Lab number: 5
Lab title: TEM transmission lines
Date lab was performed: 28.05.2020
Names of lab group members: Krzysztof Rudnicki

Theoretical introduction:

We want to focus on the characteristic feauters of tramsmission lines which support TEM wave propagation. We are considering two TEM lines, parallel-plate and coaxial line. We want to recognize the field and voltage distribution in the cross-section of these lines and how we can control the characteristic impedance of these lines.

I am using p = 5 (as my student number is 30758**5**)

3.1
a = 2,2 mm
b = 10 mm

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QuickWave Simulator started with licence: STUDENT RELEASE
Setting file: C:\Zlew\Tekst\EPHY\lab5\lab5\parplat.ta3
Environment file: C:/Zlew/Tekst/EPHY/lab5/lab5/parplat.en8
Breakpoints file: C:\Zlew\Tekst\EPHY\lab5\lab5\parplat.br3
Breakpoints not defined
Start of the Simulator-Thu May 28 15:23:55 2020
Cell Descriptors Reading passed: 783, Cells number: 390
Warning: Excitation point outside metal - hot conductor selected by the software!
Circuit type: t2dqs
No Postprocessings.
Excitation: name: input, Pulse type: step, Amplitude=1, Delay= 0 [ns], Resistance=+INF [Ohm]
Template calculations for port EM fields : Quasistatic Template input_parplat, lim=500000, check=1000, tol=0.005
Template calculations completed and saved to input_parplat file
Zc=370.6122, Eef= 5.0000
Cell Descriptors Reading passed: 783, Cells number: 390
Warning: Excitation point outside metal - hot conductor selected by the software!
Circuit type: t2dqs
No Postprocessings.
Excitation: name: output, Pulse type: step, Amplitude=1, Delay= 0 [ns], Resistance=+INF [Ohm]
Template calculations for port EM fields : Quasistatic Template output_parplat, lim=500000, check=1000, tol=0.005
Suspend simulation-Thu May 28 15:24:13 2020
Resume simulation-Thu May 28 15:24:16 2020
Template calculations completed and saved to output_parplat file
Zc=370.6122, Eef= 5.0000
Cell Descriptors Reading passed: 5, Cells number: 11730
Circuit type: t3d
Number of Postprocessings: 2
Postprocessing [0]: SK1_TEMPL, (S-Parameters): From 5 GHz To 15 GHz Step 0.01 GHz. Required frequency resolution will be reached after 29978 iterations
Postprocessing [1]: probe, (FD-Probing): From 5 GHz To 15 GHz Step 0.01 GHz
Required SubTask 1 started: Save_Waveforms: from 1 to 240 iteration
Excitation: name: input, Pulse type: band, Amplitude=1, Delay= 0 [ns], Pulse duration=0.4 [ns] / 240 iter., Frequency=5 [GHz]-15 [GHz]
Required SubTask 1 finished: Save_Waveforms: from 1 to 240 iteration
All SubTasks finished
Suspend simulation-Thu May 28 15:24:29 2020
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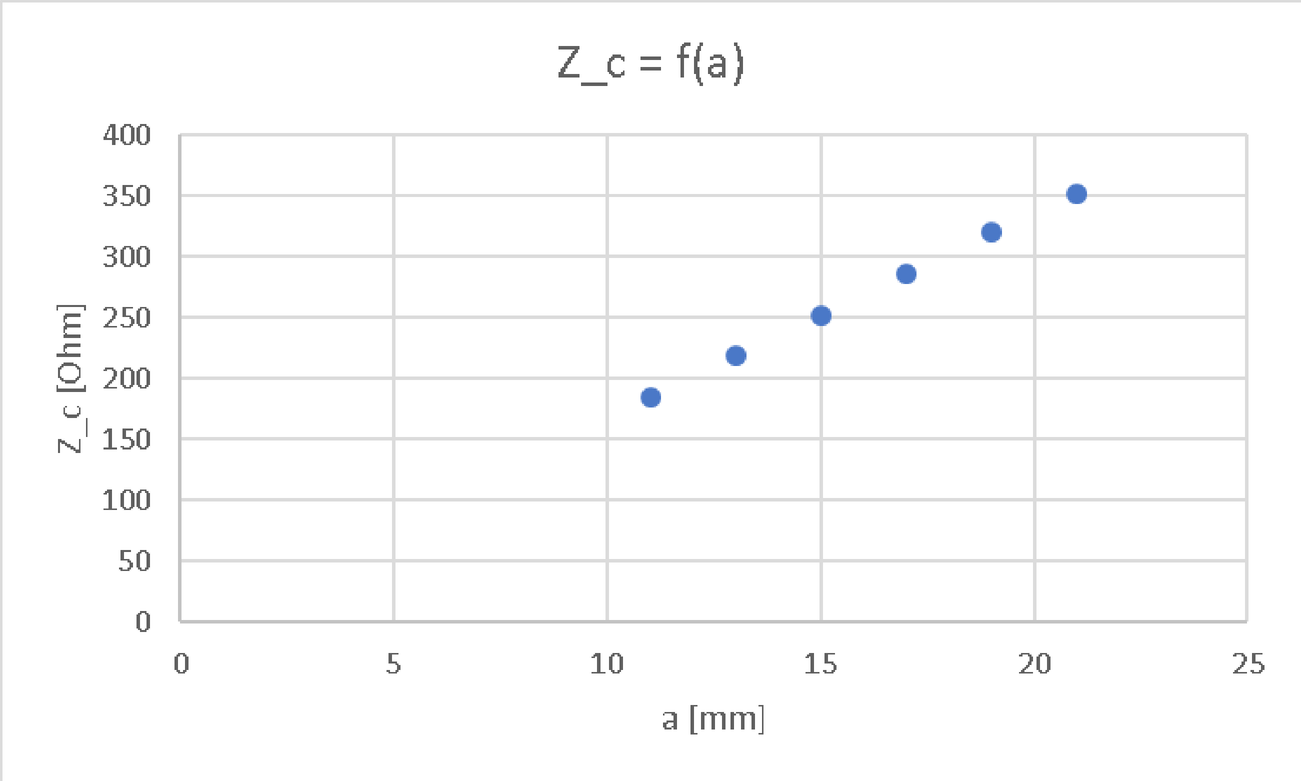
Difference between characteristic impedance calculated by the software and the intrinsic impedance of vacuum is equal to:

