ASSESSMENT OF HYPERSONIC FLOW IN THE VKI LONGSHOT FACILITY

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The development of future space vehicle requires hypersonic ground testing and extensive computations before the real flight. The success of a mission will depend on the reliability of the experimental data, the accuracy of the CFD and the methodology used to extrapolate these data from ground test to flight. The increase of the computational resources, the recent development in physical modeling and numerical schemes has given the computational part much more important role in the space missions. The validation of the computational codes with experimental data is more than necessary, therefore accurate ground test conditions are needed.

The free stream conditions in most hypersonic wind tunnel are very difficult to assess and remain one of the most challenging tasks even in the recent hypersonic facility. The uncertainties on their values could reach 20\%. It's mostly due to a lack of experimental data on some part of the facility like inside the nozzle or the driven/driven tube and also to some technical difficulties to measure some main flow parameters. The usual method to overcome this limitation is to rebuild those missing data using one dimensional solver based on isentropic assumptions and the current multidimensional numerical simulation concern only some part of the facility like the nozzle or the driven which is far from being enough to have a good understanding of the facility.

Therefore an important part of the wind tunnel is used as black box, where the data are known only at the inlet and the outlet.

In order to investigate the flow field in the Longshot facility, a series of numerical computations of Hypersonic flow in the Longshot nozzle and around the heat probe in the test chamber of the Longshot facility have been done. Thermal nonequilibrium with two-temperature model has been considered during this investigation. The numerical simulations show a strong thermal nonequilibrium in the Longshot nozzle due to the hard expansion of the gas (Nitrogen) in the nozzle. The vibrational temperature freezes near the throat at 65% of its initial value and this affect the dynamics of the flow downstream as shown from the comparison between numerical computation and the rebuilded experimental data.

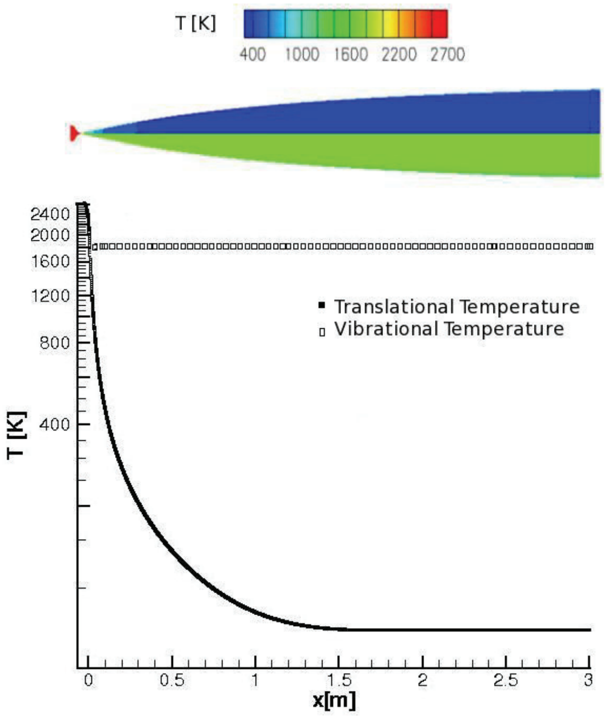

Figure 1 : Temperature profile along the symmetry axis