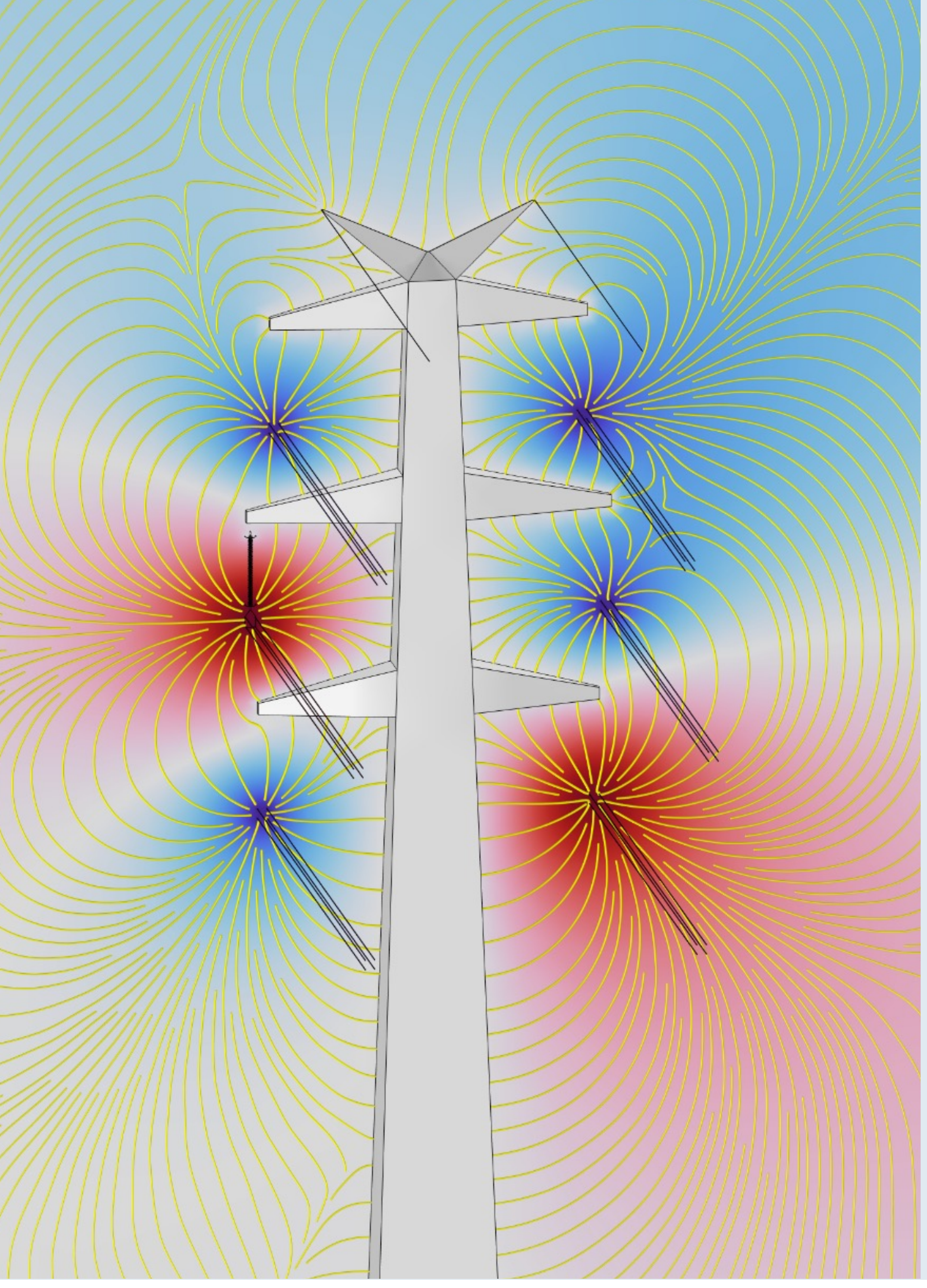

Electromechanical Simulations of High Voltage Equipment

Electric field, electric current and mechanical stress distributions in high voltage equipment components such as insulators and arrester.

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Introduction & Goals

When designing equipment extending across large potential differences, such as insulators [1] and surge arresters [2], it is crucial to evaluate how the electric field distributes around them, so that the stresses on the materials involved are kept under control. In cases where non negligible resistive currents are present, such computations are complicated by need of taking into account how they redistribute the electrical potential.

In addition to electrical considerations, mechanical aspects often require dedicated investigation to reach optimal balance between strength, weight and cost.

