Main Challenges and goals of the H2020 STRATOFLY Project

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STRATOFLY
Stratospheric Flying Opportunities for High-Speed Propulsion Concepts

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H2020 STRATOFLY Project

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Stratospheric Flying Opportunities for High-Speed Propulsion Concepts

STRATOFLY

(Stratospheric Flying Opportunities for High-Speed Propulsive Concepts)
has been funded by the European Commission under the Horizon 2020 framework

GOAL

Making benefit of the European heritage in this field, the H2020 STRATOFLY Project aims at assessing the potential of a **high-speed transport vehicle** to reach **TRL6 by 2035**, with respect to **key technological, societal and economical aspects**.

STRATOFLY CONSORTIUM: members and competencies

Expertise: Noise Emission

STRATOFLY Deputy Coordinator
Expertise: High-speed Propulsion Systems and Noise Emission

Expertise: Structural Analysis and Optimization

Expertise: Climate Impact

Expertise: Plasma assisted combustion experiments and Pollutant Emissions

STRATOFLY Coordinator
Expertise: Aircraft and Systems Design, Life Cycle Cost Estimation, Safety Assessment

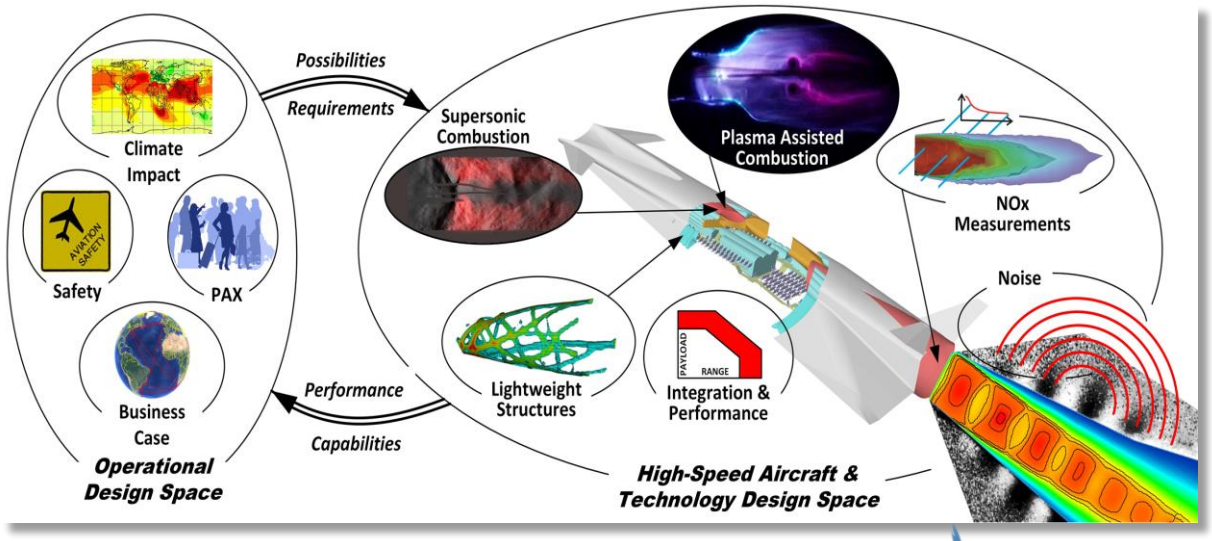
Expertise: Plasma assisted combustion

Expertise: High-speed flow analysis

Expertise: High-speed Propulsion Systems and Climate Impact

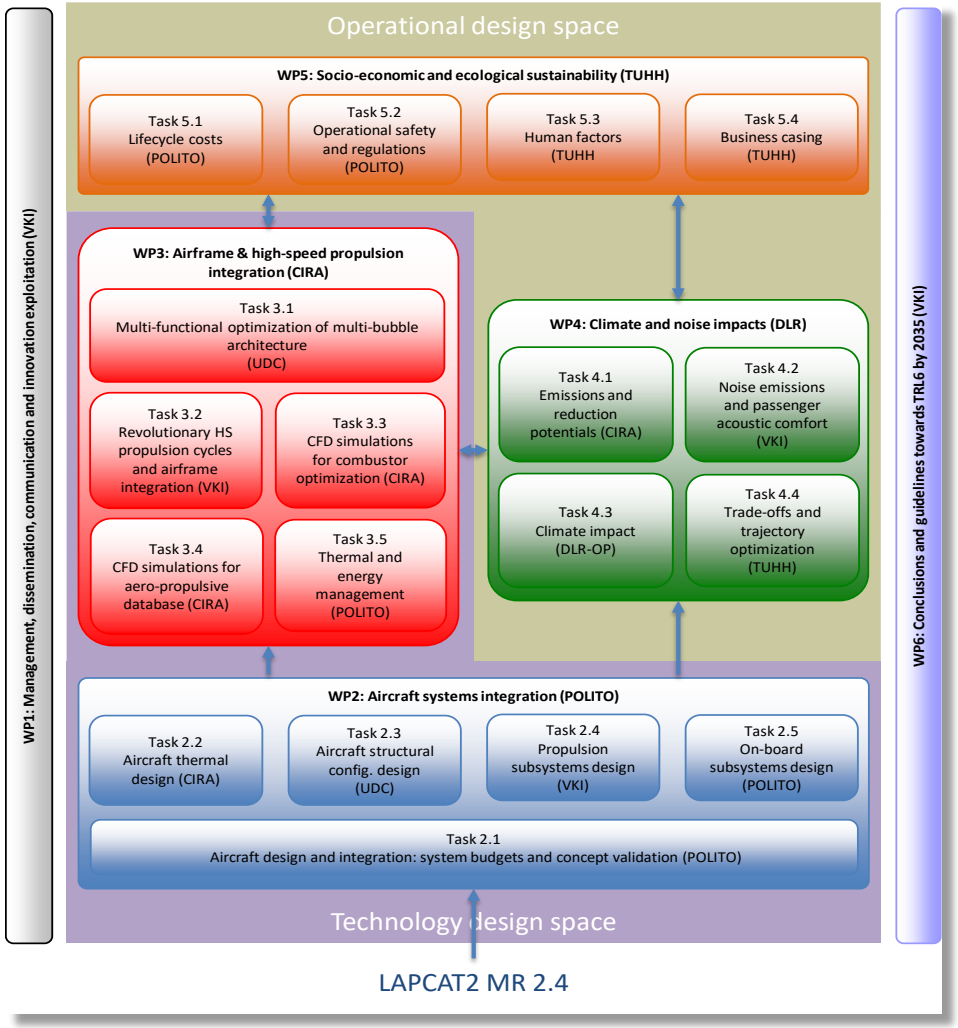
Expertise: Human Factors, Business Plan and Traffic Management

