EDISON

Electromagnetic Design of
flexIble SensOrs

FNP Team-Tech

Report 3. Simulation of bent antenna

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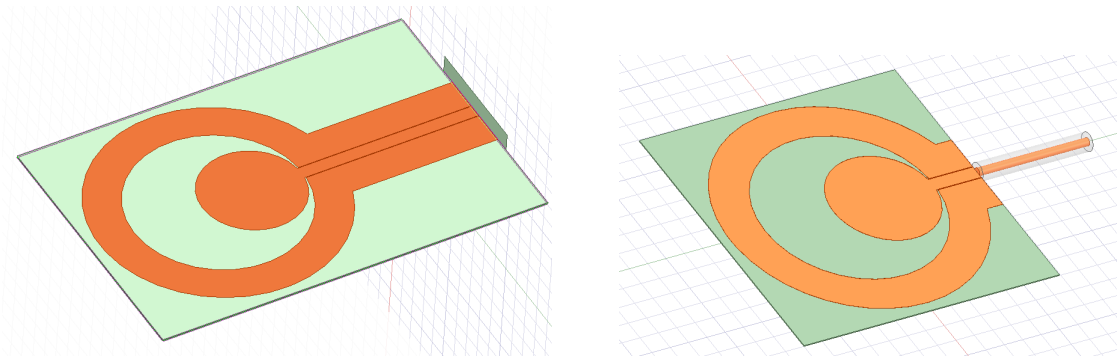
1 Introduction

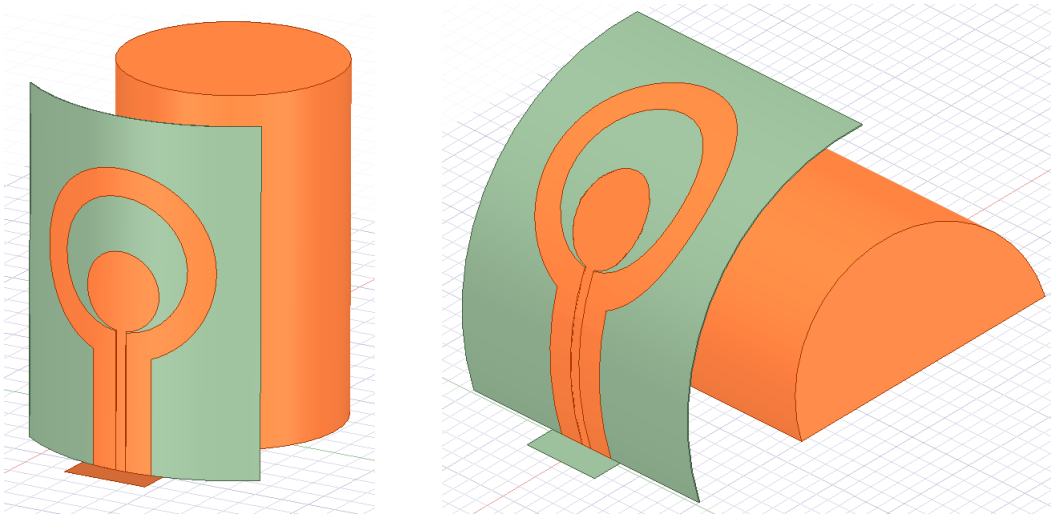
The purpose of work undertaken in this period was to validate simulation in InventSim of antenna projected onto bent surface. The reference simulation of the structure was performed in HFSS and results of analysis were compared.

