Student Research Project / Master Thesis
Thermal Load on Electrical Components in Launcher Engine Bays

The engine bays of launch vehicles have the largest temperature gradients in the technical field. While the propellant pumps transport cryogenic propellants of just 75 to 100 Kelvin, temperatures in the combustion chamber are well over 3,000 Kelvin. There are usually just a few millimeters between these components. The start phase of an engine is a particularly big challenge. While the components within the engine bay are initially brought to cryogenic temperatures with an engine chill, they are exposed to immense heat radiation and heat conduction as soon as the engines start.

Electrical components are generally designed for very specific temperature ranges and are correspondingly sensitive to excessive temperature changes. In the case of engines with electrically driven pumps, however, the high-performance electronics must be positioned as close as possible to the engine. For this reason, the thermal balance of an engine bay is to be investigated in more detail in this thesis using an exemplary launcher mission and how the temperature changes of the high-performance electronics can be minimized in terms of material technology and topology.

The work is divided into the following steps:

1. Literature research on launch vehicles, rocket engines, operating areas of high-performance electronics, heat transfer, insulation, CFD and FEM
2. Definition of a mission scenario with corresponding reference launcher and engine bay including pumps and electronic board
3. CAD modeling of the engine bay
4. Identification of the thermal conditions during the mission using CFD and FEM
5. Creation of a thermal model in Matlab/Simulink and transfer of the identified conditions
6. Material and topological optimization of the electronic board.
7. Critical analysis of the thermal conditions and presentation of further optimization potential with regard to a thermally safe design.

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Execution only after consultation of supervising university institute