STRATOFLY PROJECT:
Work Packages Structure and key issues



STRATOFLY project has a ***rational*** and ***comprehensive*** structure, consisting of two design spaces (***Technology*** and ***Operational***) mutually interacting between each other.

Positive example of how to deal with ***complexity*** and ***multidisciplinary*** domains



REFERENCE VEHICLE

LAPCAT MR2.4

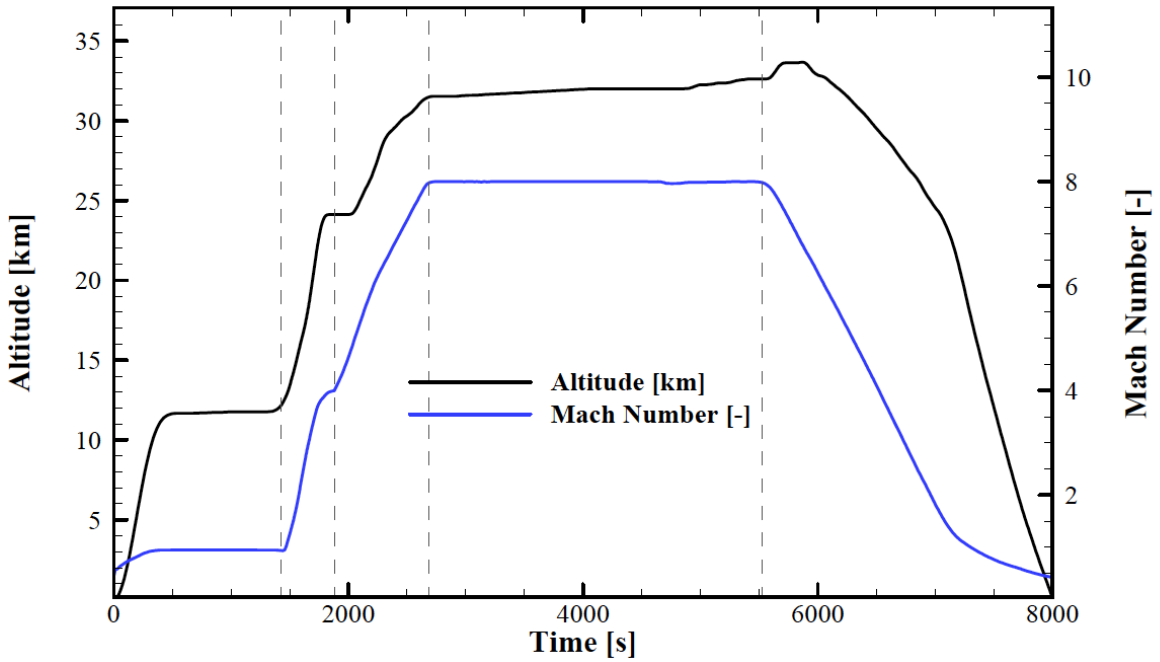
The LAPCAT MR2 vehicle is a **waverider configuration** equipped with 6 Air Turbo Ramjet (ATR) and 1 Dual Mode Ramjet (DMR). The engines exploit the ram-air coming from the central intake which is equipped with several ramps that can be moved to drive the airflow either to the ATR or to the DMR depending on the flight conditions. Notably, the 6 **ATR operate up to Mach 4-4.5, whilst the DMR is used for hypersonic flight from Mach 4.5 up to Mach 8**.

- **MTOW:** 400000 kg
- **Range:** 16000 km
- **Ceiling:** 33000 m
- **Cruise Mach:** 8
- **Engines:** 6 ATR - 3070 kN thrust @ TO and 1 DMR about 500 kN thrust in cruise
- **Propellant:** Liquid Hydrogen (LH2)
- **Capacity:** 300 passengers

REFERENCE TRAJECTORY

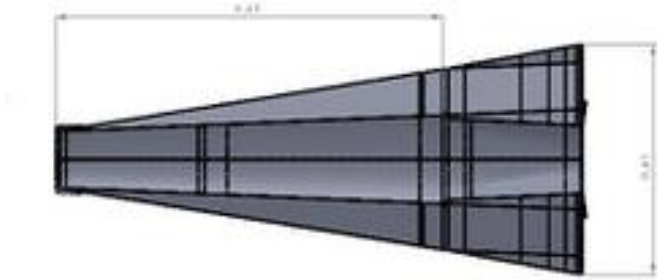
Trajectory	Distance Flown [km]	Great Circle distance [km]	Time acceleration (incl. subsonic cruise)	Time Cruise	Time Glide	Total Flight Time
BRU-SYD[1]	18734	16734	33min	95min	39min	2h47
BRU-SYD[2]	18734	16734	27min	93min	42min	2h42
BRU-LAX[3]	12845	9075	44min	53min	43min	2h20
BRU-NRT	11843	9483	45min	48min	40min	2h13
BRU-NRT	11843	9483	45min	47min	41min	2h13
BRU-JFK	5901	5901	39min	10 min	41min	1h30
BRU-MIA	7472	7472	39min	21 min	37min	1h37

