Electromagnetic Design of
flexIble SensOrs

Report 4. Further simulations of bent antenna

Maciej Jasiński
July 1, 2019

The „EDISOn - Electromagnetic Design of flexIbleSensOrs"project, agreement no TEAM TECH/2016-1/6, is carried out within the TEAM-TECH programme of the Foundation for Polish Science co-financed by the European Union under the European Regional Development Fund.

Revision	Date	Author(s)	Description
1.0	30.06.2019	M. Jasiński	created

1 Introduction

The work progress, summarized in the previous report, has finished at divergent simulation results from HFSS and IventSim. The main goal at next period was to find the source of discrepancies and acquire proper result from InventSim.

2 Investigation of radiation pattern calculation procedure

In the last report, the discrepancies were noticed by comparing radiation patterns of bent antenna from InventSim and HFSS. Firstly, the improper way of characteristics plotting was considered as potential reason of results disagreement. By plotting the 3D radiation patterns it was found out, that error was somewhere else.

The next suspicion were related to the mesh projection algorithm. In order to investigate correctness of projection algorithm, the RBF representation of projection surface was replaced by analytic representation.

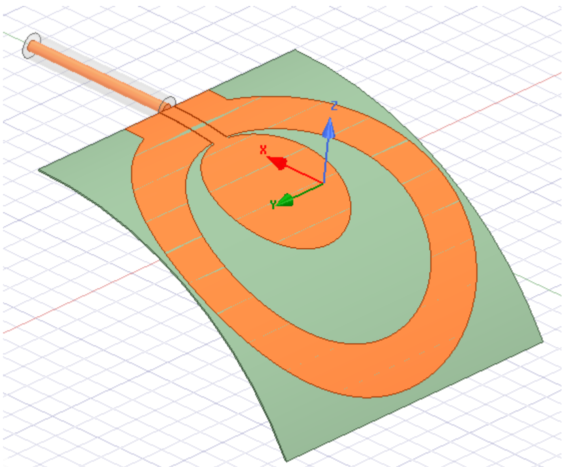
The comparison of structures bent by both algorithms showed that they were different and the improper mesh projection procedure was the source of discrepancies. In the next step, the RBF algorithm was fixed and the correct bent structure were obtained.

3 Simulation of bent antennas

Two antennas were projected onto cylinder and analyzed in InventSim and HFSS. The bending was performed in two cases for each antennas: along x and along y axis of the antenna.

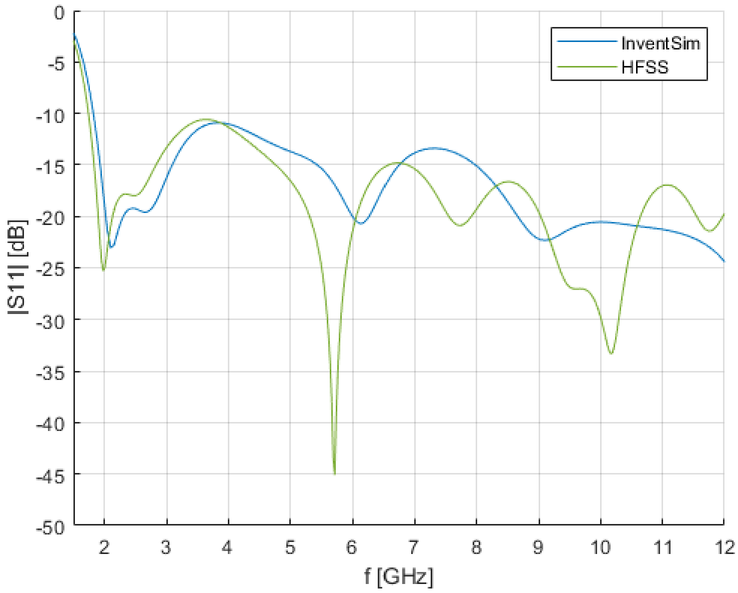
3.1 UWB antenna bent along X axis

The simulated antenna is based on [1]. It is planar UWB antenna projected onto lateral surface of cylinder. The diameter of cylinder is equal to 70 mm. The only difference between structure in InventSim and article is lack of metal cylinder under substrate in simulated structure. It is caused by inability of bending some non-planar objects. Since metal cylinder was removed, the structures from article and analysis were not identical. In order to compare results to reference data, the same antenna was simulated in HFSS.



