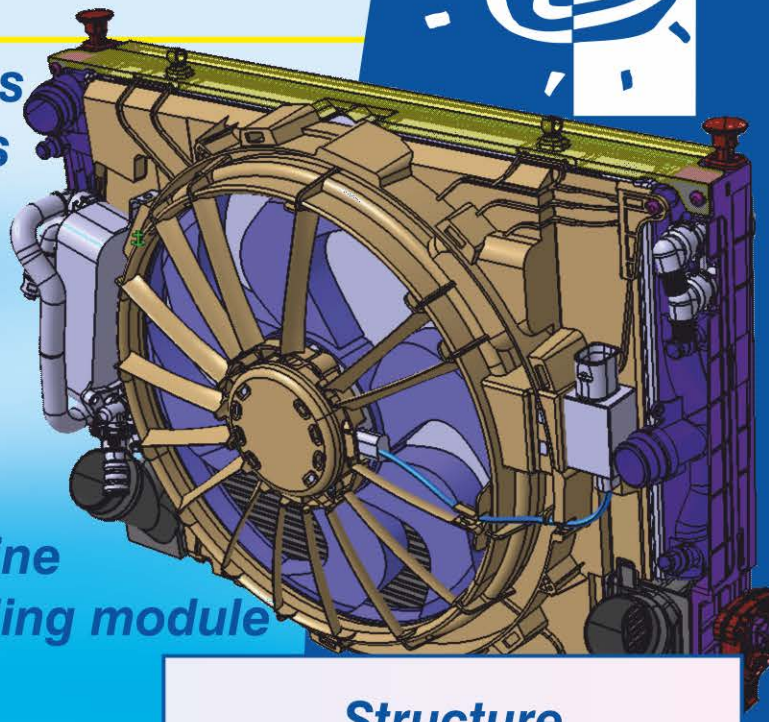
PERMAS

Design of Mechatronic Devices by Electro-Thermal FE Analysis and Coupled CFD Analysis

Power module

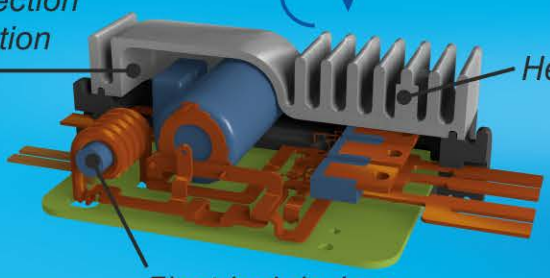


Engine cooling module

Inner cavity
- ✔ Convection
- ✔ Radiation

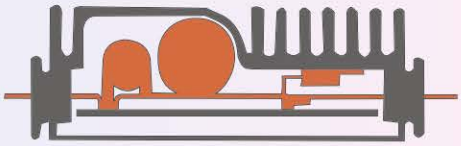
Air flow

Heat sink



Electrical devices
- ✔ Joule effect

Structure

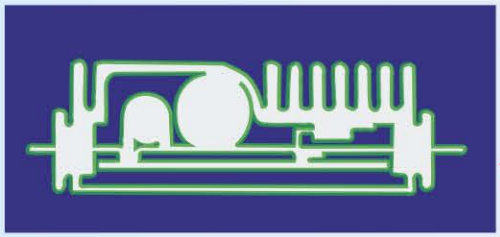


Current density

Heat sources

Flow and temperature

Fluid

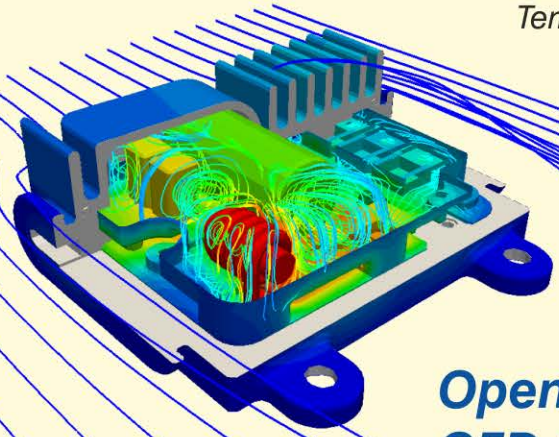


Bidirectional coupling

CFD computations were performed with OpenFOAM © Copyright OpenCFD Ltd.

