ALTEC-The Spacegate Study for point-to-point flights and the ESA Intermediate Experimental Vehicle (IXV) Ground Segment

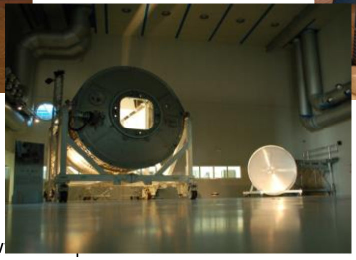
International Symposium: ''Hypersonic: from 100,000 to 400,000 ft''
Rome, Italy, June 30th-July 1st 2014

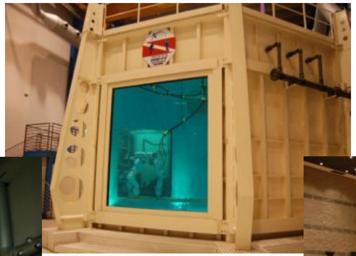
CONTENTS

ALTEC: Advanced Logistics Technology Engineering Center

- PPP: public private partnership
- Mission: to provide high tech engineering services for operations and exploitation of space systems for human spaceflight, planetary exploration and observation of Universe
- Vision: to be an international center of excellence for supplying high tech space products and services and for handling complex systems

ThalesAlenia Space 51%
asi 29%
Icarus 20%





ALTEC GROUND CONTROL

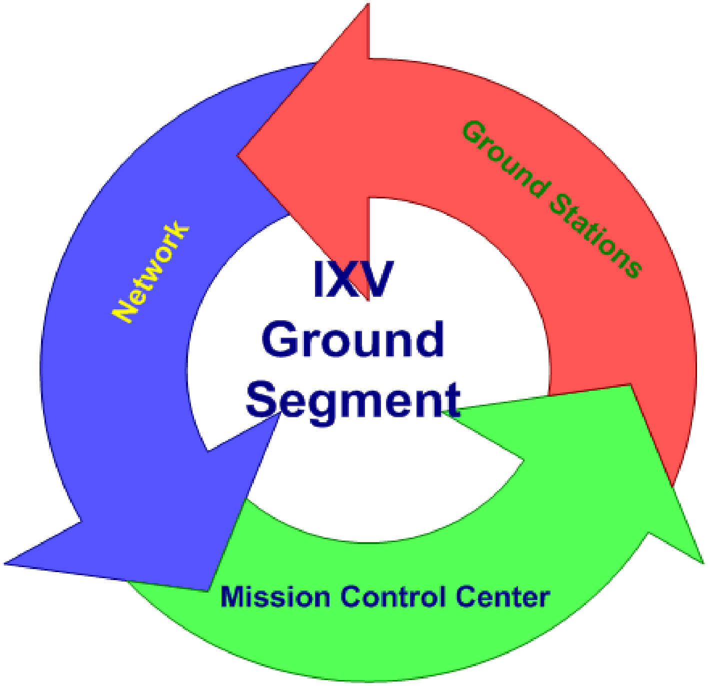
- **ALTEC Mission Control Center (MCC):**
  - **MPLM and PMM:** Provision of Sustaining Engineering and Operations Support to NASA per bilateral agreements between the Italian Space Agency and NASA
  - **Intermediate EXperimental Vehicle (IXV):** ALTEC is responsible for the design, development, deployment and operations of the Ground Segment
  - **PCM CYGNUS:** ALTEC provided to Thales Alenia Space capability to receive selected Telemetry to support the CYGNUS PCM demo mission
- **Engineering Support Center (ESC):**
  - ALTEC operates one of the ESA "Engineering Support Centers" (ESC) to provide support to the ESA ISS programs (Columbus, Payloads, ATV)
- **EXOMARS- Rover Operations Control Centre (ROCC):**
  - ALTEC is responsible for the ROCC in charge of monitoring and controlling the Rover operations on the Mars surface

IXV GROUND SEGMENT

- Design, development, deployment and operations execution of the whole Ground Segment

- IXV Ground Segment is composed of:
  - Mission Control Center – MCC (at ALTEC)
  - Ground Stations (3)
  - Communication Network of the Ground Stations with MCC (Libreville and Naval via satellite connection, Malindi via ASINET)