Antenna structure

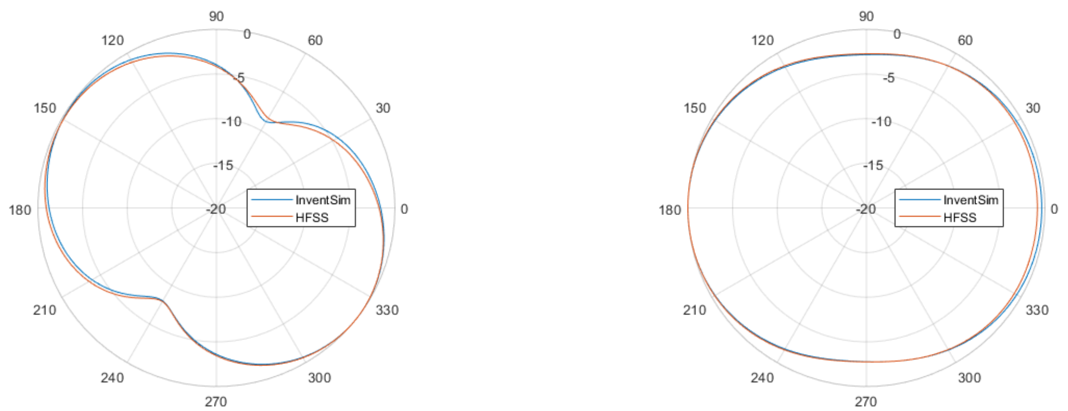
The |S11| parameter characteristics from both simulations are converge for lower frequencies. For frequencies range from 5 to 12 GHz some differences occurs, but in general there is an accordance between obtained results.



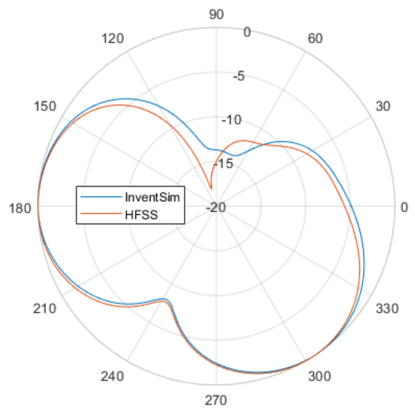
|S11| characteristic

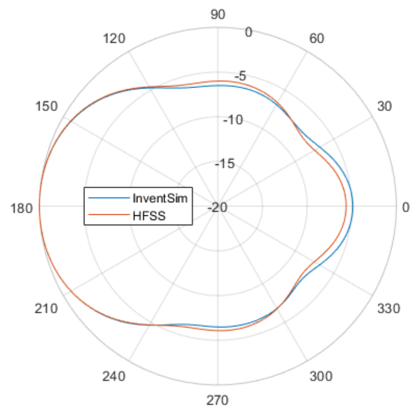
The radiation patterns at 3 GHz match well. At 5 GHz there are some minor discrepancies, but again there is high level of agreement between simulations. The patterns are the most different at 10 GHz, but still the main character of the antenna can be observed.

The analysis of radiation patterns and |S11| characteristics indicates that the error grows with frequency. It may be the effect of the mesh density, which could be not enough for high frequencies.

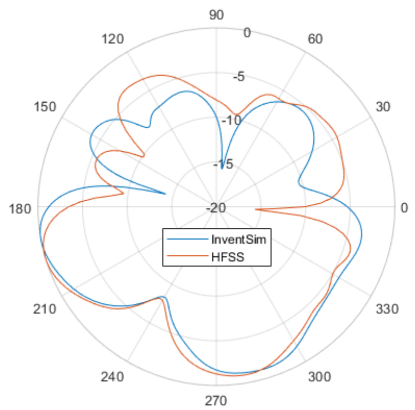


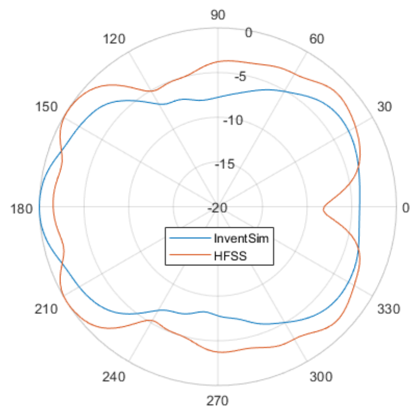
Radiation patterns at 3 GHz. XZ plane (left) and YZ plane (right)





Radiation patterns at 5 GHz. XZ plane (left) and YZ plane (right)

