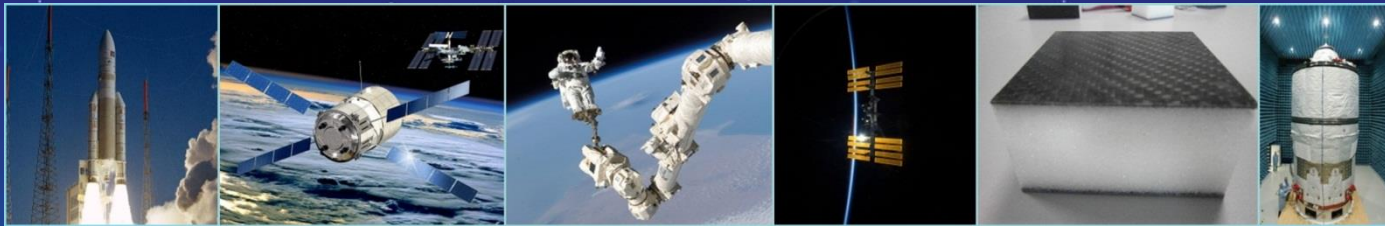


# Hypersonic studies and related technology programs/perspectives in Aviospace - an Italian company of AIRBUS Defence & Space



Roma, 1<sup>st</sup> July 2014

Franco Alberto Fossati  
Head of Engineering



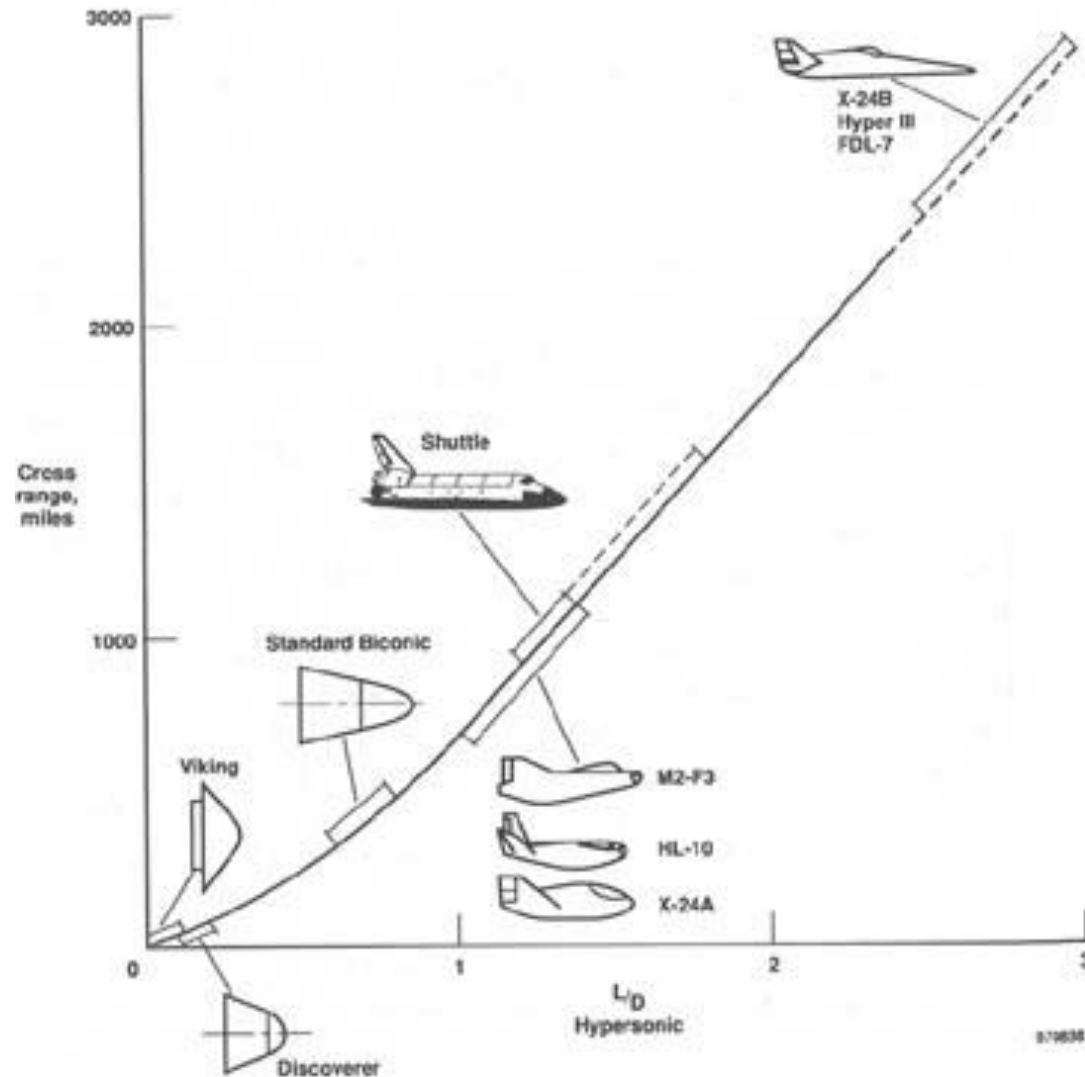
Aviospace is an aerospace company created in 2004.

