

Introduction: The main idea of the AC/DC hybrid line is to replace an existing AC system by a HVDC system on the same tower. Consequently a DC system and several AC systems will be operated on the same tower. On those hybrid transmission lines the electromagnetic coupling causes interaction between those systems.

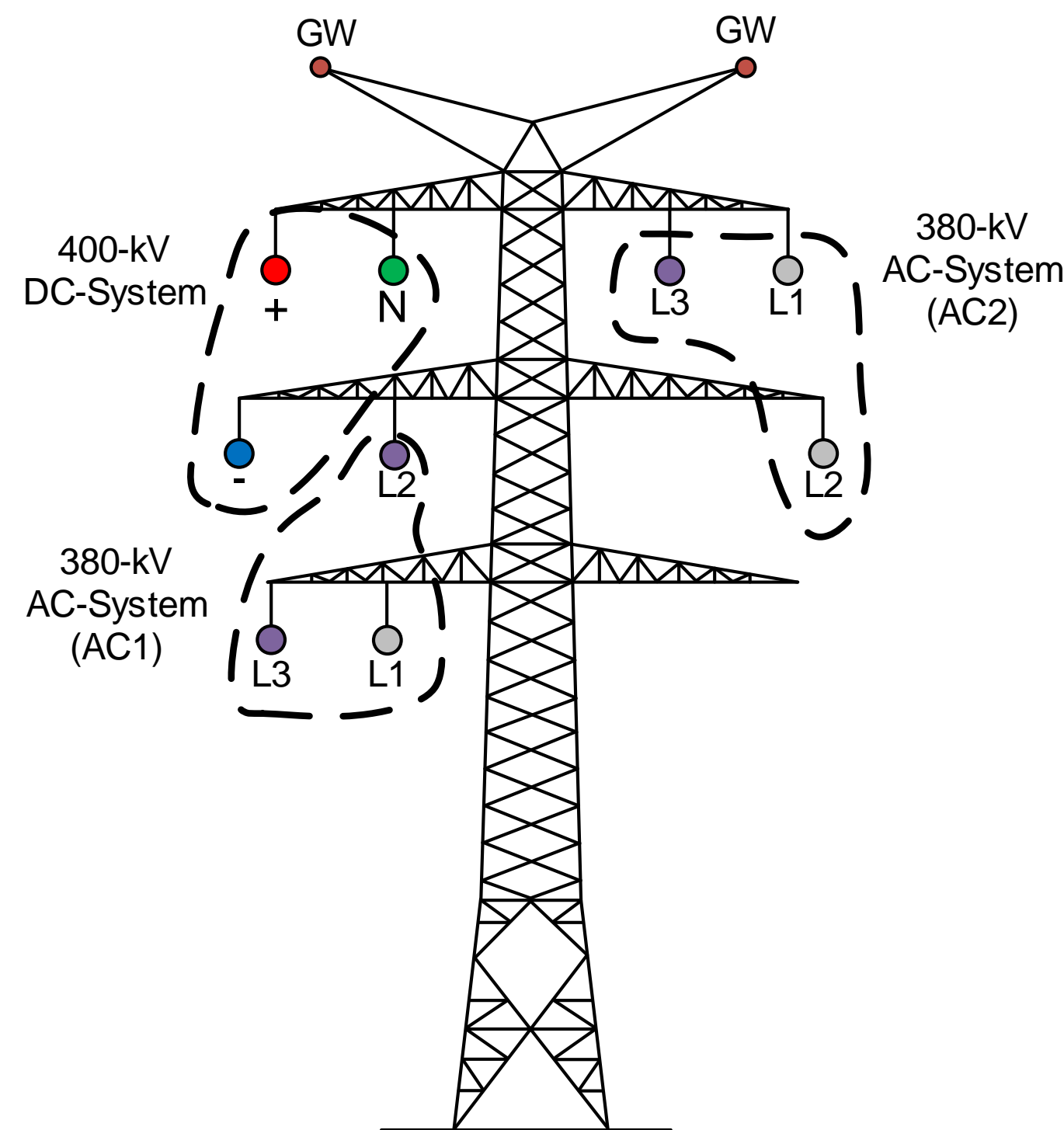


Figure 1. AC/DC hybrid line

Computational Methods: The following Maxwell's equations were used for simulations

$$E = -\nabla V \quad \nabla \cdot J = -Q \quad J = \sigma E + \frac{dD}{dt} + J_e$$

Simulation model of an AC/DC-Hybridline in 3D-Space: Conductors, ground wires, towers and insulators are considered

