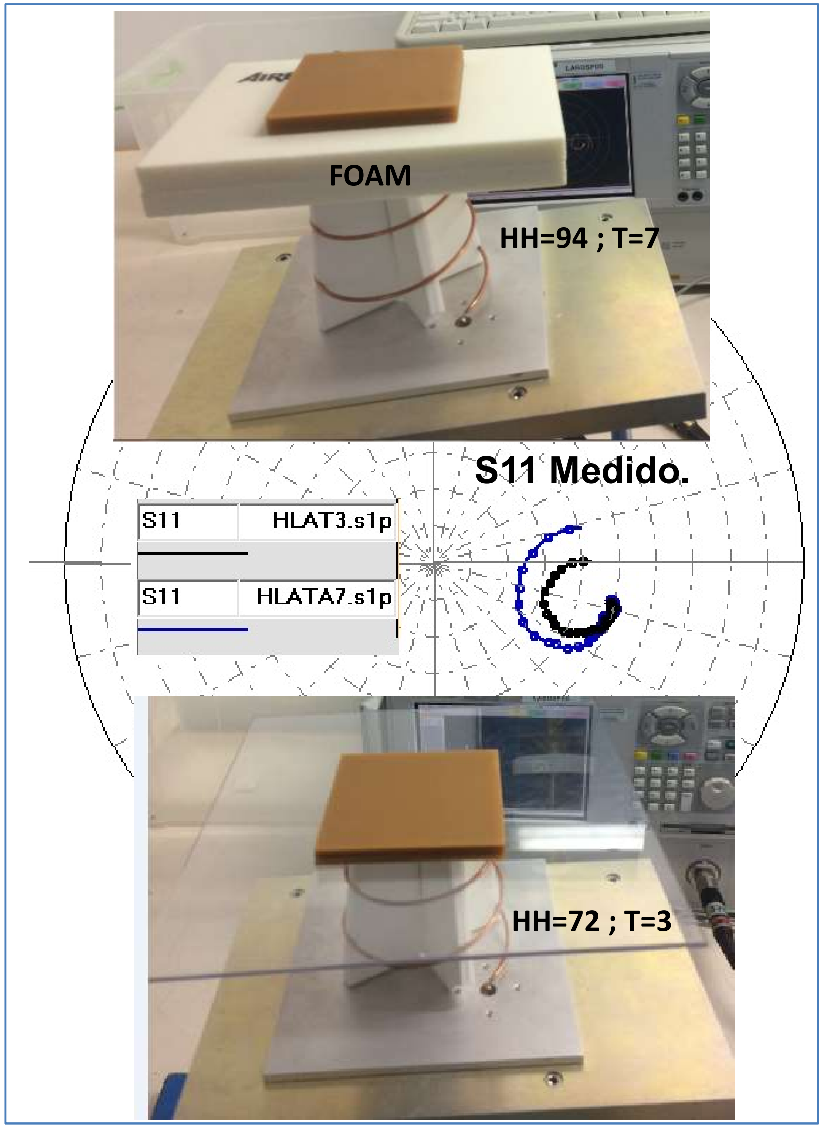
$\boldsymbol{\varepsilon}'$ **= 4.2** **(**Estimated)

HELIX ALONE : S11 MEASURED (left) & COMPUTED NEC (right)

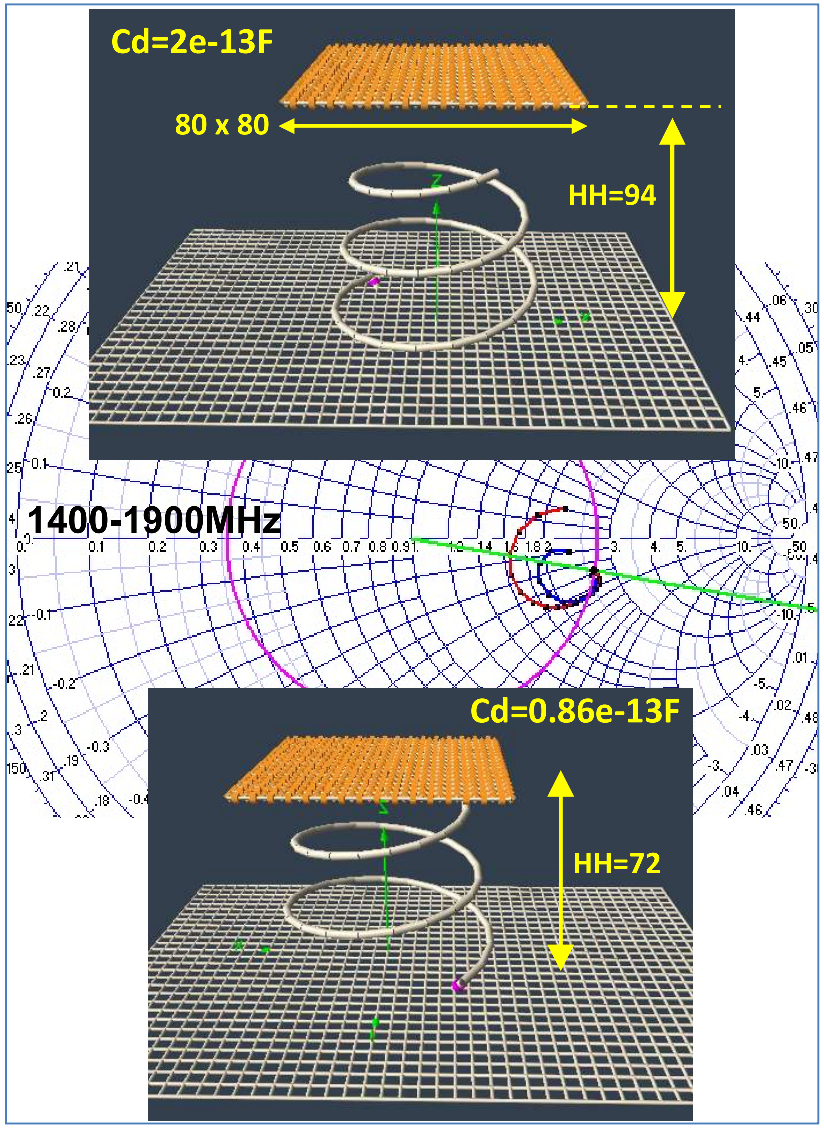


HELIX PLUS DIELECTRIC PLATE (T=7mm) VERSUS HH

MEASURED (S11)