2 Model of the antenna

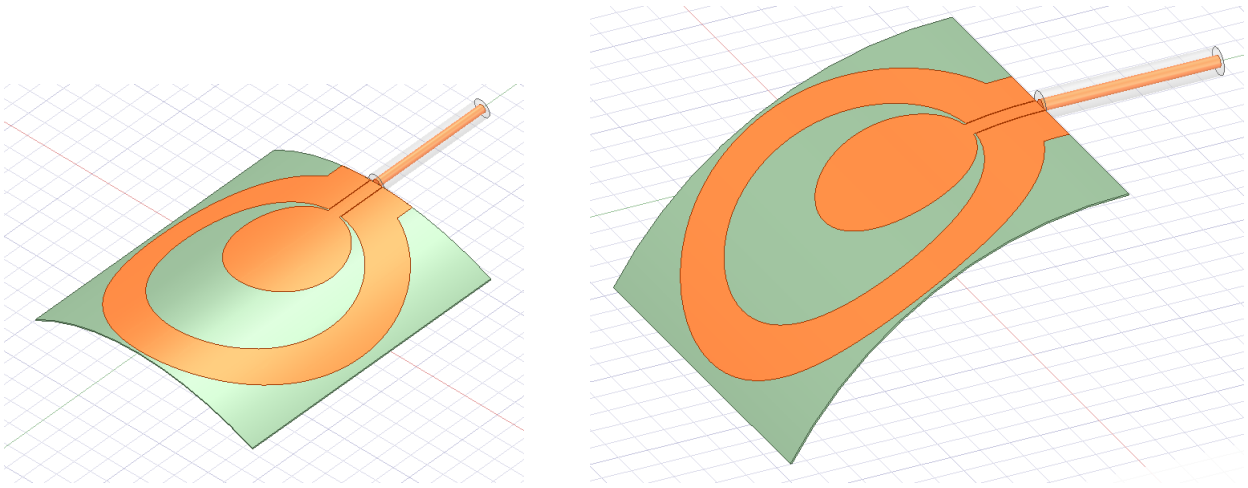
The structure of the antenna is based on [1]. It is planar, ultra wide band antenna, with operating bandwidth from 1 GHz to x GHz. In the simulations, 6 variants of structure were considered: planar structure with microstrip feed, planar with coaxial line feed, bent antenna along X axis and along Y axis. For each bent antennas (along X and Y axis) two cases were simulated: with metallic cylinder, microstrip feed and without cylinder, coaxial line feed. To clarify these, models described above are presented in the following figures:



Planar antenna with microstrip line feed and with coaxial line feed



Microstrip feed antenna with metallic cylinder bent along X and Y axis

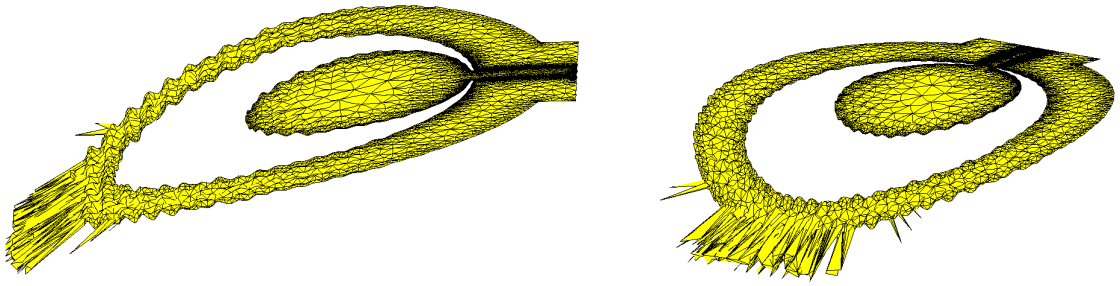


Coaxial line feed antenna without metallic cylinder bent along X and Y axis

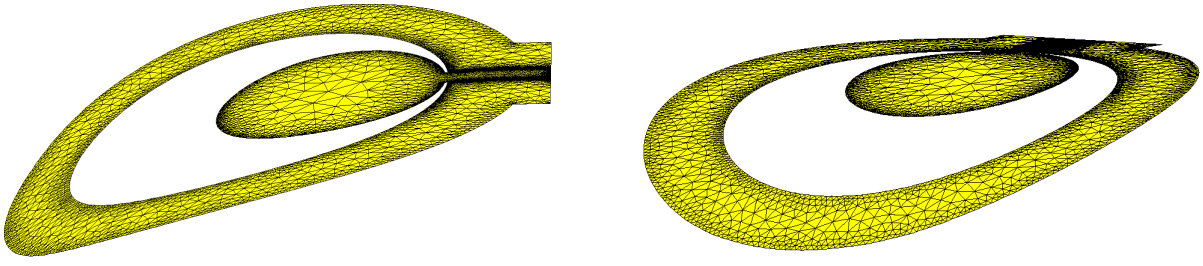
3 Antenna projection

The model of the antenna has been bent using mesh projection algorithm based on radial basis function, which has been described in previous reports. The antenna was has been projected onto surface of cylinder. The profile of curvature is presented below:

Although such procedure has been tested on rather simply structures, in case of more complex model some problems occurred. The figures below present an incorrectly projected mesh:



The proper deformation of the structure has been achieved by adjusting parameters of the project algorithm: β and number of radial basis function. The correct model of bent structure is presented in the next figures:



4 Results of simulation

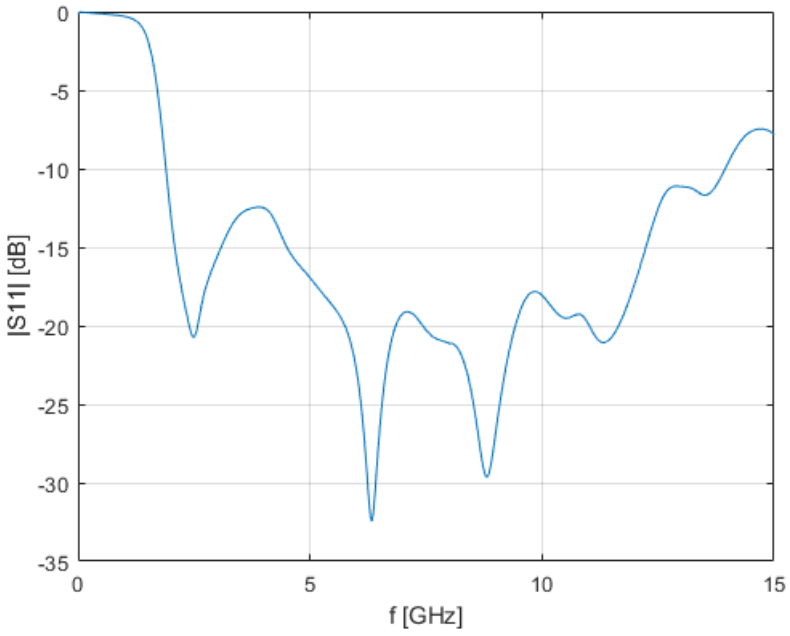
Correspondence of antenna variant and results source is presented in table below:

Antenna type \ Results source	Article	HFSS	InventSim
Planar, microstrip feed	✓	✓	
X bent, microstrip feed, with cylinder	✓	✓	
Y bent, microstrip feed, with cylinder	✓	✓	
Planar, coaxial feed		✓	✓
X bent, coaxial feed, without cylinder		✓	
Y bent, coaxial feed, without cylinder		✓	✓

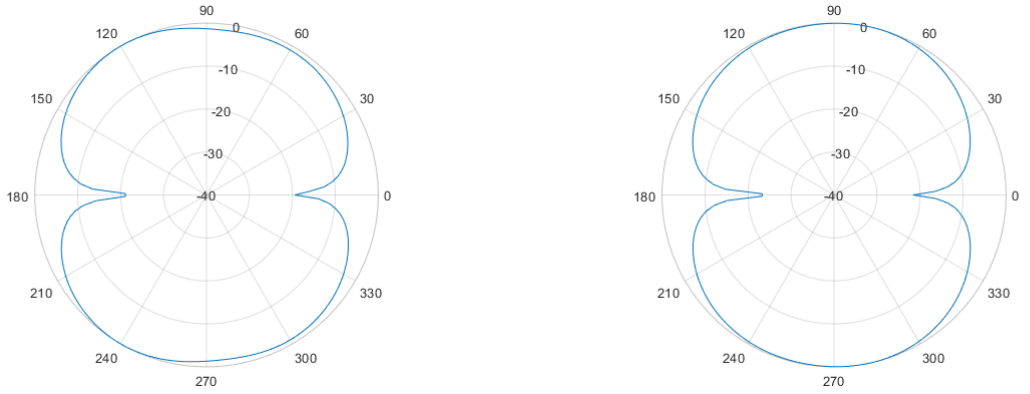
Simulation of planar structure with microstrip and bent antenna with metallic cylinder were performed to confirm correctness between results from article and HFSS model. Due to inability of projection antenna with metallic cylinder onto curved surface, in InventSim the structure without it were analyzed. Also, since coaxial line is closed structure and does not affect radiation pattern, the microstrip feed was replaced with coaxial one. Similar model was made in HFSS and results were compared. The simulation in InventSim of antenna bent along X axis is not yet performed, because of some problems with plotting analysis results. As soon as this problem will be solved, the simulation of X-bent will be performed.