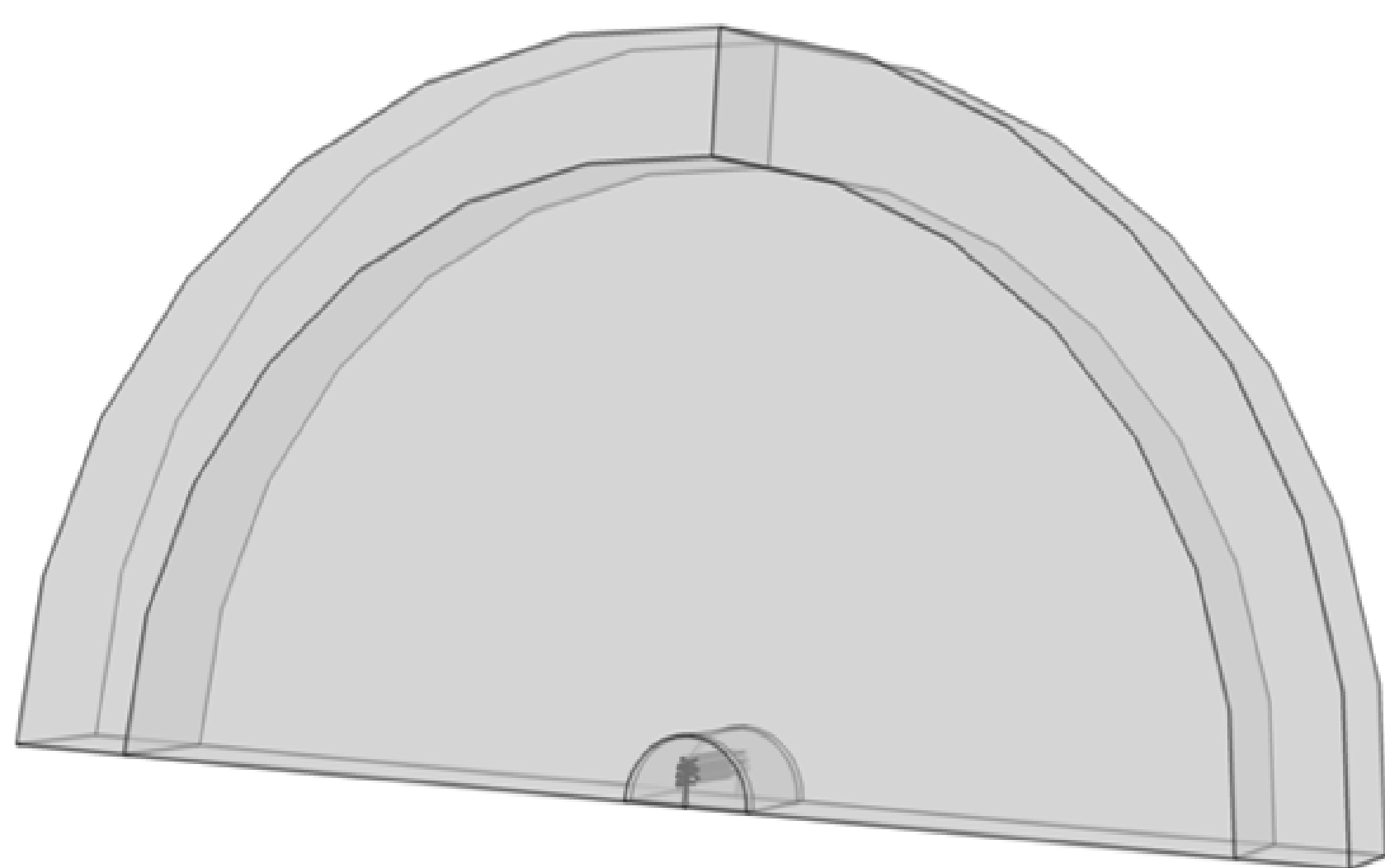


Figure 2. Overview of the 3D model

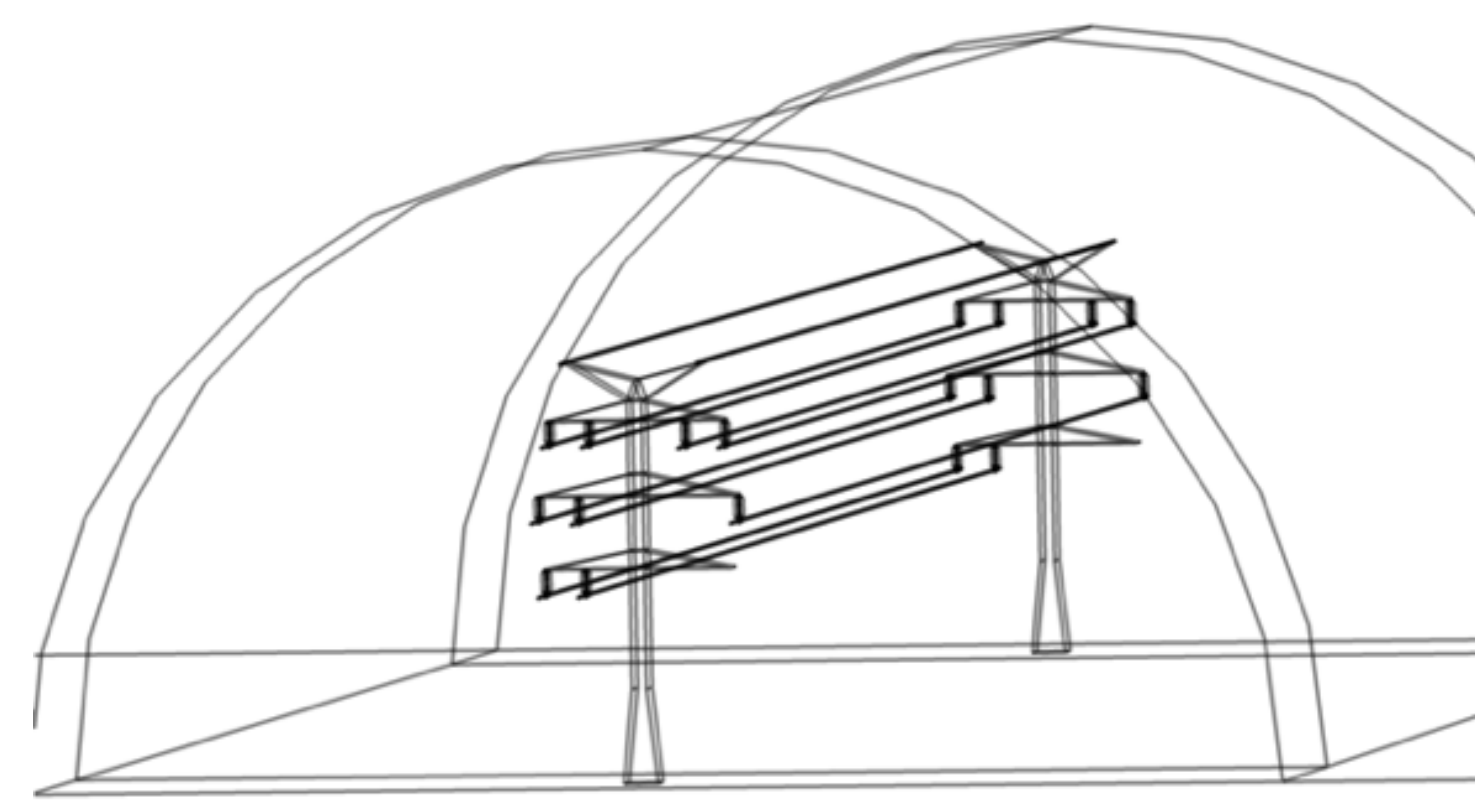


Figure 3. Detailed view of the 3D model



Figure 4. 3D structure of the Composite insulator