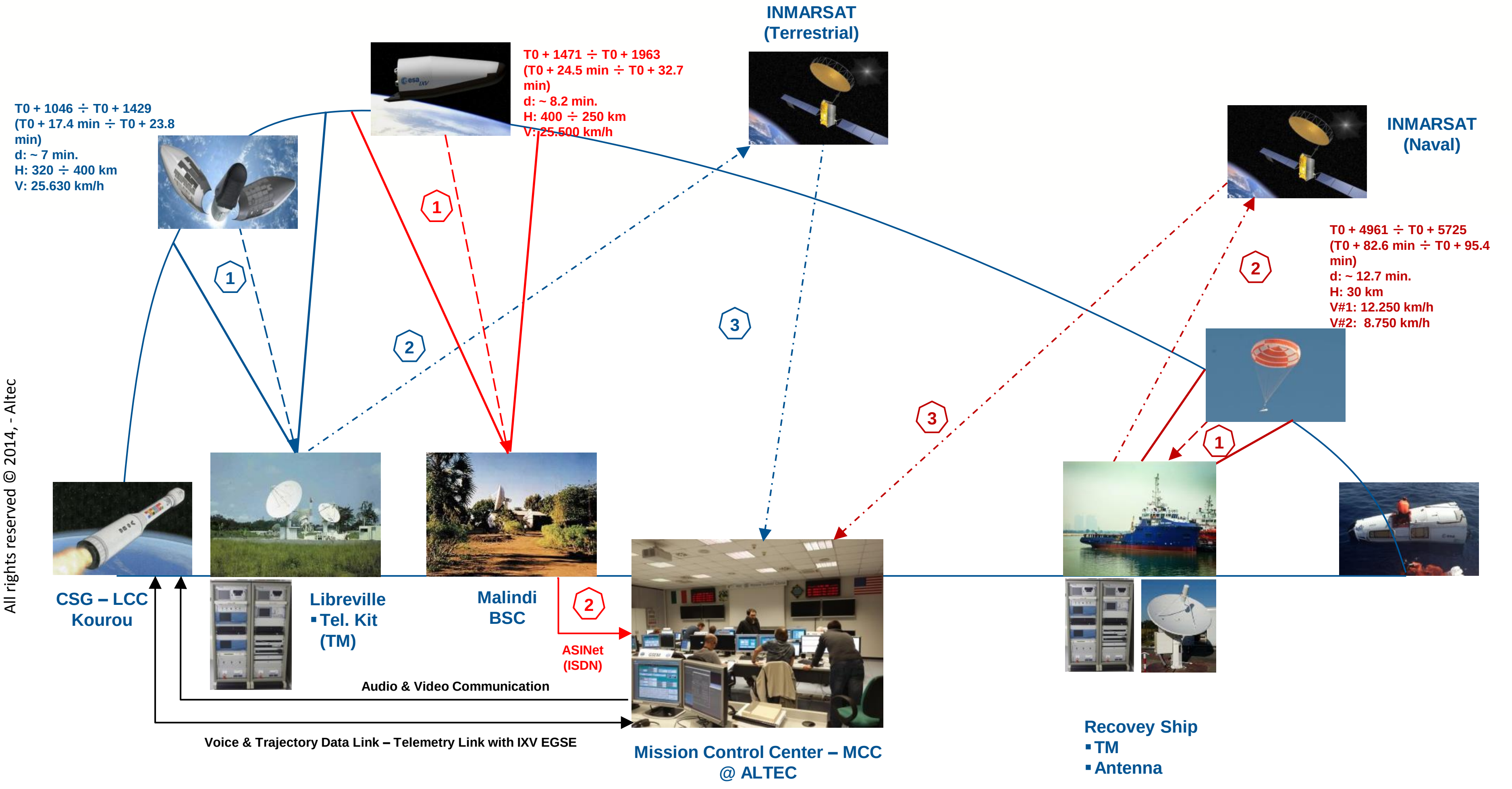
- Interface with the launch site operations and support to the vehicle post-mission recovery



IXV GROUND SEGMENT CHALLENGES

- To build up a dedicated Ground Stations Network for a unique mission profile
- To track and monitor a space vehicle during the atmospheric reentry trajectory
- To manage a one shot flight lasting about 100 minutes
- To localize the system and to support recovery operations
- To adapt and/or reuse as much as possible existing Ground Segment elements in order to reduce costs