4.1 Planar antenna with microstrip feed

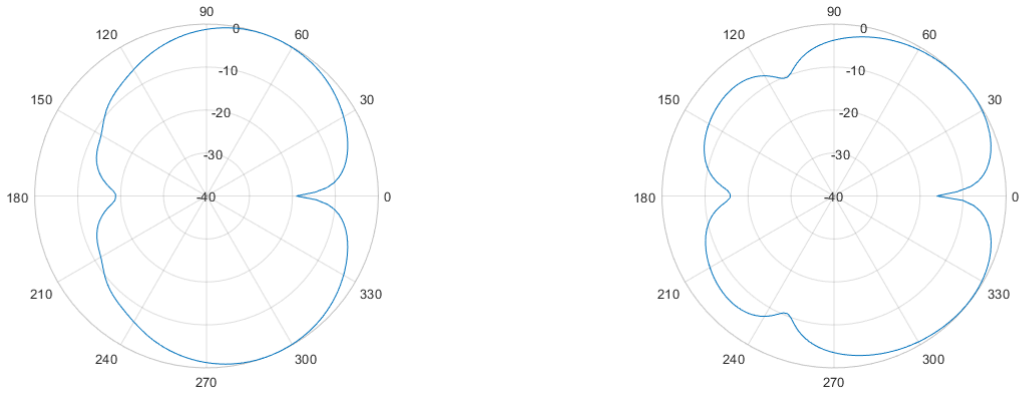
Simulations has been performed in HFSS and results has been compared with article [1].