Table 1. Insulator Parameter

SIR relative permittivity	4.3
FRP relative permittivity	7.3

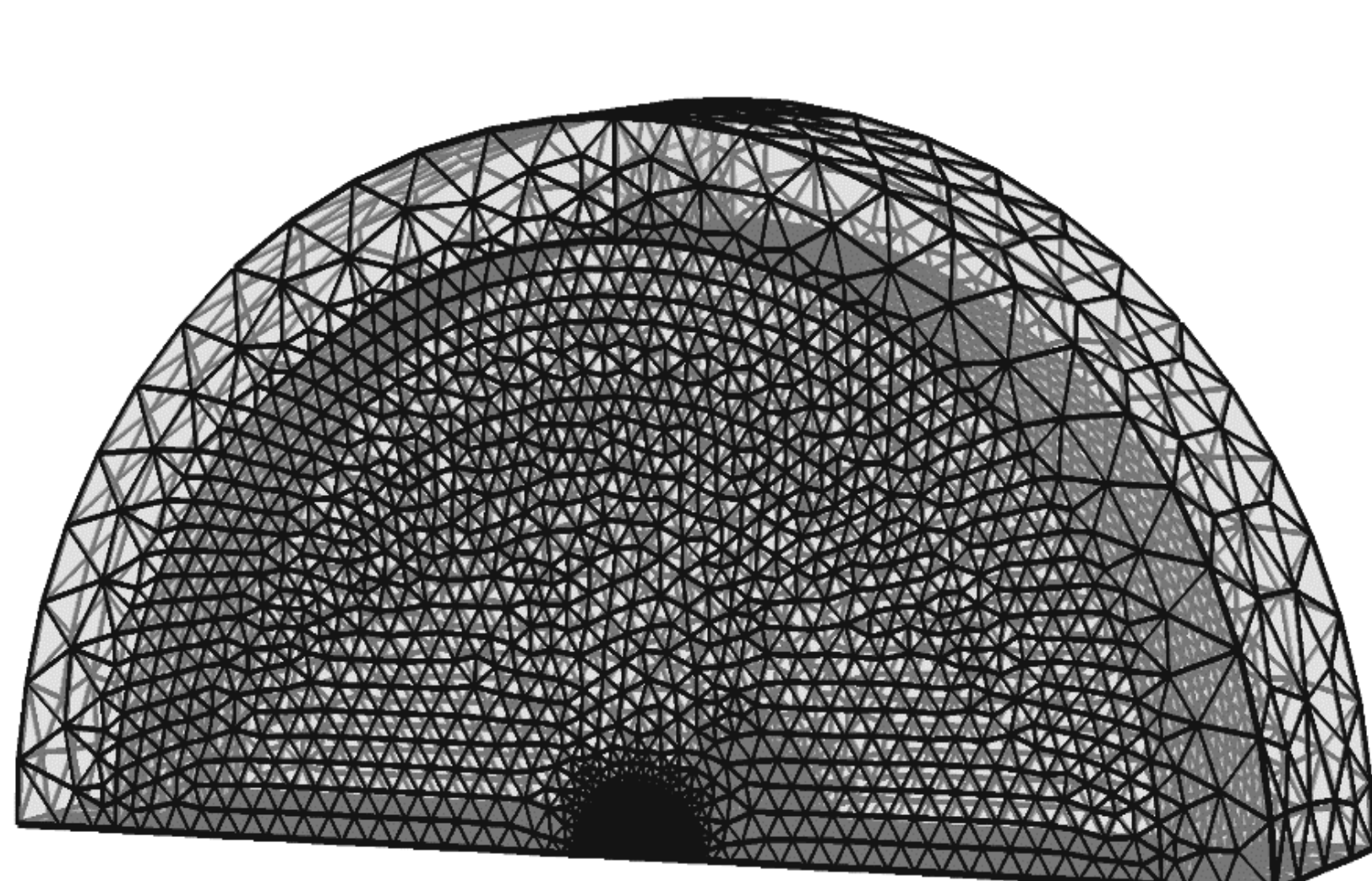


Figure 5. Overview of the discretized model

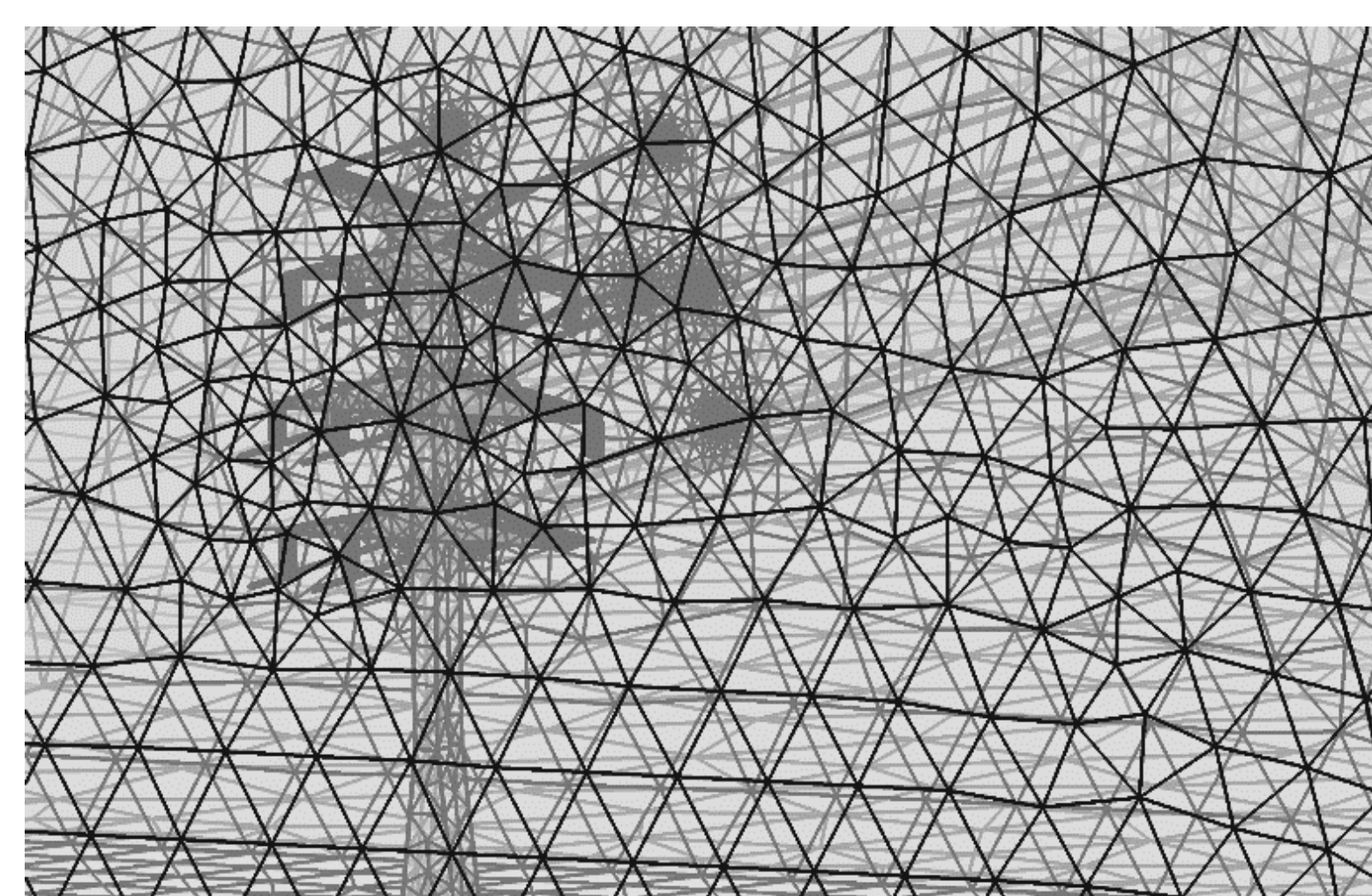


Figure 6. Detailed view of the discretized model

Results: Time domain simulations are performed for two different scenarios. The electrical field under the AC/DC hybrid line and the electrical potential along the HVDC insulator are taken into account.