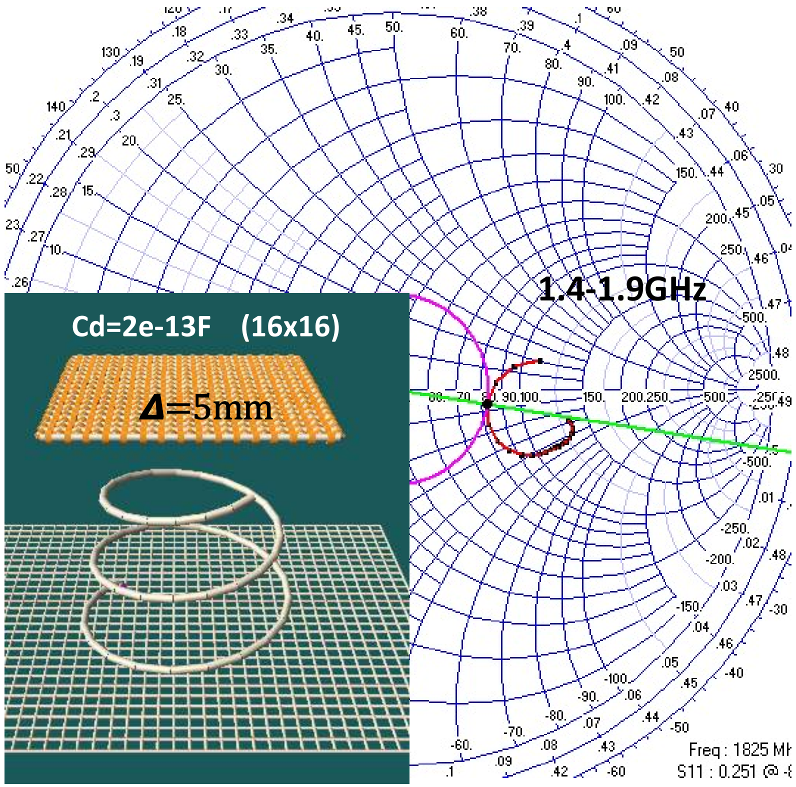


Nec-HLATA6_.NEC

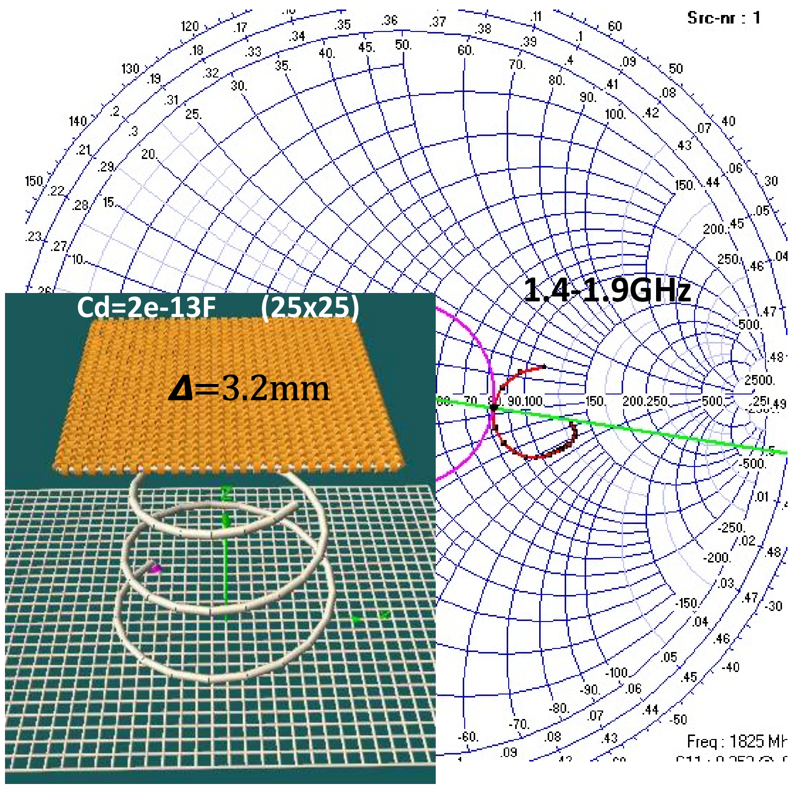


S11 VERSUS DIFERENT GRID MESHING (4NEC2)

nec-HLATA6.out



nec-HLATJ6.out



$$\mathrm{Cd}_x = \varepsilon_0(\varepsilon' - 1)\,\frac{T * \Delta_x}{\Delta_y} \quad (\mathrm{F}/\square)$$

