design and performance validation of a high performance heating system.

MULTIPHYSICS

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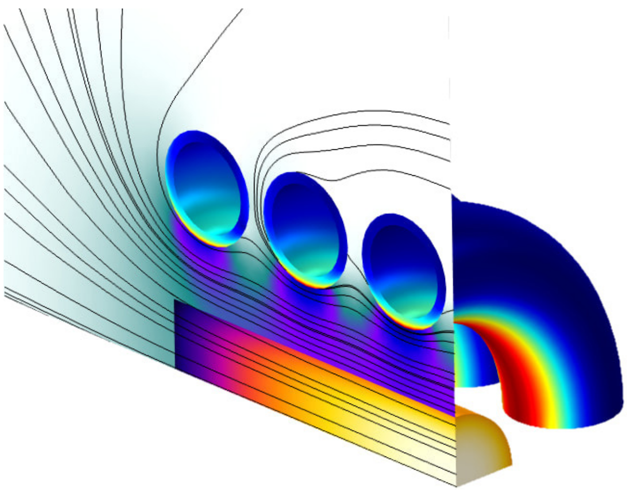
Goal

A high performance heating system is required for a proof of principle experiment. This is needed to experimentally simulate the heating effects of a high intensity electron beam exposing a target.

The heating system has to depose 26kW on a metal workpiece of 4mm by 30mm. This can be achieved by applying induction heating, for which a small heating coil was designed. At the same time, the coil itself needs to be cooled by a high pressure liquid to prevent it from melting down.



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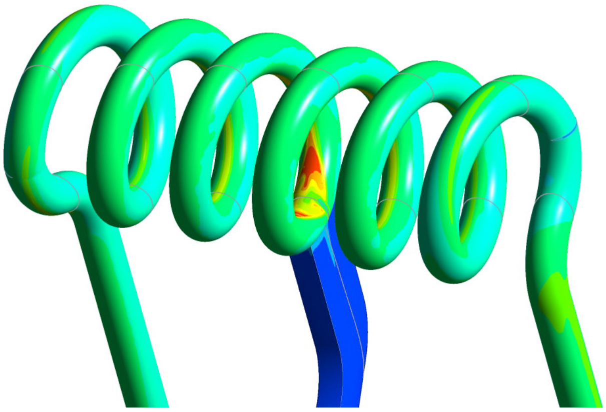
Approach

1/8 of the coil geometry is modelled using COMSOL Multiphysics. The frequency used to generate the magnetic fields needs to be carefully chosen in order to achieve a sufficiently uniform current distribution in the work piece, but at the same time minimizing the required total input power (40 kW, including 14 kW dissipation in the coil).

An accurate Computational Electromagnetics model was applied to determine the most suitable heating parameters. In order to achieve sufficient cooling, pressurized water is pumped into both sides of the coil and leaves in the middle, reducing the pressure drop. Thereby, the mass flow can be sufficiently large without decreasing the electrical inductance. The geometry of the water-cooling is modelled using Computational Fluid Dynamics. The minimal required mass flow to avoid boiling was determined.



Results

After production of the heating device the coil is pressure tested and the inductance heating performance is analyzed.

Physical insight and use of sophisticated simulation tools made it possible to meet the device's requirements with the first design.