Simulation of an Impulse Arc Discharge in Line Lightning Protection Devices.

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Introduction: Impulse arc discharge in Line Lightning Protection Device (LLPD) triggered by lightning overvoltage is

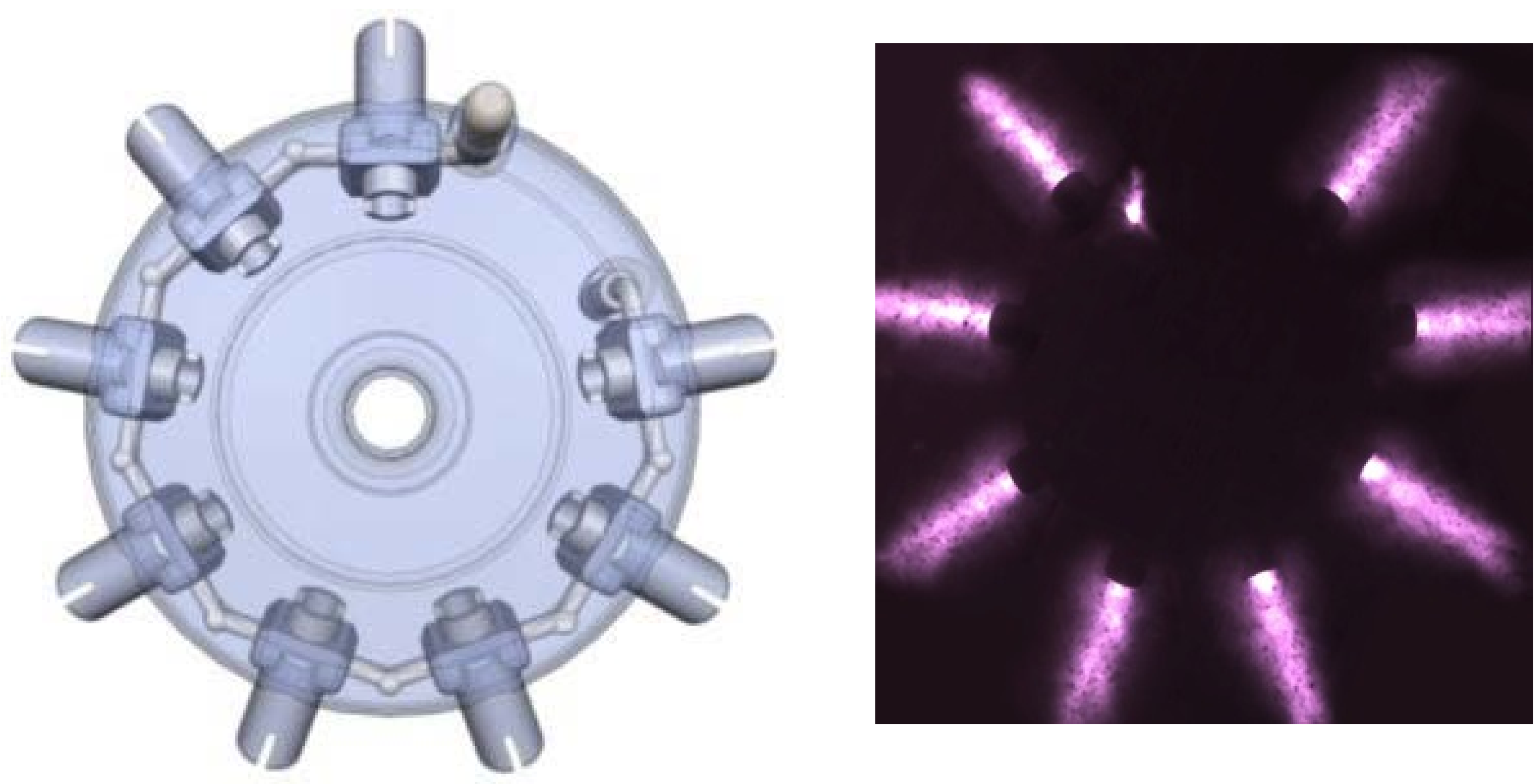

Figure 1. LLPD CAD model and real sample in operation mode

Computational Methods: Set of magnetohydrodynamic (MHD) equations is applied to describe arc discharge behavior during lightning current pulse impact. Coupling of CFD and ACDC modules was implemented.