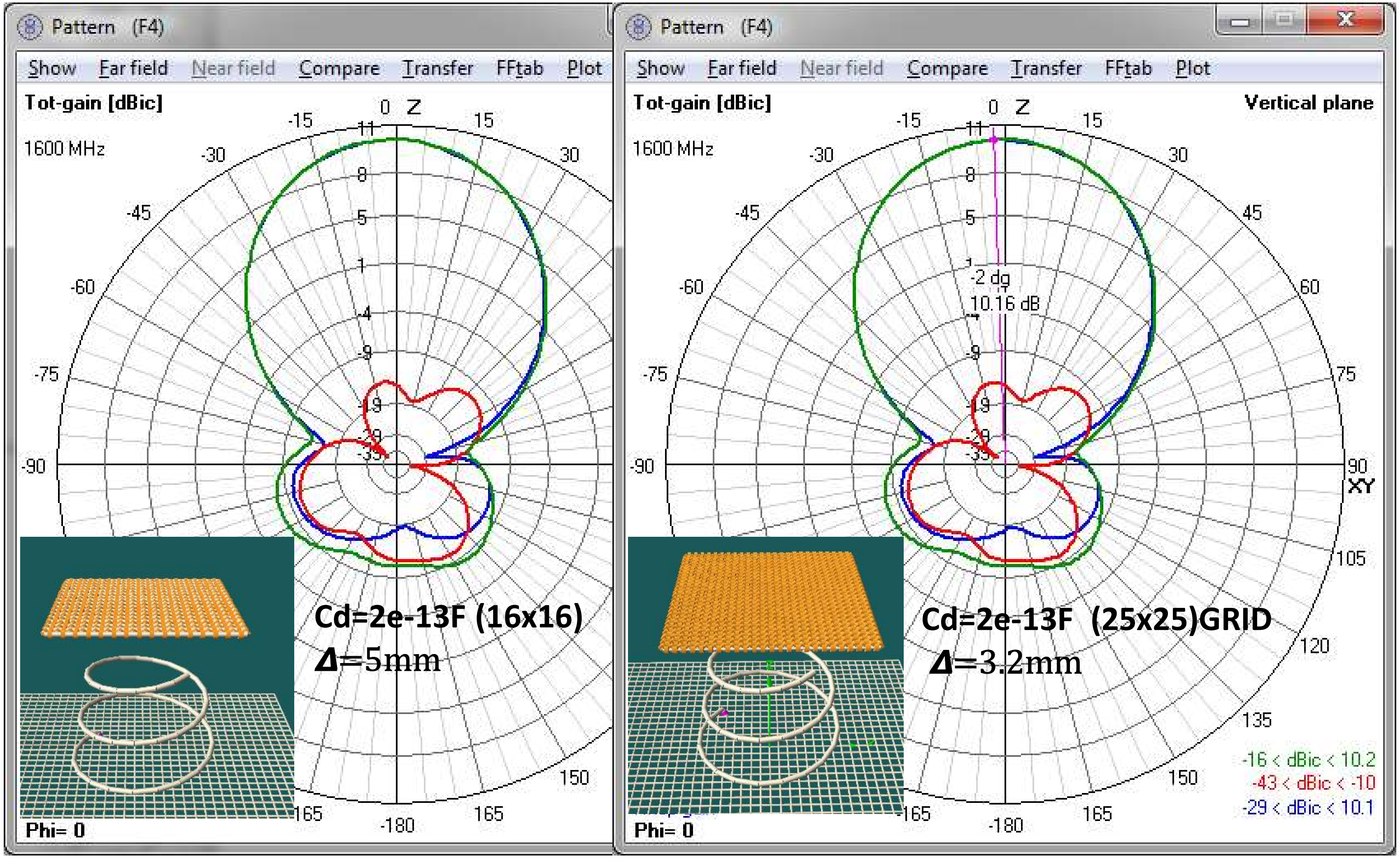
T thickness of dielectric film

Δ_x grid segment length (x)

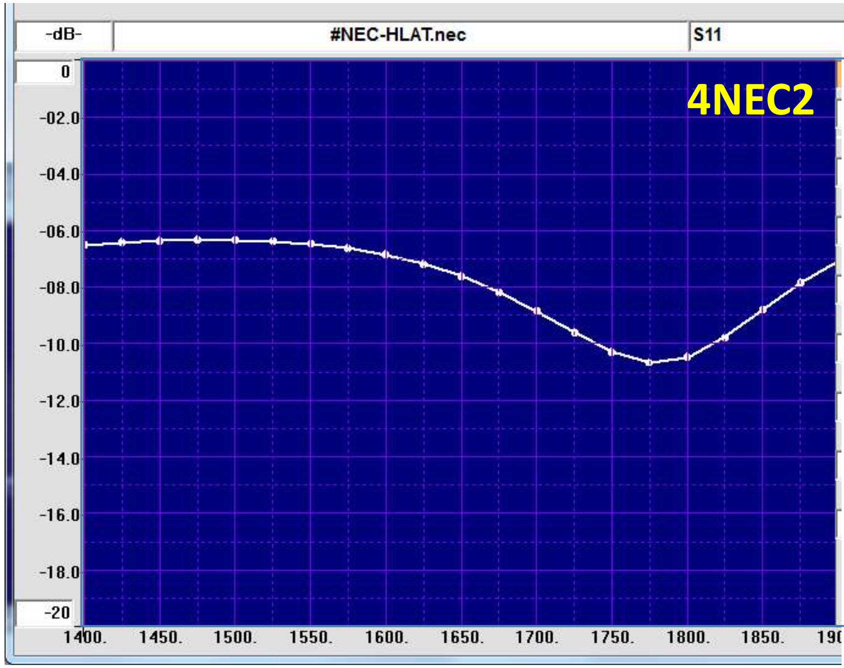
Δ_y grid segment length (y)

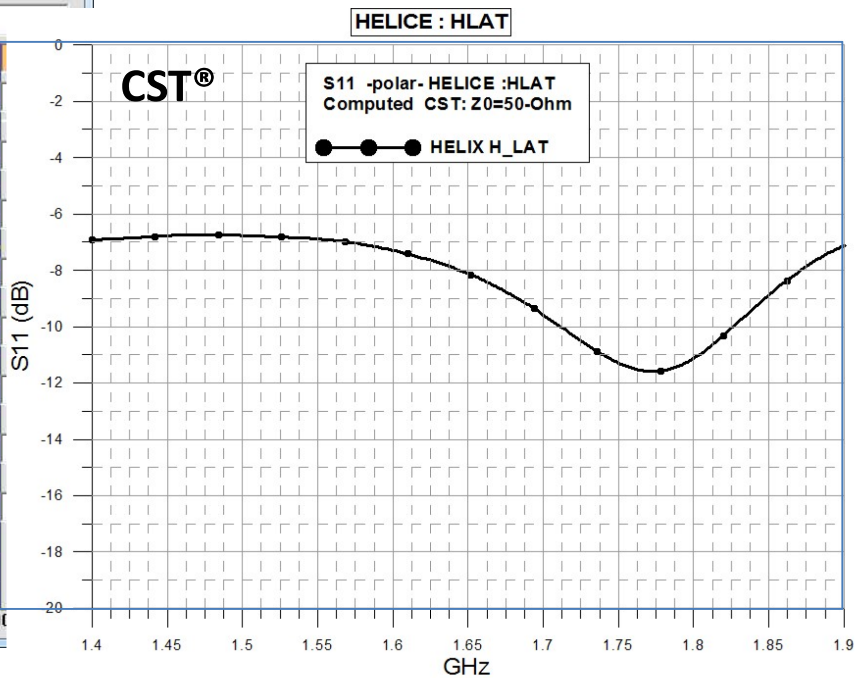
ε_0 8.85 e-12 (F/m)

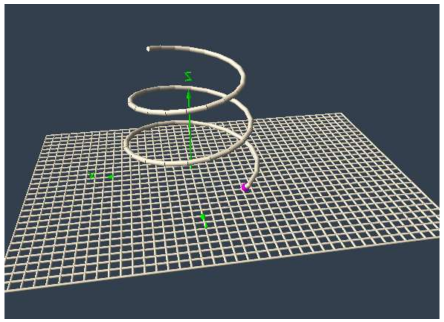
PATTERN CUT VERSUS DIFERENT MESHING (4NEC2)