IXV GROUND SEGMENT



INTRODUCTION TO SPACEGATE

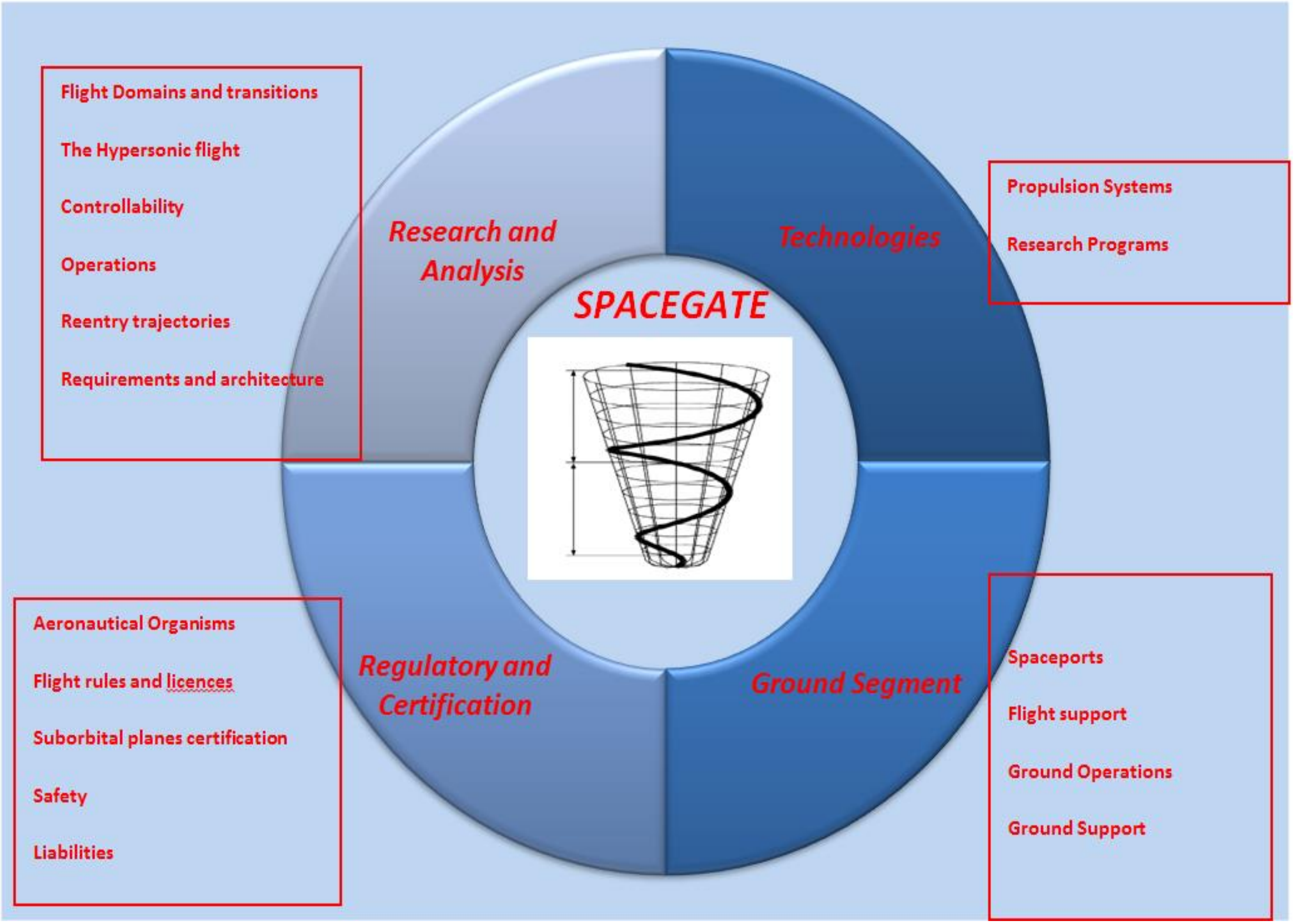
ALTEC received a contract from the NATO SUPPLY AGENCY (NSA) to perform a preliminary feasibility study on the Spacegate Concept.

The study was aimed at the opportunities offered by the suborbital flights with special emphasys to future generation transportation (point to point).

A Paper was presented at the IAC Congress in Beijing, China in September 2013 and published in the ACTA ASTRONAUTICA Journal.

The study was significantly supported by the Italian Air Force and Segredifesa.

