CHALLENGES OF THE INSTRUMENTATION FOR HIGH SPEED ENTRY VEHICLES

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In order to achieve a low cost access to space while keeping the reliability at a high level, the design cycle duration has to be reduced and the service and refurbishment of the space vehicle have to be simplified. Design tools like CFD or structural codes are to be improved with respect to physical modelling using accurate data from ground testing or flight experiments. Although ground testing facilities still provide the main validation data and allow a better understanding of the physics, a complete duplication of the flight conditions is mostly not possible. Flight experiments are the only way to obtain validation data for design or prediction tools under real conditions. On the other hand during flight experiments only coupled information can be gained and therefore a parametric study is not possible. Therefore a further use of ground testing facilities and CFD simulations for post flight analysis is essential to interpret the flight data correctly.

For vehicles using an ablation material for the TPS the instrumentation is more difficult. One of the key problems is the strong contour change of such materials resulting from thermal expansion and recession. In addition the phase change inside the material leads to a significant modification of the material properties and makes the determination of the thermal properties of the structure more difficult. Ablation products in gas, liquid and solid form enhance this problem. These phenomena dominate the behaviour of the capsule front surface, which is exposed to very high aerothermal loads. On the rear surface the convective heating is low but difficult to estimate. This is a result of the shortcomings of numerical tools. In addition for some atmospheres, like the Martian atmosphere, the radiative heating on the base could reach the same level as the convective heating. To measure these phenomena in flight experiments a dedicated sensor has to be designed. The COMARS sensor of DLR has been developed to have a combined measurement of pressure, temperature, heat flux rate and radiation at the base of the capsule during a Martian entry (Figure 1).

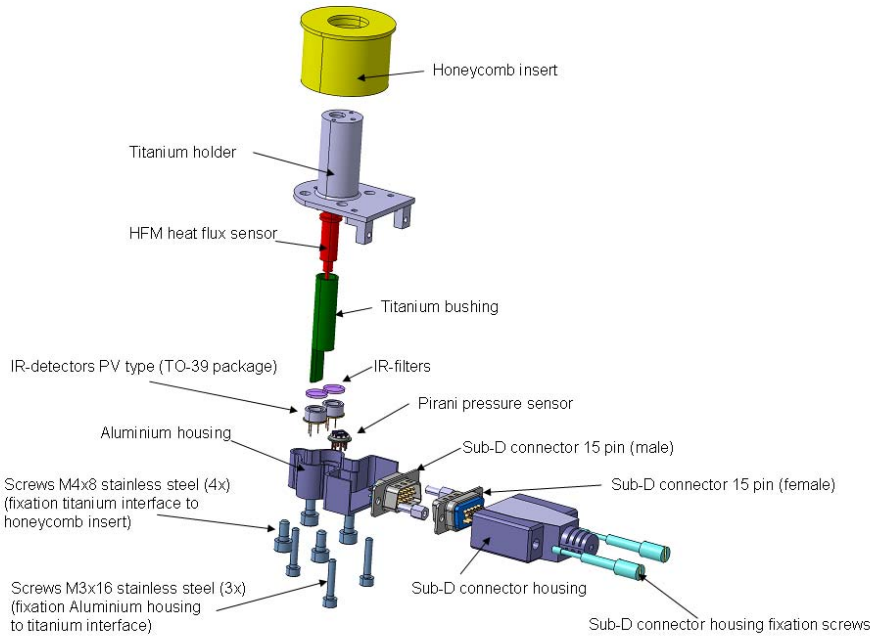

Figure 1: Exploded view of the COMARS sensor