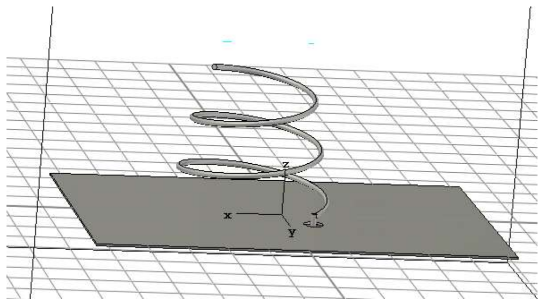


HELIX ALONE : RETURN LOSSES (4NEC2 versus CST)

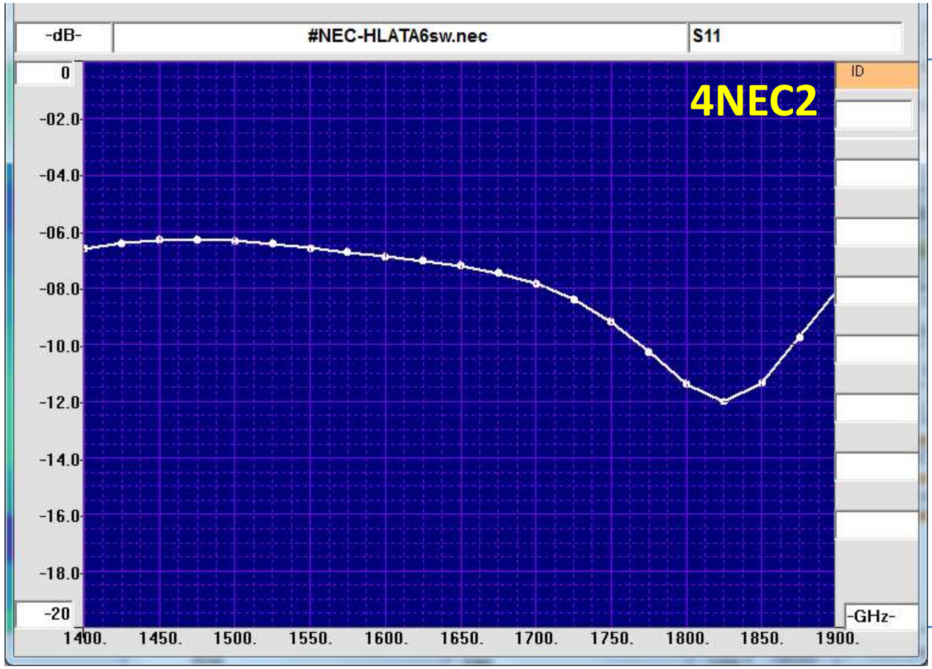


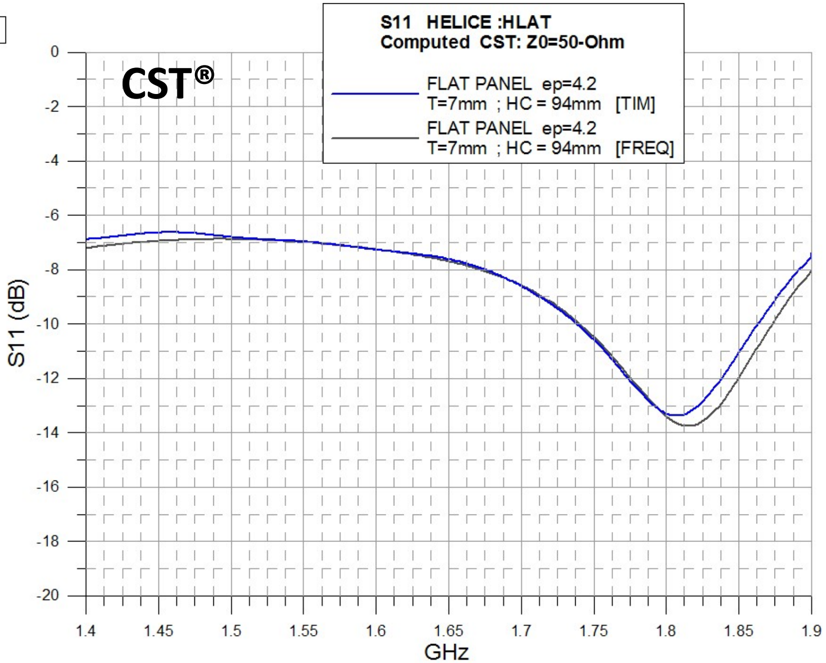


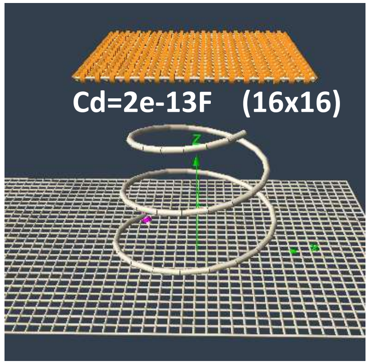


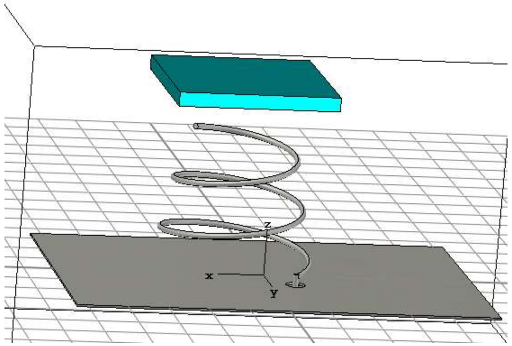


HELIX PLUS DIELECTRIC PLATE: RETURN LOSSES (4NEC2 versus CST)

