

## Paper 11.7

### Laser-Doppler velocimetry measurements in a plasma discharge

by

O. Chazot and M. Carbonaro

Von Karman institute for fluid dynamics

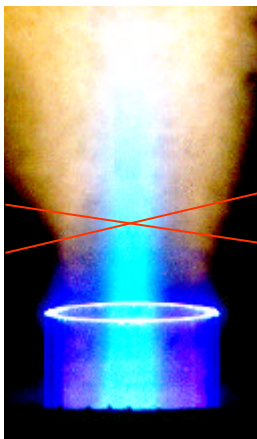
Aerospace Department

72, Chaussée de Waterloo, 1640 Rhode-St-Genèse, Belgium

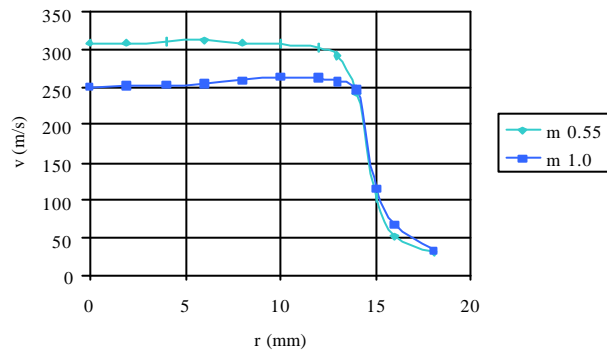
#### ABSTRACT

Plasmatron facilities are used to generate high enthalpy flows to test Thermal Protection System (TPS), of space vehicles, in planetary re-entry conditions. Such flow has to be accurately characterized in order to assess these tests based on the concept of local heat transfer simulation.

To this aim, the practical adaptation of laser-Doppler velocimetry has been examined for the high temperature of the plasma flow, and the severe environment of an Inductively Coupled Plasma (ICP) torch. This measurement technique has been installed on the 15 kW VKI Minitorch facility operating with air plasma. Interference filter has been placed to remove the emission of the plasma discharge. The particle behaviors in a plasma flow have been inspected in order to determine criteria to select the convenient seeding particles. The seeding generation and the transportation of solid particles have been checked for the powder used. With SiO<sub>2</sub> and Al powder, a classical LDV set-up, used with forward scattering, appeared to be suitable for the measurements in the plasma flow conditions. Velocity measurements in the plasma jet have been performed for typical operating conditions of the VKI Minitorch facility. The velocity profiles have been measured 20 mm downstream from the torch exit, for static pressure of 50 hPa and 200 hPa in the test chamber. The characterization of the flow field in the discharge region, for the same plasma conditions, is also presented.



(a)



(b)

Fig.1. LDV measurement in an air plasma jet

a) Picture of an air plasma jet seeded with Al particles ( $\sim 1 \mu\text{m}$ )

(The traces of the laser beams have been artificially intensified for their visibility on the picture)

b) Velocity profiles of an air plasma jet 20 mm downstream from the torch exit

(Power: 3.6 kW, static pressure: 50 hPa, mass flow: 0.55 g/s and 1.0 g/s)