The LAPCAT MR2.4 was aiming at covering **antipodal routes** with a hypersonic cruise at **Mach 8**

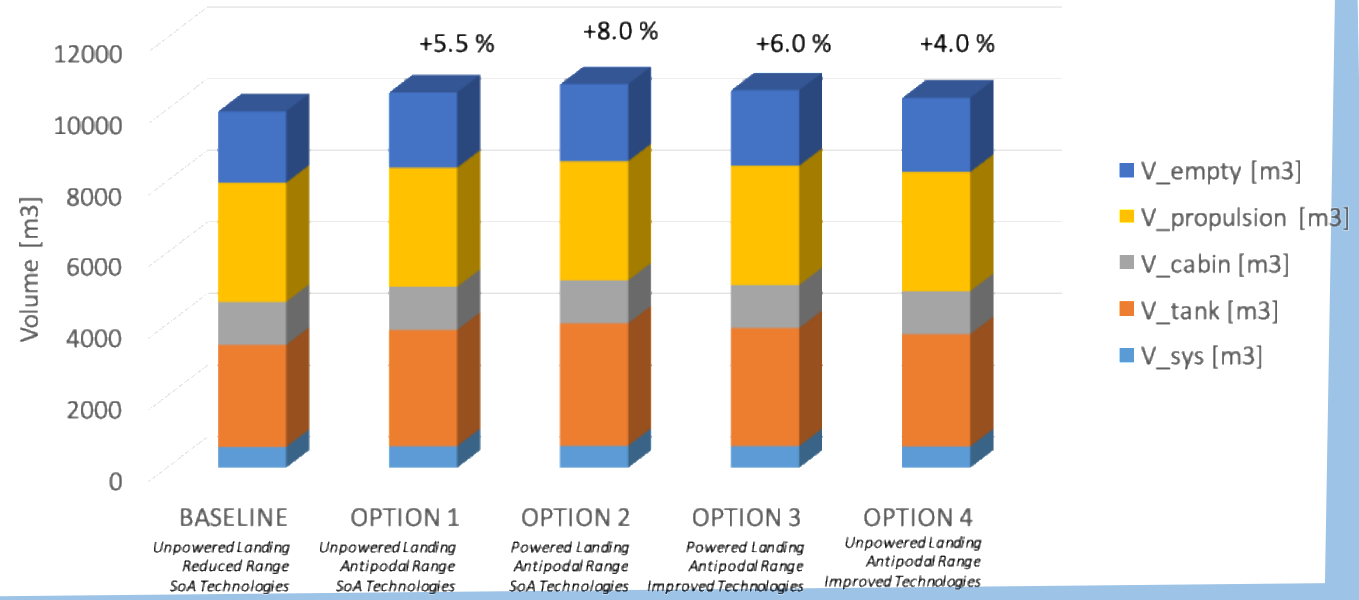


STRATOFLY MR3: external configuration

- LAPCAT MR2.4 propulsive configuration has been considered: 6 ATR + 1 DMR
- LAPCAT MR2.4 external waverider configuration has been considered, together with its related AEroDataBase (AEDB)
- Empennages and flight control surfaces' design has been improved, coupled with the design of the actuators
- The impact on the AEDB is currently under investigation
- The overall mass and volume budgets at vehicle level are currently under investigation: different options are considered to cover antipodal routes with powered/unpowered landing and state-of-the-art/enhanced technologies



