SUPERSONIC AND HIGH PRESSURE PLASMA TESTING

Pablo Fajardo Peña, Spain
Supervisors: O. Chazot & H.W. Krassilchikoff

The election of the thermal isolation is one of the most important issues to consider during the design of a reentry capsule. During the reentry in the atmosphere, the capsule receives an enormous amount of heat, which implies a temperature rise on its surface. For a designer, it is important to know the conditions that the capsule will have to bear with. If the thermal protection system is underestimated it will be catastrophic for the capsule, but overestimating it is not advisable either, since it will involve an increase in the weight of the capsule and therefore, a reduction of the payload. This brings an idea of the necessity to perform ground testing.

Using the Local Heat Transfer Simulation, a methodology developed by Kolesnikov that has already been used at the VKI, it is possible to extrapolate from ground to real flight conditions.

The current capabilities of the VKI Plasmatron, allow to experimentally simulate trajectories of vehicles as the Shuttle, however not all reentry vehicles follow the same trajectory. The objective of this project is to extend these capabilities to be able to simulate the trajectories of other vehicles as Apollo and Rosetta, for which a higher stagnation pressure is needed.

In order to be able to simulate these conditions, a sonic nozzle has been designed by H.W. Krassilchikoff and has been installed in the Plasmatron. The purpose of this project is to study the new capabilities of the facility and extend the testing methodology used at the VKI, to characterize the new experimental environment created around the stagnation point. The first intention was to work in supersonic regime injecting an under-expanded jet into the test chamber. However, at the view of the results obtained, it has been seen that better results could be obtained in subsonic high pressure flow. In this situation, the contraction is used in order to increase the stability of the jet in the test section.

In the following pictures, an image taken during the supersonic tests campaign and the capabilities obtained with the subsonic contraction are shown superimposed with the capabilities of the Plasmatron without the nozzle and some “typical” trajectories of some reentry vehicles. From them, it can be seen that supersonic jet is achievable in the Plasmatron and that the new extrapolated points obtained are for trajectories at lower altitudes, which was the main objective of the project.

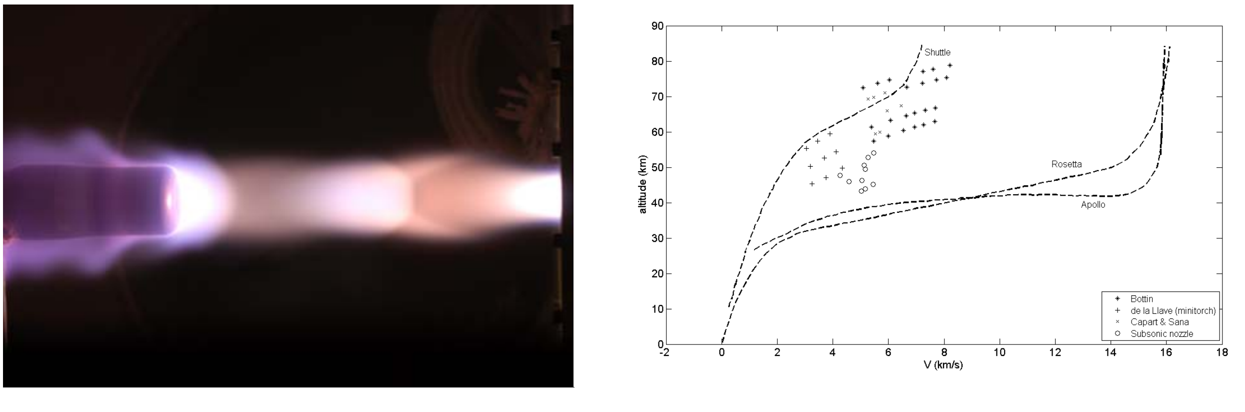

Figure 1: Picture of the supersonic plasma jet impinging over the standard probe (a) and new operational capabilities obtained with the nozzle working in subsonic regime (b)