University of Stuttgart
INSTITUTE OF SPACE SYSTEMS

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Bachelor Thesis

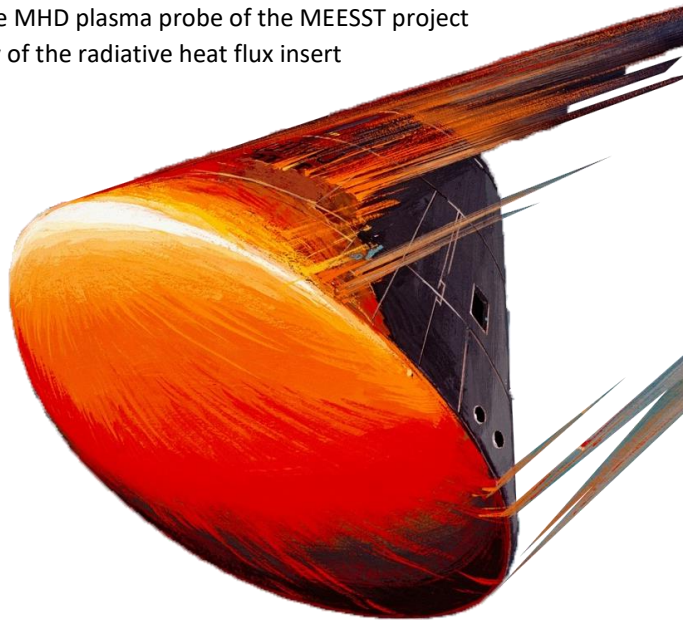
Design of a Radiative Heat Flux Insert for an MHD Plasma Probe

Motivation:

Within the international EU project MEESST (Magnetohydrodynamic Enhanced Entry System for Space Transportation), research on magnetohydrodynamic (MHD) influence on air plasmas is performed. The project aims to study the feasibility of an active magnetic thermal protection shielding for highly elliptical or hyperbolic re-entry trajectories into the Earth's atmosphere. These trajectories generally have higher re-entry velocities and re-entry angles than re-entries from low Earth orbit. Thurs, the surrounding gas exhibits higher ionization degrees in the occurring plasma. Therefore, the charged particle separation by the applied magnetic field in the plasma sheath becomes more efficient forming a stronger electromagnetic field and more particles been deflected by the resulting Lorentz force in inflow direction. On a macroscopic scale, this MHD effect is exploited to mitigate both thermal loads and communication blackout during space re-entry. One goal of the MEESST project is to assess and measure the effects of the magnetic field generated by a superconductive coil on the mitigation potential of the radiative heat flux on an MHD plasma probe, which is exposed to high enthalpy air plasmas within the PWK1 test facility at IRS. Consequently, it is crucial for the success of the project to design a measurement insert capable of measuring the radiative heat flux at the stagnation point if the MHD plasma probe. The insert shall be properly designed to meet the thermal and mechanical requirements of fast responding and accurate thermal column measurements within a high heat flux air plasma environment. A calibration methodology of the thermal column shall be proposed and tested. Additionally, the influence of the high magnetic fields on the radiative heat flux measurement with a thermal column shall be assessed.

Task:

- Literature review on radiative heat flux measurements in general and with thermal columns
- Assessment of the requirements and boundary conditions of such diagnostics
- Design of a radiative heat flux measurement insert for the MHD plasma probe of the MEESST project
- Implementation and testing of a calibration methodology of the radiative heat flux insert
- Documentation in English



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