MINI IRENE FLIGHT EXPERIMENT

Vedi file "*IRENE Story*"

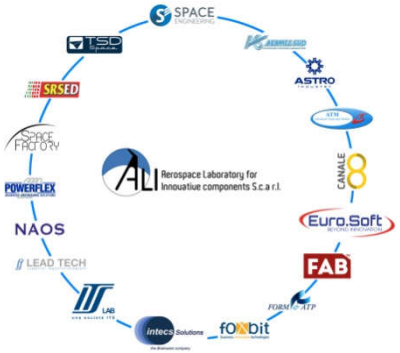
Seminario Interdisciplinare: NELLO SPAZIO, INFINE…

Scuola Politecnica e delle Scienze di Base, 15/12/2018

The Team

CIRA - Centro Italiano Ricerche Aerospaziali is the prime contractor. *It was created in 1984 to manage PRORA, the Italian Aerospace Research Program, and uphold Italy's leadership in Aeronautics and Space. CIRA is a company with public and private shareholders.*

Università degli Studi di Napoli Federico II is the Scientific Partner *located in Naples, Italy and founded in 1224 it is the oldest public and laic university in the world. It is now organized in 13 faculties.*

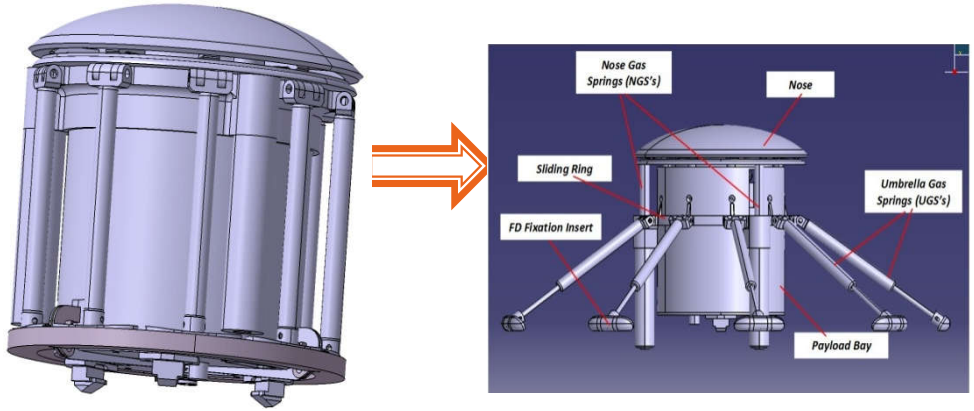


ALI - Aerospace Laboratory for Innovative components is the Industrial Partner. *It is as a Consortium of 17 Companies operating within the fields of design, engineering, prototyping and realization of innovative aerospace subsystemsand Ground Segment for technological and scientific platforms*

Swedish Space Corporation *(**SSC**) Will provide support to launch. It is a comprehensive space company that has 40 years of experience in helping space organizations, companies and research centers with access to space.*

IRENE main feature

The Italian Space Agency (ASI) and the European Space Agency (ESA) have been supporting since 2010 a research programme, called IRENE "Italian RE-entry NacellE" to develop a low-cost re-entry capsule, whose innovative characteristics are the heat-shield opening mechanism (*umbrella-like configuration*) - covered by an international patent - and the (*off the shelves*) material used for the thermal protection. The deployable heat shield allows a drastic reduction of the ballistic coefficient which results into reduction of the peak heat flux and mechanical loads.