$$376{,}9911184 - 370{,}6122 = 6{,}378918431\,\Omega$$

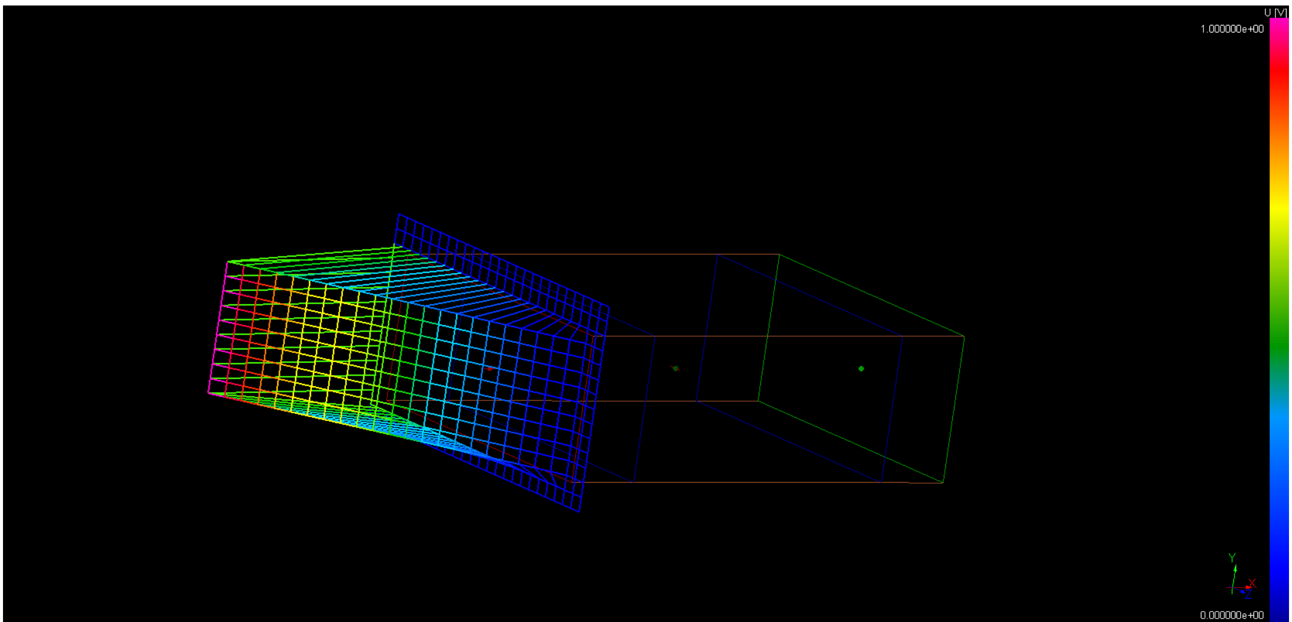
The difference comes from the fact that all the values we entered into the program were rounded

