LAPCAT II : conceptual design of a Mach 8 TBCC civil aircraft

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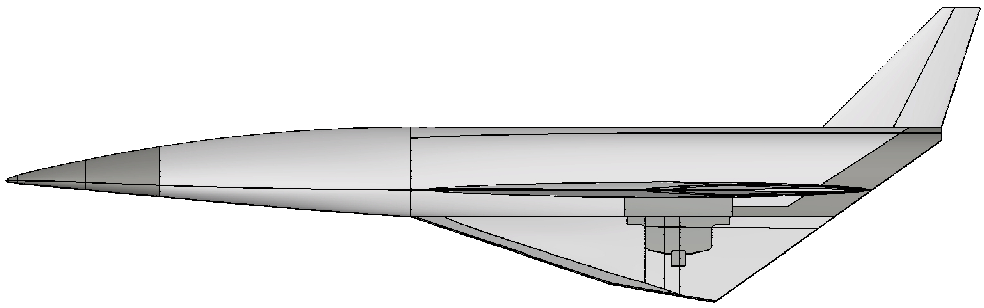
Abstract

Within the frame of the LAPCAT II project (Long-term Advanced Propulsion Concepts and Technologies, funded by the European Commission as part of the 7th Frame Program and involving several European research labs and industries), four concurrent system studies have been carried out to design a Mach 8 vehicle able to carry passengers on the Brussels-Sydney route. The required range is above 18000 km, and the defined number of passengers is 300, which correspond to a 60 tons / 1400 m^3 payload.
Inspired by the previous analysis led by Onera on PREPHA-based concepts ([1]), by the University of Rome on TBCC hypersonic performances ([2] and [3]) and by Université Libre de Bruxelles on precooled turbofan performances ([4]), a deeper analysis on a turbofan/ramjet/scramjet concept was performed, including a parametric sizing of the vehicle, a more detailed internal layout, some additional performance figures to model the turbofan operation phase, and relevant trajectory computation.



The paper will first detail the layout choices that were made to be compliant with the mission requirements :

- Aerodynamic shape suited for cruise efficiency, based on Küchemann parameter analysis,

- Potentially pre-cooled turbofan sizing : the main characteristics of the chosen concept and its performance assessment will be described in details,

- Dual-mode ramjet concept for acceleration and cruise.

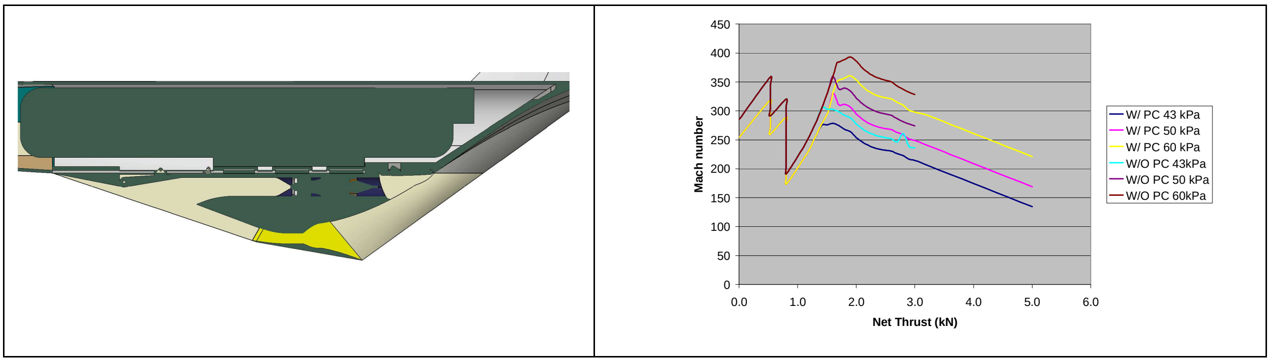


Figure 1: baseline TBCC layout (left) ; turbofan unitary net thrust (right)