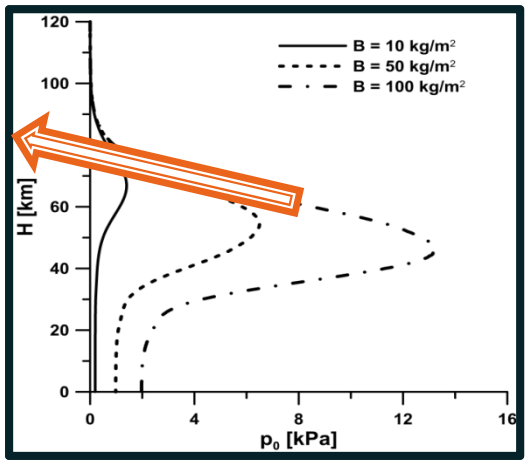


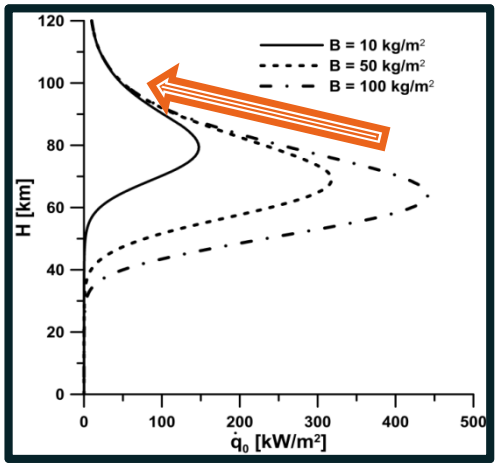
The heat shield is composed by:

- **a fixed nose** (made by a special ceramic material)
- **a deployable aero-brake** (umbrella-like, made by special multi-layered fabric).

The diagrams show how the reduction of the ballistic coefficient causes the reduction of heat flux and pressure at the stagnation point.

It is also possible to see that the pressure and heat flux peaks occur at higher altitude, where the atmosphere is more rarefied.

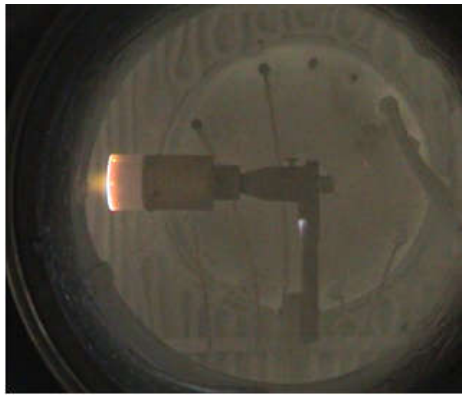


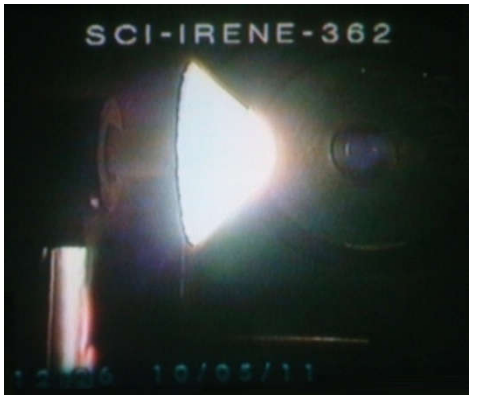


Heritage ALI activities

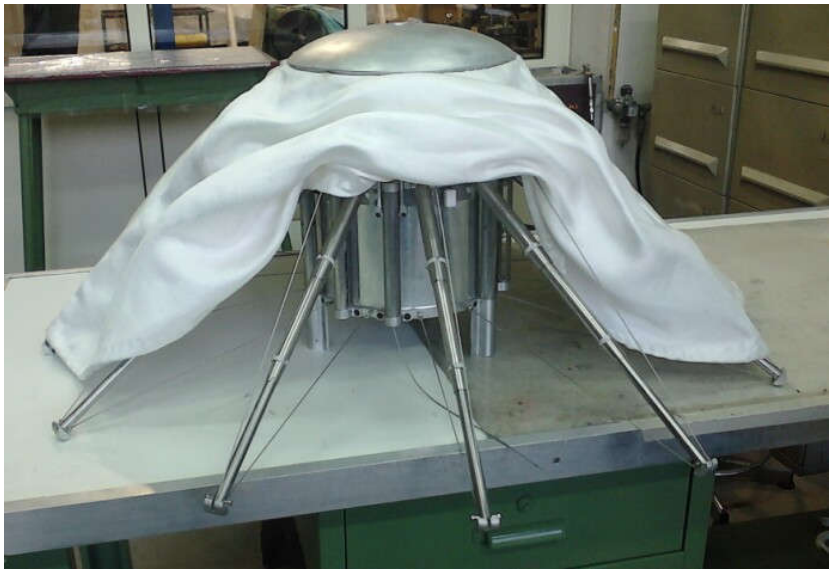
The feasibility study of this deployable re-entry system was carried out in 2011.

The TPS materials, selected for the nose cone and for the flexible umbrella shield, were preliminarily tested in the SPES hypersonic wind tunnel at the University of Naples, and in the **SCIROCCO PWT** (Plasma Wind Tunnel) at **CIRA** (Centro Italiano Ricerche Aerospaziali) of Capua, Italy.