11 mm	13 mm	15 mm	17 mm	19 mm	21 mm
185,326 Ω	218,9848 Ω	252, 2711 Ω	286,404 Ω	320,009 Ω	353,2603 Ω

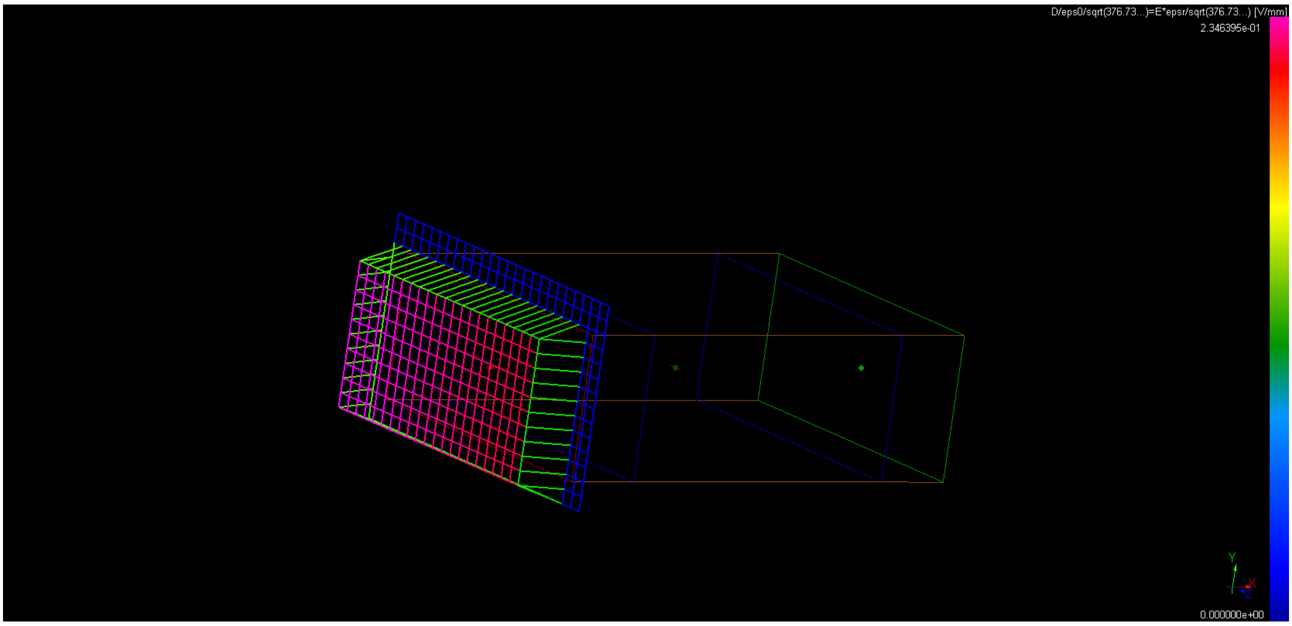


As we increase height, the impedance increases, impedance is proportional to height.