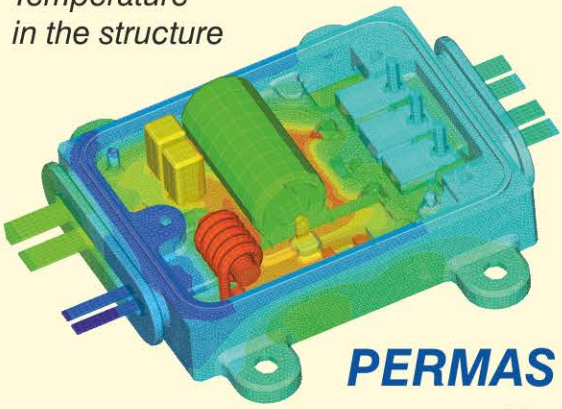
Temperature

Temperature and streamlines in the fluid



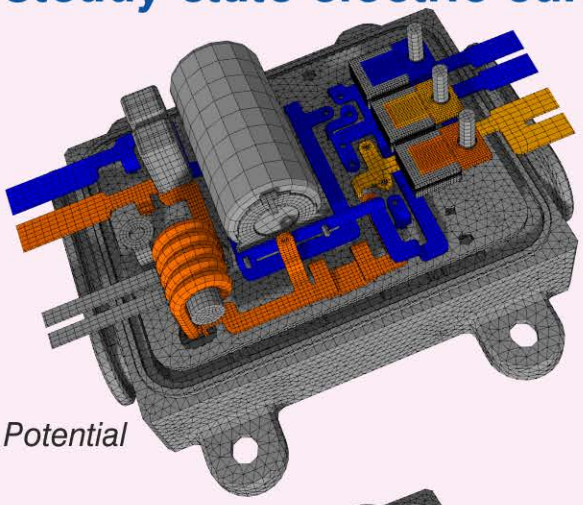
OpenFOAM CFD results

Temperature in the structure

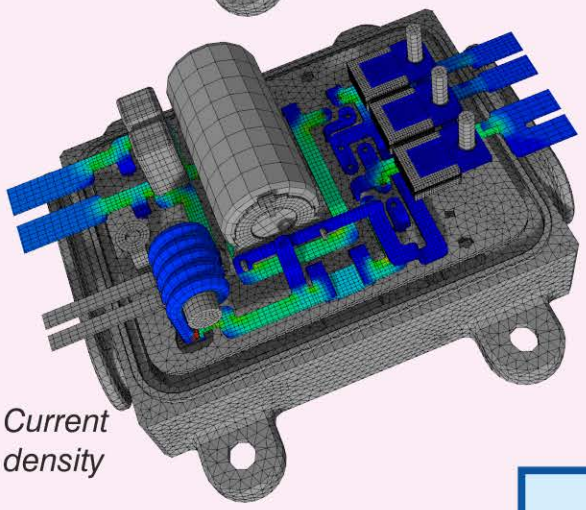


PERMAS results

Steady-state electric current



Potential

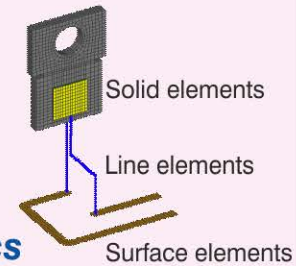


Current density

PERMAS *Electromagnetics*

- ✔ *Steady-state electric and magnetic field computations*
- ✔ *General dynamic electromagnetics, inductance, and wave propagation*
- ✔ *Absorbing boundaries and infinite elements for **unbounded domains***
- ✔ ***Joule heat sources** for subsequent thermal analysis*
- ✔ ***Electromagnetic forces** for sub-sequent structural mechanic analysis*

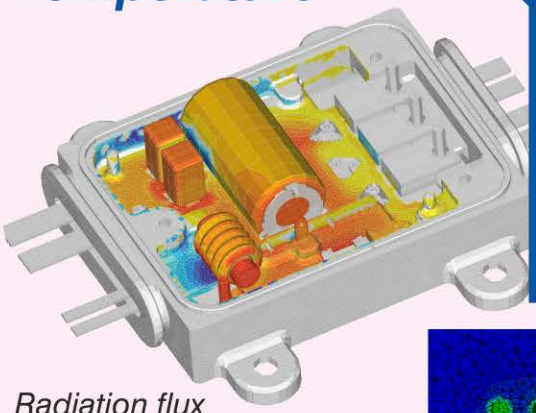
- ✔ ***3D modeling***
- ✔ *Convenient **incompatible meshing** for all kinds of DOF*
- ✔ *Fully integrated: **one model for all physics***



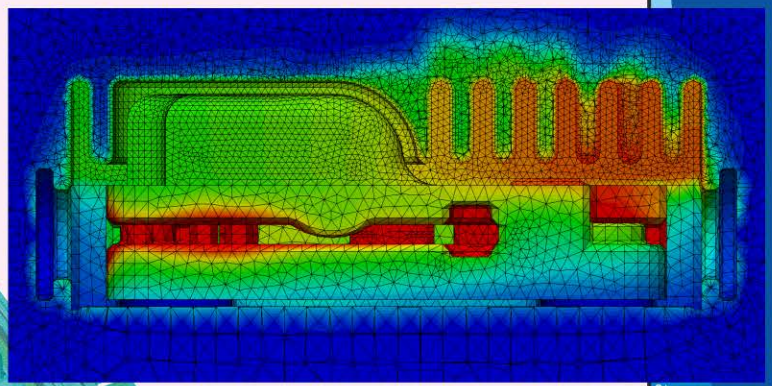
PERMAS *Heat Transfer*

- ✔ *Convection elements*
- ✔ *Efficient **radiation** computation (octree algorithm) for any kind of cavity under the grey body assumption, check of **view factors***
- ✔ *Fully integrated solution with structural mechanics*

Temperature

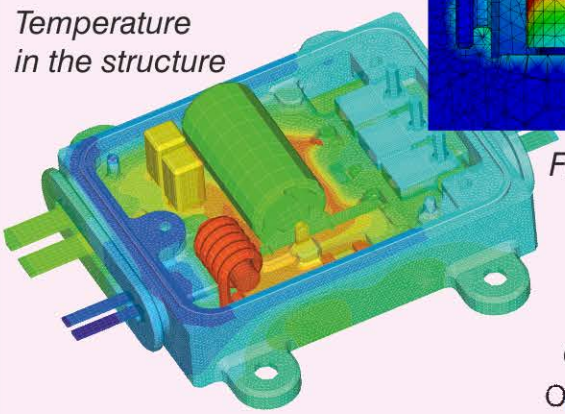


Radiation flux in the cavity



Fluid temperature near the structure

Temperature in the structure



CFD computations were performed with
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