Individual aspects of the Study were addressed as part of a single system approach



THE SUBORBITAL FLIGHT

Atmosphere Operational division in three main zones:

- The Aeronautical domain
- The Space Domain
- The High Altitude Flight (HAF) domain

Based on evidence and differences between forces order of magnitude it can be stated that:

- The transition from the aeronautic to the HAF domain and from the space to the HAF domain depends both on the value of altitude and of the velocity
- Transition velocity does not depend on the vehicle aerodynamic features, but transition altitude does
- HAF boundaries are a combination of altitude and velocity, also accounting for the vehicle’s aerodynamic and propulsive features

THE SPACEGATE CONCEPT

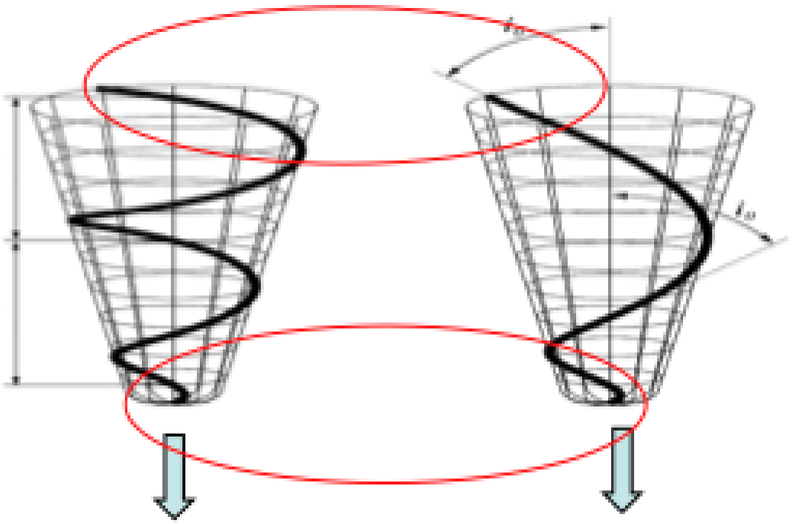
Spacegate: Final target point of transfer, reached through an active control by the pilot

Re-entry Trajectory: Collapsed into a spiral shaped, limited aerial space, centred in the Spacegate to allow the pilot to maintain visual contact with the Ground and a higher degree of controllability of the re-entry vehicle

Amplitude and inclination of the re-entry trajectory depend only on the features of the vehicle

Spaceport: includes a master facility and a number of surrounding, satellite facilities that can also be traditional airports

Spacegate entry interface

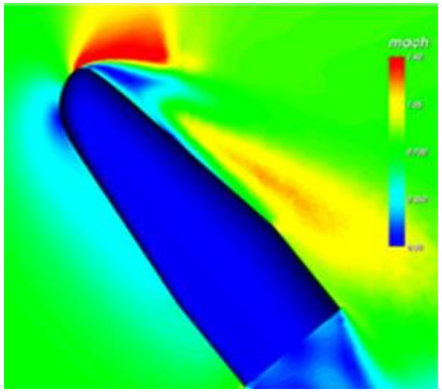


Vehicle behaves like an airplane heading for landing sites

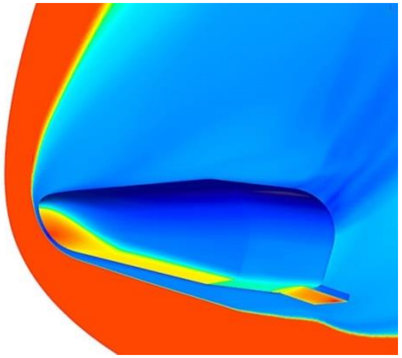
RE-ENTRY TRAJECTORIES

START REENTRY
The early, and the most critical, phase of the re-entry should be crossed in a traditional way passing the most critical phases :

- ***Max heat flux:*** *velocity is 80% - 85% of the value at the beginning of the re-entry*
- ***Max acceleration****: velocity is 55% - 60% of the value at the beginning of the re-entry*



START SPACEGATE SPIRAL MANOUVER
After peak heating and close to the maximum dynamic pressure. Pilot gradually acquires vehicle controlduring the “Spacegate” maneuver