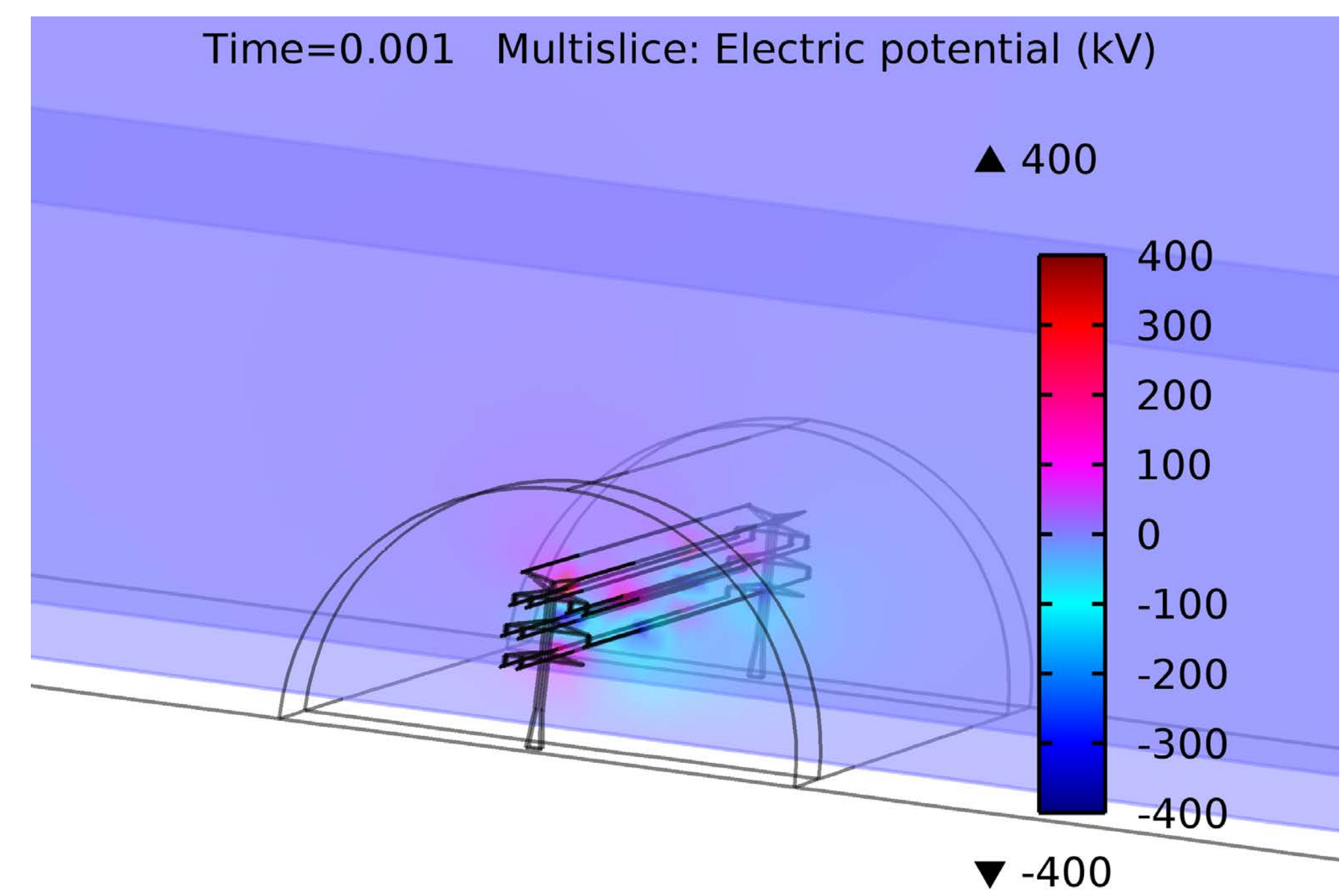


Figure 7. Time domain simulations, AC/DC hybrid line

Scenario 1: One bipolar HVDC system and two 380-kV HVAC systems.

Scenario 2: One monopolar HVDC system and two 380-kV HVAC systems.