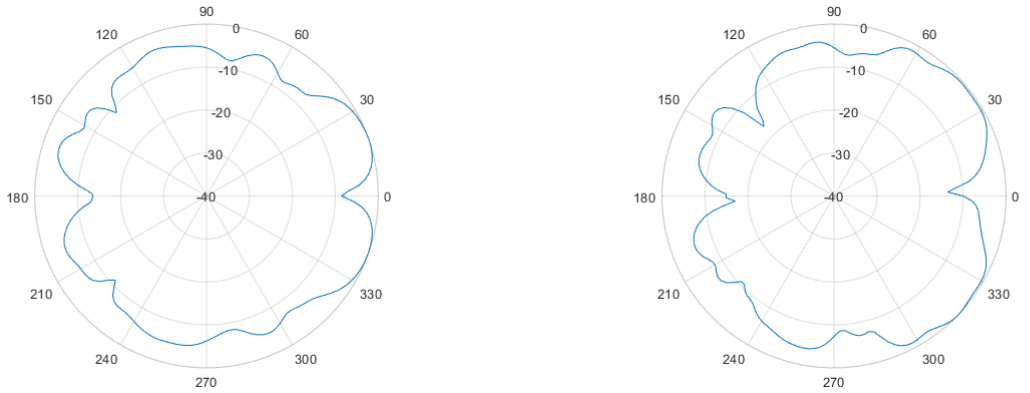
Characteristics of $|S11|$ parameter



Radiation patterns at 3GHz for XZ and YZ plane



Radiation patterns at 5GHz for XZ and YZ plane



Radiation patterns at 10GHz for XZ and YZ plane

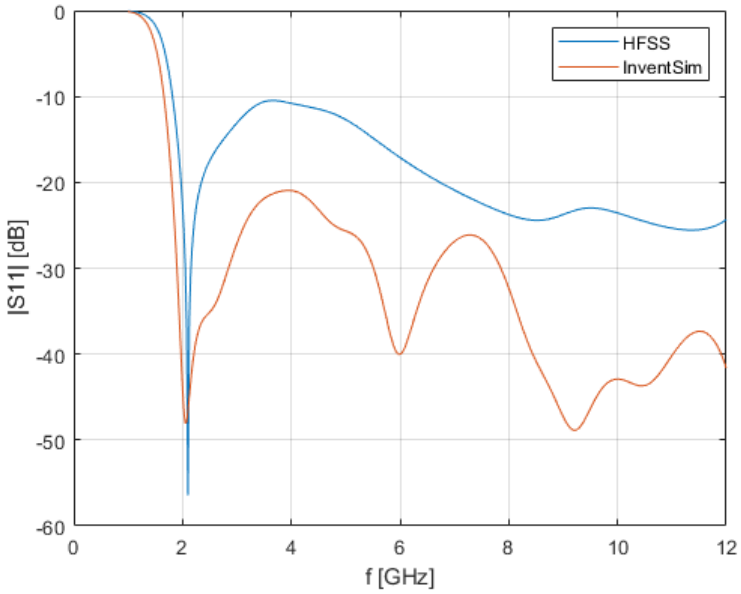
$|S11|$ characteristics corresponds to results from article - the operating band of this antenna (where $|S11|$ is less than -10 dB from 2 GHz to 12 GHz. However there is some problem with radiation patterns - it is possible that far field is computed correctly , but the failure occurs at plotting the pattern. It could be caused by misinterpreted the spherical coordinates in processing the data and characteristics are drawn wrong.

4.2 Antennas bent along X and Y axis, microstrip feed with metallic cylinder

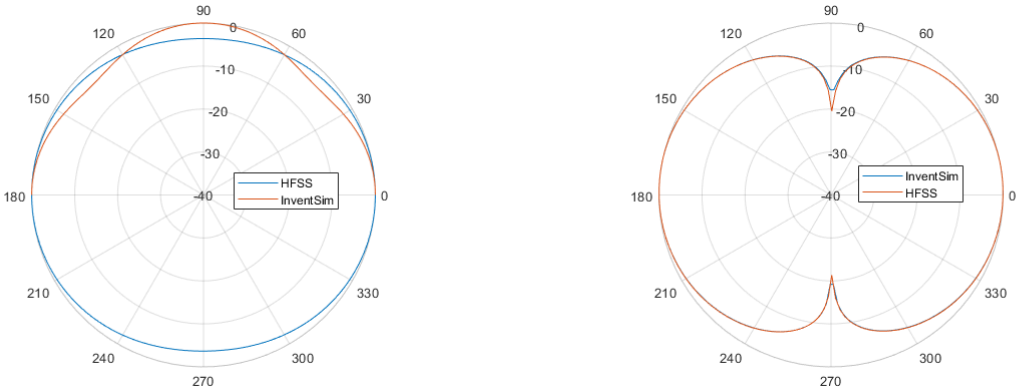
The same problem as in previous section occurs.

4.3 Planar antenna with coaxial feed

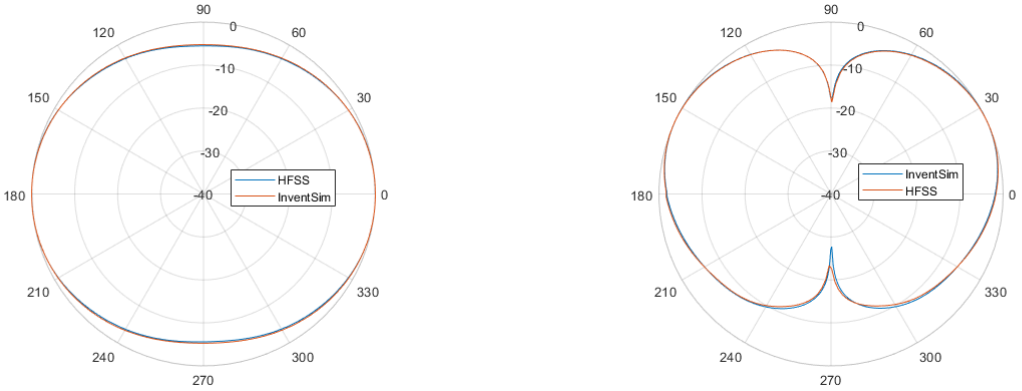
Simulations has been performed in InventSim and HFSS.



