

IAF SPACE PROPULSION SYMPOSIUM (C4)  
Hypersonic Air-breathing and Combined Cycle Propulsion, and Hypersonic Vehicle (7)

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TECHNOLOGICAL CHALLENGES OF THE DESIGN OF A SCRAMJET HYPERSONIC VEHICLE  
AND ITS FLIGHT MISSION

**Abstract**

The main technological challenges of an Italian running research project, aimed to develop and validate some key-technologies for hypersonic flight by means of an experimental mission, will be described in this paper. The project complements numerous initiatives born in Europe in the last 20 years, funded by EU or as national initiatives, which have created the proper momentum to proceed towards the needed technological developments for hypersonic flight and access to space, whose needs typically show some commonalities. The present project on a Scramjet Hypersonic Experimental Vehicle (SHEV) starts from the experience gained thanks to the strong involvement of CIRA in the European projects HEXAFly-INT (design and flight test of a hypersonic glider demonstrator) and HEXAFly (feasibility study for a hypersonic propelled demonstrator), posing the challenge of creating a vehicle capable of supporting a levelled hypersonic flight powered by a scramjet propulsion system. The project is co-funded by the national research programme PRO.R.A. and the Italian Space Agency (ASI), with the aim of designing a hypersonic propelled demonstrator capable of performing a levelled and controlled flight at Mach 6-8 and 28-32 km altitude, thus realizing and testing the enabling technologies for future civil transport systems at hypersonic speed. Among the different technical problems faced in the first period of the project it is worth

mentioning: i) the definition of the configurations of the demonstrator (SHEV) and the booster-propelled Launch Vehicle (LV), in the hypothesis of an air-launched mission scenario with an existing carrier aircraft, in order to bring the SHEV to the nominal experimental window; ii) the setup of aerodynamic-propulsive databases for both SHEV and LV; iii) the aero-propulsive performance assessment of the SHEV, with the goals to have a rather large aerodynamic efficiency ( $L/D = 3-4$ ) and the aero-propulsive balance ( $T > D$ ) at Mach 6-8 in controlled flight; iv) the preliminary design of the scramjet propulsion system including its auxiliaries for the SHEV; v) the selection of an off-the-shelf booster for the LV; vi) the preliminary mission analyses of both SHEV and LV verifying their flyability, stability and trimmability with calculation of first nominal flight trajectories; vii) the avionic architecture for the SHEV and preliminary avionic concept for the LV. The full paper will report about all these updated developments, and possibly other activities which will have been started, and it will include also the definition of the experimentation plan of the project (aerodynamics, propulsion/combustion, materials).