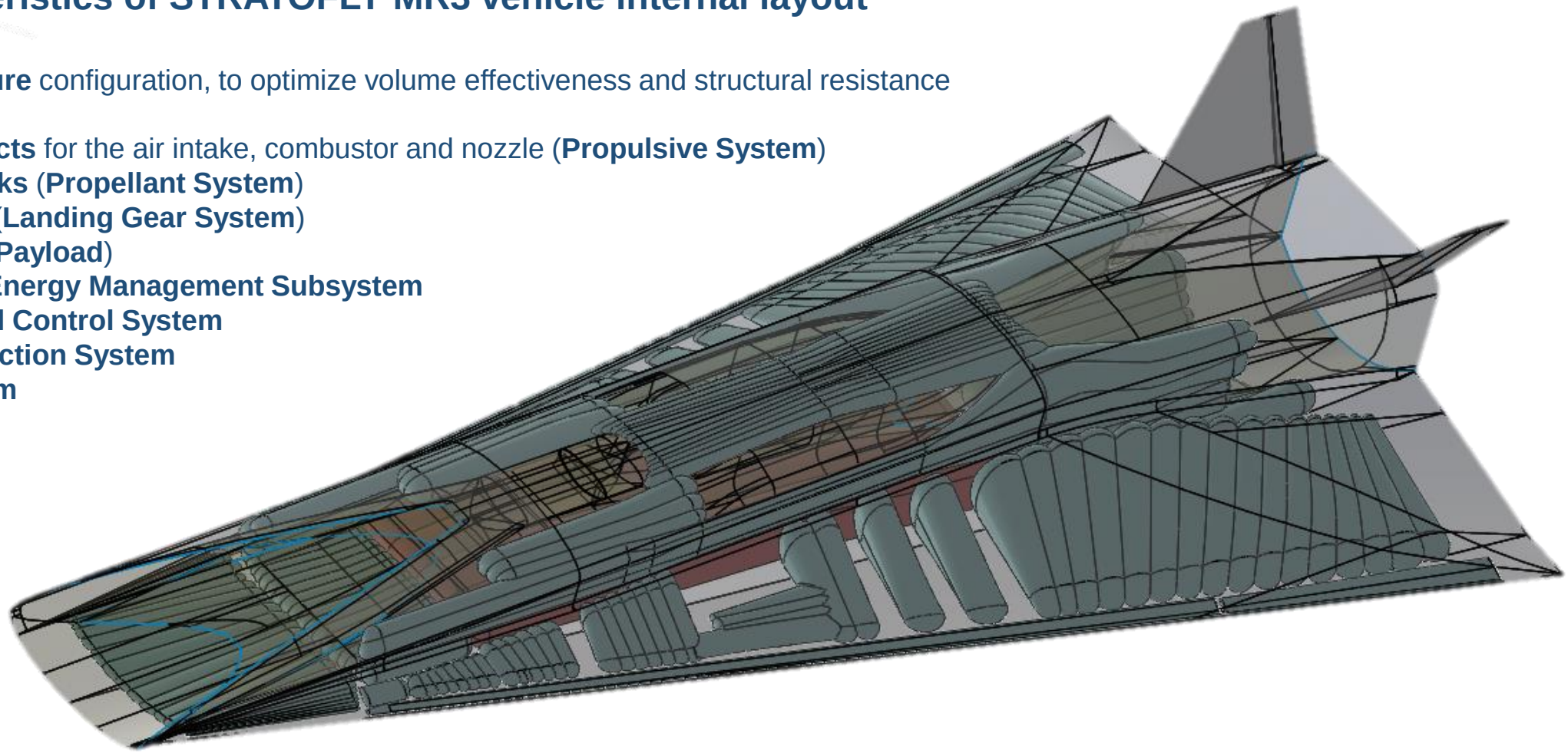
- Maximum length: 94 m
- Wing span: 41 m
- Maximum height: 17 m
- GTOW: 400 tons
- Fuel mass: 200 tons



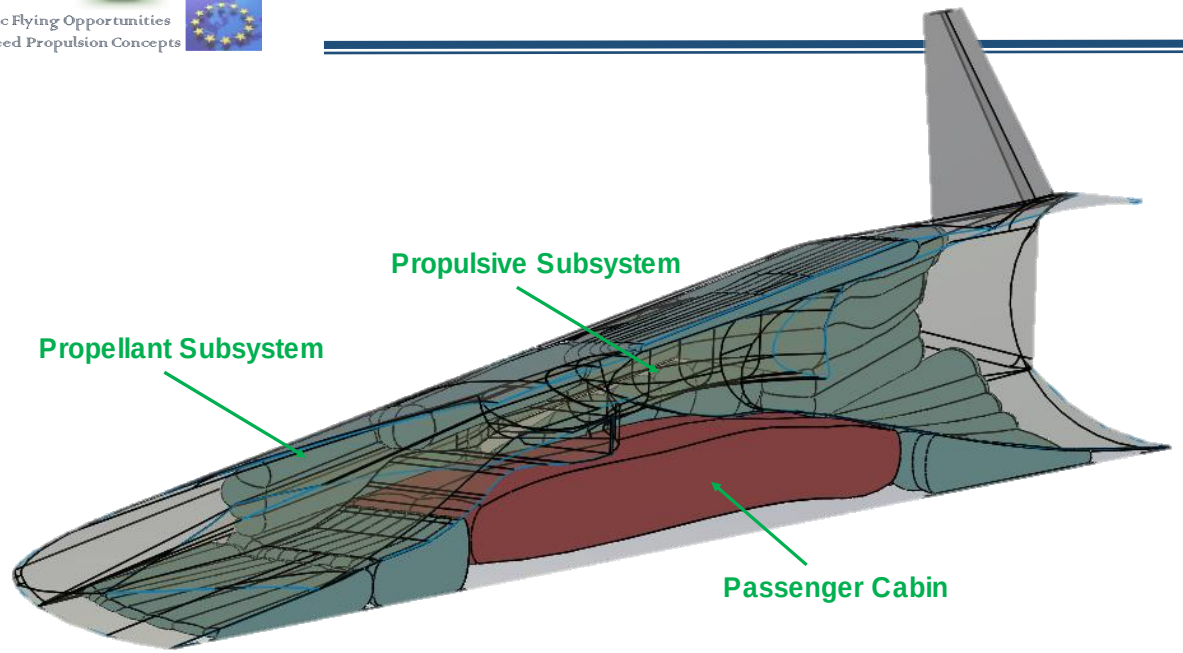
STRATOFLY MR3: internal configuration and main subsystem