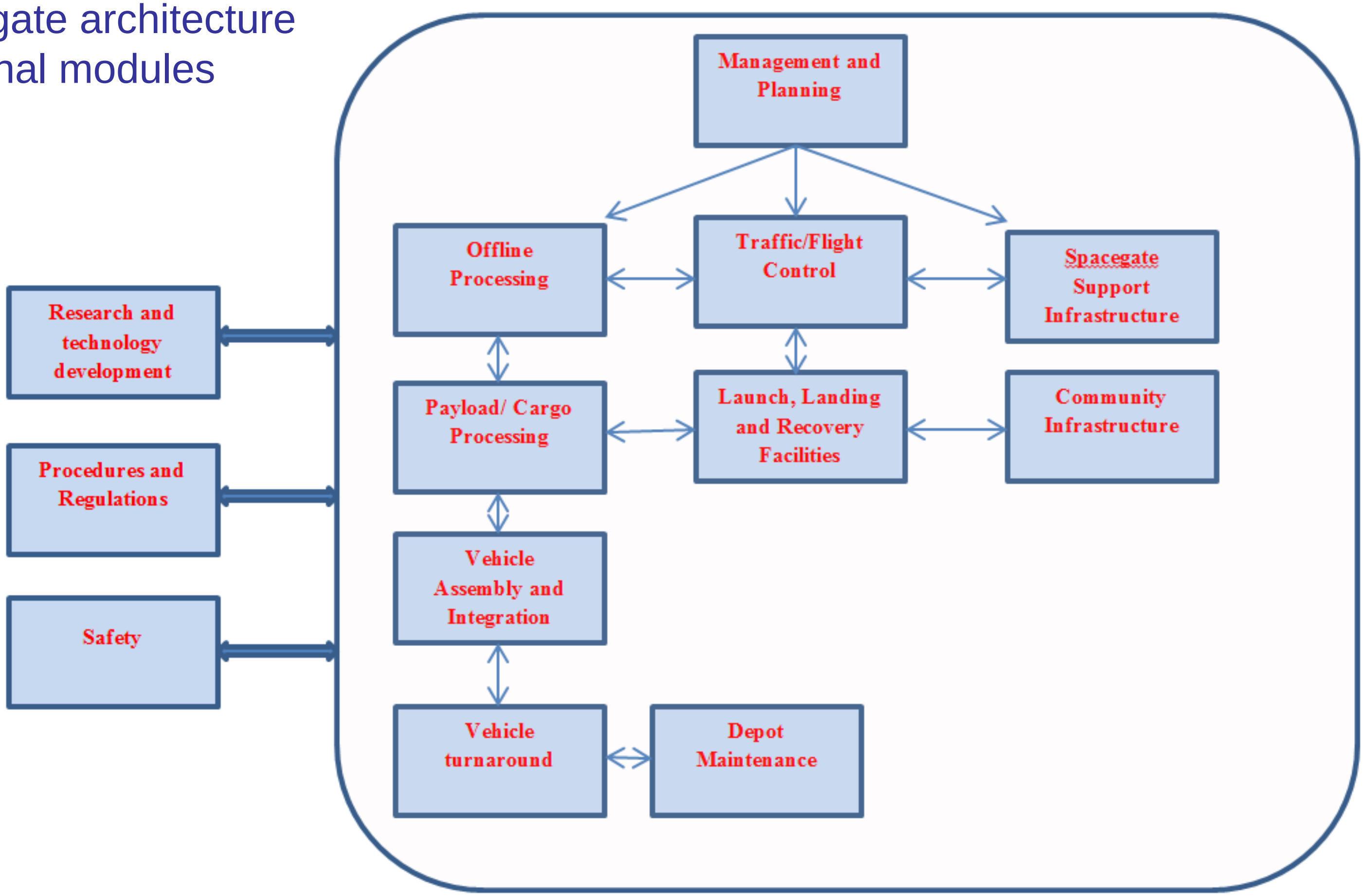
COMPLETION OF SPACEGATE MANOUVER
After the end of the “Spacegate” maneuver the behavior of the re-entry vehicle matches that of a traditional airplane or glider.

