HEXAFLY-INT Project: Design of a High Speed Flight Experiment

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The HEXAFLY-INT project, funded by the European Commission within the 7th Framework Programme and the European Space Agency, aims at designing, manufacturing, assembling and flight testing an unpowered high speed vehicle in a glider configuration.

The main target is to gradually increase the readiness level of a number of breakthrough technologies suitable for future high-speed transportation systems.

The main technical challenges of the project are specifically related to the design of the vehicle gliding configuration and to the complexity of integrating breakthrough technologies with standard aeronautical technologies.
The project is involving partners from Europe, Russia and Australia

Main responsibilities:
- CIRA Project Engineer and Design Authority
- TET Cold Structure design
- TsAGI (Russia) cold structure manufacturing
- DLR hot structure manufacturing
- DLR and Australian part in-flight experiment

The experimental payload is composed by the Experimental Flight Test Vehicle EFTV, and the Experimental Support Module ESM.

- The first is designed to glide through the experimental window; it is equipped with an avionic system composed by an inertial measurement unit (IMU), GPS, servo-actuators, a mission specific flight control computer (FCC). The vehicle will also be equipped with an in-flight measurement system.
- The latter has the aim of stabilizing and controlling the vehicle attitude at the higher altitudes by means of cold gas Reaction Control Systems thrusters.
**Mission Profile**

**Objective:** to perform a high-speed flight experiment with a target flight Mach number of 7 to 8 altitude range in between 27 and 33 km

Ad-hoc designed sounding rocket provided by DLR in cooperation with Brazil, relying on background experience (SHEFEX)

1. VS-43 Launch Vehicle lifts off;
2. Fairing release (about 80 km);
3. Payload release (90km);
4. Cruise phase to the experiment window (Stabilization by CGS);
5. ESM separation from the EFTV (50 km);
6. Experimental window; gliding phase.

As no recovery of the payload is foreseen, the reception of experimental data is guarantee by telemetry (TM)

**Glider Trajectory**

After the separation from the ESM, a pull-out manoeuver brings the EFTV at a target altitude;
Banking manoeuvre just after the pull-out;

Experimental window:
- min 150 s
- L/D > 3.5

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The aeroshape is the result of the analyses driven by key design requirements:

- aeroheating
- stability and control
- high aerodynamic efficiency
- necessity to reduce problems in manufacturing and assembling

### Nominal Mass [kg]

- 461

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**Materials:**

The EFTV thermal protection system is composed both of metallic and ceramic parts (hot structures):

- **CMC (hot structure):**
  - Ailerons
  - Wings Leading edge

- **Copper:**
  - Nose cap
  - Vertical tail leading edge

- **Titanium:**
  - Wings, fuselage, vertical tail
Materials:
The EFTV thermal protection system is composed both of metallic and ceramic parts (hot structures). Due to the high temperatures involved, the metallic parts of the vehicle are protected by a ZrO2 coating.

Materials:
Fittings and Rods: Ti + ZrO2 coating; Cone structural parts: Aluminium
On-board Systems

- Autonomous Guidance, Navigation and Control provided by the Flight Software running on Flight Control Computer and using data from IMU and GPS
- Experimental data collected by the on-board DAQ and sent to ground by a Telemetry System
- The system relies, at the maximum extent, on flight proven or on-ground qualified sub-systems and equipment developed within international projects.
- Use of COTS H/W coming from space and aeronautics heritage

The ESM communicates with the EFTV through Umbilical connections; The separation of the ESM is realized by means of pyrotechnic devices.

- The PM function ensured by the power supply system;
- Electrical power supplied to on-board systems and actuators by rechargeable Li-ion batteries;
- The control of the vehicle attitude after the Payload release and before the ESM separation by means of the CGS unit;
Instrumentation layout defined in order to cover different scientific objectives with different sensor types mounted in the interested regions.

- Free stream quantities derivation by means of Flush Air Data System (FADS) integration;
- Aerodynamic heating
- Flap separation and gap-flow;
- Transition;
- Shock wave boundary layer interaction
- Wake and corner flow;
- Internal structure stress determination;
- Internal health monitoring;
- Visual vehicle status.

Five cameras, three external and two internal, used to get visual feedback from the vehicle flight status and get temperature measurements of the Temperature Sensitive Paint.

**Schedule**

- **Preliminary Design Review** successfully accomplished in March 2015
- **Critical Design Review** scheduled by the end of 2016
- **AIV/AIT** of Launcher and EFTV scheduled by mid 2017
- **Flight Readiness Review** scheduled by mid 2018
Conclusions

- The key features of the HEXAFLY-INT mission and flight payload have been described.
- The project has the final aim to demonstrate the technical feasibility of concepts and technologies for the hypersonic flight and to increase the Technology Readiness Level (TRL) of the breakthrough technologies on board.
- Project Critical Design review (CDR) is foreseen by the end of 2016.

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