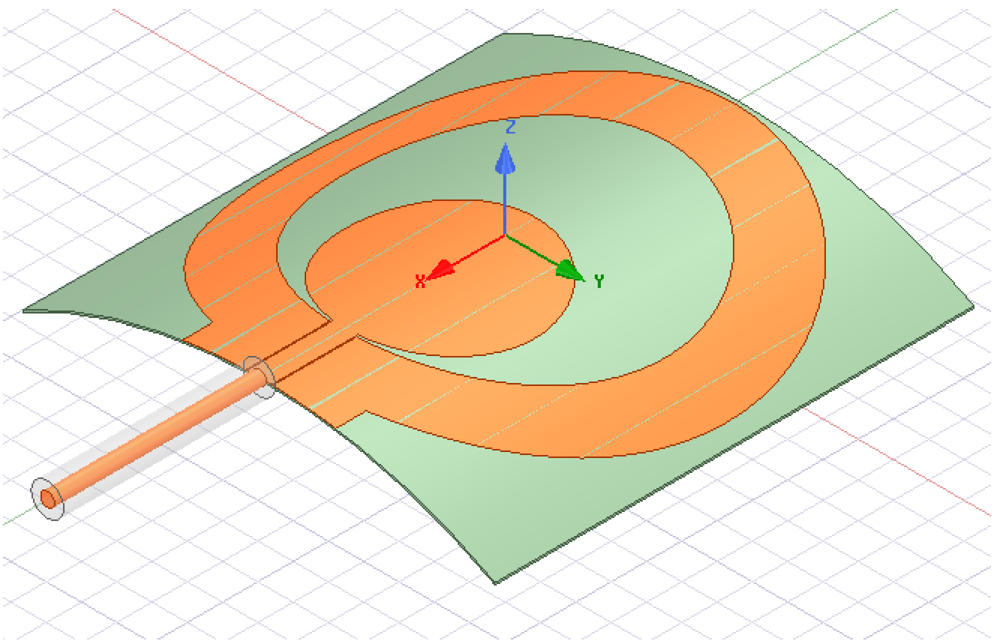




Radiation patterns at 10 GHz. XZ plane (left) and YZ plane (right)

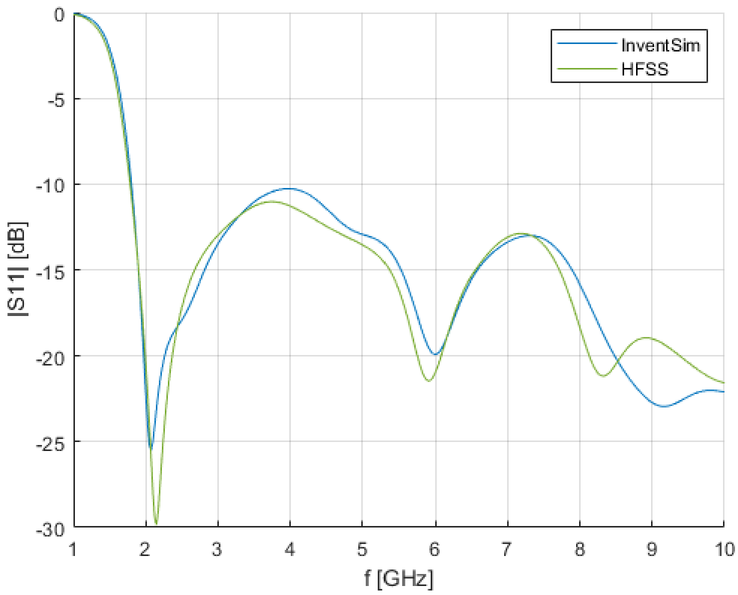
3.2 UWB antenna bent along Y axis

This structure is also based on [1], the same as previous one, but bent along Y axis.



Antenna structure

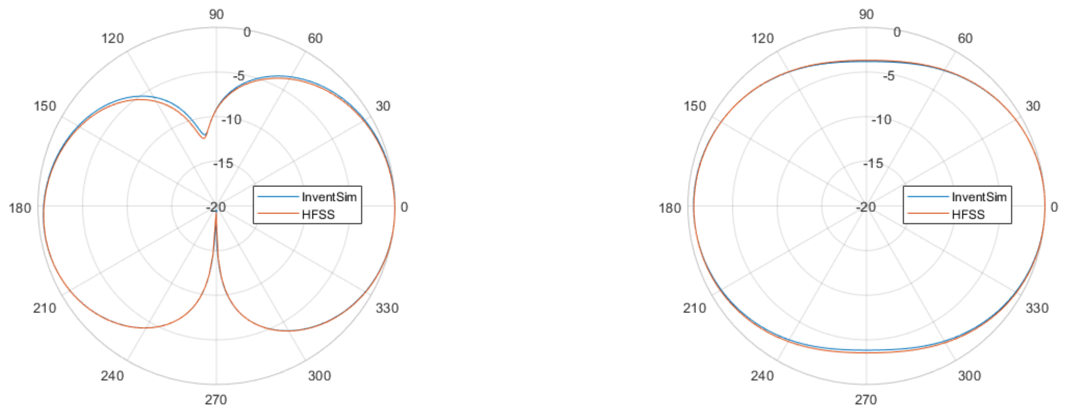
The |S11| characteristics are convergent. The first and second minimum are shifted by 100 MHz.