Functional Analysis:

- Top level Spacegate requirements were identified in the following areas:
  - Air Space Requirements
  - Launch and Landing Sites
  - Safety
  - Spacegate Operations and Engineering Support
  - Maintenance and Logistics
  - Space Medicine
  - Passenger Services

- The Spacegate architecture model of operations was divided in functional modules that need further detailed development; this is useful to develop data on cost, process flowtime and headcount

Spacegate architecture functional modules



RESEARCH PROGRAMS AND FACILITIES

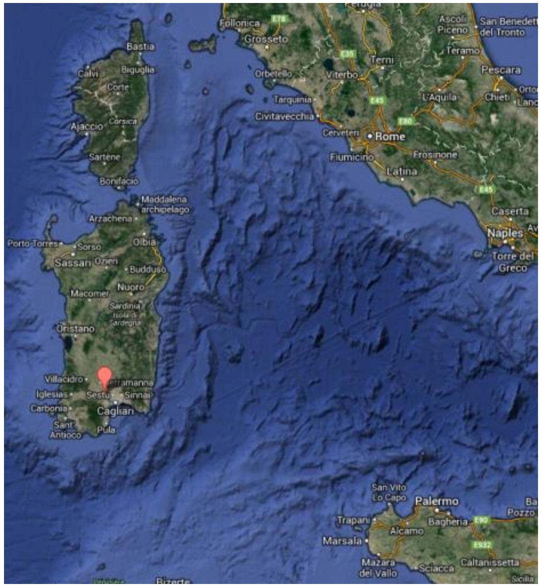
Extensive data collection of the most significant technology research Programs

The Spacegate preliminary feasibility study included a thorough literature survey of existing infrastructures

Future generation transportation require a reduced number of Spacegates in each Continent, each one having a wide number of satellite landing sites

Spacegate concept includes maximization of usage of existing facilities

As an example, among the surveyed Italian sites, a possible Master Spacegate Facility location was identified in Sardinia

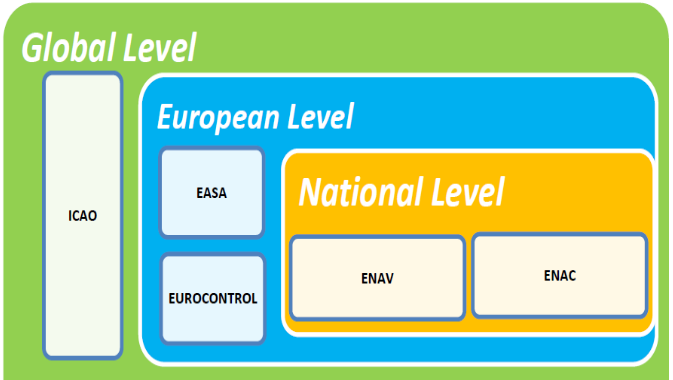


REGULATORY AND CERTIFICATION

European Aviation Safety Agency (EASA) promotes is the center of a new regulatory system and it may be considered the equivalent of FAA for the European Union.

In the United States, the Federal Aviation Administration Office of Commercial Space Transportation (FAA/AST) regulates and promotes U.S. commercial space transportation.

On March 12th 2014 at Washington DC, FAA-ENAC signed a Memorandum of Cooperation in the development of Commercial Space Transportation, and a follow-on working agenda was generated identifying specific areas of interest



Overall Schematic of Organisms

The agenda includes the definition of regulatory approach, strategy, licensing versus aviation-like or other ad-hoc approach, legal aspects, liability, insurance, etc

ALTEC AREAS OF INTEREST FOR FOLLOW-ON

ALTEC has identified the following key areas of interest for further development, that can also be eventually handled and executed by the Company:

Spacegate development coordination:
Continue at system level the development of the Spacegate study. Participate and support to the experimental activities

Spaceports:
Participate in the Spaceports and relevant infrastructure assessment for experimental activities

Spacegate Suborbital Ground Control Center:
Evaluation of a Control Center able to support all the Launch, Mission and Reentry suborbital point to point operations in Europe

Liaison and technical support Center:
Following the FAA-ENAC Memorandum of Cooperation, participate and support to the activities relevant to implementation of the working agenda

BACKUP CHARTS

The beginning of the trajectory occurs when the dynamic pressure is sufficient to perform a bank with the specified lateral acceleration.