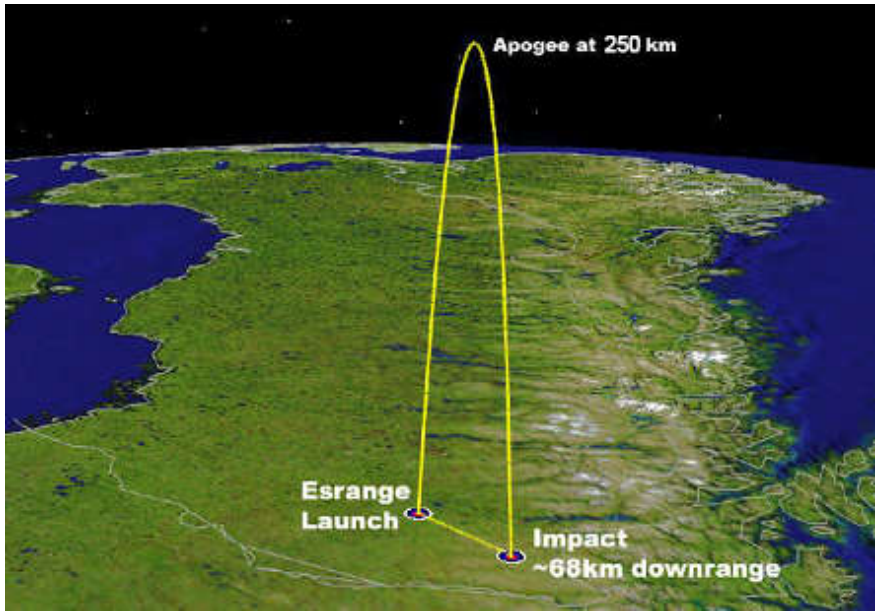


Other studies have been focused on the development of **a scaled down prototype** of IRENE, called **MINI-IRENE**, for suborbital flight on MASER sounding rocket and the current deployment logic has been conceived.



Mini IRENE Ground Demonstrator

MINI IRENE FLIGHT EXPERIMENT
PROJECT Objectives



Mission trajectory

The Mini-Irene Capsule **objectives** are:

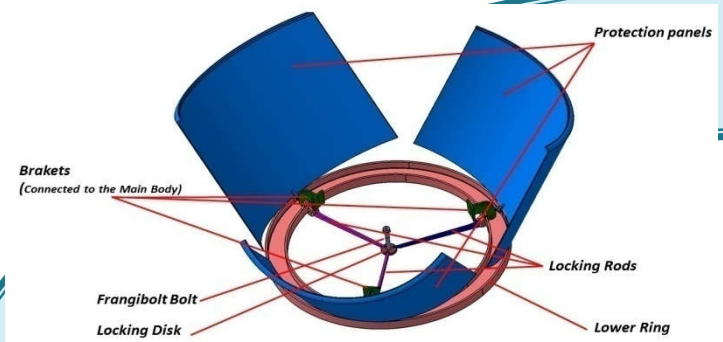
- Survive the launch
- Separate from the rocket;
- **Deploy the heat shield** before the re-entry phase;
- Maintain **aerodynamic stability** and structural integrity during the flight;
- Acquire and **store data** during the flight (pressures, temperatures, accelerations, attitude);
- Endure (only the payload) the re-entry environmental conditions allowing the retrieval of data collected in flight;
- **Be localized and retrieved after landing**.

The capsule shall be dropped from the payload stage of an **VSB-30 Rocket** after the burn out of the second stage during the ascent, at 65 seconds from the lift off **at an altitude** close to **83km** at a speed of about 1700 m/s.
The flight would continue up to a **250km** altitude. The landing is scheduled 860 seconds after the separation from the Launcher.

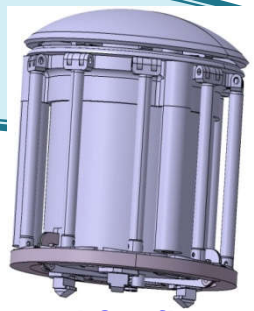
Concept

The **deployment** of the heat shield is articulated in **two phases:**

1. In the **first phase** the rods are extended.
2. In the **second phase** the nose cap is extended, and the flexible TPS spreads the rods, while it is tensioned in order to withstand the mechanical loads.