$$\frac{\partial \rho}{\partial t} + \nabla \cdot (\rho \boldsymbol{u}) = 0$$

$$\frac{\partial (\rho \boldsymbol{u})}{\partial t} + \nabla \cdot (\rho \boldsymbol{u} \otimes \boldsymbol{u}) = -\nabla p + \nabla \cdot \hat{\boldsymbol{\tau}} + [\mathbf{j} \times \mathbf{B}]$$

$$\frac{\partial (\rho \boldsymbol{h})}{\partial t} + \nabla \cdot (\rho h \boldsymbol{u}) = \frac{\partial p}{\partial t} + \nabla \cdot (\hat{\boldsymbol{\tau}} \boldsymbol{u}) + \boldsymbol{j} \cdot \boldsymbol{E} + \nabla \cdot (\boldsymbol{q}_{cond} + \boldsymbol{q}_{rad})$$

Terminal and Ground conditions are applied to corresponding electrodes. The boundary of air domain is set as Outlet.

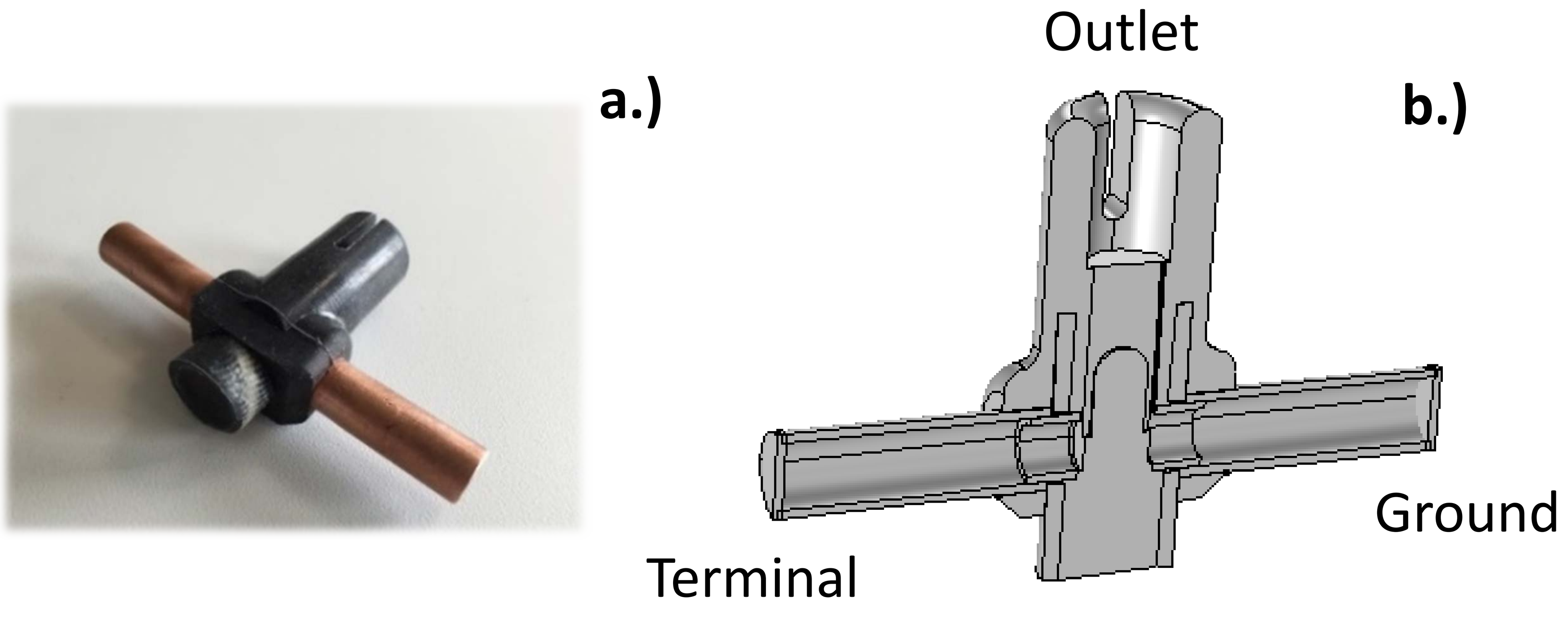

Figure 2. Discharge chamber: a.) Real-size sample b.) Computational domain

Results: Preliminary simulation results allow to evaluate the influence of chamber geometry on arc decay rate.