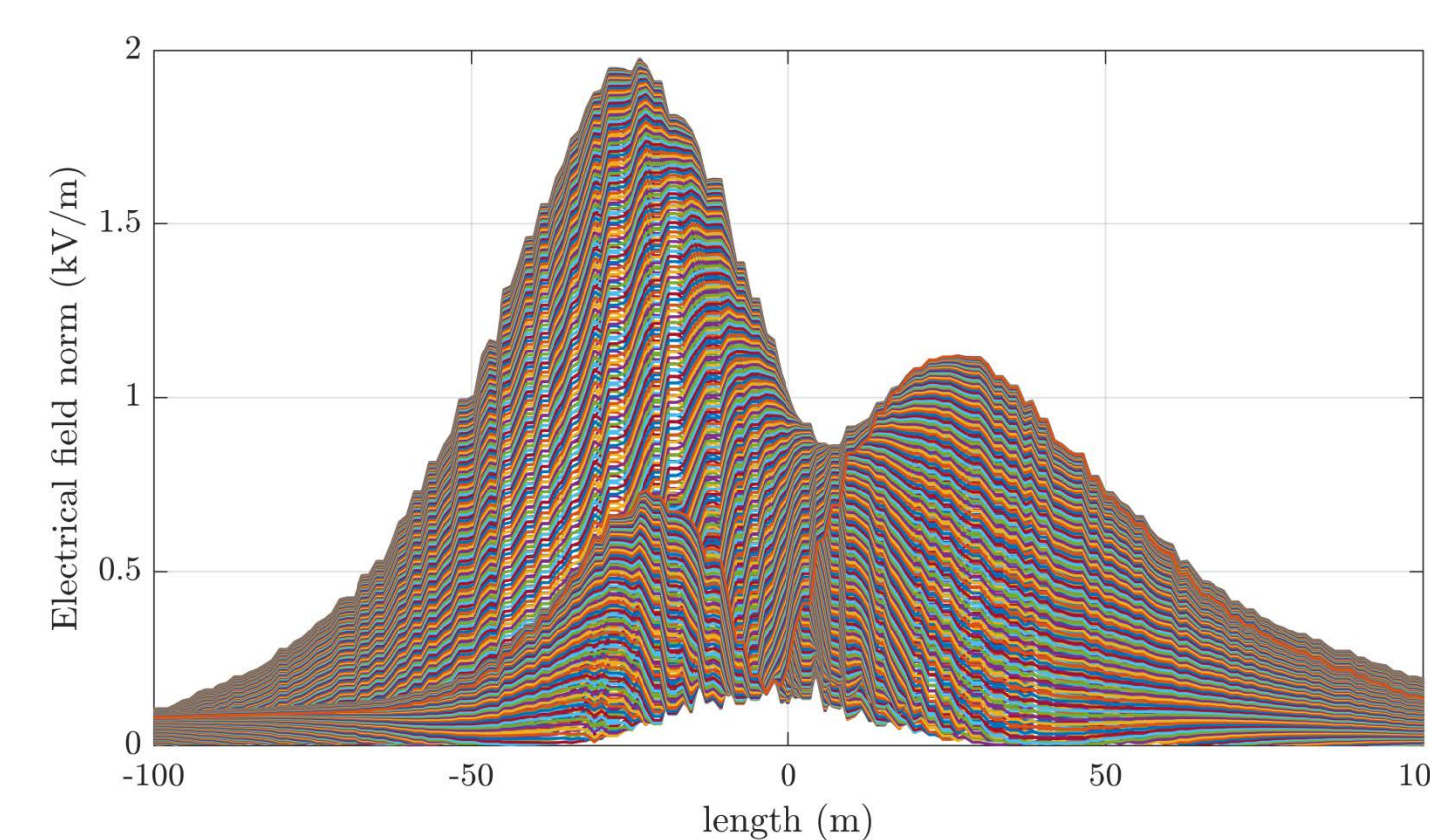


Figure 8. Scenario 1, Electrical field 2m above the ground level

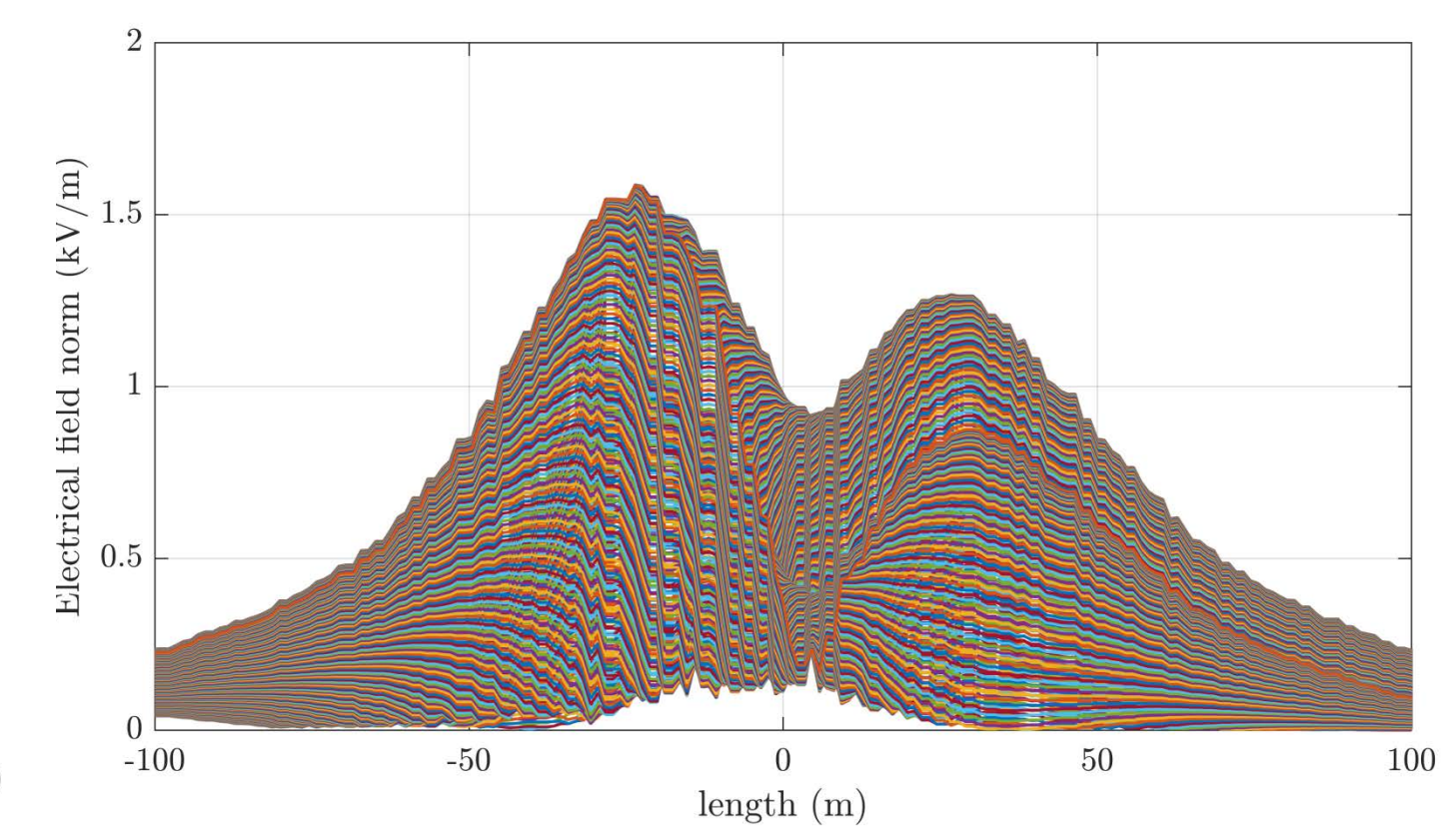


Figure 9. Scenario 2, Electrical field 2m above the ground level

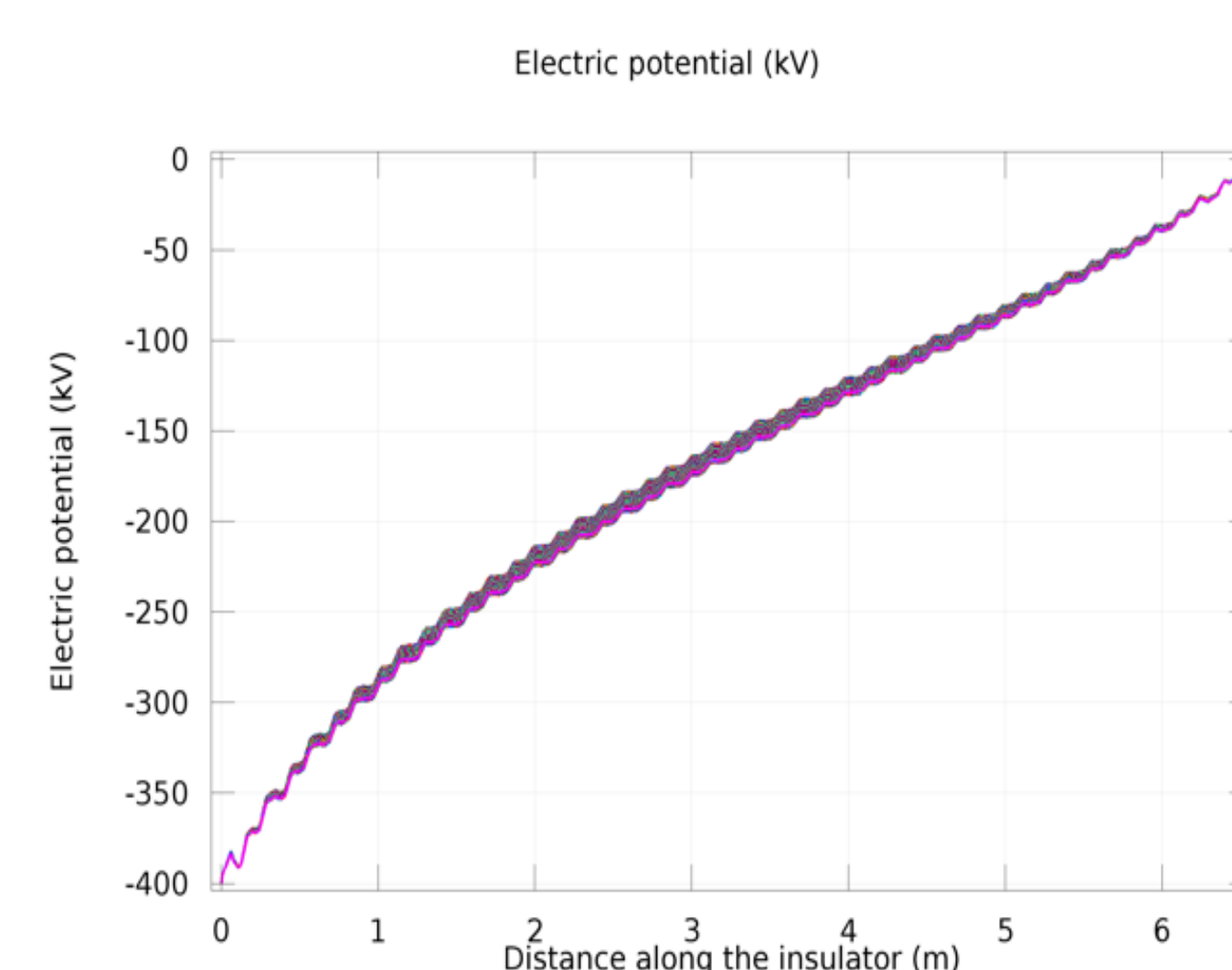


Figure 10. Scenario 1, Electrical potential along HVDC-insulator

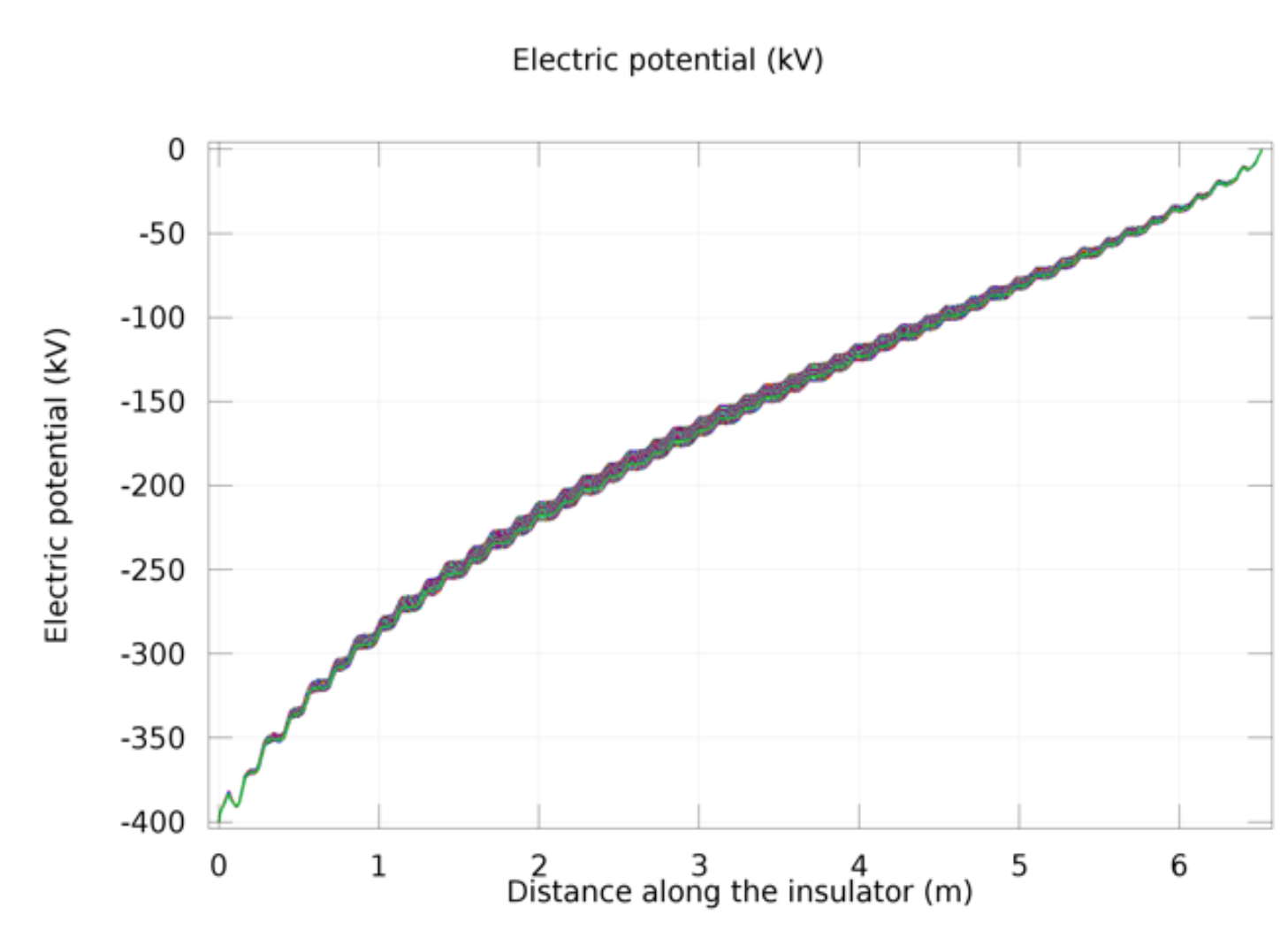


Figure 11. Scenario 2, Electrical potential along HVDC-insulator

Conclusions:

- 1.The electrical field under the transmission line is influenced by the different HVDC operation states.
- 2.The electrical potential along the insulators are influenced by the different HVDC operation states insignificantly.
- 3.On those hybrid transmission lines the electromagnetic coupling causes interaction between DC-system and AC-systems. The mutual influence can be of steady-state or transient type. In order to investigate the transient electromagnetic influences, the RF Module of COMSOL Multiphysics could be used.

References:

- 1.D. Potkrajac, S. Papenheim, M. Kizilcay: Three-dimensional FEM model of an AC/DC hybrid high voltage transmission line to analyze the electrical field along composite insulators, IPST Conference 2017, 26.06-29.06.2017, Seoul, Republic of Korea.