RE-ENTRY PLATFORM FOR RADIATION STUDIES.

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Abstract: The experimental data available from in-flight measurements by means of optical emission spectrometry are scarce. Only two programs have been conducted: Flight Investigation of the Reentry Environment (FIREI&II) (1964/1965) conducted under hyperbolic reentry conditions at high speeds (v≈11.5 km/s) and the Bow Shock Ultra Violet (BSUV I&II) (1990/1991) experiments for suborbital flight regimes (v≈3.5 km/s and 5.1 km/s). These two programs covered the extremes of the reentry missions of interest at their time (lunar return and suborbital flight) and provided time-resolved emission spectra along the reentry trajectory. They evidenced and corrected major unknowns in the physic-chemical models, but the limited sets of data leave important gaps and partially validated models for the range of conditions needed for nowadays expectations on Low Earth Orbit (LEO, v≈7.5 km/s) return. In an attempt to complete the databases, an emission spectrometer will be imbedded within a constraining form and mass factor (340x100x100 mm3 for 3kg) reentry vehicle named QARMAN (QubeSat for Aerothermodynamic Research and Measurement on AblatioN, Fig.1). Developed by the von Karman Institute for Fluid Dynamics (VKI), the reentry vehicle will focus on reentry phenomena such as radiation with LEO return trajectory conditions that will permit to respond to the interest of the scientific community. The emission spectrometer studied and developed through a collaboration between Airbus Defence & Space, Ecole Centrale Paris and VKI, will demonstrate the feasibility of an efficient payload within a constrained mass/form factor and will collect missing data.

Investigations have been conducted to estimate the radiative flux and the contribution of molecular systems and atomic lines in order to select and calibrate the proposed spectrometer. Integration of the payload on the reentry platform has also been studied. Design work and tests in an Inductive Coupled Plasma torch facility have enabled us to converge to an efficient design capable takeoff making measurements in the harsh reentry environment and despite an optical path contaminated with ablation products. Measurements of the radiation emitted in the bow shock layerduring the reentry of the vehicle will provide flight data for the validation of numerical codes and ground test methodologies. The ground-to-flight extrapolation models will also benefit from these data as the full duplication of flight conditions is not possible on the ground.

The understanding of radiative flux during reentry is phenomena key challenge with a direct influence on the thermal protection system of the vehicle. The radiative component can reach up to 20% of the total heat flux for a LEO reentry, and about 50% for a Lunar reentry. In conclusion, the low-cost QARMAN vehicle should provide valuable data for a better understanding of the radiative processes during reentry.

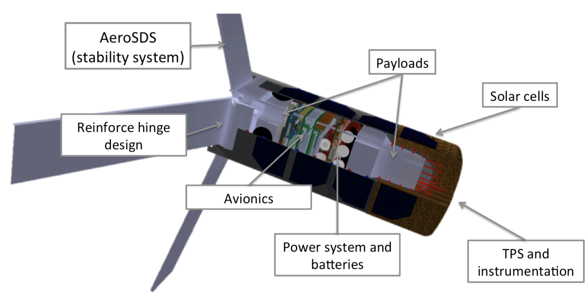

Figure 1: Breakup view of QARMAN vehicle