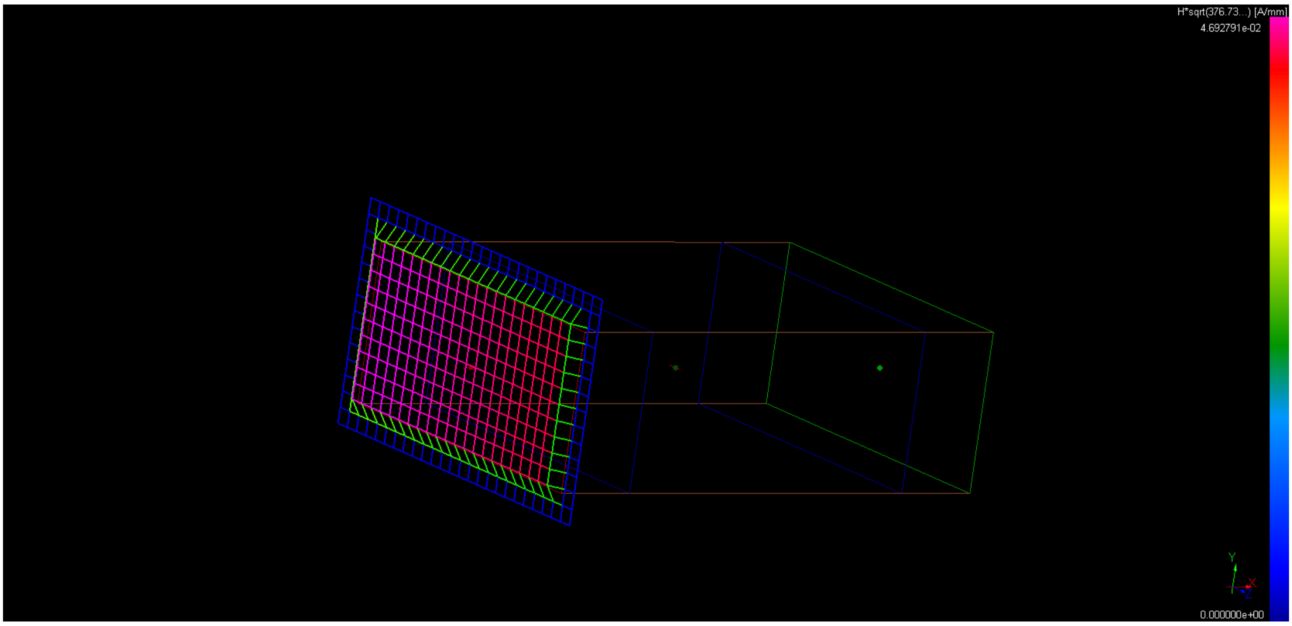
Sketch of the electric potential (Ue):



Sketch of the electric displacement (D):



Sketch of the magnetic field (H):



Shape of the electric potential distribution is the prism. Polarization for Electric field is Z, height of the triangle is the same as the height of the cuboid. Also both of them are convex. polarization for magnetic field is Y, we can see all of this on the picture.

