

# Aerodynamics of hypervelocity bodies

## GSTP activity summary

ESA contract No. 4000114170/15/NL/KML



The operational capabilities of the VKI Longshot hypersonic wind tunnel have been upgraded in order to support ESA's future aerothermodynamic investigations. The key achievements described hereafter all contributed to establish this facility as a reference cold hypersonic wind tunnel:

- Development of a state-of-the-art free-stream flow characterization methodology. New probes have been developed in order to directly measure free-stream flow properties of interest. Additional flow quantities are determined using a rigorous approach accounting for high-temperature effects. The application of this methodology is strongly recommended in other European hypersonic facilities.
- Extended operational map towards higher Mach numbers. The VKI Longshot has been fitted with a new Mach 14 contoured nozzle (540 mm exit diameter) designed with the method of characteristics. Calibration runs have demonstrated an excellent flow uniformity and the largest Mach and Reynolds numbers currently achievable across Europe.
- Wider set of measurement techniques. A fast-response 6-components aerodynamic balance has been designed and instrumented in order to complete the set of measurement techniques already available for this wind tunnel. The geometry of the balance has been optimized to fit within the short geometries characterizing the reentry capsules.
- Improved operational efficiency, safety and repeatability. An automation system has been implemented for the VKI Longshot wind tunnel. It increases the system awareness and reduces the operational cost of the facility.
- Lagrangian modeling of the wind tunnel. Accurate predictions of the complete compression cycle of the Longshot (gas compression using an inertial piston) have been achieved. The numerical tool accounts for the peculiarities of the VKI Longshot tunnel (presence of check valves, high pressure and high temperature leading to real gas effects...). It enables the determination of sensitivities to initial flow conditions, the determination of operational maps, and provides unprecedented insight into the operation of the wind tunnel. This tool will also support the future operation of the tunnel with new test gases in order to investigate entries into the atmosphere of other planets.