Then the conceptual design process will be described. This process was performed using an integrated multi-disciplinary analysis tool including parametric aerodynamics, propulsion, waight breakdown and trajectory models. This high-level system loop was fed with performance models mentioned above, more detailed trajectory computation, and a high-fidelity (3D Navier-Stokes nose-to-tail) aeropropulsive analysis on the Mach 8 cruise point. Results will be presented regarding :

- The conceptual design process and trade-offs,
- The trajectory analysis on turbofan, DMR acceleration and scramjet cruise phases,
- The results of CFD computation compared with preliminary assessments,
- The updating of the general vehicle layout (passenger cabin, tanks, gears… accommodation).

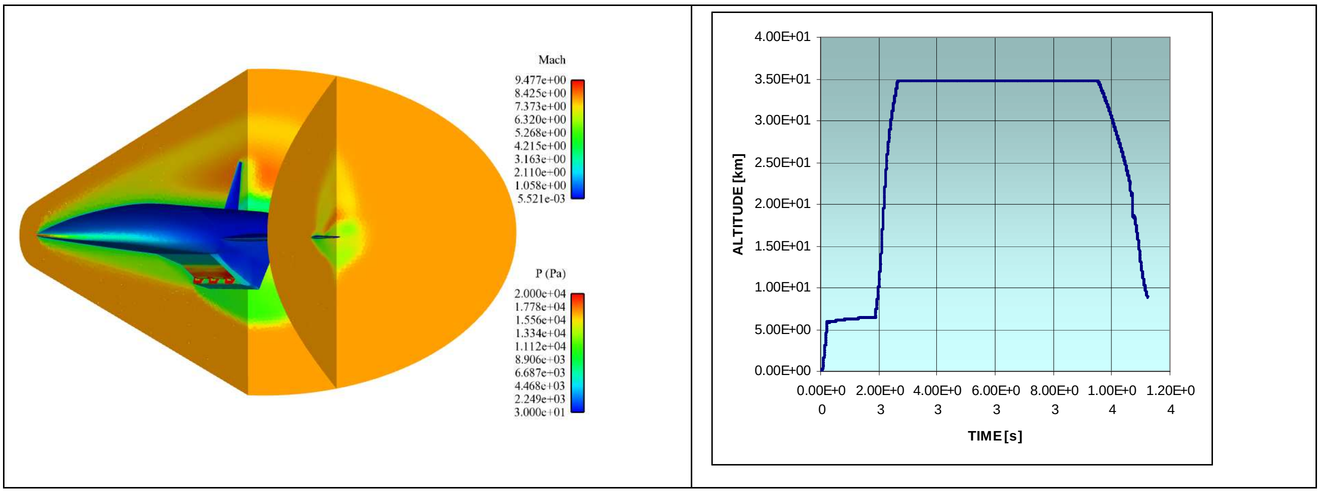


Figure 2: examples of CFD and trajectory computation

References

Previous papers on the same topic :

[1] L. Serre, S. Defoort (Onera), *Lapcat-II : towards a Mach 8 civil aircraft concept, using advanced Rocket/Dual-mode ramjet propulsion system*, 16th AIAA/DLR/DGLR International Space Planes and Hypersonic Systems and Technologies Conference, Bremen, October 2009

[2] A. Ingenito, S. Gulli, C. Bruno (University of Rome), *TBCC Hypersonic Performance : Effect of Inlet Entropy*, 16th AIAA/DLR/DGLR International Space Planes and Hypersonic Systems and Technologies Conference, Bremen, October 2009

[3] A.Ingenito and C. Bruno, *Sizing of Hypersonic Airbreathing Vehicles*, AIAA 2009-5186, 45th Joint Propulsion Conference & Exhibit, Denver, Colorado, USA, August 2009.

[4] C. Paridaens, D. Verstraete, P. Hendrick (Université Libre de Bruxelles), *Performance Assessment of a Pre-cooled Turbofan for Hypersonic Vehicle Acceleration*, http://www.ecosimpro.com/download/articles