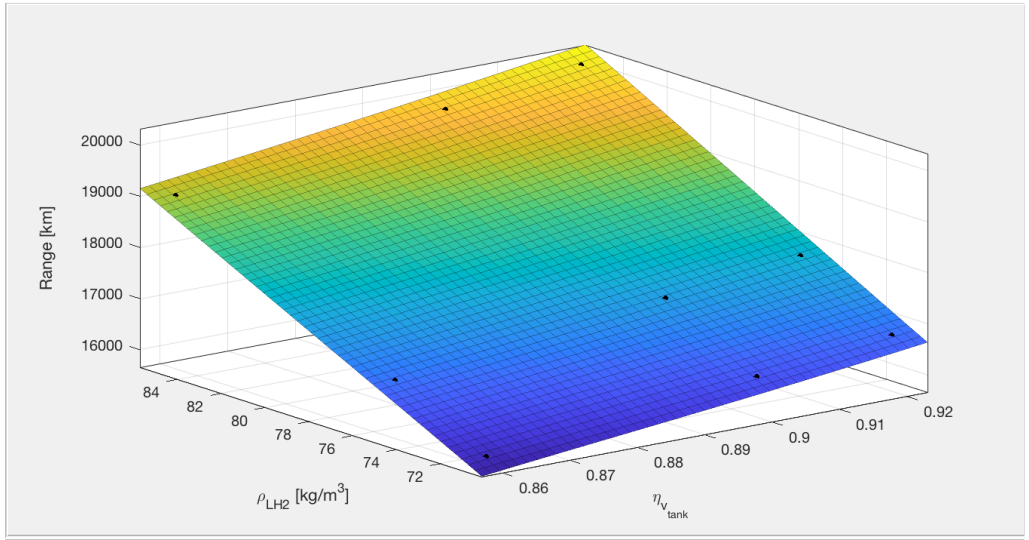
Main characteristics of STRATOFLY MR3 vehicle internal layout consist of:

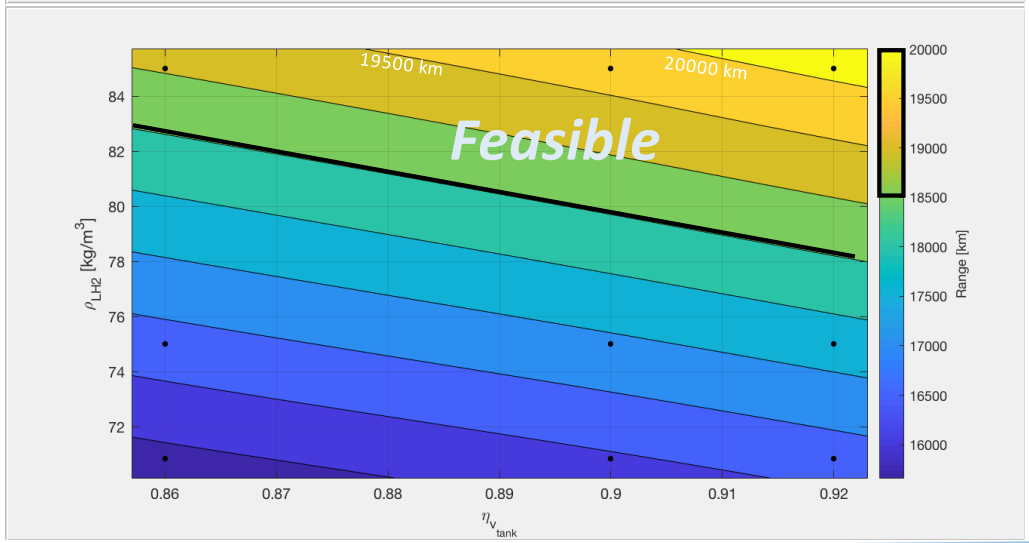
- **bubble structure** configuration, to optimize volume effectiveness and structural resistance (**Structures**)
- **Propulsive ducts** for the air intake, combustor and nozzle (**Propulsive System**)
- **Cryogenic tanks** (**Propellant System**)
- **Landing gear** (**Landing Gear System**)
- **Cabin layout** (**Payload**)
- **Thermal and Energy Management Subsystem**
- **Environmental Control System**
- **Thermal Protection System**
- **Avionic System**