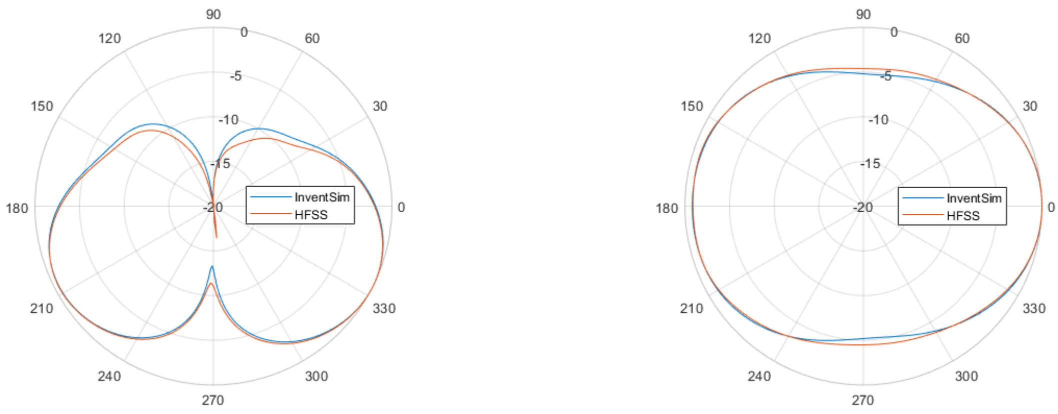
|S11| characteristic

The radiation patterns from different software are nearly the same at 3 and 5 GHz. Even at 10 GHz, the differences are much smaller than in previous case.

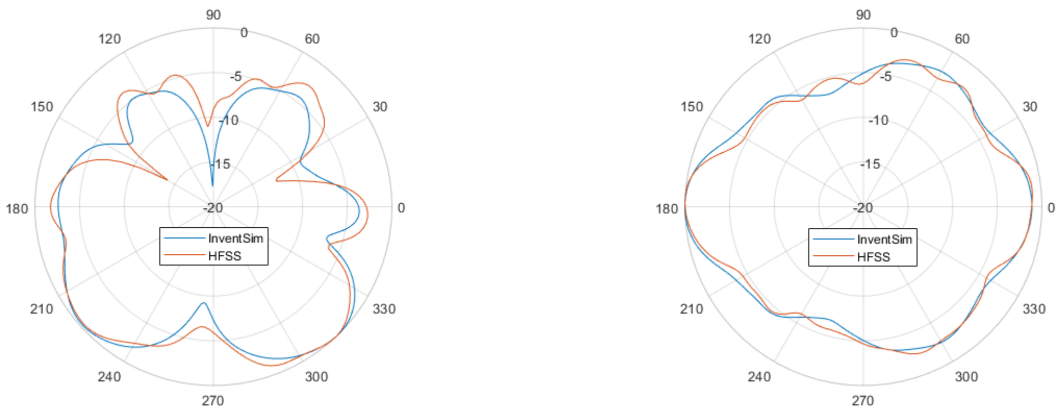
Probably, such good agreement is caused by relatively small curvature of projection surface at this case.



Radiation patterns at 3 GHz. XZ plane (left) and YZ plane (right)



