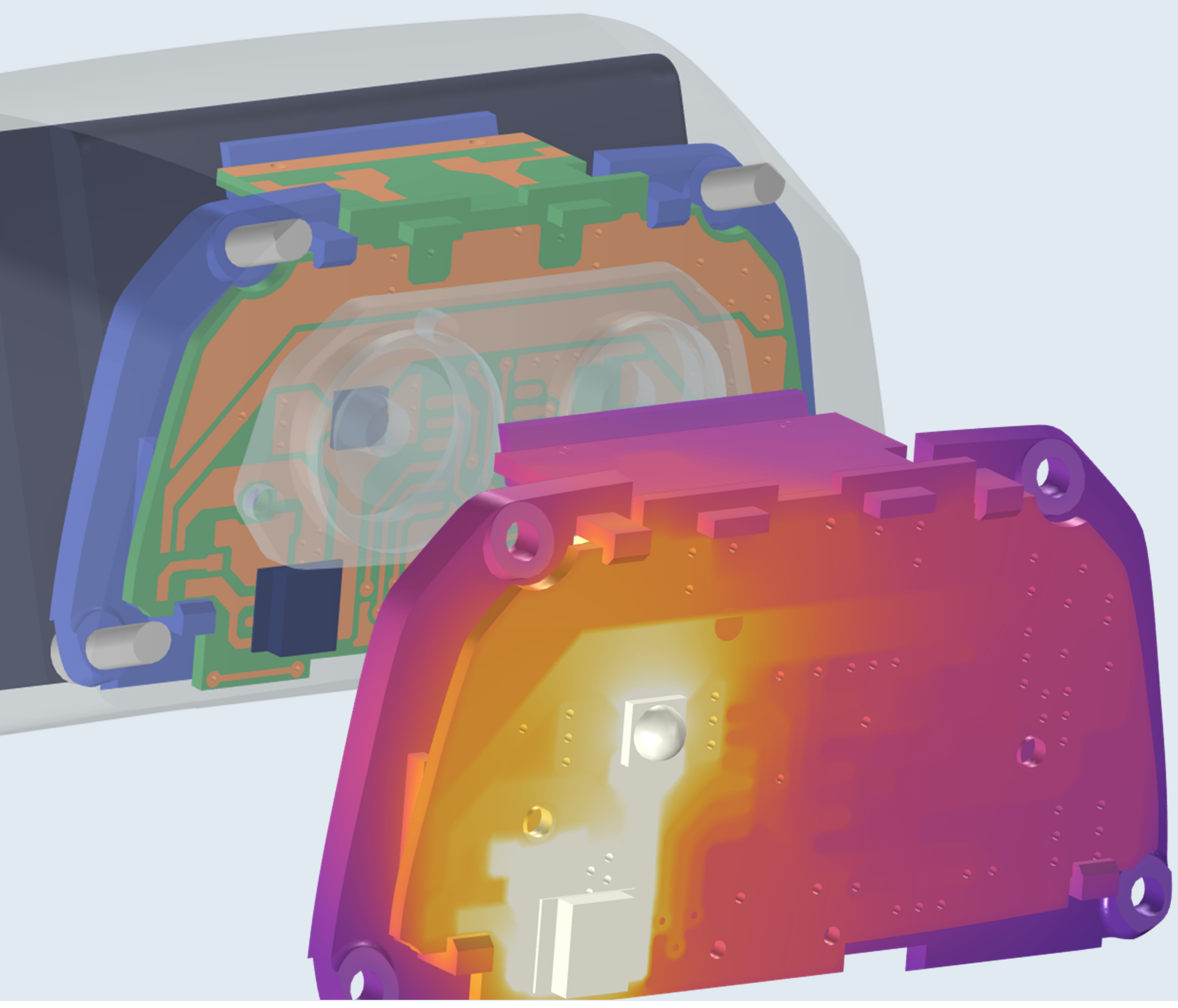

Modeling the Heat Dissipation of a Head Lamp within COMSOL Multiphysics®

This work studies the modelling of the heat dissipation of a head lamp within COMSOL Multiphysics®, aiming to ensure the thermal resistance of new designs.

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Abstract

Employing new materials is a lever to reduce the environmental footprint of a serial production of head lamps. It often requires to redesign the product to ensure its thermal resistance. This work studies the modelling of the heat dissipation of a head lamp within COMSOL Multiphysics®, by considering the three heat transfer modes.

Experimental results (thermal camera and thermocouple measurements) are available to validate the model. It allows to use it as a digital twin to assess the heat dissipation performance of new designs, by forecasting the temperature field and the hot spots within the lamp.