STRATOFLY MAIN TECHNICAL CHALLENGES



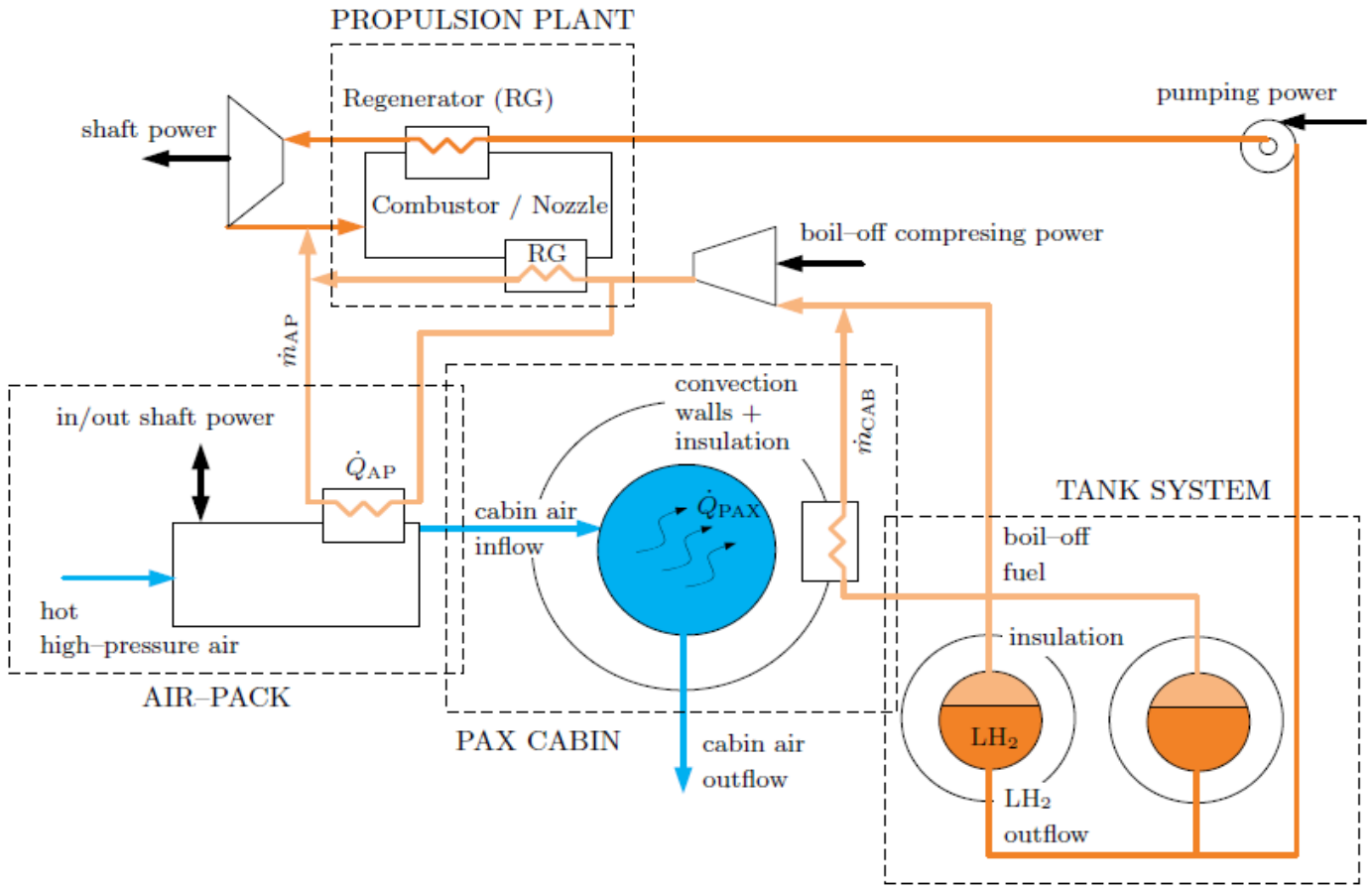




- STRATOFLY MR3 vehicle has an overall available volume of about 10000 m^3. Tanks occupy about 2700 m^3 of volume. Considering **enhanced tank efficiency** and **enhanced liquid hydrogen density**, the aforementioned volume for the tanks guarantees the accomplishment of antipodal routes (about 19000 km of range).
- The new concept of the cabin layout and integration leads to a **windowless cabin**, thus requiring the **adoption of glass cabin technologies. Public consensus shall be assessed.**
- **Virtual reality cockpit versus autonomous vehicle concept shall be traded-off.**

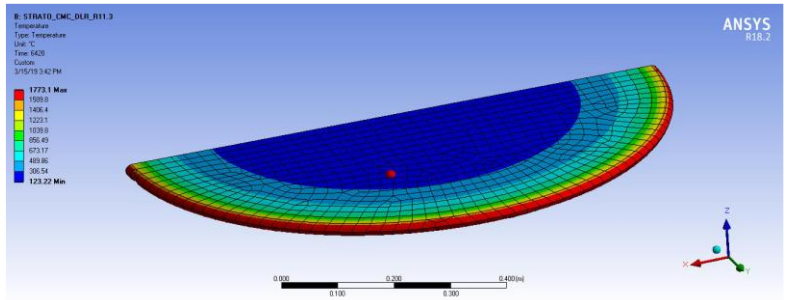
STRATOFLY MAIN TECHNICAL CHALLENGES

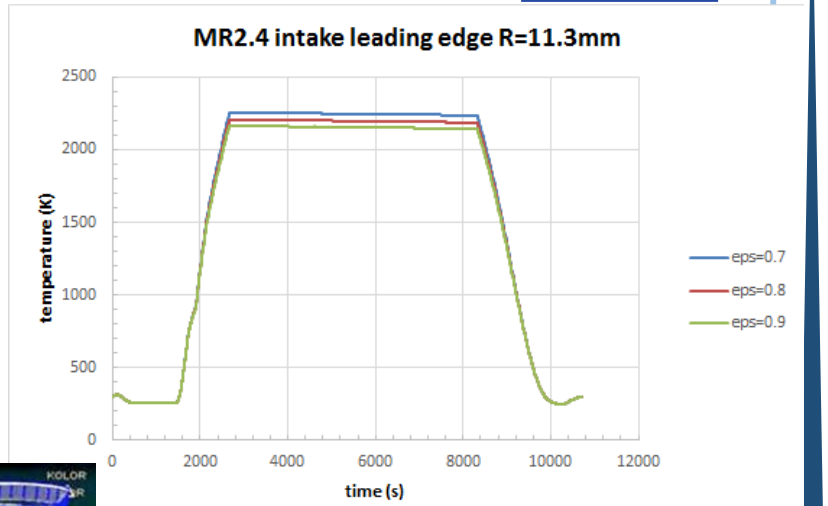
- **Thermal and Energy Management System**, **TEMS**, is a clear example of highly integrated multidisciplinary subsystems:
  - **LH2,** the cryogenic propellant of the **Propellant System,** is the key element of the **Thermal Control System**, as it cools down the vehicle through the exploitation of the liquid or boil-off fuel as coolant fluid of the **Heat Exchangers**.
  - The **heat exchangers** that use as coolant fluid LH2 are crucial equipment of the Air-Pack of the **Environmental Control System**.
  - **LH2 tanks** do also help as **insulated structure** of the **Thermal Protection System**. The need of boil-off fuel has to be carefully traded-off against insulation needs for different areas of the vehicles and different mission phases.
  - LH2 flows through the **turbine**, which drives electrical power generators of the **Electric Power System**. The order of magnitude of the power budget is MWs.
  - Strong interface with **Propulsive System**.
- The **Environmental Control System** uses **dedicated compressors driven by electric motor** to compress, if needed, the external air coming from engine air intake.
  - Impacts of the air bleed from the engine air intake onto the propulsion system performance shall be assessed carefully. An air cycle sub-freezing architecture for the Air-Pack can be envisaged but performance shall be evaluated.
- **Bubble structures** are envisaged for the structural configuration.