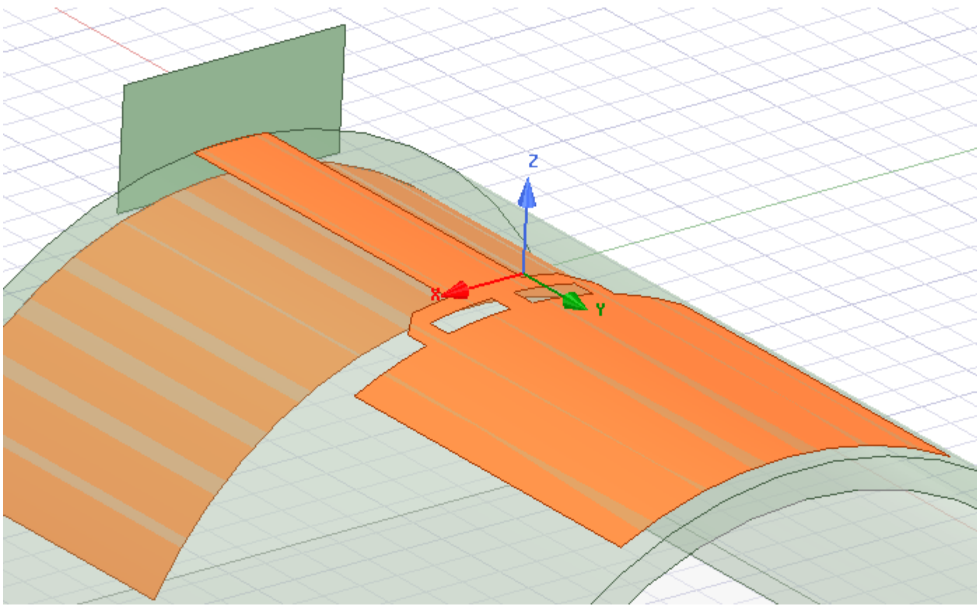
Radiation patterns at 5 GHz. XZ plane (left) and YZ plane (right)



Radiation patterns at 10 GHz. XZ plane (left) and YZ plane (right)

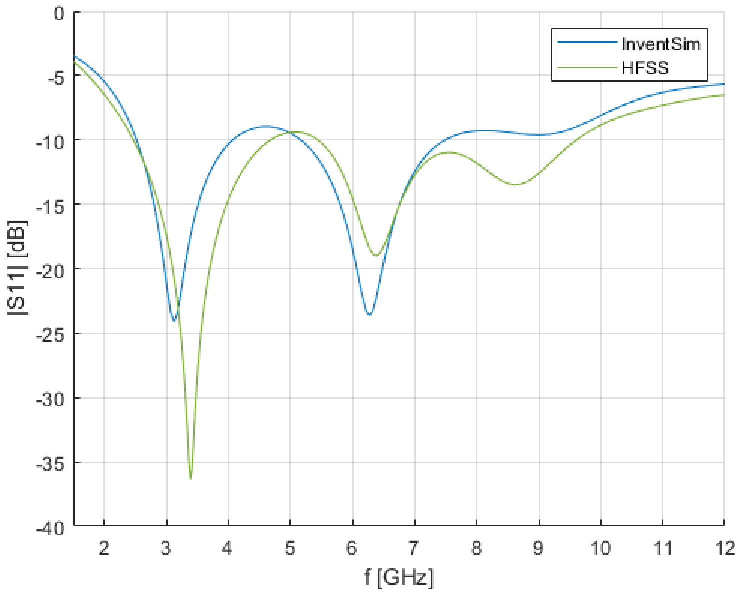
3.3 Forkfeed antenna bent along X axis

The next structure is base on [2]. It is an UWB monopole antenna with microstrip feeding line. The antenna in this case was projected onto lateral surface of cylinder with a radius of 20 mm.