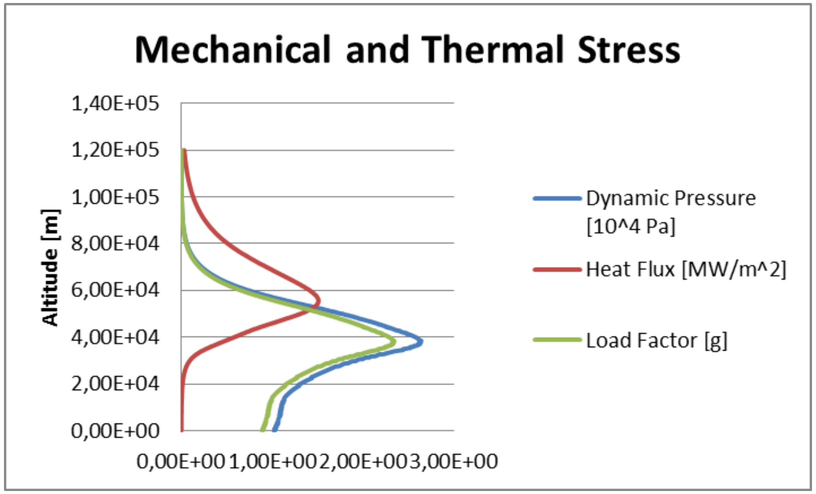
Simulation of the Spacegate Re-entry Maneuver

- ***Inputs:***

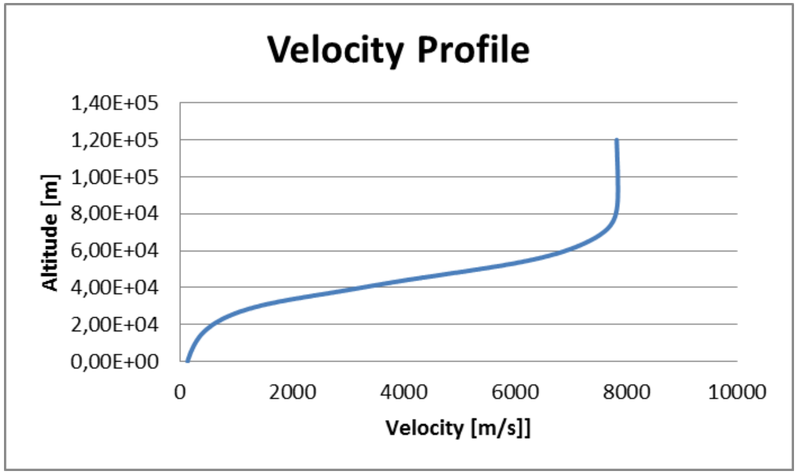
Vehicle mass = 7600 kg,
Aerodynamic surface = 18 m2,
CL / CD = 1
Bank angle = 65˚
Lateral Load Factor <= 1.7

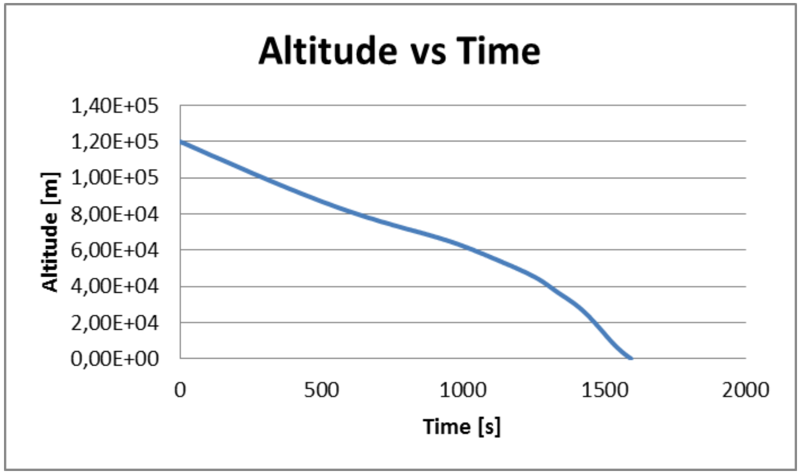
- ***Outputs:***

Altitude= 43.80 Km (dependence on the CL)
Velocity= 4084 m/sec, nearly 55% of the velocity magnitude at the early phases of the re-entry of 7576.49 m/sec.



