INVESTIGATION OF PLASMATRON PERFORMANCE FOR MARS ENTRY

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During planetary re-entry, high temperatures behind the bow shock wave in front of a blunt nose produce dissociation and ionisation of the gas, which becomes a partially ionised plasma. This can result in increased thermal loading at the vehicle surface.

The VKI has been involved in re-entry and catalycity determination investigations since 1997. The methodology used is based on the hybrid numerical-experimental LHTS: a local simulation approach developed at the Institute for Problems in Mechanics (Moscow) which allows to relate ground tests to real flight conditions. Experimentally obtained heat flux and Pitot pressure data are post-processed to obtain flow properties using a VKI code. Finally, extrapolation to flight is carried out using this processed data.
Experiments in CO_2 plasma with several heat flux probes and different sensing elements were carried out. Silver was found to have a higher catalycity than copper in a carbon dioxide plasma. The radiant heat flux was measured and shown to be negligible at the working conditions chosen. Small discrepancies are visible in the facility repeatability tests and a need to calibrate the effect of the Plasmatron configuration on the plasma jet is established.

The flow rebuilding code accuracy is limited by its hypotheses and presents some problems of a numerical nature. Extrapolation to flight allows evaluating the chosen Plasmatron working ranges for typical real flight simulation. It was found that operating parameters should be modified in order to allow simulating a greater range of typical Mars entry trajectories.

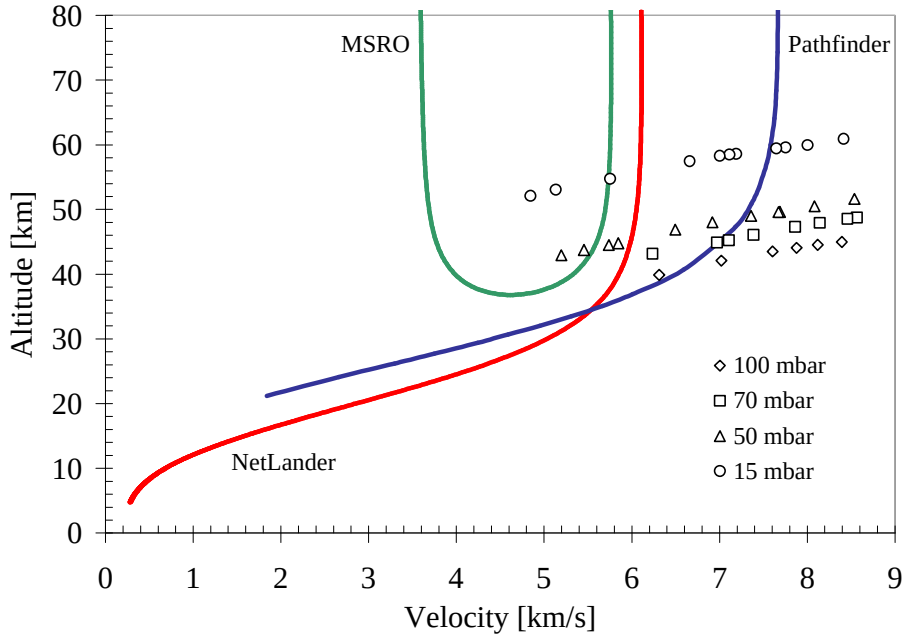

Figure 1: Velocity-altitude map with paths of three space vehicles and he conditions simulted in the Plasmatron facility