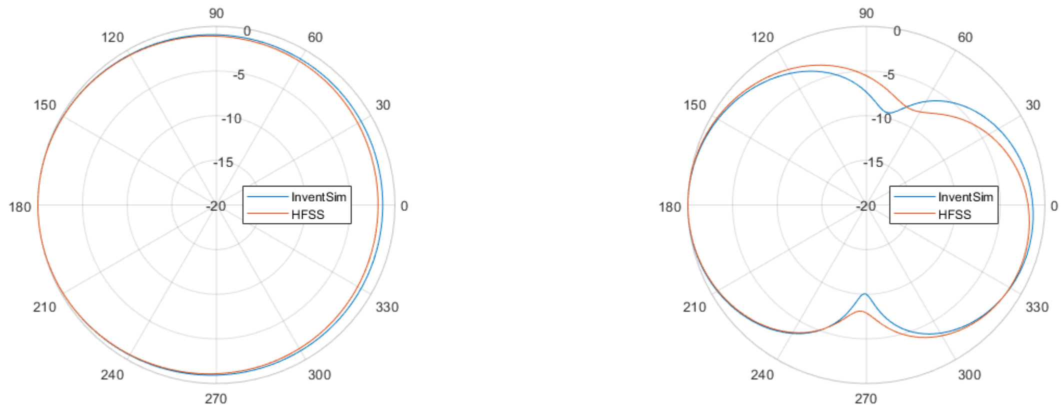


Antenna structure

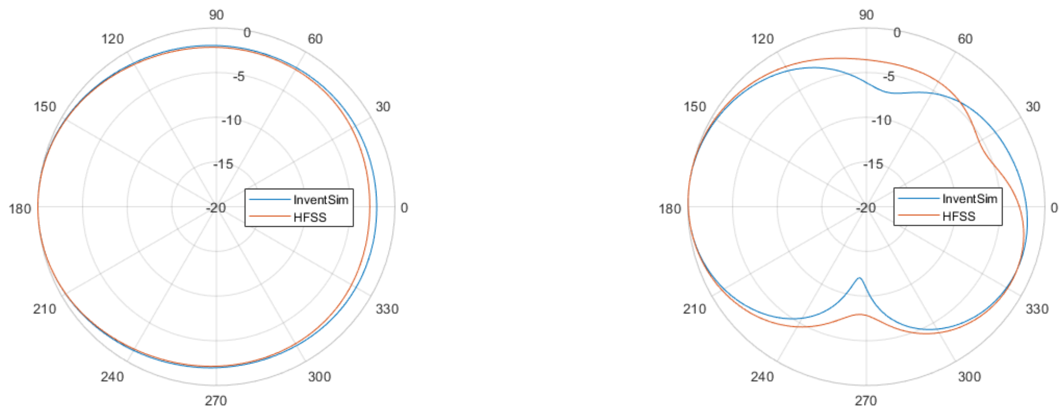
The convergence between |S11| parameter characteristics is achieved. The radiation patterns from InventSim and HFSS are very similar, but the differences can be noticed. Again, the maximum error occurs at highest frequency.



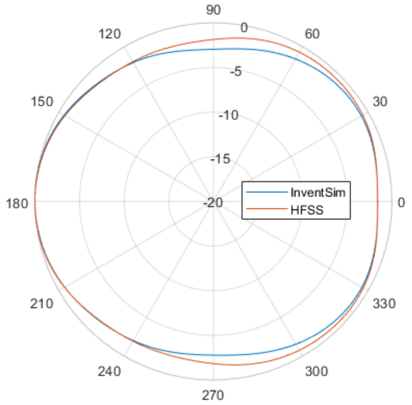
|S11| characteristic

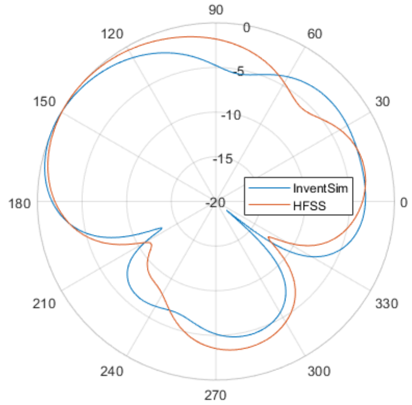


Radiation patterns at 3 GHz. XZ plane (left) and YZ plane (right)



Radiation patterns at 5 GHz. XZ plane (left) and YZ plane (right)

