Waveguide Bends

E-plane bend

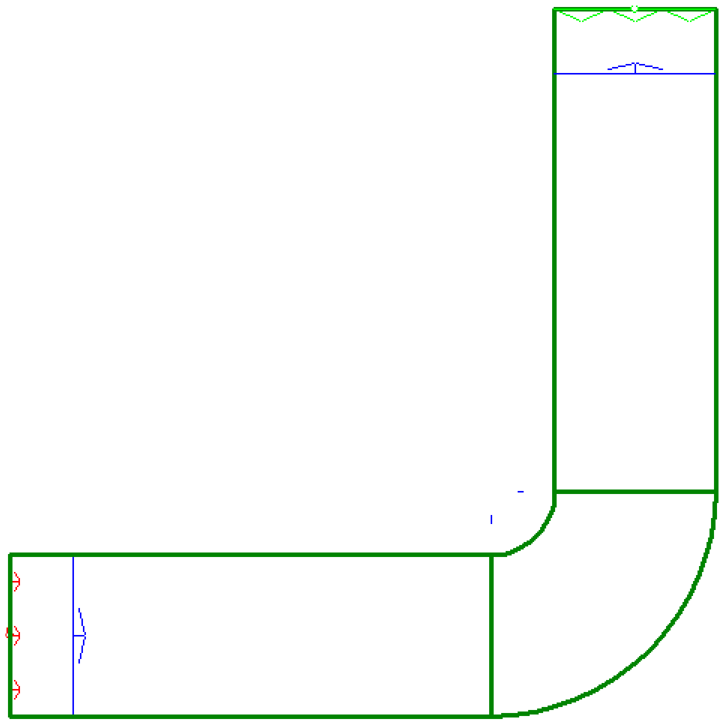

Fig. 1 Scheme of E-plane WR-10 waveguide bend proposed in [1].

Simulation scenario

Simulation model consists of E-plane waveguide bend based on WR-10 waveguide (1.27 x 2.54 mm). According to the data given in [1] there are four models considered with different values of inner radius of the bend: 0.508 mm, 0.762 mm, 1.016 mm, 1.524 mm.

In order to simulate the model properly, a variable mesh size adjusted to geometry is utilized. A maximum cell size, in all three directions, is 0.085 mm. Since present example is a non-radiating structure, the background medium is set to metal and only fields inside the structure are of interest.

The simulation scenario varies in size depending on the inner radius value and therefore, occupies 205 to 270 thousands of FDTD cells for smallest and biggest parameter value respectively, which results in 20 - 26 MB of RAM memory occupation. The FDTD simulation with QuickWave takes from 6 to 15 seconds when performing multicore computations on AMD Ryzen Threadripper 2950X 16-Core processor.

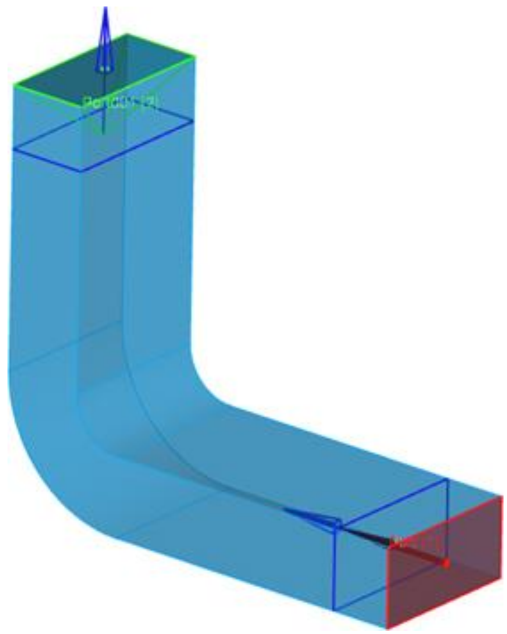

Fig. 2 Simulation model of E-plane WR-10 waveguide bend, prepared in QW-Modeller [3].

EM Simulation results

Reflection coefficient was extracted using S_{k1} postprocessing option. The circuit was excited from Port 1 (Fig. 2) and complex S_{11} was calculated.