A particular case requiring load decomposition and search for the load envelope in a beam structure was approached running COMSOL® through its API.

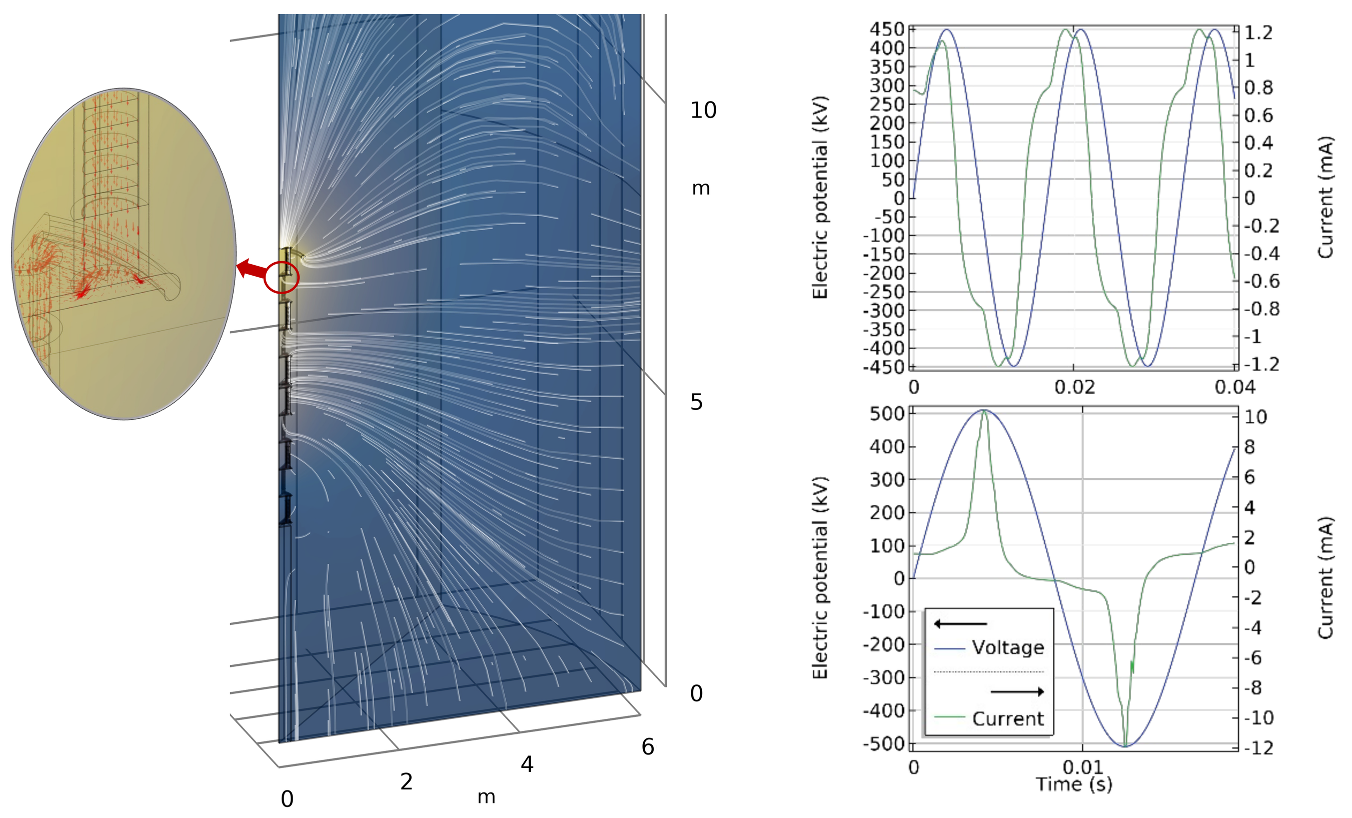

FIGURE 1: Left: electrical potential and electric field lines in a multicolumn arrester. The detail highligths the current density through the the tower. Right: voltage and current waveforms for below and above the threshold voltage.

Methodology

The studies are modelled in 3D profiting from mirror symmetries. The physics interfaces for the electrical studies are electrostatics (es) or electric currents (ec). Non-linear field-dependent conductivity was introduced to model the peculiar behaviour of doped ZnO material of surge arresters.

To perform parametrical searches we found convenient running COMSOL through its Java® API. This was accomplished in Python™ by using the third party tool MPh [3] offering a scripting interface.

Mechanical studies are setup considering the material plasticity and are solved in the steady state condition, cycling the load with a parameter sweep.