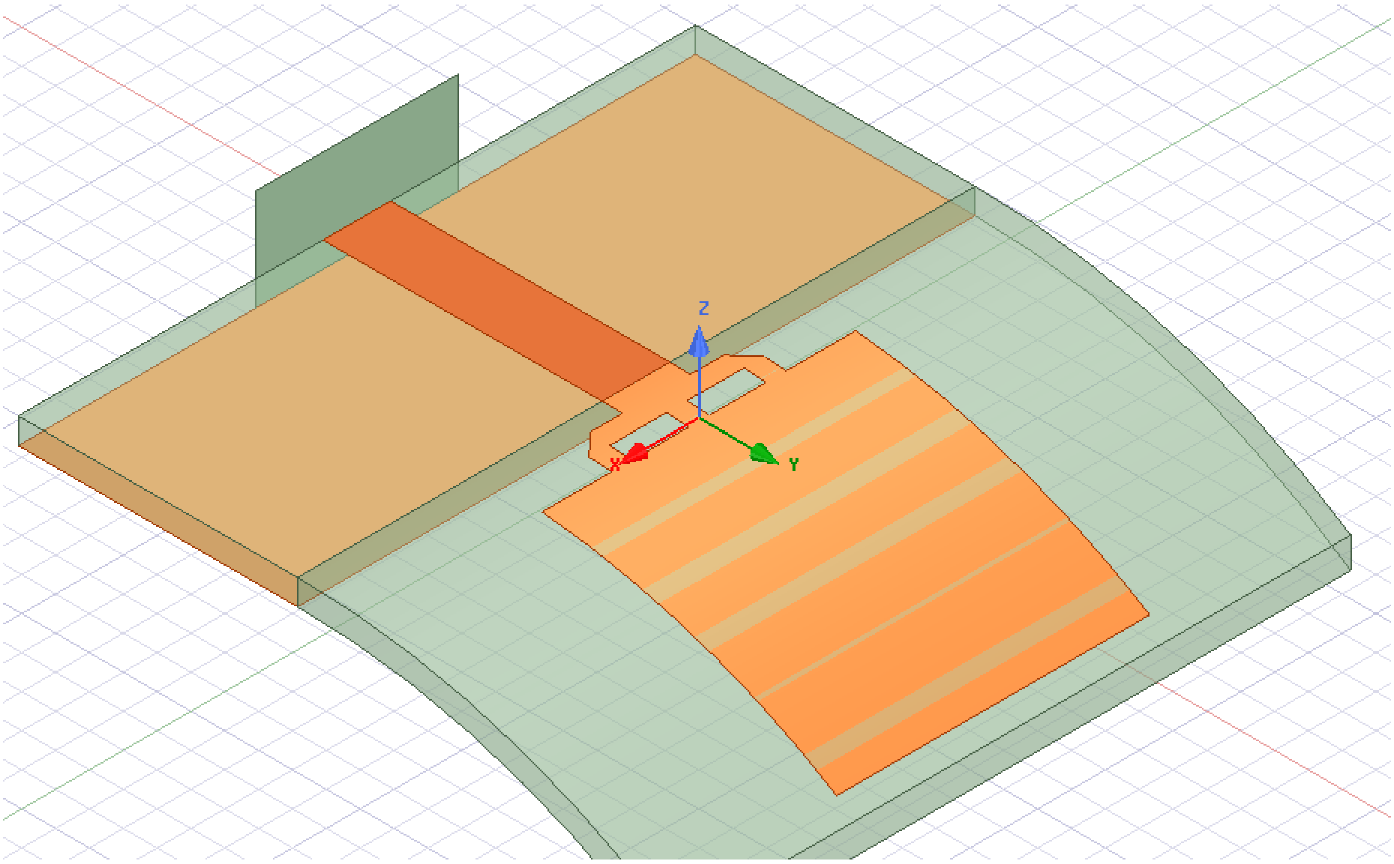




Radiation patterns at 7 GHz. XZ plane (left) and YZ plane (right)

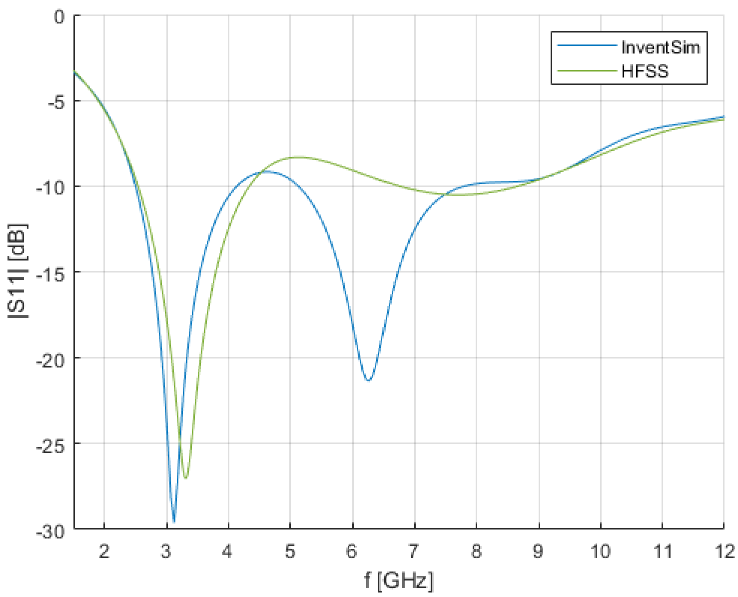
3.4 Forkfeed antenna bent along Y axis

In this section antenna based on [2] is analyzed. The structure is projected onto cylinder with a radius of 40 mm.

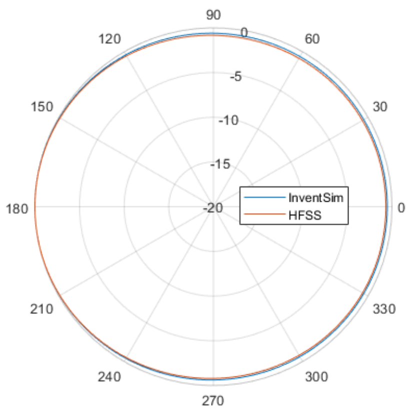


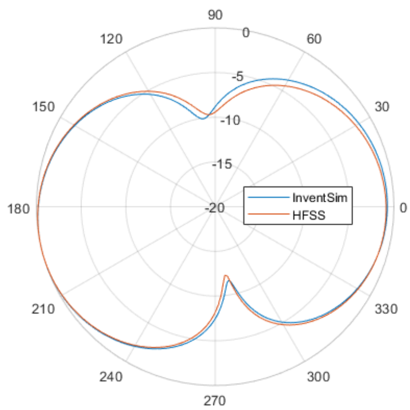
Antenna structure

Despite the lack of the minimum at 6.2 GHz, there is a high level of similarity between |S11| characteristics. The radiation patterns at 3 GHz are matched. At 5 GHz there are some differences, but patterns are very similar. Although the characteristics at 7 GHz for XZ plane are nearly the same, there is a significant mismatch between patterns in YZ plane. Once more the error grows with frequency.