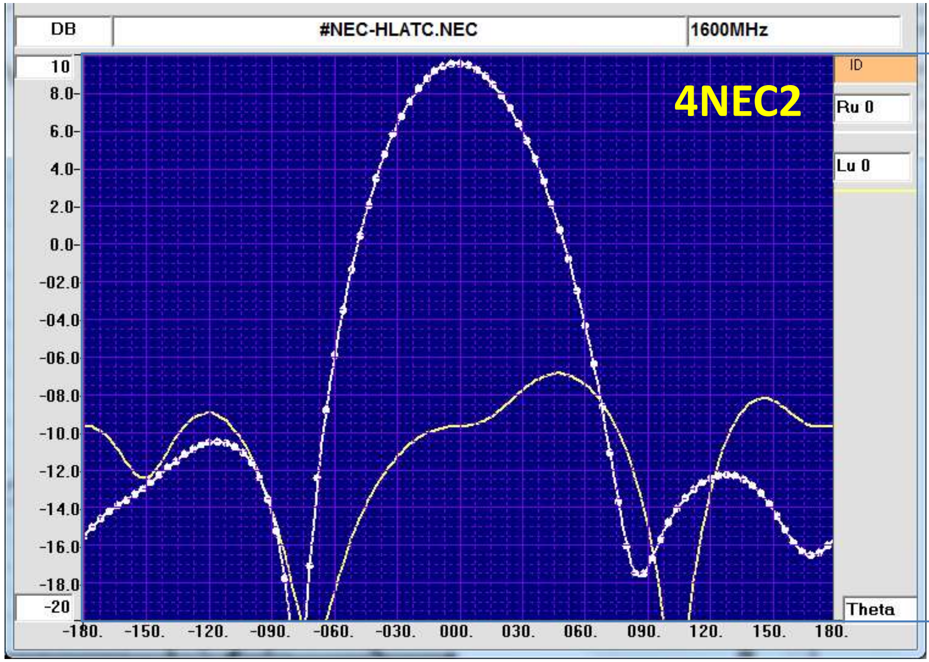


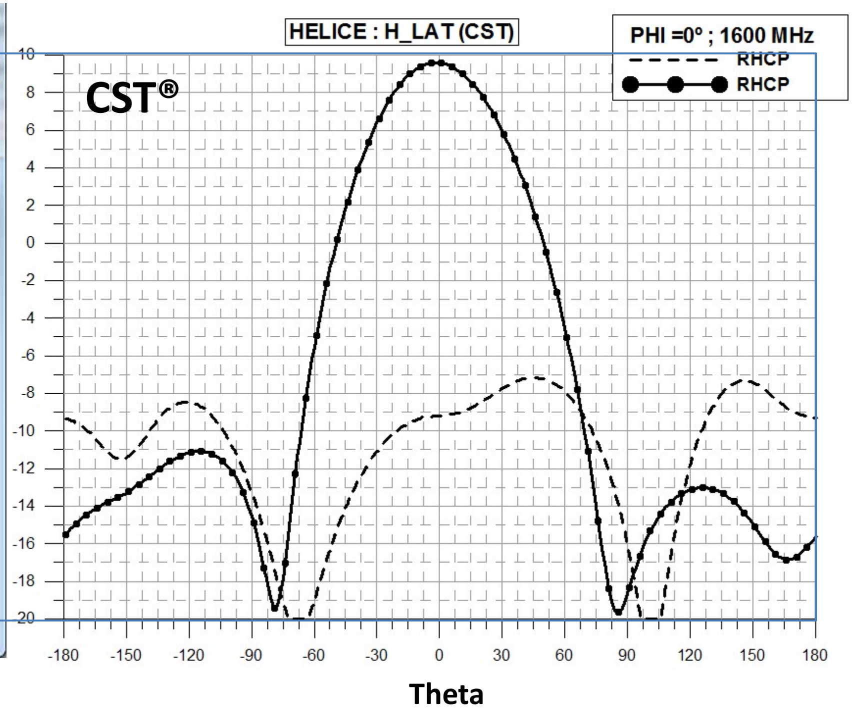


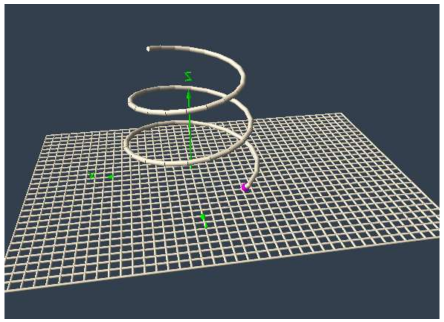


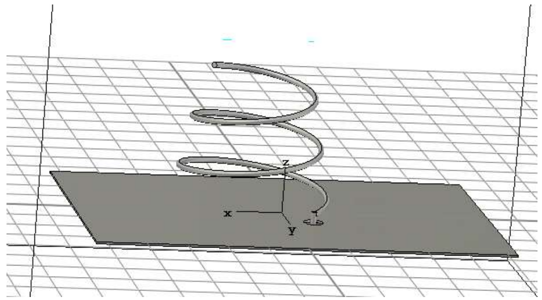


HELIX WITHOUT DIELECTRIC: PATTERN (Phi=00° & 1600MHz)