In January 2010, Aviospace has been acquired by EADS Astrium (now AIRBUS Defence & Space), although remaining an Italian registered company with Italian management and personnel.



Main fields of Aviospace activities are design and development of Space Transportation and Exploration systems (ST&E).

- The hypersonic flight is often confused with the atmospheric entry.
- Clearly in both cases we are dealing with free vehicles but there are fundamental differences, although basic technologies may be in common.



Source: NASA

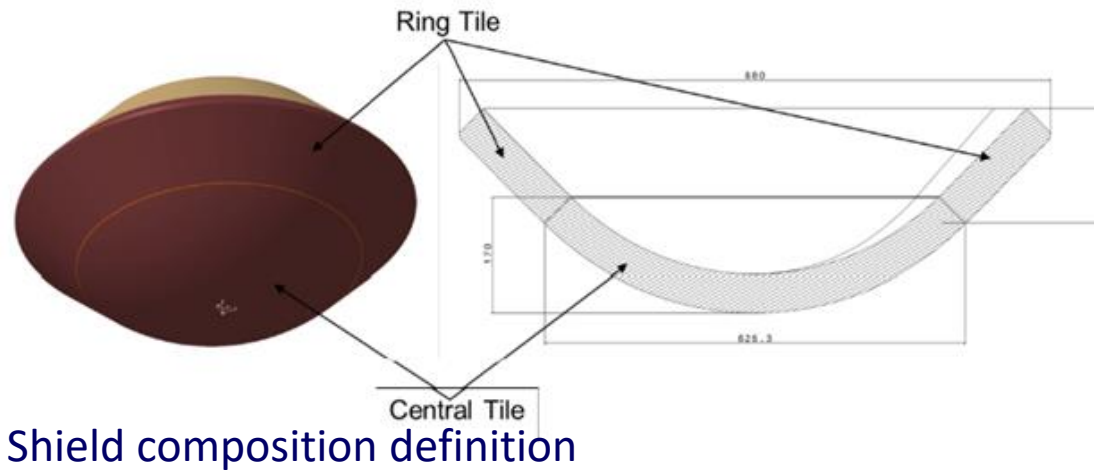
- Aviospace , in force of the background of the engineering backbone, could be taken on board onto ESA, FP/ and AIRBUS internal projects focused on hypersonic vehicles design and/or related materials.

Namely:

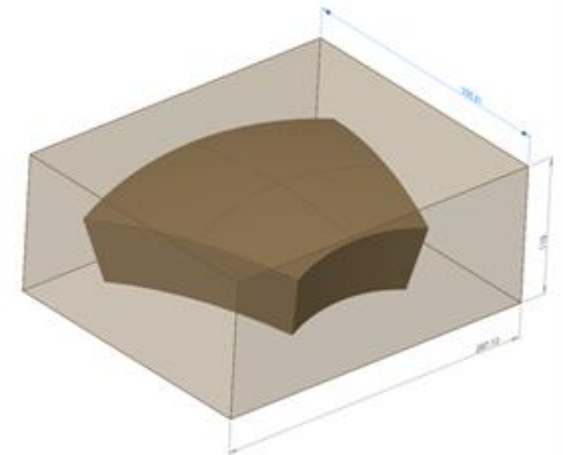
- **DEAM 2**
- **ZEHST**
- **HYPMOCES**
- **MoD support program**

While there are talks concerning possible participation to the AIRBUS Spaceplane and to the SHEFEX 3 vehicle.