Results

Detailed distribution of the electric field were obtained allowing to evaluate the need for mitigation devices. This helped to provide evidence for compliance with the international norms and client specifications to a level of detail not easily attainable through physical testing.

On the mechanical side we obtained precise load envelopes for insulating crossarms made by multiple insulators. In addition we computed hysteresis curves evaluating the effects of material plasticity on the pedestals of insulators subjected to cantilever load.

The increasing level of confidence with COMSOL® will allow for more and more applications in the future.

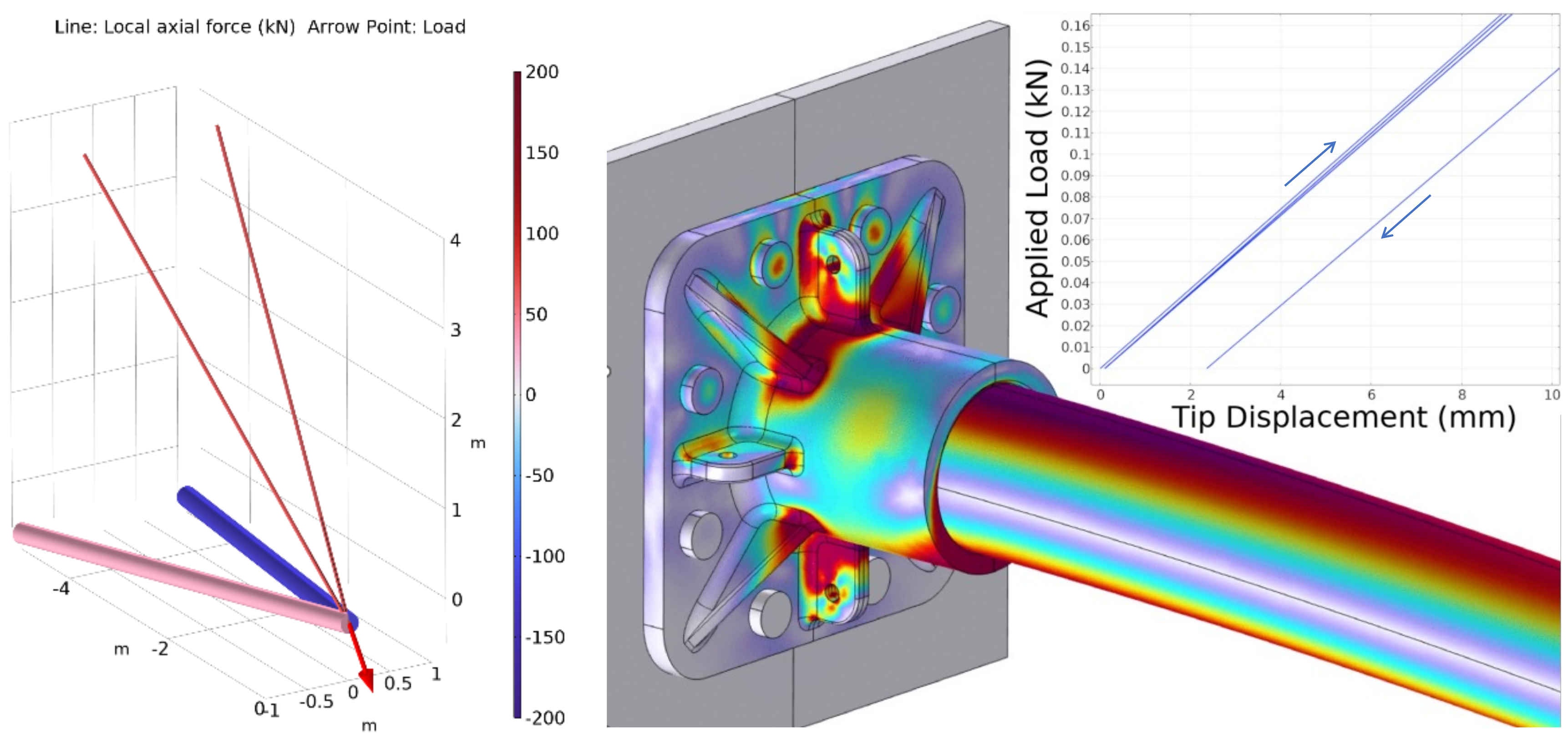

FIGURE 2: Left: load decomposition on a insulated crossarm structure. Right: Von Mises stress in a rod subjected to cantilever load, together with its hysteresis curve.

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