3.2

2b = 1 mm

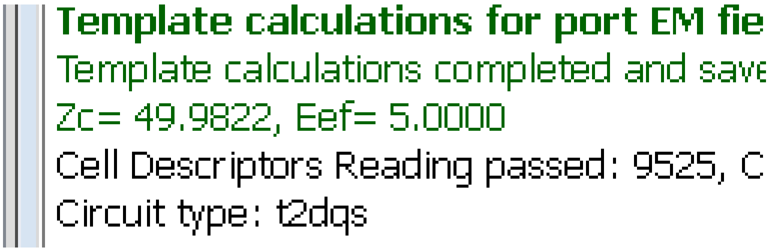
a = 3,22 mm

2a = 6,44 mm

Z_c = 49,9822

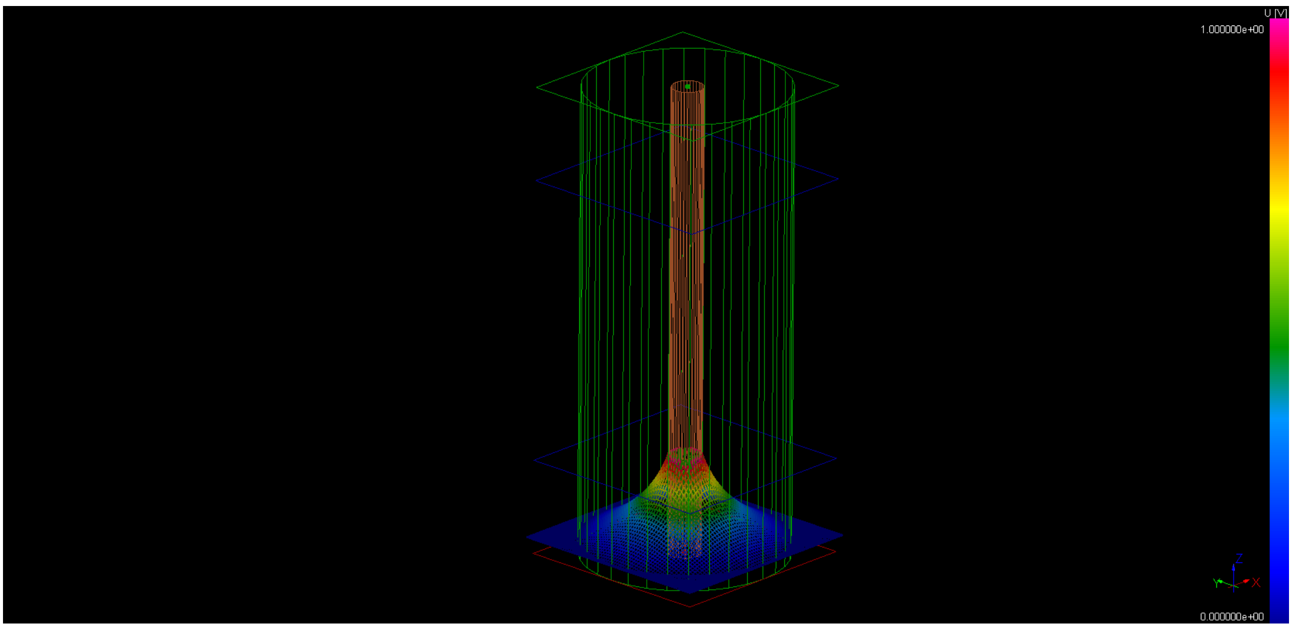
Z_c ideal = 50

Z_c ideal – Z_c = 0,0178

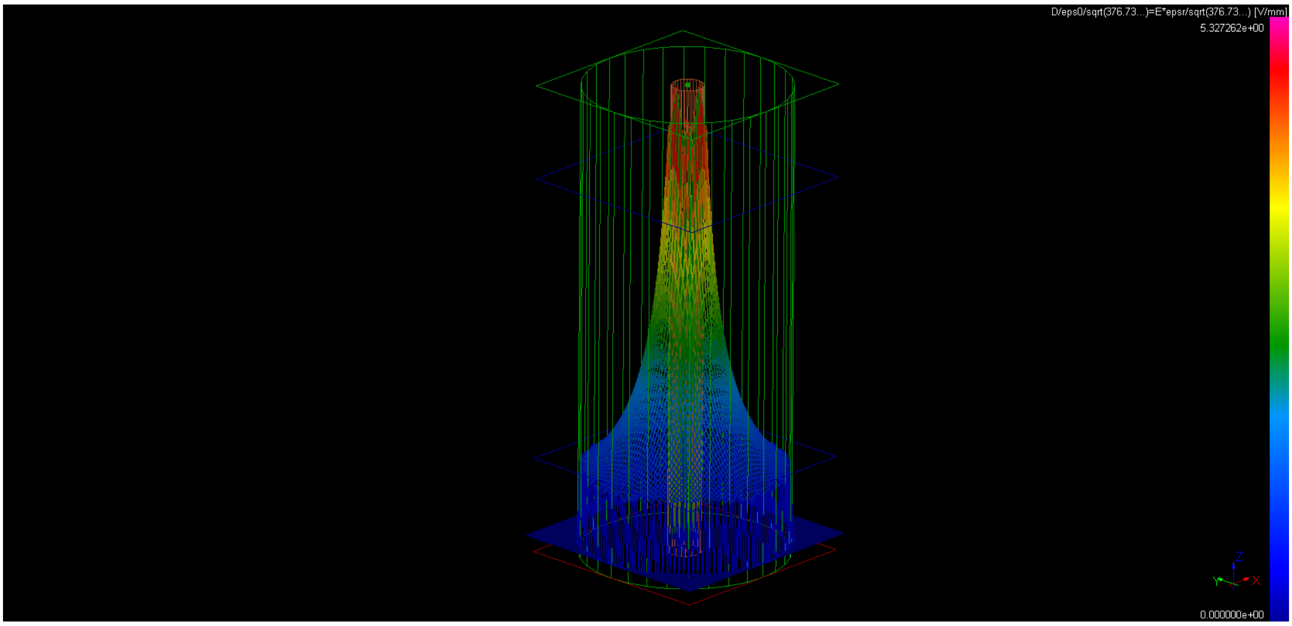

Template calculations for port EM fie
Template calculations completed and save
Zc= 49.9822, Eef= 5.0000
Cell Descriptors Reading passed: 9525, C
Circuit type: t2dqs

Difference again comes from the fact that the values of a were rounded in the program.