SIMULATION: RE-ENTRY TRAJECTORIES





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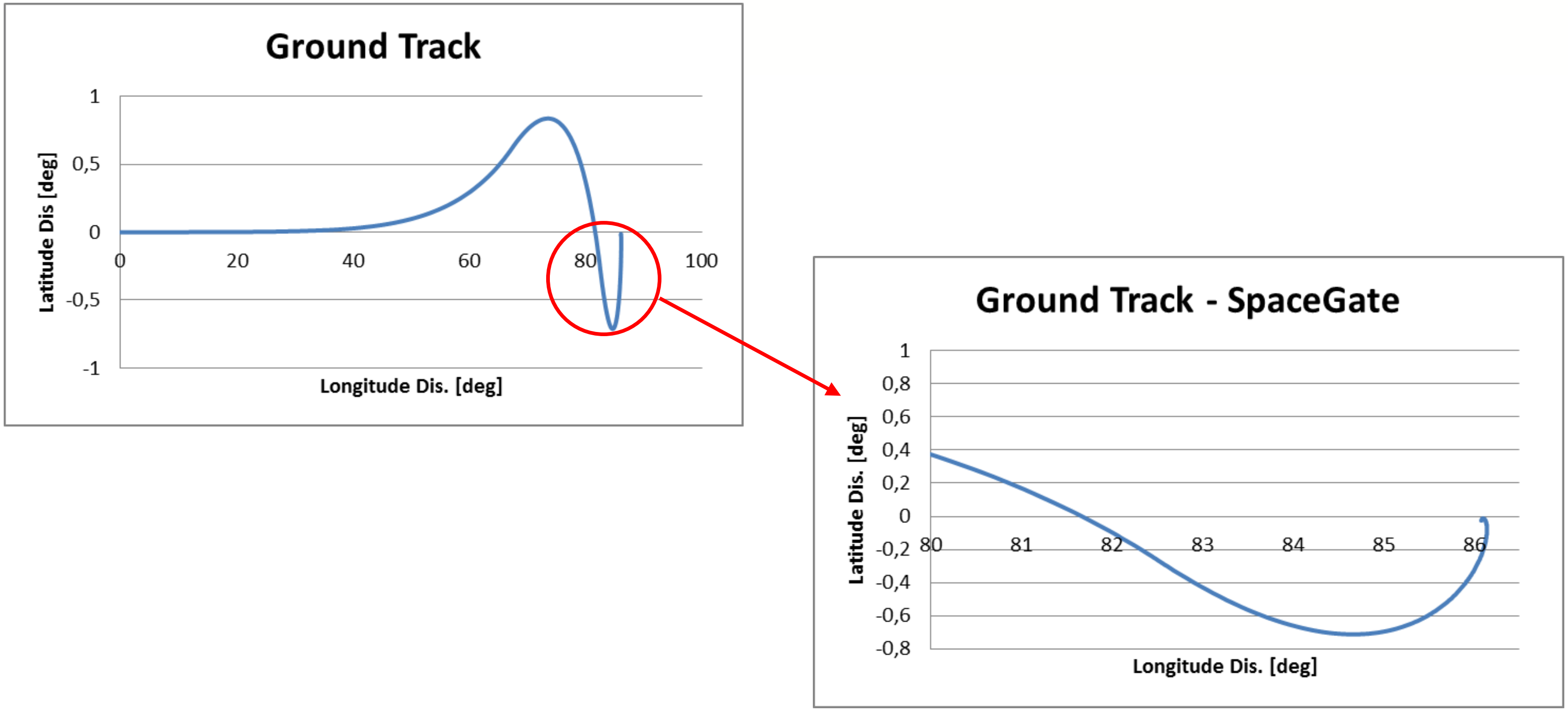

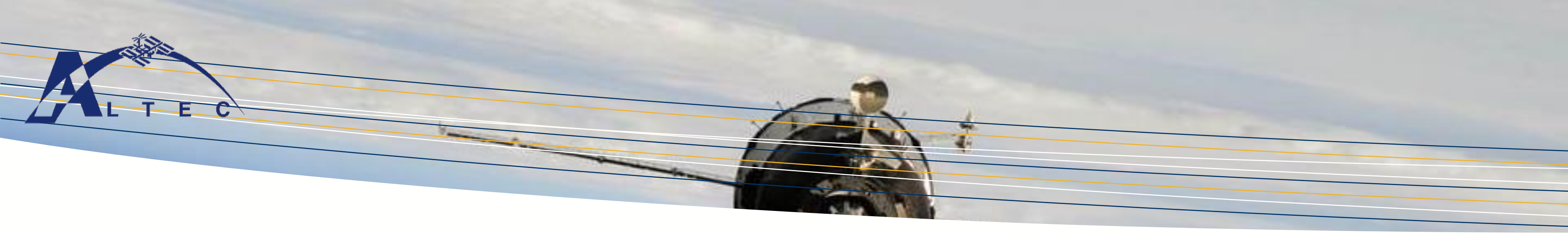

Thank you for your kind attention