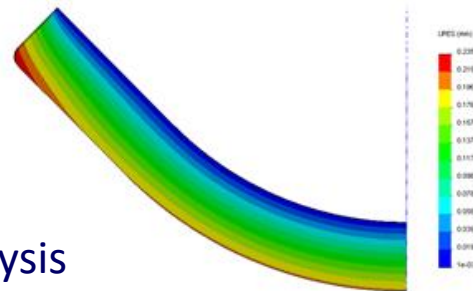
- ESA program focused on the qualification of Ablative material for very high energy trajectories (in the range of 15 MW/m<sup>2</sup>).
- Aviospace is in charge for the design of an heat shield oriented to interplanetary exploration and for the associated test campaign definition and preparation.



Fibers orientation verification



Transient analysis

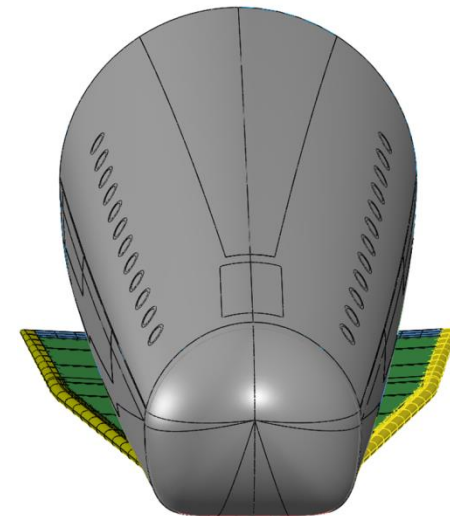
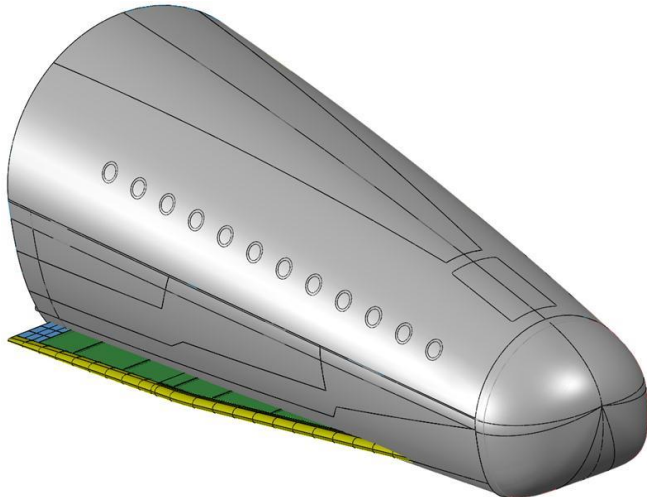
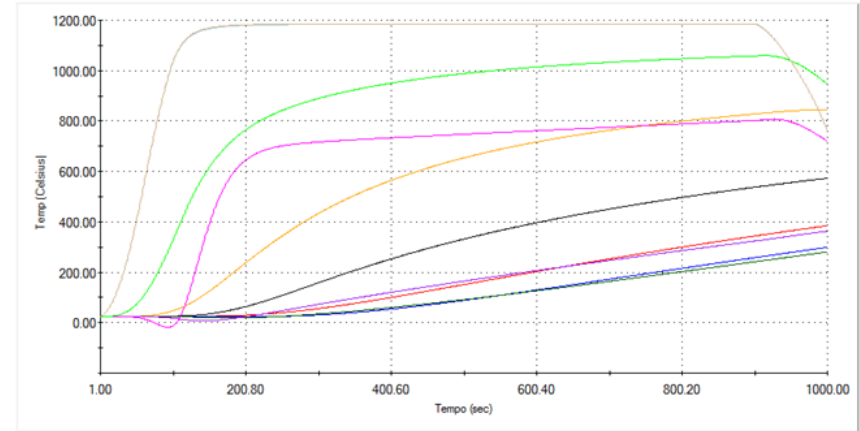


Hybrid vehicle intended for clean civil transportation based on mixed rocket/scramjet propulsion.