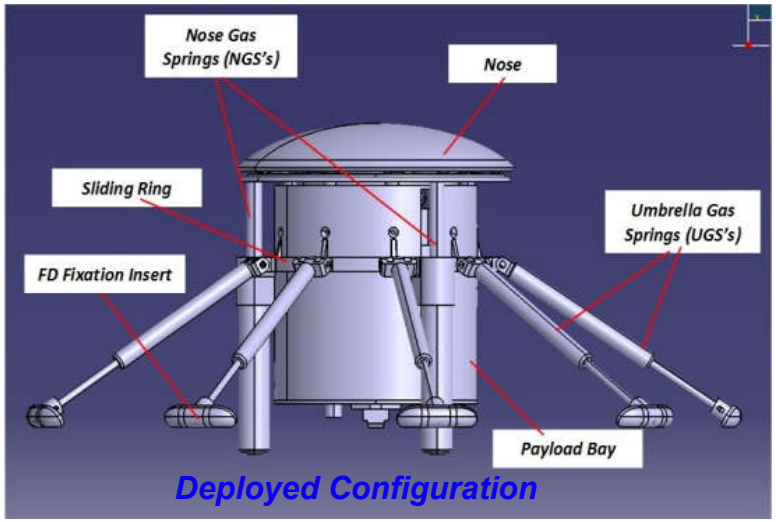


Opening the Protection Panels

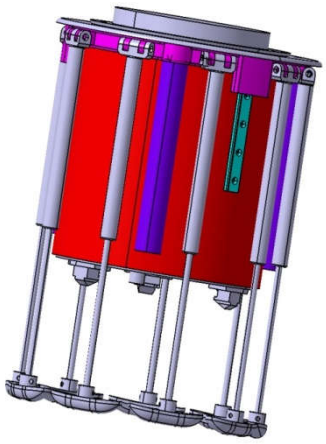


Stowed Configuration

Capsule dropped from the payload stage



Deployed Configuration

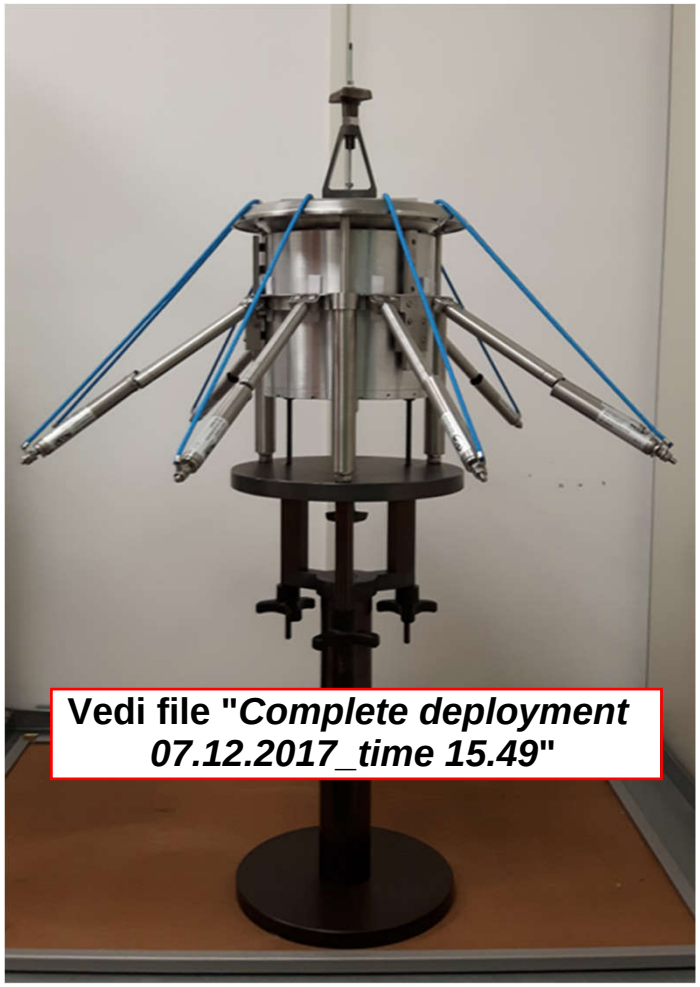


First phase of deploying

Integrated Test Equipment

The deployment sequence is the most critical part of the mission so an Integrated Test Equipment (ITE) has been conceived and manufactured.