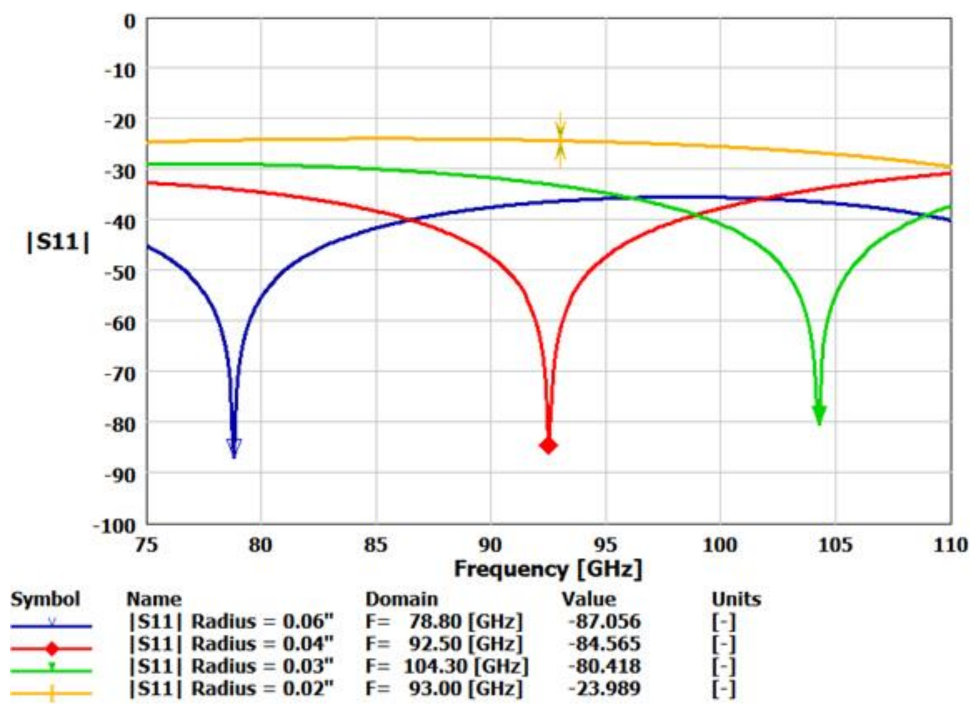

Fig. 3 Magnitude of reflection coefficient of E-plane bend for different values of the inner radius, computed with QuickWave 3D.

From the Fig. 3 it can be seen that by increasing the value of radius, the frequency of the perfect match (full transmission) between input and output, shifts towards lower range. The average magnitude of reflection coefficient in the band of interest, is reduced with increasing value of inner radius. For 0.060" bend |S11| < -37 dB across the full waveguide band.

In Fig. 4, distribution of time-average of momentary Poynting vector at 90.80 GHz for the 0.06'' bend is presented.

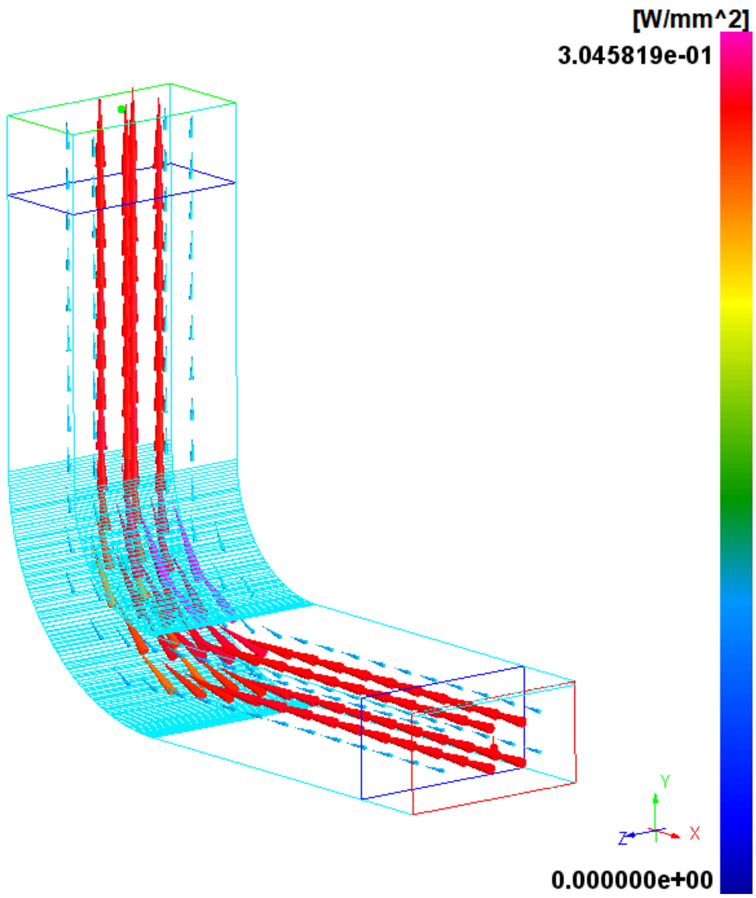

Fig. 4 Distribution of time-average of momentary Poynting vector at 90.80 GHz.

