Experimental Methods for Re-entry Aerothermodynamics Analysis – from Ground Based Measurements to Airborne Detection

Abstract

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The High Enthalpy Flow Diagnostics Group (HEFDiG) at the Institute of Space Systems of the University of Stuttgart develops methods for the experimental assessment of flow fields as occurring during atmospheric entry. The challenging environment of a high-enthalpy air flow at possibly thermal and chemical non-equilibrium is assessed using mainly non-intrusive optical diagnostics. We are using optical emission spectroscopy and have recently advanced new methods, e.g. Echelle spectroscopy, high frame rate spectroscopy or 3D imaging using plenoptic cameras. The surface heat flux being somehow the result of the high-enthalpy flow field at the material interface the is determined using new heat flux measurement methods developed by HEFDiG. Here, the basic idea is to characterize the respective problem entirely by using non-destructive testing of the actual hardware. A well characterized flow field allows the analysis of materials. Therefore, we have developed our own ablator (HARLEM) in order to study ablation mechanisms, e.g. spallation and radiation. The assessment of real re-entries was possible in rare occasions through airborne observation campaigns.

In the talk, the approach to analyse aerothermodynamics in ground testing facilities taking into account airborne observation data is presented with exemplary results and outlook to new measurement approaches.