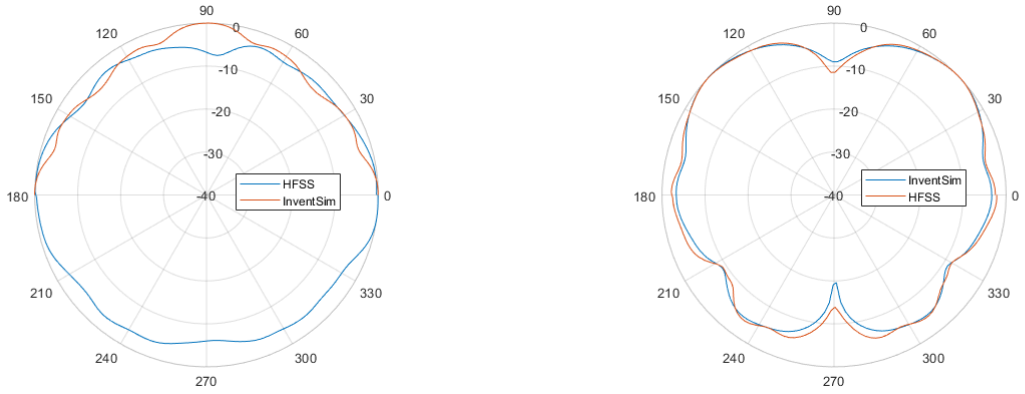
Characteristics of $|S11|$ parameter



Radiation patterns at 3GHz for XZ and YZ plane



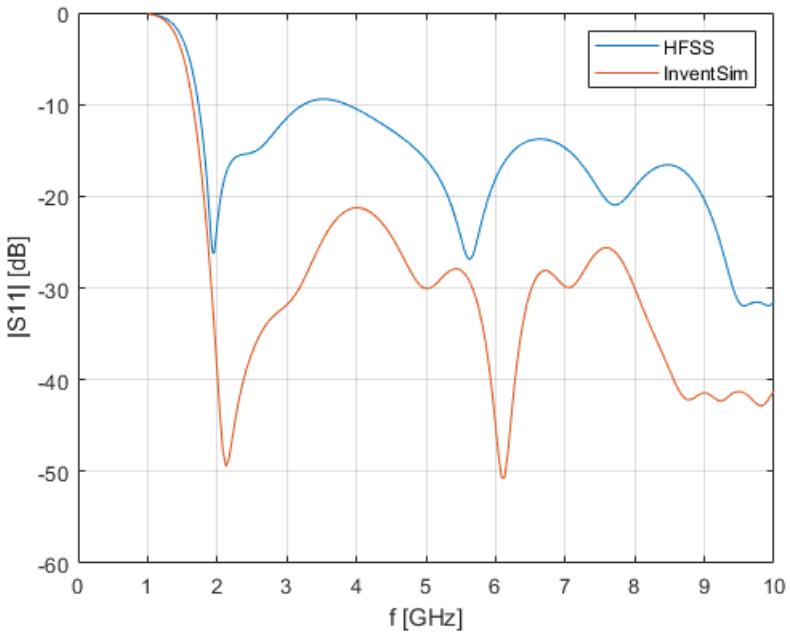
Radiation patterns at 5GHz for XZ and YZ plane



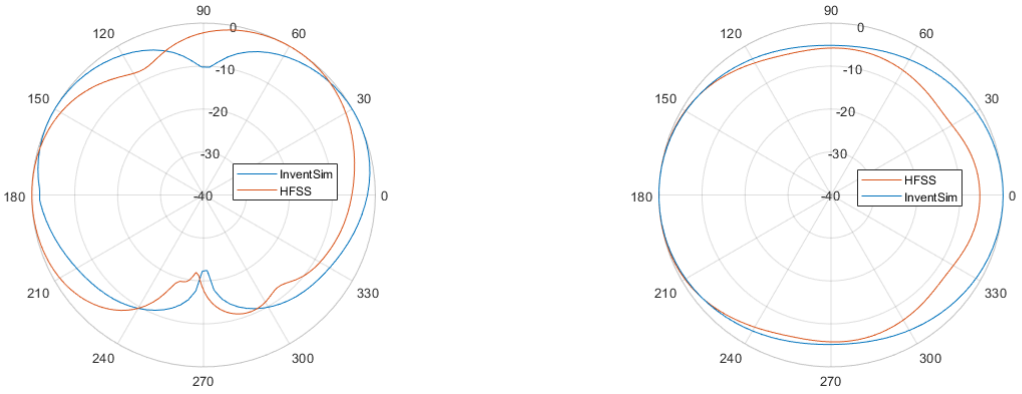
Radiation patterns at 10GHz for XZ and YZ plane