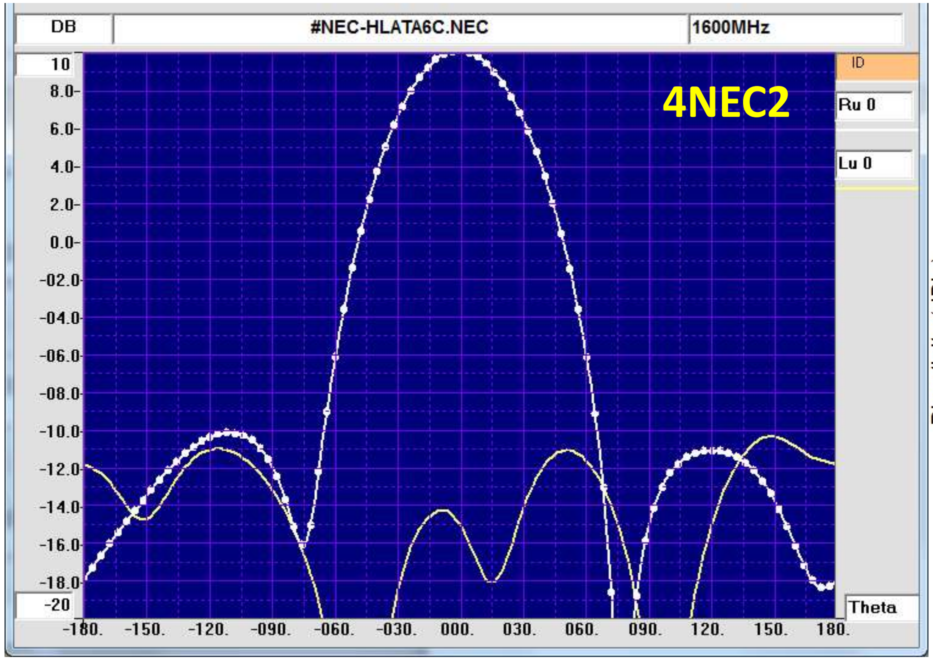


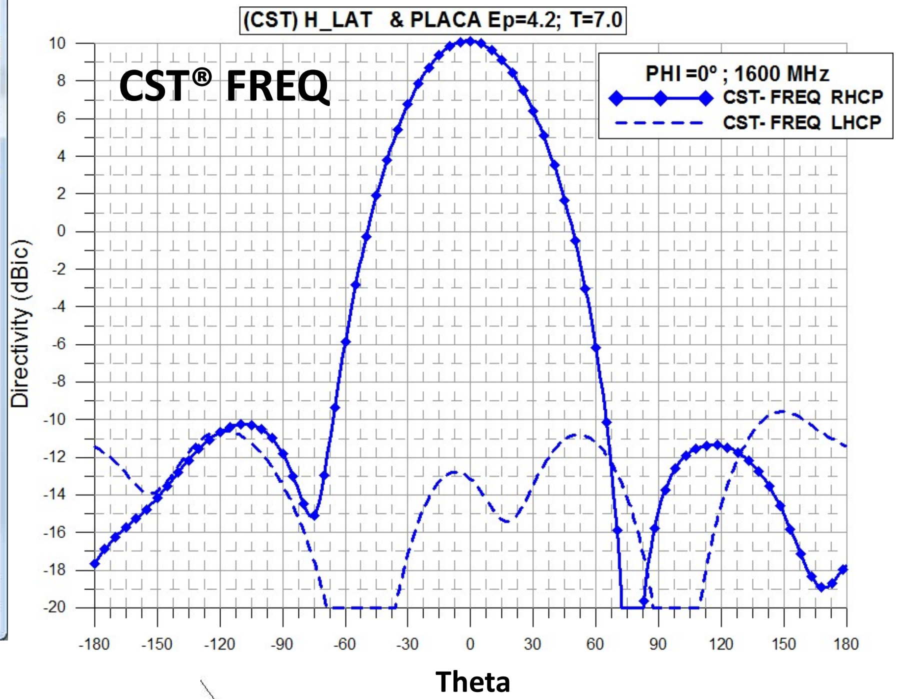


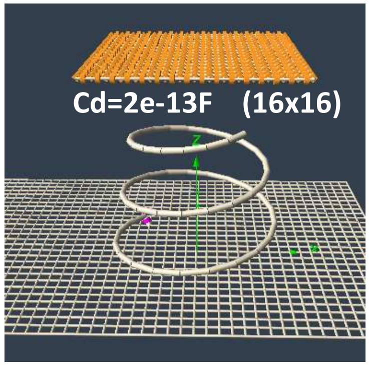


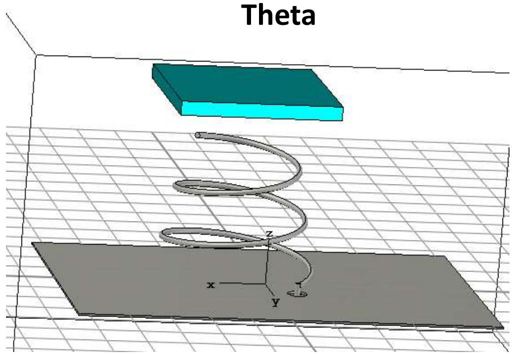
HELIX WITH DIELECTRIC: PATTERN (Phi=00º & 1600MHz)