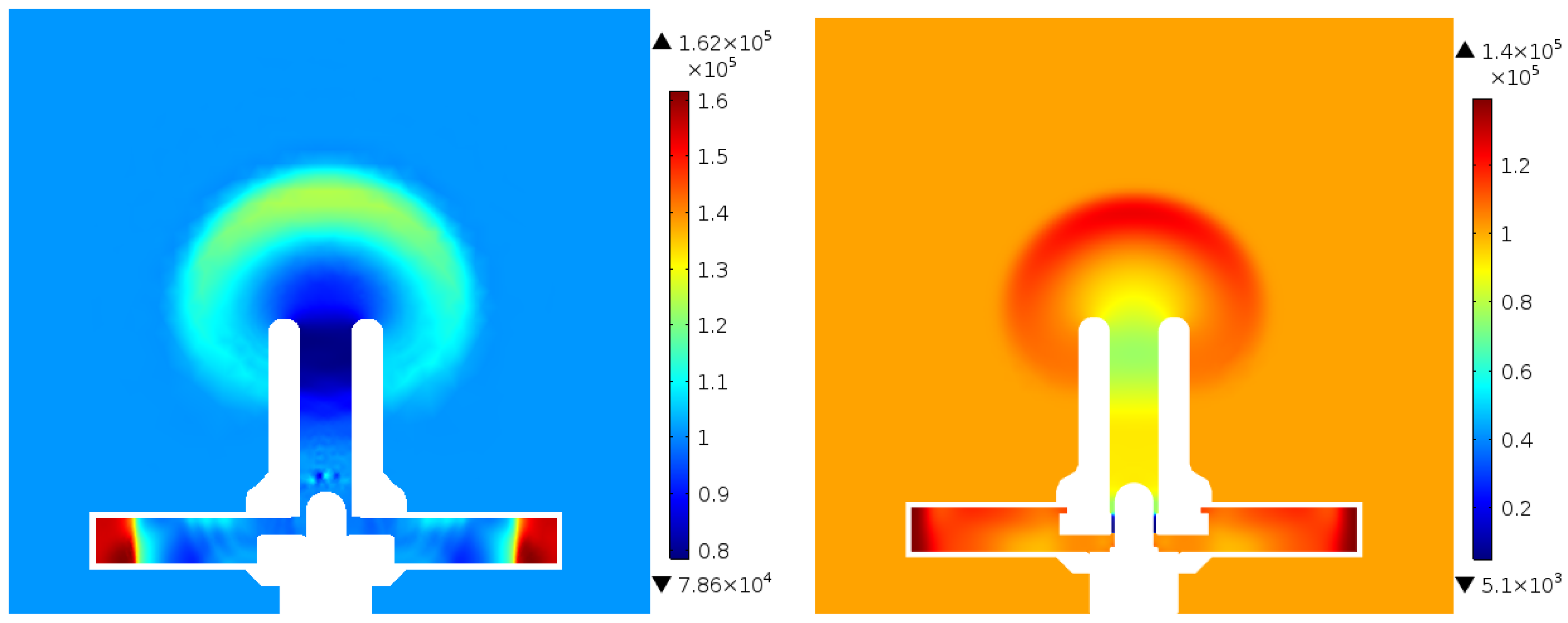

Figure 3. Pressure distribution

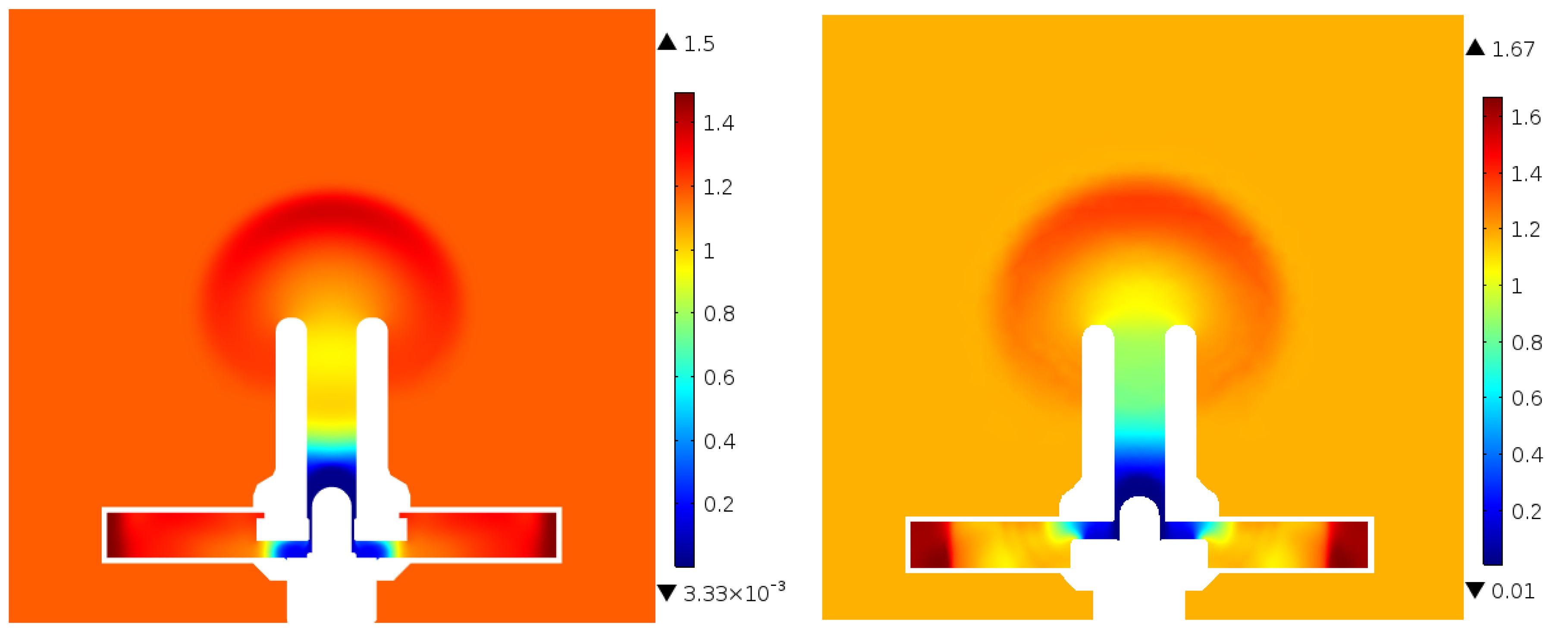

Figure 4. Density distribution

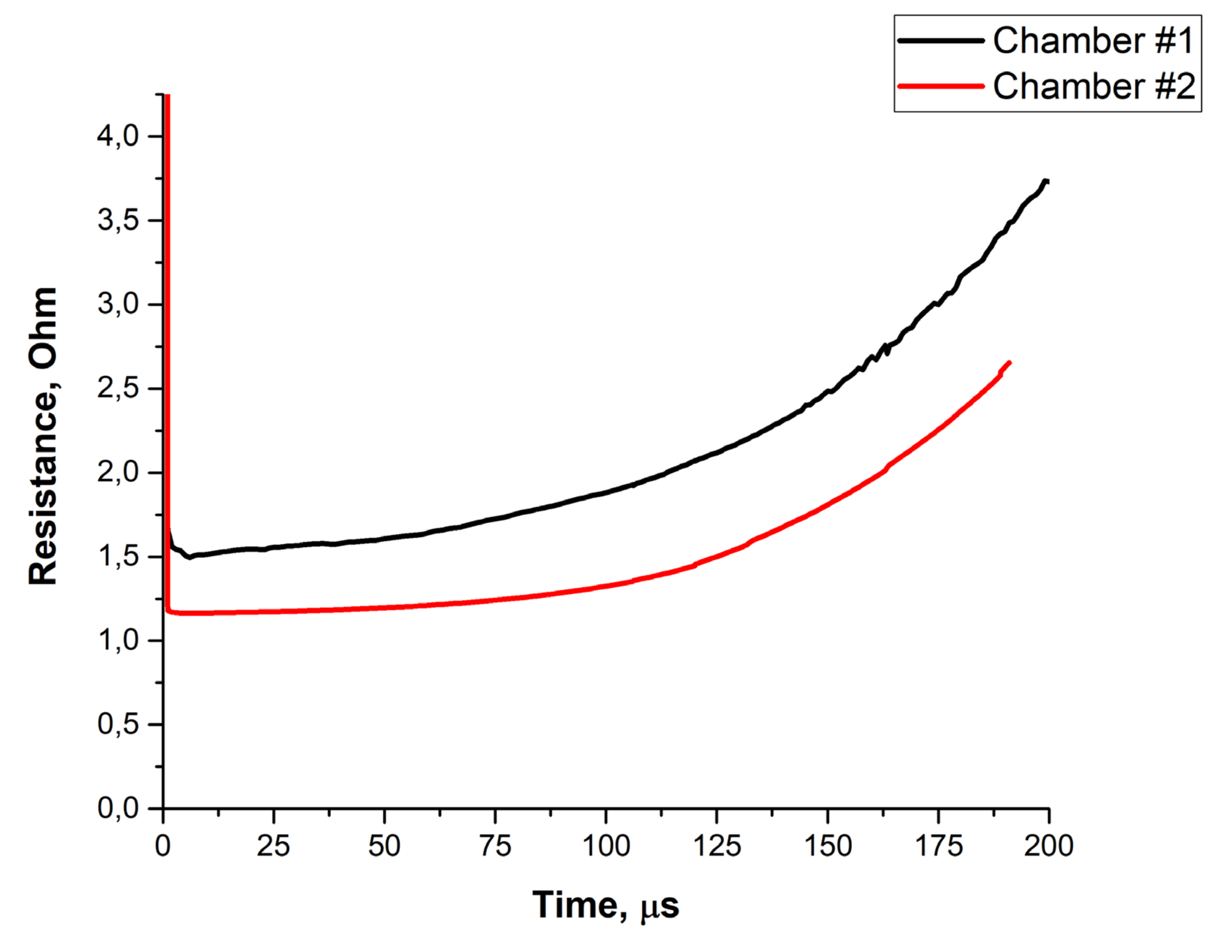

Figure 5. Resistance time dependence for two chamber designs.

Conclusions: Current state of simulations gives qualitative agreement with experimental data.

References:

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2. H.Nordborg, Modeling and simulation of the current quenching behavior of line lightning protection device, Journal of Physics D: Applied Physics, 50, (2017)