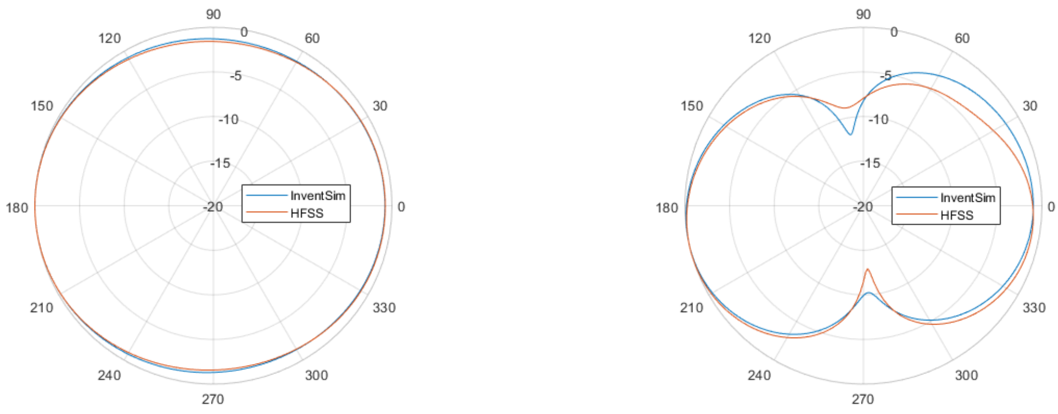


|S11| characteristic

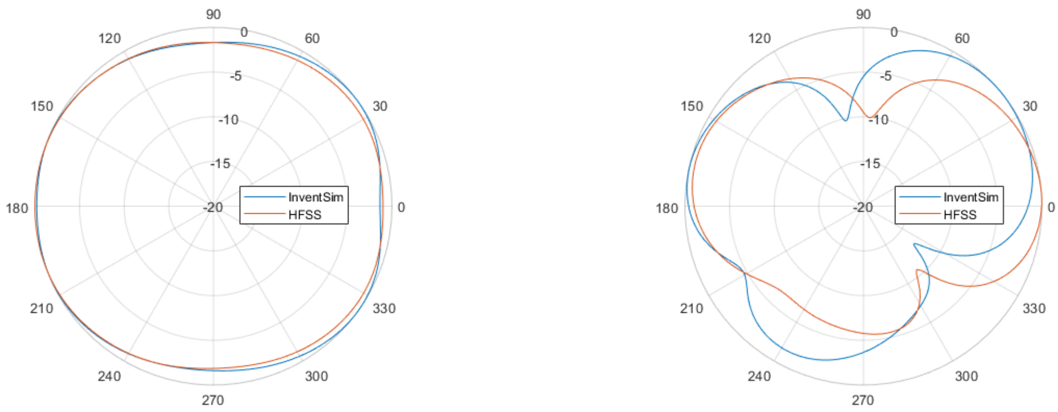




Radiation patterns at 3 GHz. XZ plane (left) and YZ plane (right)



Radiation patterns at 5 GHz. XZ plane (left) and YZ plane (right)



Radiation patterns at 7 GHz. XZ plane (left) and YZ plane (right)

4 Further work

In order to find the cause of error growth with frequency, the mesh density at higher frequencies should be checked. In the near future the comparison of results from simulation and measurement will be performed. There will be no limitation with capabilities of bending structures with arbitrary curvature - HFSS allows projection only onto some surfaces. To test projection algorithm, the surface will be varying in two directions - the lateral surface of the cone is under consideration.

5 Summary

The results of bent antenna simulations in InventSim and HFSS were compared. In general the characteristics from both software are converge. However, the error growth with frequency was found out, which, in some cases, results in significant discrepancies between radiation patterns. The direction of further work has been determined.

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.

[2] Ding Yi, Guang-Ming Wang and Zhong-Wu Yu, "Compact UWB Printed Monopole Antenna", International Symposium on Microwave, Antenna, Propagation and EMC Technologies for Wireless Communications, 2007.