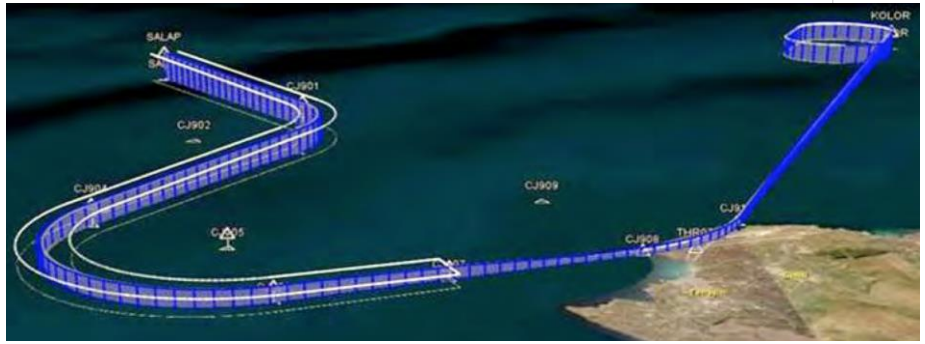


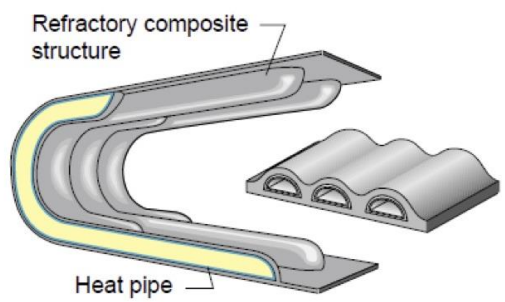
STRATOFLY MAIN TECHNICAL CHALLENGES

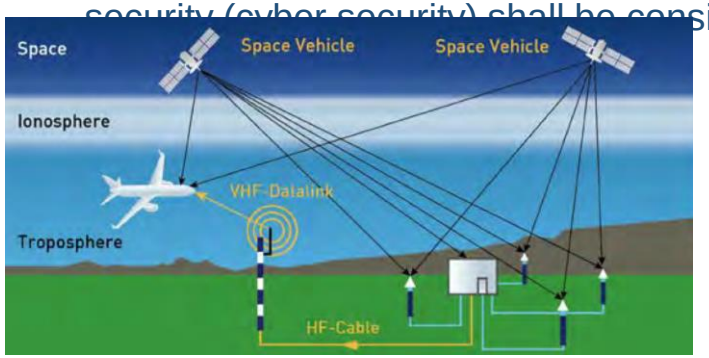
- The **Thermal Protection System** includes **heat pipes cooled leading edge**, considering as cold source propellant tanks and as working fluid solid material at sea-level temperature.
- The **Propulsion System** includes many challenges: **high-speed propulsion** in general and **plasma assisted supersonic combustion** specifically.
- The **Avionic System** shall comply with the requirements of the **future ATM navigation** for what concerns 4D navigation capability and CNS (Communications, Navigation and Surveillance) performance. Safety versus security (cyber security) shall be considered.