H-plane bend

The second model we consider within this paper is a H-plane waveguide bend, which also has been proposed in ALMA Memo 381 from 2001 [1]. It was designed for ALMA receiver as a building block for more complex circuits.

The considered bend has been designed and analysed with QuickWave FDTD software [2] and its dimensions are presented in the figure below.

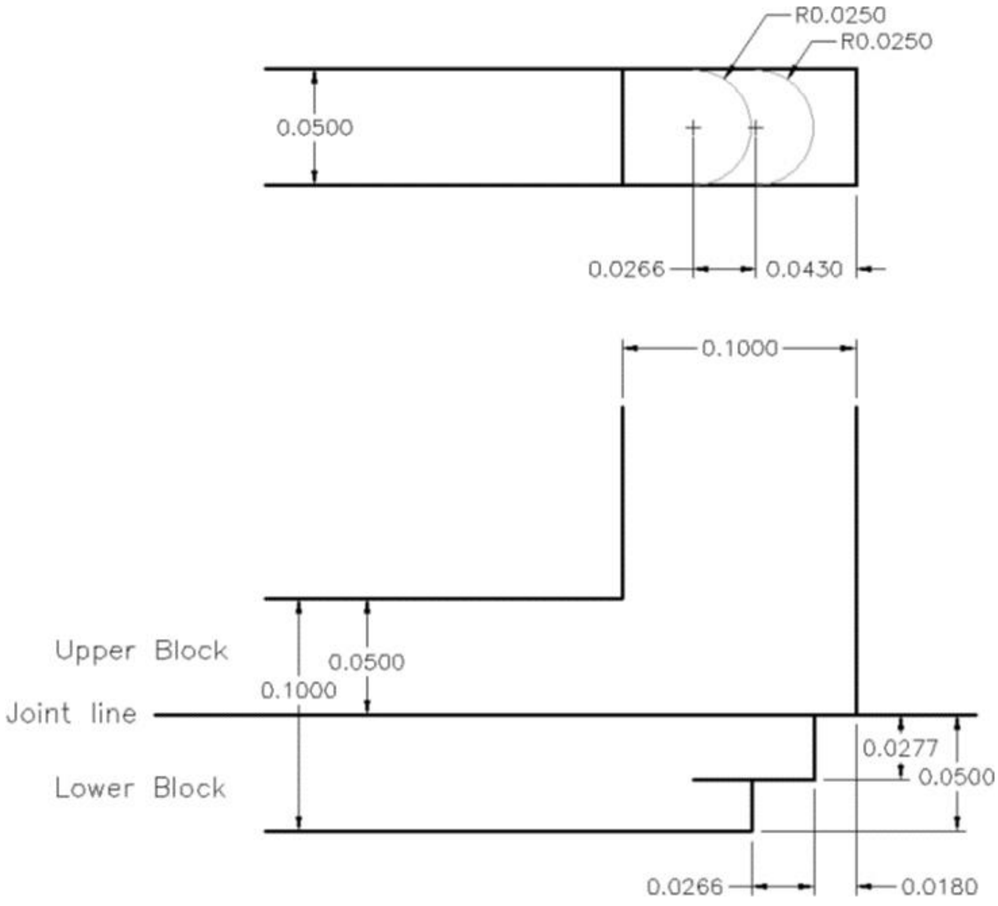

Fig. 5 Scheme of H-plane waveguide bend proposed in [1]. All dimensions are given in inches.

Simulation scenario

Simulation model consists of H-plane waveguide bend based on WR-10 waveguide (1.27 x 2.54 mm).

Similarly as in the previous example, a variable mesh size, adjusted to geometry is utilized. A maximum cell size, in all three directions, is 0.085 mm. Since present example is a non-radiating structure, the background medium is set to metal and only fields inside the structure are of interest.

The simulation scenario occupies 150 000 of FDTD cells, which results in 14 MB of RAM memory usage. The FDTD simulation with QuickWave takes 15 seconds when performing multicore computations on AMD Ryzen Threadripper 2950X 16-Core processor.