Aviospace tasks were related to sizing of the propulsion system and related pipelining



- Aviospace, is partner of Deimos, DLR and ONERA in the definition of morphing systems for the emergency compartment of the DLR's Space Liner. Aviospace is the thermo-structural architect of the study



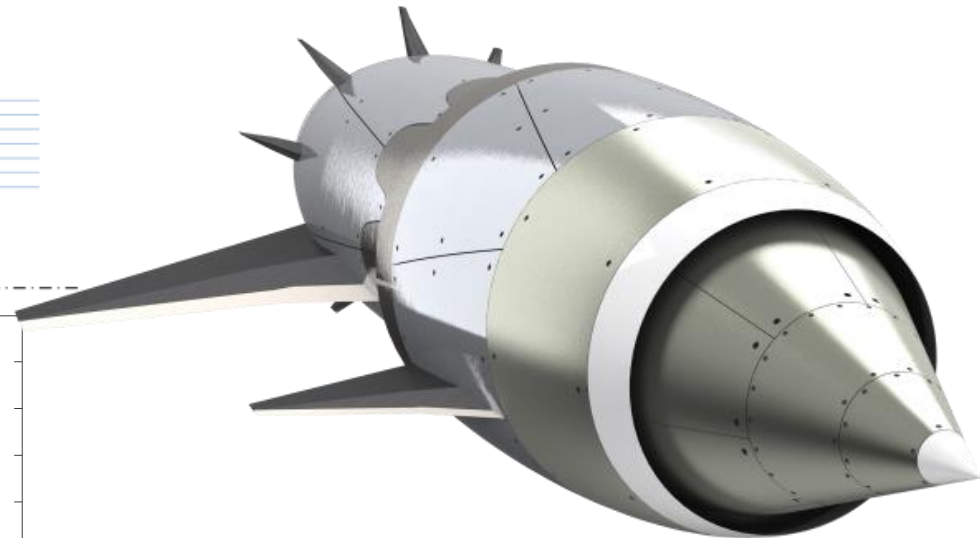
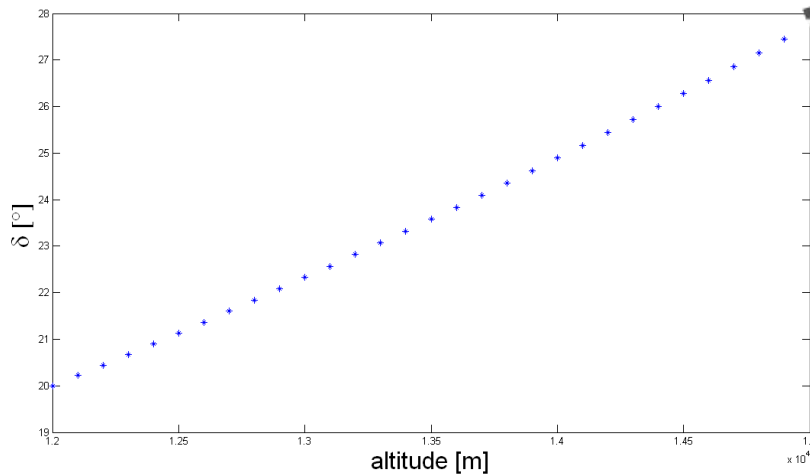
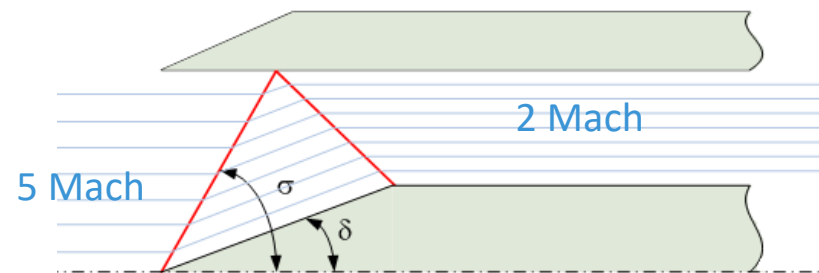
- Aviospace is partner of an Italian Medium Enterprise that is establishing a novel product line for advanced ceramics.
- Such initiative is fostered by the Italian MoD. Aviospace is acting as the technical advisor enabling the technological growth of existing industrial realities, all based in Italy and already working as supplier for the Airbus Group, focused both on the processes and on the realization of dedicated machinery,
- This program focuses on and demonstrates one of the core-functions of Aviospace: the valorization of the Italian industrial tissue in support to the AIRBUS GROUP interests.