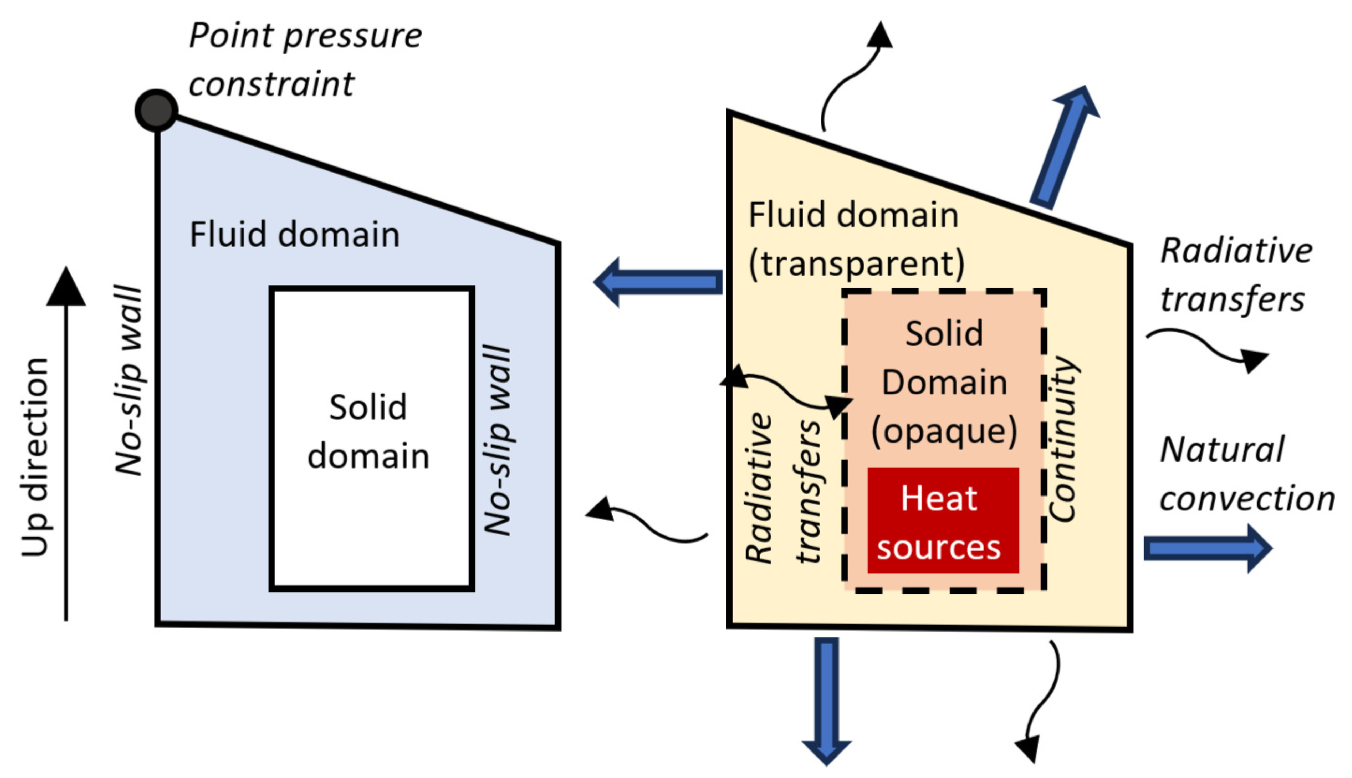

FIGURE 1. Schematic representation of the conduction-natural convection-radiation model.

Methodology

The solid parts and the air contained in the head lamp are modelled in 3D. The thermal equilibrium within the lamp, including the three heat transfer modes: conduction, convection and radiation, is solved.

Electronic component are modelled as isothermal domains and heat sources. Natural convection and radiative transfers are *explicitly* solved within the lamp. The copper pads are treated as shell elements. Heat transfer coefficients are used to treat lamp to environment dissipation.

Simulations of this model provide the average temperature within each components, and the surface temperature of the lamp, allowing the assess the thermal resistance, and locate hot spots near the user.

Results

The model simulated without the enveloping shell of the lamp and without radiative transfers shows a good qualitative agreement with experimental results, while large quantitative differences remain (FIGURE 2 – top).

With the enveloping shell, the model is simulated without and with radiative transfers, showing that (1) radiative transfers are not negligible in this process, and (2) the model with radiative transfers is very accurate by predicting the temperature at locations of interest to within a few degrees (FIGURE 2 – bottom).