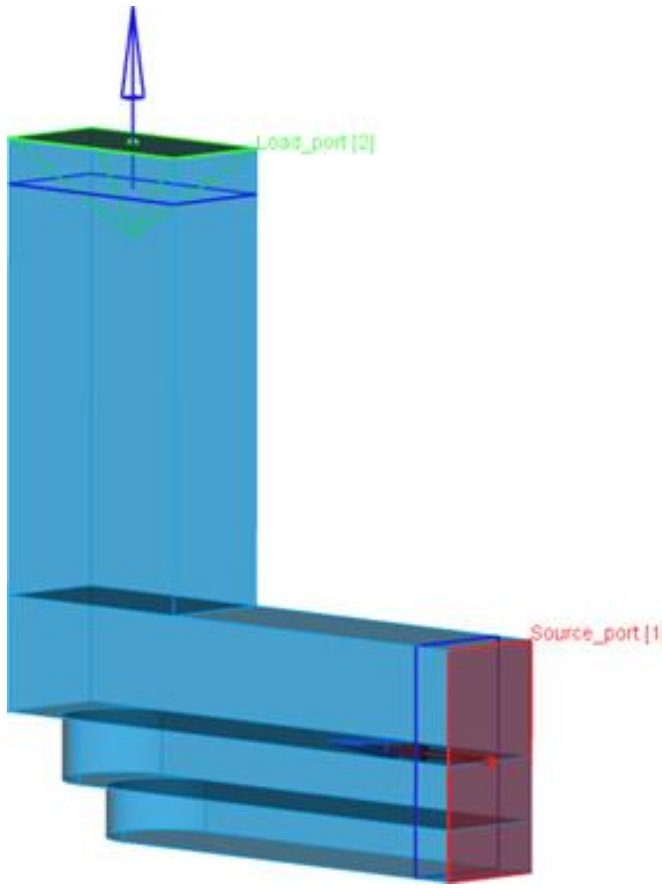

Fig. 6 Simulation model of H-plane WR-10 waveguide bend, prepared in QW-Modeller [3].

EM simulation results

Reflection coefficient was extracted using S_{k1} postprocessing option. The circuit was excited from Port 1 and complex S_{11} was calculated.

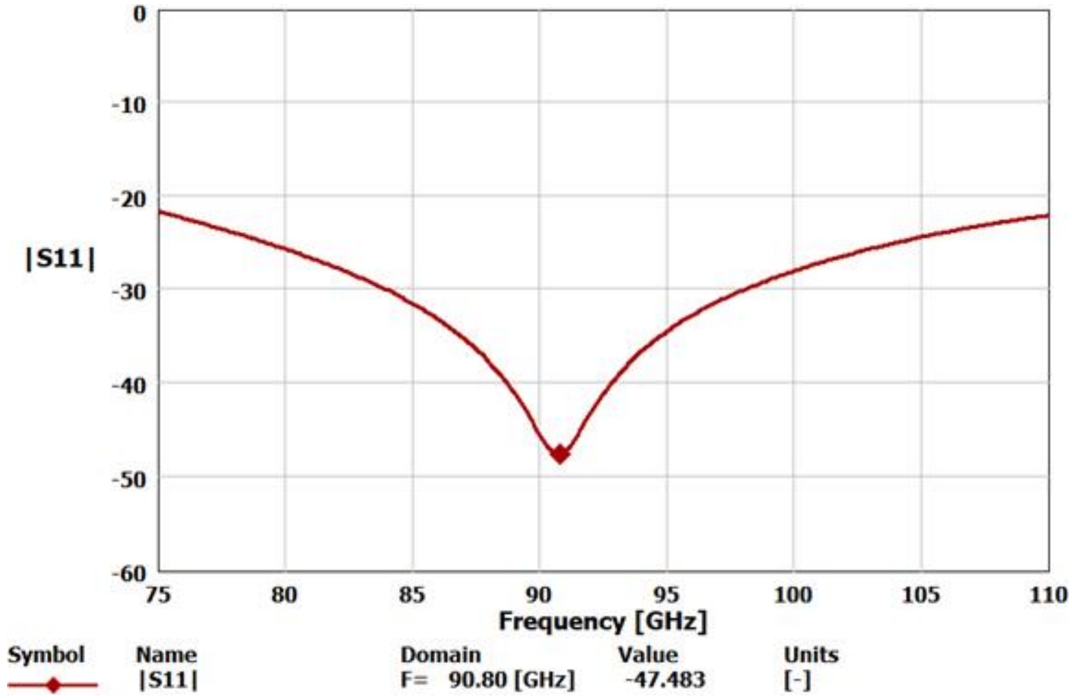

Fig. 7 Magnitude of reflection coefficient of H-plane bend computed with QuickWave 3D.