- A vehicle concept was worked out in order to size a system oriented to the study of the scramjet propulsion through an two-stages, air launched solution. The study was used to identify critical technologies to focus on.

## Inlet Preliminary Design



- Spaceplane (but has space tourism something dealing with real hypersonic flight?)



- Shefex 3 (but can Germany to work it alone?)
- Aviospace is actively in touch with the Shefex design office both in DLR and in AIRBUS (now prime contractor of the program)

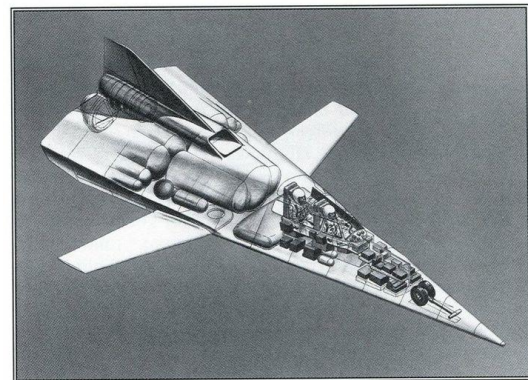


The only real hypersonic flight campaign was performed in the 60's-70's by the X15. Followed an interim where FDL5 and FDL 7 were studied but not developed apart some subsystem (circular aerospike firings)

From 2000 on NASA and DARPA conducted experiences culminated with the X51, prototype of a new-generation cruise missiles.



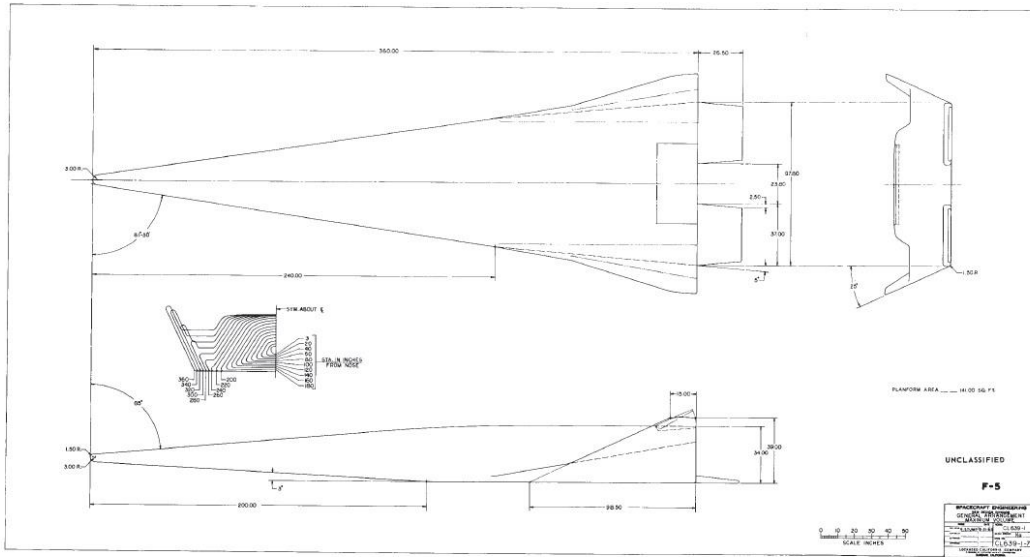
NASA Dryden Flight Research Center Photo Collection  
<http://www.dfrc.nasa.gov/gallery/photo/index.html>  
 NASA Photo: EC08-1889 Date: 1967 Photo by: NASA photo  
 X-15A-2 launch from B-52 with ablative coating and external tanks



*Source: NASA*

Contrails

UNCLASSIFIED



FIGURES 1 (U) P-5 GENERAL ARRANGEMENT



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## INTEGRATED BATTLESPACE/ISR

### U.S. Air Force Set To Begin X-51 Hypersonic Flight Tests

TURNER BRINTON, WASHINGTON

The U.S. Air Force is gearing up for the first of three planned test flights of a hypersonic aircraft designed to operate for much longer durations and cover far greater distances than previous platforms of its type.