First resonant frequency for S parameter is exactly the same for both results, but in general $|S11|$ characteristics from InventSim and HFSS differs. It could be effect of finite metal thickness in InventSim, while in HFSS it is infinitely thin. The radiation patterns are convergent, except XZ plane for 3 GHz and 10 GHz. This could be due to less accurate radiation pattern calculation - the analysis for this two cases were performed with lower angular resolution than in simulation at 5 GHz.

4.4 Antenna bent along Y axis, coaxial feed without metallic cylinder



Characteristics of $|S11|$ parameter

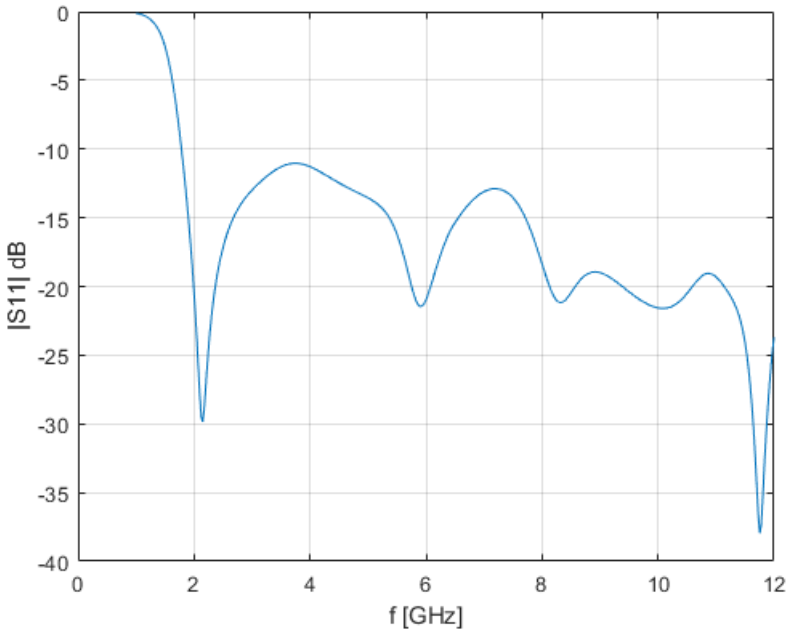


Radiation patterns at 5GHz for XZ and YZ plane

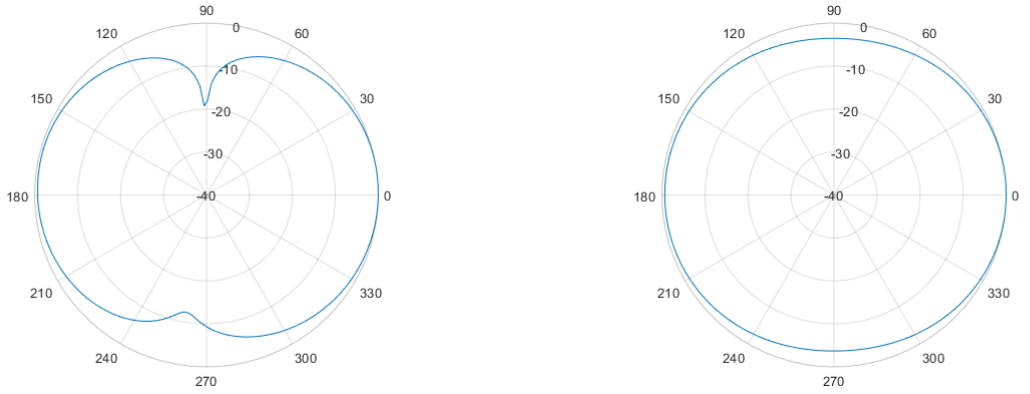
The resonant frequencies in S parameter characteristics from HFSS differs from InventSim by 100 MHz at first resonance and nearly 0.5 GHz at the second one. Moreover, characteristic from HFSS is much higher in whole operating band. Also, the radiation patterns are not convergent. There is a suspicion that this is caused by plotting problem mentioned above.