T = 7mm ; ε' = 4.2

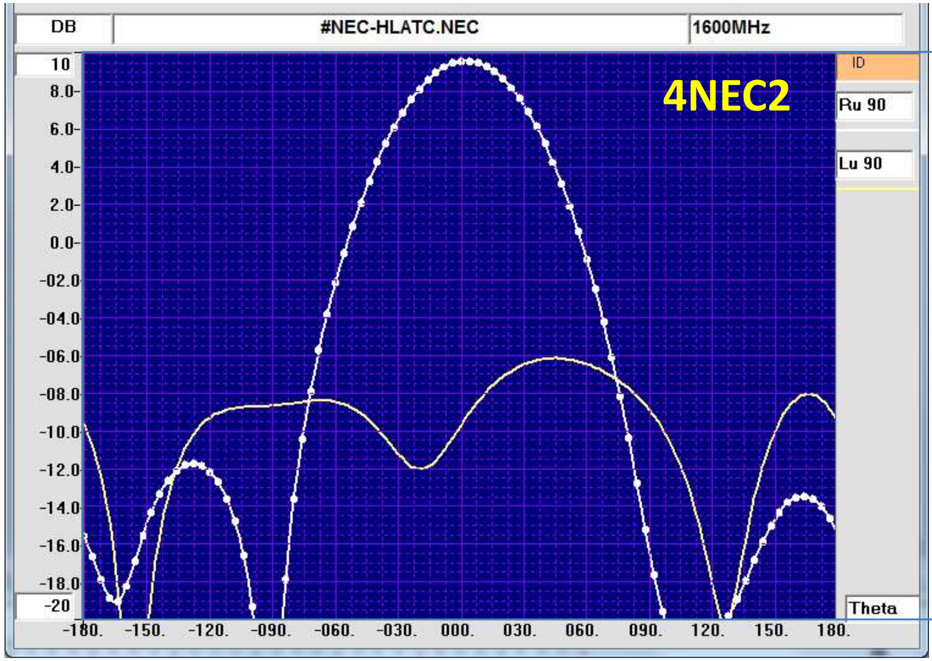


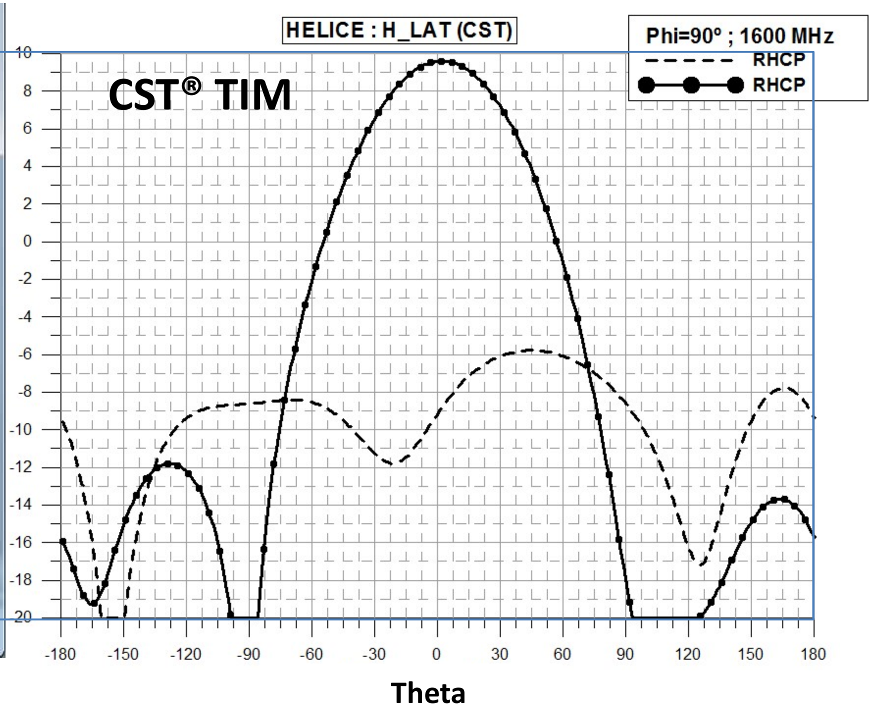


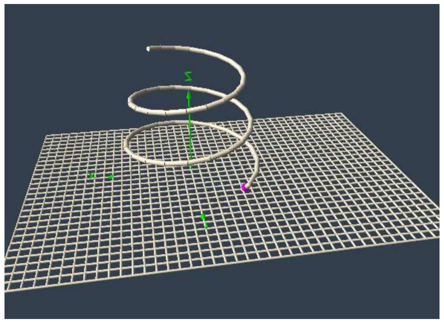


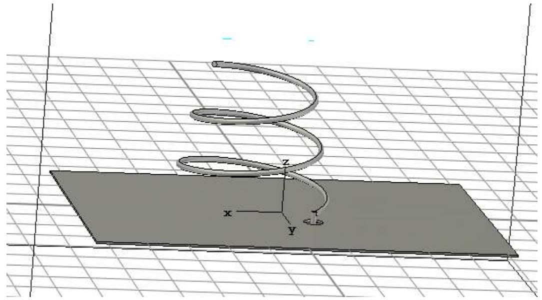


HELIX WITHOUT DIELECTRIC: PATTERN (Phi=90° & 1600MHz)



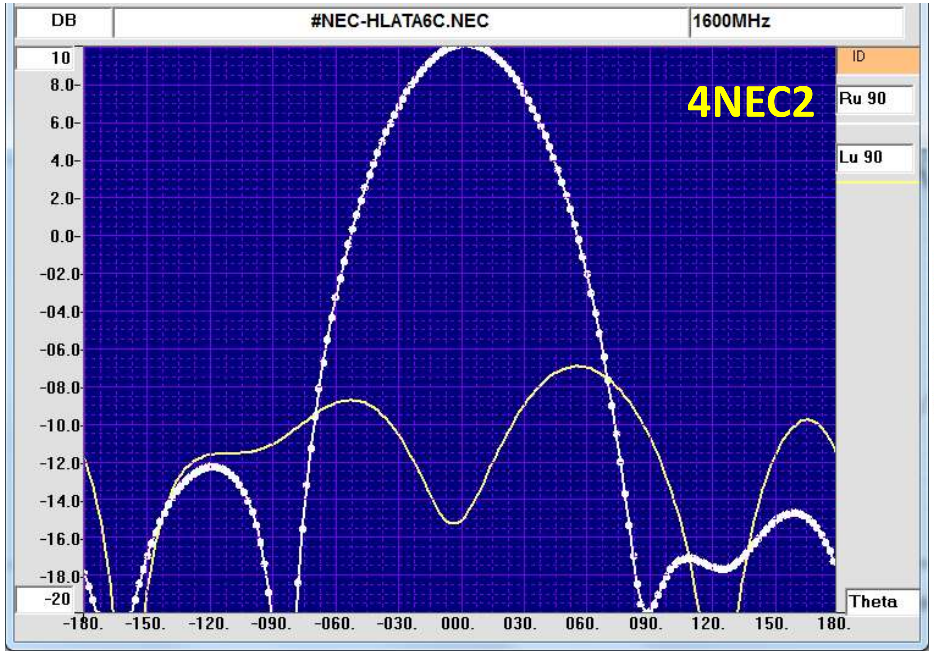


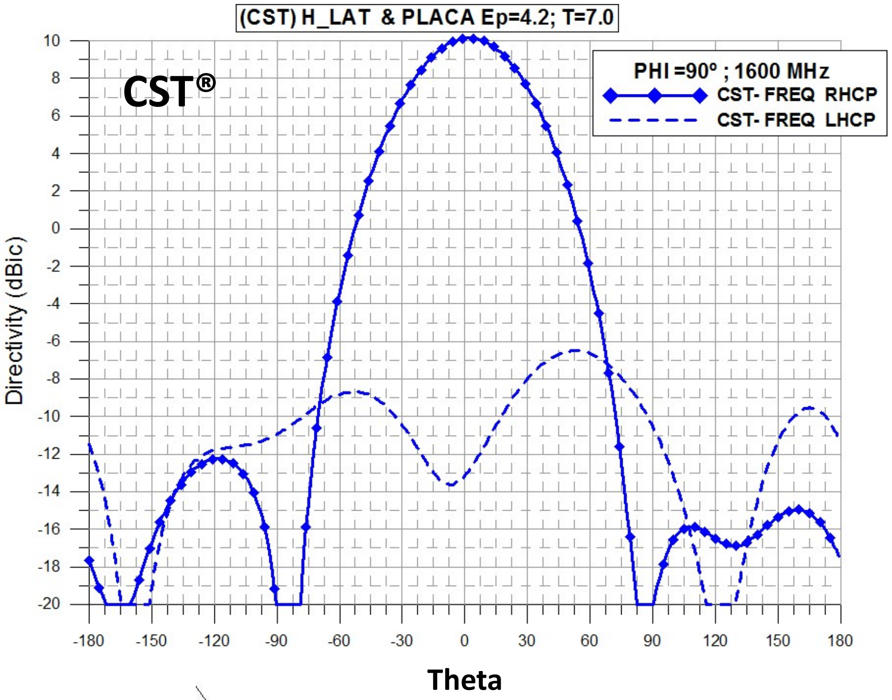


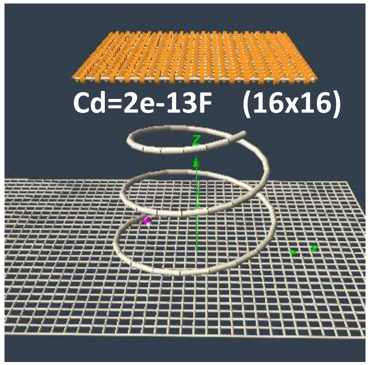


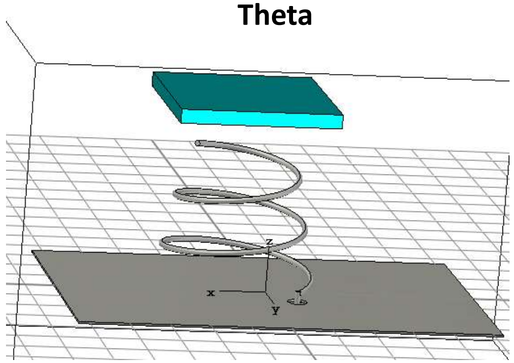
HELIX WITH DIELECTRIC: PATTERN (Phi=90º & 1600MHz)