The maiden flight of the X-51 "Wolverine aircraft"—the first U.S. hypersonic vehicle to fly in six years—is scheduled to take place later in March. Boeing Defense, Space & Security Systems of St. Louis has been developing the aircraft since 2003 on behalf of the Air Force Research Laboratory and Defense Advanced Research Projects Agency.

The ramjet-shaped X-51 will be carried aloft under the wing of a B-52 bomber, the Vigil, Boeing's carrier of hypersonic, said in a Feb. 27 interview. It will be released from the jet over the Pacific Ocean and drop for four seconds until its rocket motor ignites and accelerates to about 3,000 kilometers per hour, just shy of the widely accepted speed of hypersonic flight at Mach 5, or about 6,300 kilometers per hour. At that point, an air-breathing scramjet—or ramjet-combustion engine—will take over.



Low maneuver to 10 Mach speed takes hypersonic to a regular flight path for way of 151 miles to the Vigil carrier jet and the platform for further flight for the shot.

approach on X-51 has been to demonstrate the technologies that could one day enable things like single-stage-to-orbit vehicles.

"Essentially you can probably get three women, one trying to do it all at once with one enough money is very, very challenging," Vogel said.

Potential applications for hypersonic technology are superior airplanes, missiles and reusable space launch vehicles, Vogel said. While the technology is not ready to fly, hypersonic vehicles have been around for decades but they just were often unaffordable and not matched by engines, resulting in failure. The coming demonstration should show

that the technology could be used in a next-generation missile program, he said.

Boeing has 42 people working on the X-51 program, down from a peak of about 90 people in 2007. Pratt & Whitney Rocketdyne's team peaked around 60 people and is now down to nine people, Vogel said.

Boeing also built the United States' previous hypersonic flight demonstrator, the X-43, on behalf of NASA. The X-43A program made two successful flights in 2004, an 11-second flight that reached Mach 7, and a shortened flight that approached Mach 10 and set a new record for fastest

SR-71 surveillance aircraft, and its engine could be adapted to use other hydrocarbon-based fuels, he said. The X-51 is expected to fly about 900 kilometers under pressure in about five minutes, 50 times longer in duration than the X-43A flight.

Boeing has built four X-51 aircraft for the upcoming test campaign. Though none will be recovered after its test flights, their liquid-cooled rocket engines have shown in ground testing to be very durable, Vogel said. The X-43A engine was not actively cooled and was not intended for reuse.

"This [the X-51] engine has been tested multiple times," Vogel said. "In theory, if we had more time and more money and more space in the vehicle, we probably would have had a reusable engine. It's easier vehicles could have a reusable engine, and we have started looking at ways to recover the engine."

The government does not currently intend to support the X-51 program beyond the four identical flight tests, which should be complete by the fall, Vogel said. Boeing has proposed a second phase of the program to the government, but he declined to say if the government has accepted it.

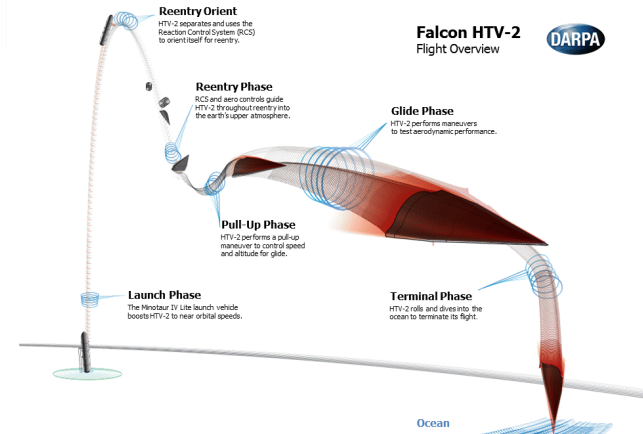
Since 2003 the government has spent about \$200 million on the X-51 program, Vogel said. Air Force Research Laboratory program manager David Kottman was unable to provide funding details by press time.

