# SIMULATION OF THE SUPERSONIC NOZZLE FOR THE VKI PLASMATRON FACILITY

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This report details an attempt of the numerical simulation of a Laval nozzle for the Plasmatron facility applied at the VKI. The Plasmatron is the most powerful inductively-coupled plasma wind tunnel in the world, which is used for the simulation of reentry conditions of spacecraft, determination of catalycity properties and general study of plasma flows. The main disadvantage of this facility is the accessible speed, which is very low. The primary objective of this project is the engineering design of a necessary nozzle, with which Mach 3 is available. Reaching this Mach number, the edge of the boundary layer in the off stagnation point region can be simulated.

Nowadays numerical simulations are used for design purposes. The extreme conditions of plasma flows with the temperature of about 10000 K can not be simulated by commercial numerical codes, but only special scientific codes, just like the von Karman Institute's Inductively Coupled Plasma (ICP) code. The ICP code is capable to handle the physical properties of plasma, but it suffers from instability and is sensitive to many parameters. It seemed to be hopeless to obtain convergence in many cases starting from uniform flow as initial solution, that is why we decided to use Fluent in order to get preliminary results, which can be used as initial solution for the ICP code hoping better chance to converge in this way. For this purpose a conversion tool was written. It was tested, it works.

At first Fluent was run on the investigated geometry, then the ICP code. Easy convergence was obtained with ICP in subsonic cases on different meshes. The supersonic case, on the geometry of the inductive torch and the Laval nozzle (Figure 1) was more difficult, but it also converged. The simulations were run using different values of mass flow rates according to the expectations of the experiences. Although the flow parameters are quite different in the results of the two codes, there are general tendencies, which are very similar. So it is pointed out that using Fluent can be very useful from the point of view of searching for the suitable geometries for the Plasmatron and saving much computational time and efforts.

In the future other shapes and the full geometry (containing the torch, nozzle and test chamber) should be investigated with several different values of ambient pressure and electrical power. The detailed analysis of the given results is also future task.

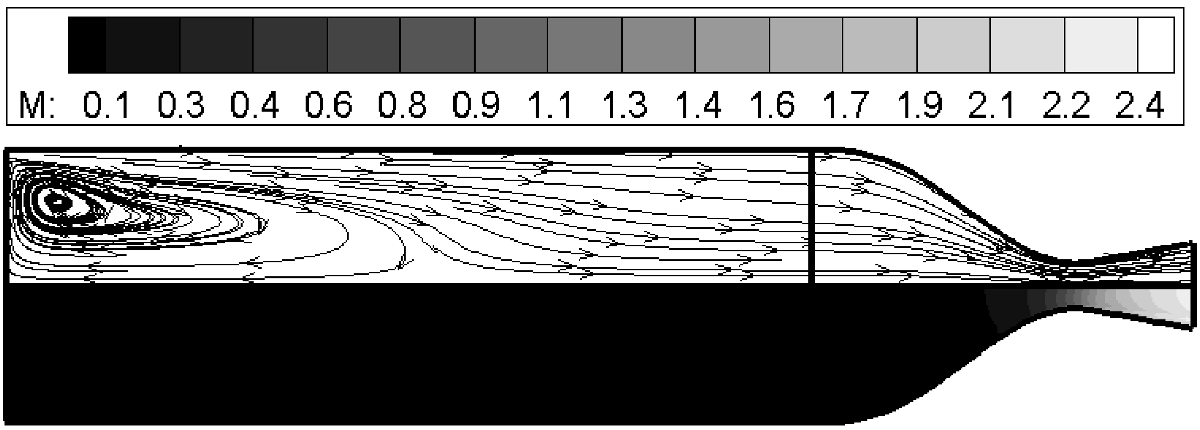


*Figure 1: Streamlines and the Mach number field on the torch and the scaled up nozzle of the Minitorch*