This model can then be used as a digital twin to evaluate the thermal dissipation of new designs.

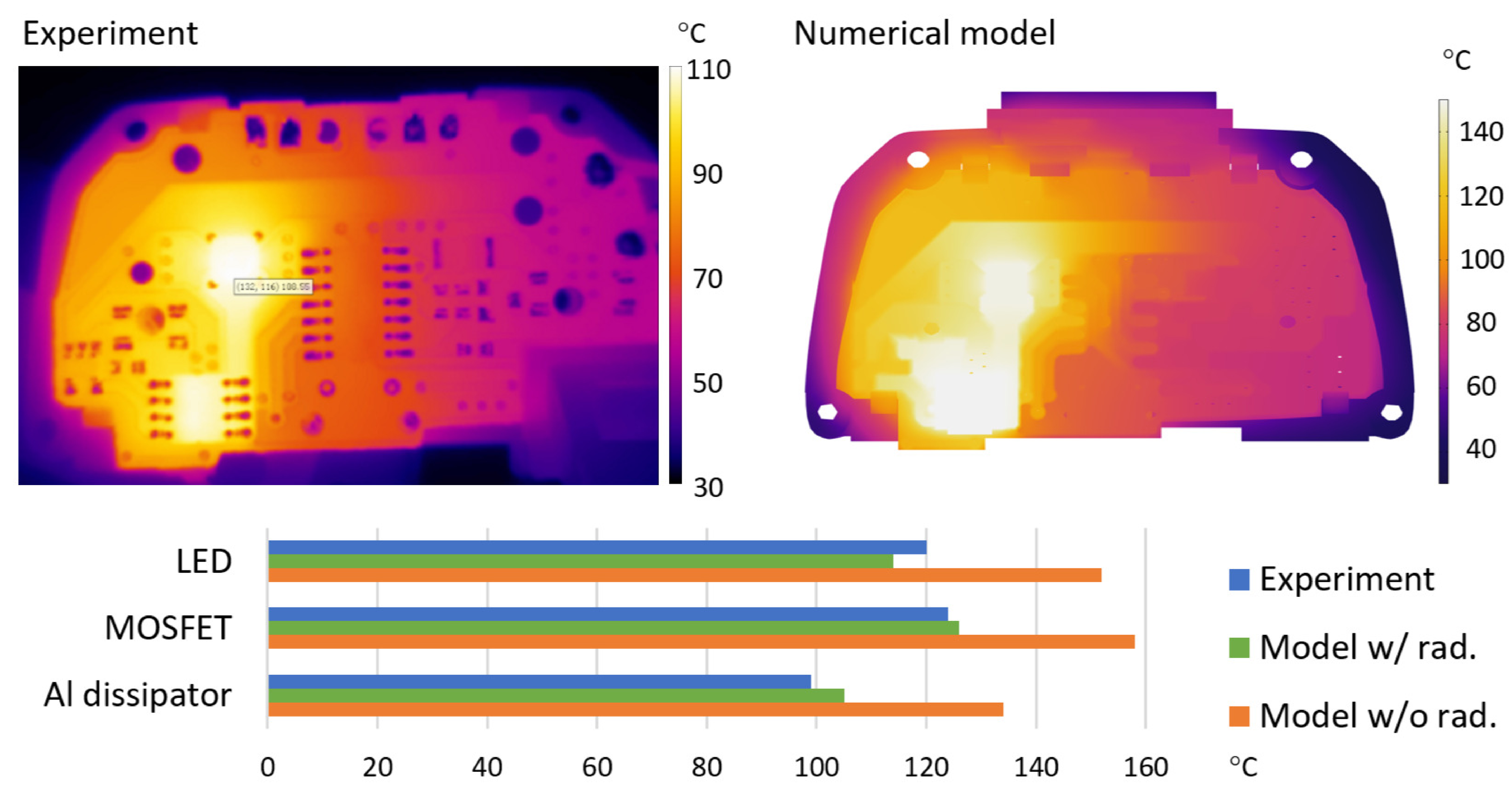

FIGURE 2. Comparison between experimental and numerical results. Top: open lamp temperature field. Bottom: closed lamp local temperature.

REFERENCES

1. A. Bejan, in Convection Heat Transfer, 3 ed., John Wiley & Sons, 2004, p. 215.
2. COMSOL, "Thin Layer - Thermally Thin Approximation," in Heat Transfer Module User's Guide, 2021, pp. 225-227.
3. COMSOL, CFD Module User's Guide, 2021.

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This work has been founded by DECATHLON and made in a fruitful collaboration between DECATHLON and SIMTEC.