T = 7mm ; ε' = 4.2



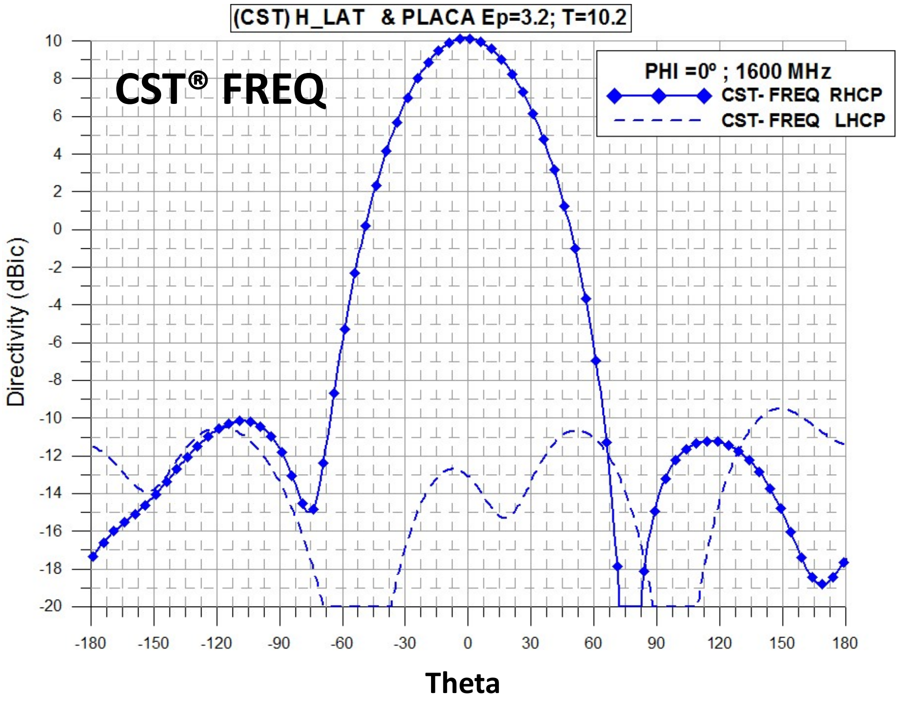


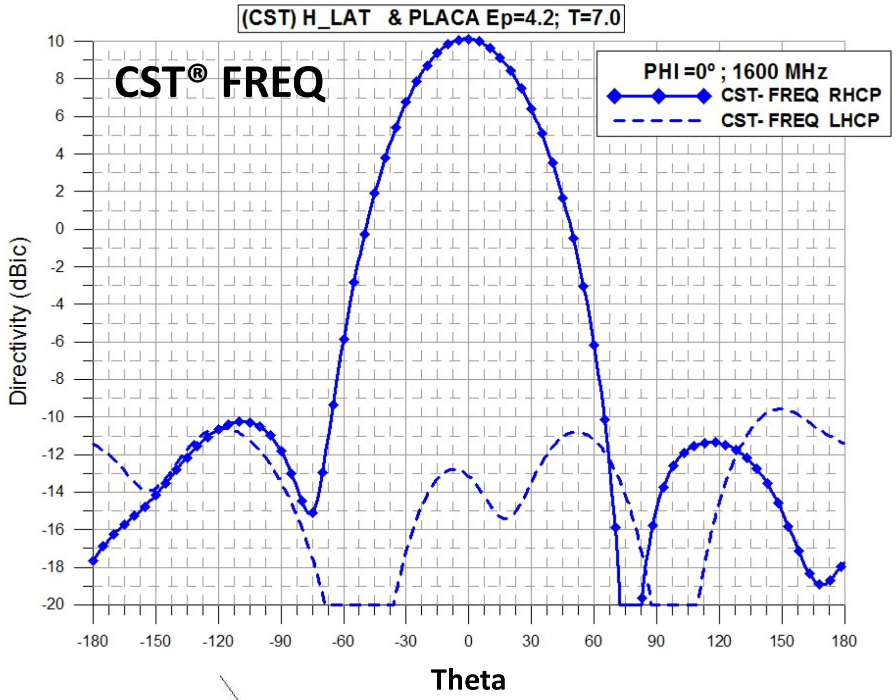


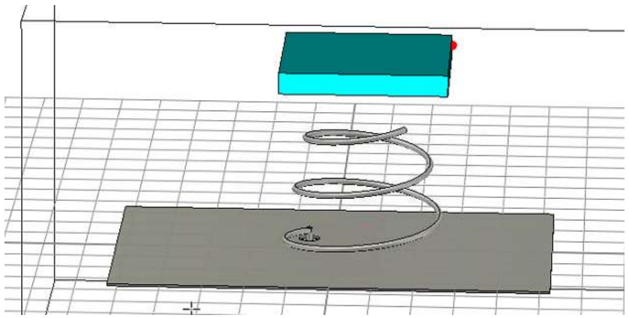


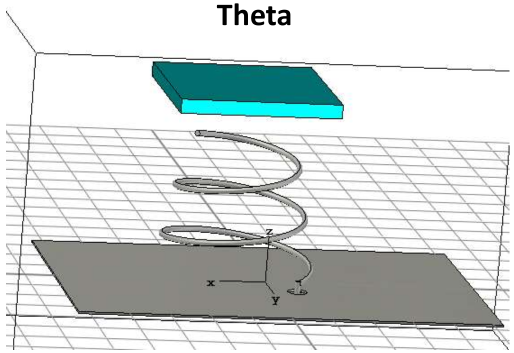
HELIX PLUS DIELECTRIC PLATE : PATTERN (Phi=00º & 1600MHz)

T = 10.2mm ; ε' = 3.2 **EQUIVALENT** T = 7mm ; ε' = 4.2









HELIX PLUS DIELECTRIC PLATE : PATTERN (Phi=90º & 1600MHz)

T = 10.2mm ; ε' = 3.2 ⟷ **EQUIVALENT** ⟷ **T = 7mm ; ε' = 4.2**