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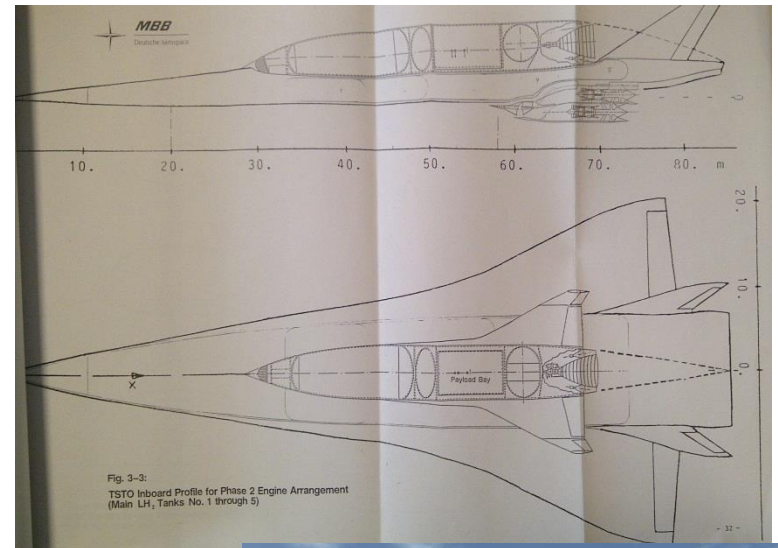
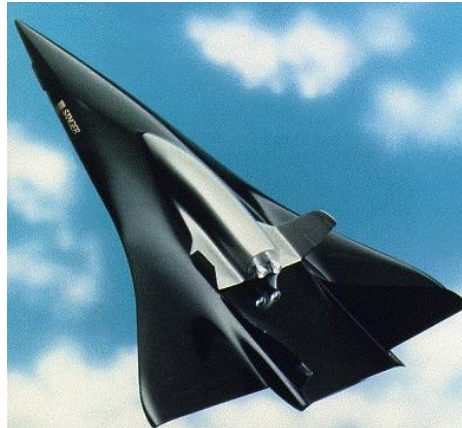
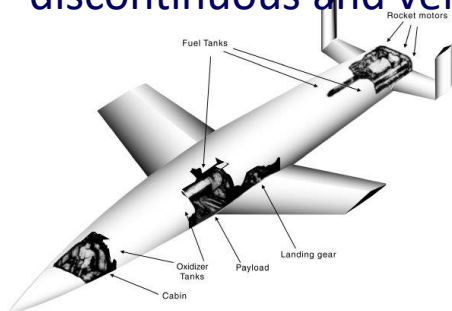
Falcon HTV-2  
Flight Overview



Source: NASA/DARPA/USAF

The hypersonic flight as a concept was born in Europe during the second world war, then after the 50's, where high speed rocket-climber where tested every activity was dismissed.

This lasted up to the 80's, where the European interest could re-born although with discontinuous and very limited effort