4.5 Antenna bent along X axis, coaxial feed without metallic cylinder

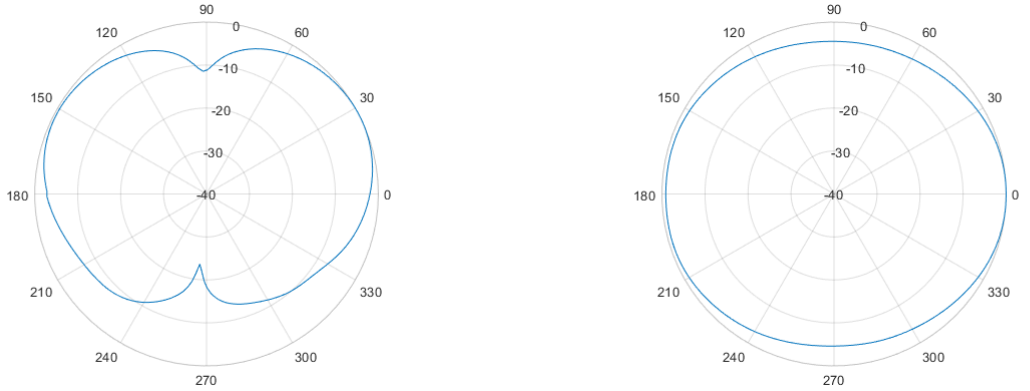
This section contains results only from HFSS.



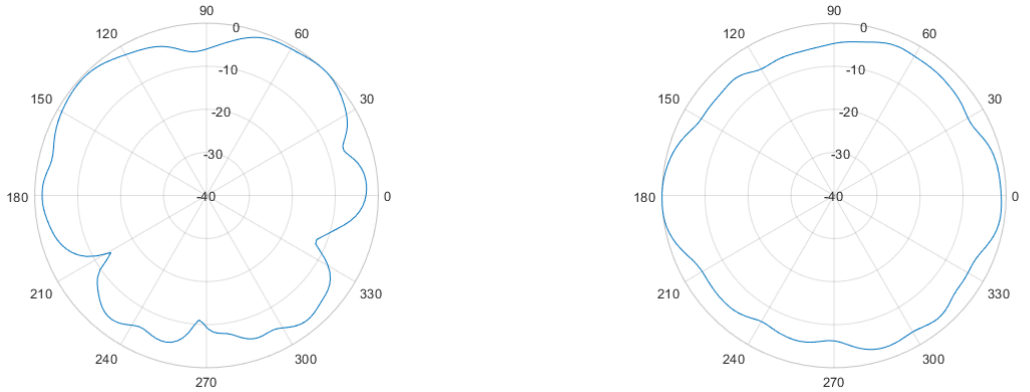
Characteristics of $|S11|$ parameter



Radiation patterns at 3GHz for XZ and YZ plane



Radiation patterns at 5GHz for XZ and YZ plane



Radiation patterns at 10GHz for XZ and YZ plane

The results are ready for this antenna variant, but for now there is no reference to check validity of this solution. It could be done, assuming that difference between feed method is irrelevant, but simulations shows that microstrip line affects radiation pattern in other way than coaxial line.

5 Further work

The work in the nearest future will be focused on investigating the source of divergence in simulation results. Currently, a work on comparing 3d radiation patterns are in progress in order to solve problem with spherical coordinates misprocessing. Also, the differences between S parameter characteristics will be investigated.

References

[1] R. Lech, W. Marynowski, A. Kusiek, "Finite ground CPW-FED UWB antenna over the metallic cylindrical surfaces", Progress In Electromagnetics Research, Vol. 140, pp. 545-562, 2013.