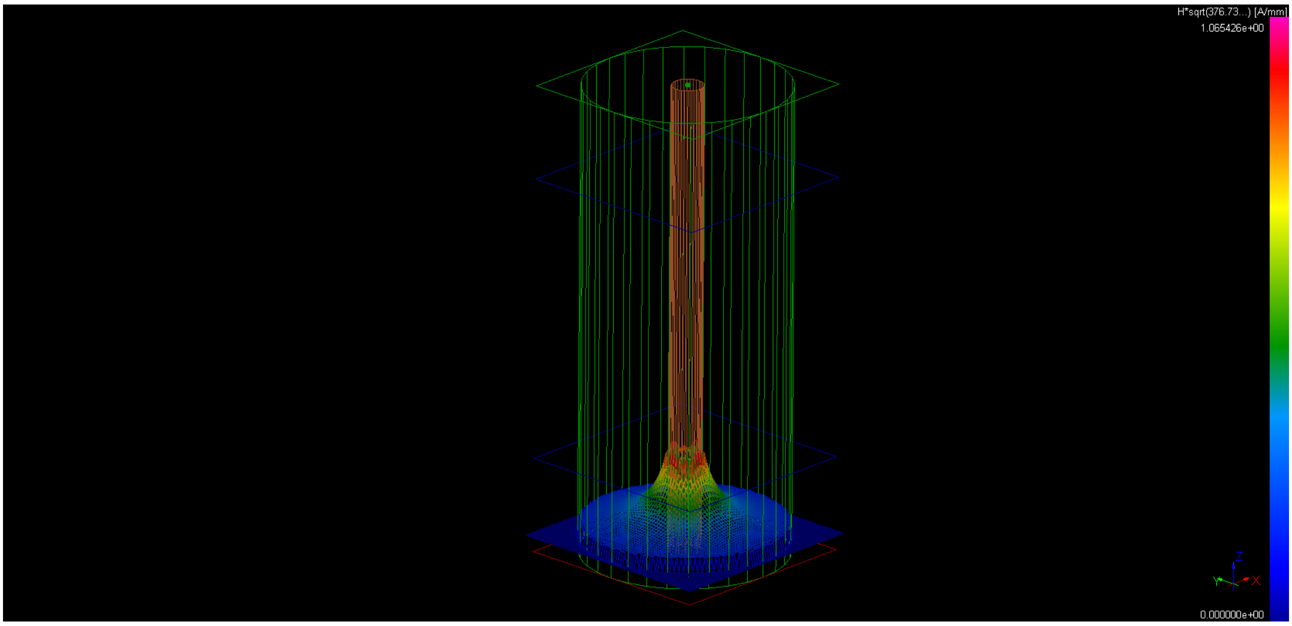
Sketch of the electric potential (Ue):



Sketch of the electric displacement (D):



Sketch of the magnetic field (H):



How the electric potential and displacement depend on the radius? What is the polarization of electric displacement?

Electric potential and displacement are inversely proportional to radius.

Polarization of electric displacement is equal on both z and y.

We can see all of this on the adjacent screens.