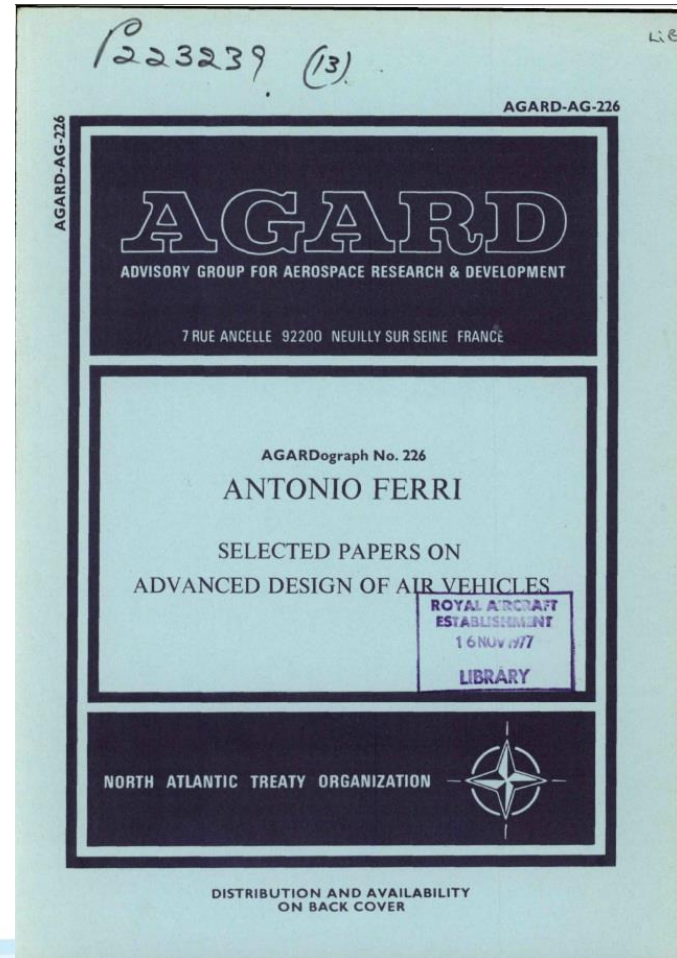


Italy can claim to be listed among the countries that pioneered the hypersonic flight, unfortunately not through established institution but thanks to individual excellences that could play a fundamental role in the researches related to the solution of the issues presented by hypervelocity.

Italy is a reference point for high temperature ceramics – a cornerstone for elements such air intakes or leading edges.

Today, despite an overall disregard versus the real high speed flight (the focus being mostly pointed onto atmospheric entry), there is a revamp of interest versus hypersonic systems witnessed also by studies emerging from SME's

hyplane+



**Whatever system must be the answer to a need.**

Today there is not real need (or at least demand) from the civil market

There is, on the contrary, a clear strategic interest at continental level.

There is the need of dedicated developments in materials

There are available competencies

**SHOULD WE TRY ESTABLISH AN INITIATIVE?**

**WHY?**

**WHO's “WE”?**

**Hypersonic vehicle are a mix of space and aeronautic systems allowing reaching nearly any point in the world within 4 hours with high-to-very high accuracy**

**Their main utility seems to be related to strategic issues (allowing a prompt reactivity upon alert coming from a network of on-orbit reconnaissance systems)**

**Ancillary fall-out are expected in the field of high temperature materials increase in reliability (with beneficial fall-out mostly in the power systems)**

**Great Britain, Germany and France have development plans and hypotheses of product lines feeded by national funds.**

**ITALY IS PRESENTLY OUT FROM ANY SCHEME. THE ITALIAN SEMESTER OF PRESIDENCE OF THE EU (AND THE PARALLEL ESA MINISTERIAL CONFERENCE) COULD BE AN OPPORTUNITY to act as link among the separate realities in a EUROPEAN POWER FRAMEWORK, consolidating a technological axis among the most solid realities in space transportation.**

**The results would be VALUABLE strategically, IMPORTANT industrially and PRICELESS politically.**



**THE OVERALL SITUATION IS CONFUSED, AS MOSTLY HAPPEN IN SPACE SYSTEMS WHEN MORE THAN A COUNTRY IS INVOLVED.**

**VERY LIKELY A DEDICATED GOVERNANCE FOR HYPERSONIC VEHICLES MUST BE ESTABLISHED – ITALY OUGHT TO BE THERE**

**BUT... HYPERSONIC VEHICLES WILL COME SOONER OR LATER**

**LET'S STAY IN TOUCH**

**Thanks for the attention**

**F.A.Fossati**

**AVIOSPACE s.r.l. - Via Pier Carlo Boggio 59/61 – 10138 TORINO – ITALY**

**[www.aviospace.com](http://www.aviospace.com)**

**Tel. +39-011-0867.100 Fax +39-011-1950.4596**

**[contact@aviospace.com](mailto:contact@aviospace.com)**



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