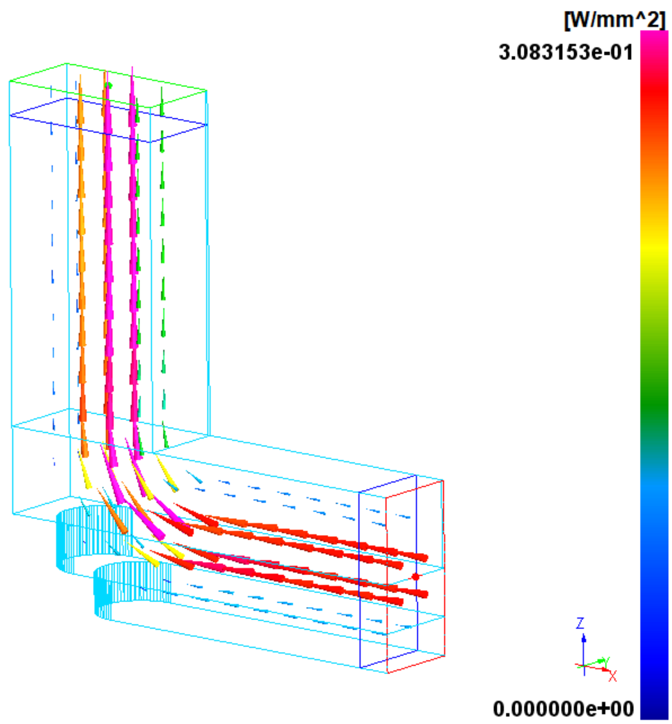

Fig. 8 Distribution of time-average of momentary Poynting vector at 90.80 GHz.

Measurement results

The comparison between our simulated results and measured values of magnitude of reflection coefficient is shown in Fig. 9. The measurements were performed by Dr. Anthony R. Kerr and results are given in [1]. A very good agreement is observed between both sets of compared data, proving capabilities of QuickWave software to handle analysis of components designated to space technology.

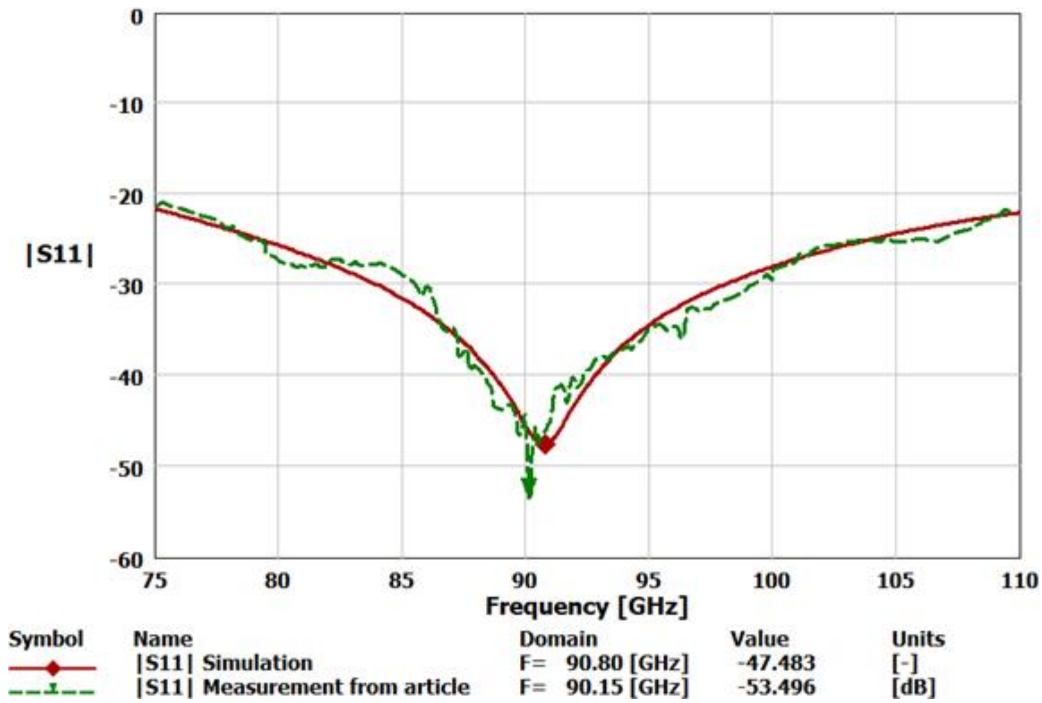

Fig. 9 The magnitude of reflection |S11| coefficient of H-plane bend – simulated data and measurements from [1].

References

[1] A. R. Kerr, *Elements for E-Plane Split-Block Waveguide Circuits*, ALMA Memo 381

[2] QuickWave software, http://www.qwed.eu

[3] QW-Modeller for QuickWave software, http://www.qwed.eu/qw_modeller.html