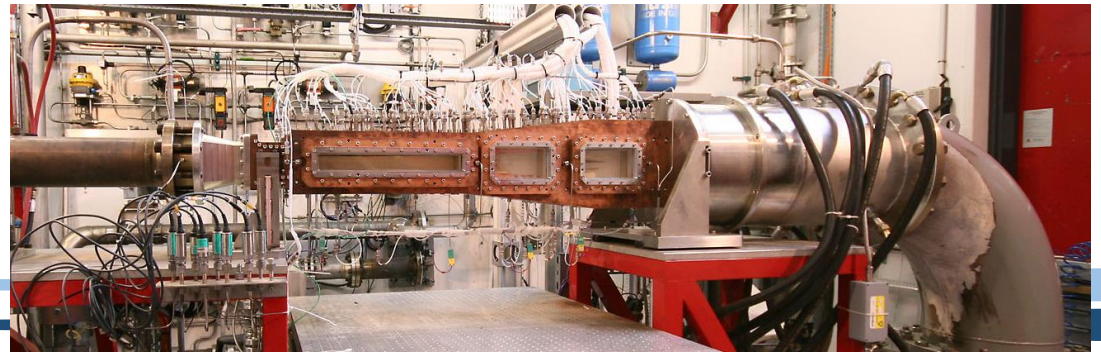


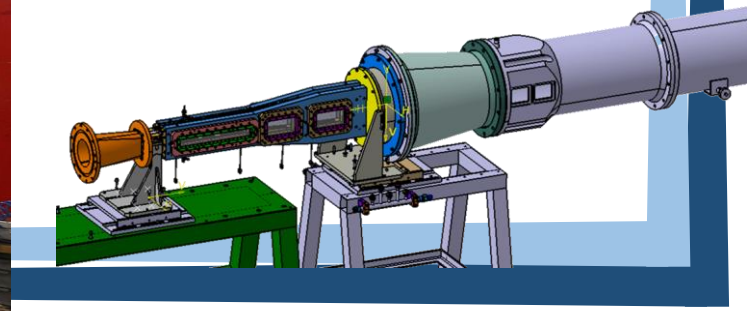




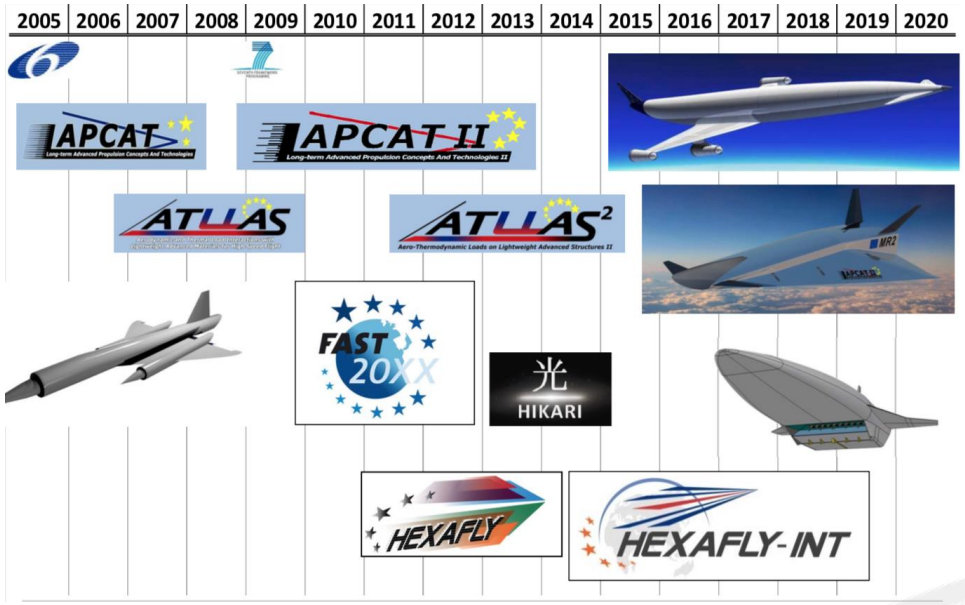








CONCLUSIONS



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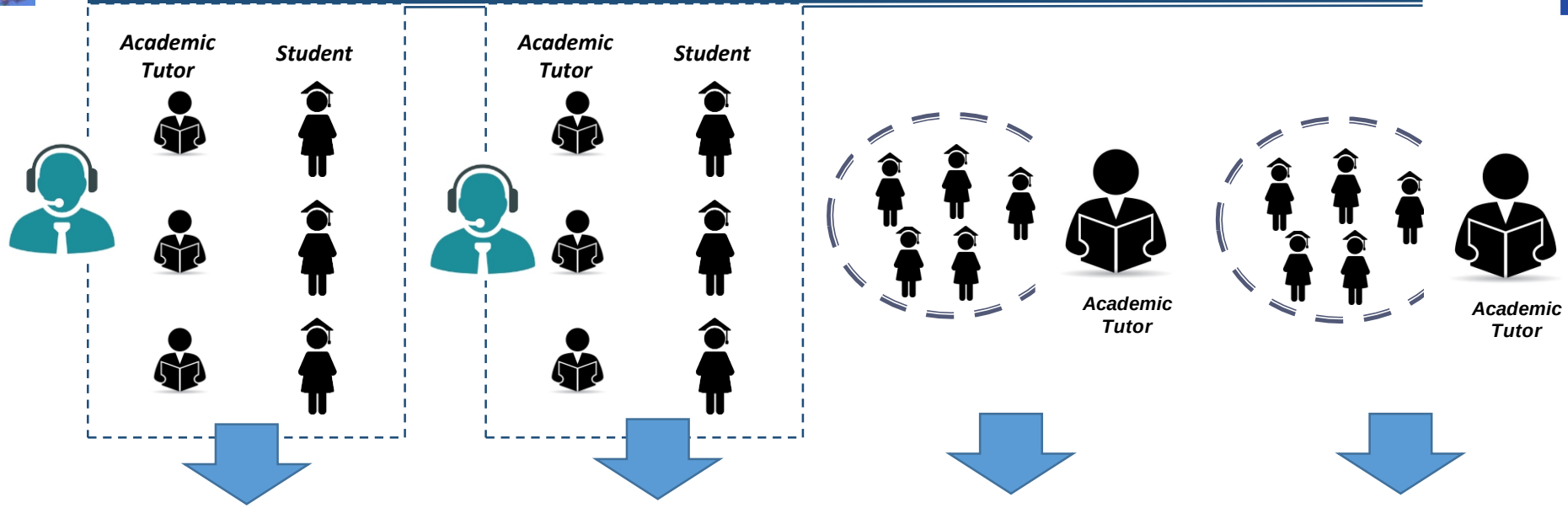
2035

RUMBLE

- From **past and currently on-going projects**, a **list of activities and missions** shall be derived to build the overall technology roadmap
- **Key technical and operational aspects of hypersonic flight and vehicles** are currently under investigation within H2020 STRATOFLY Project
- Let's continue in this direction towards the future hypersonic civil transportation

CONCLUSIONS: STRATOFLY Academy



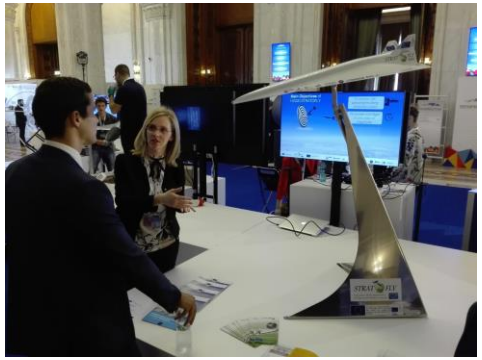
Executive summaries and final presentations will be evaluated by experts

ACADEMY BOARD

Best Team Award
(scientific publication)

Best Student Award
(International Congress participation)

CONCLUSIONS: Aerodays 2019 - Bucharest



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Thank you for your attention

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