ITE in closed configuration

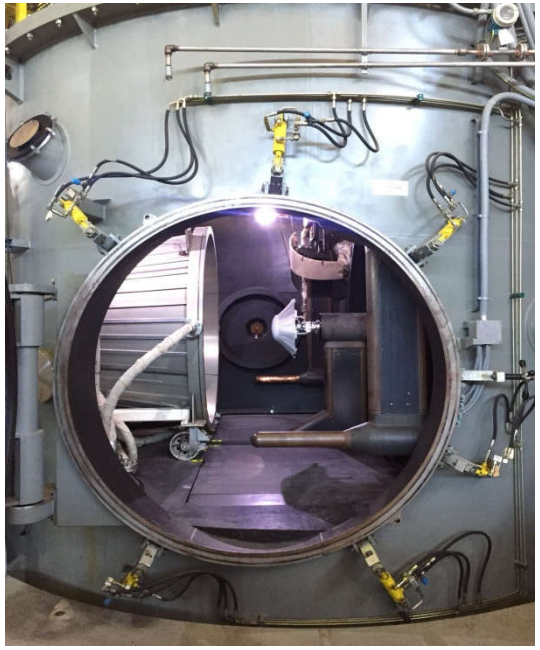


ITE in opened configuration

ITE with TPS in opened configuration

MIFE PWT TEST

The new TPS materials, selected for the nose cone and for the flexible umbrella shield, have been tested in the **SCIROCCO PWT** (Plasma Wind Tunnel) at **CIRA** (Centro Italiano Ricerche Aerospaziali) of Capua, Italy on the 28th June 2018.



MIFE Ground Demonstrator installed into the SCIROCCO chamber

Vedi file "*Filmato test capsula di rientro miniirene pag_8*"

MIFE Ground Demonstrator during the Test

MIFE Ground Demonstrator after the Test

An IRENE application: Small Mars Satellite Project

➢The purpose of **SMS** (**S**mall **M**ars **S**atellite), **exploiting IRENE technology,** is to develop a **small technology mission to Mars** to be launched onboard VEGA carrier rocket and carrying scientific and technology payloads to Mars.

➢The core characteristics of **SMS** are the low cost and the small ballistic coefficient, features that stand out with respect to previous Mars missions and systems.

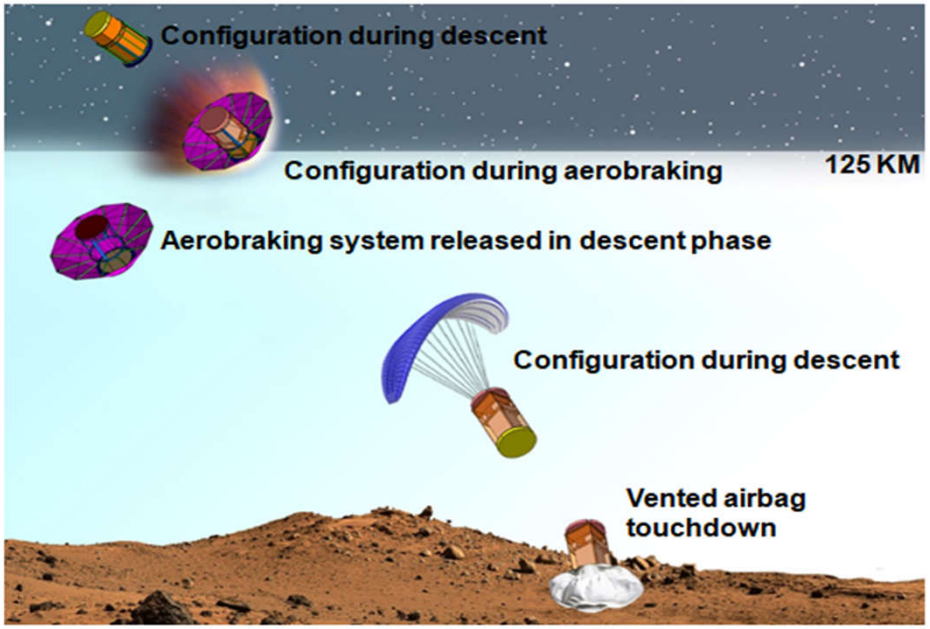
➢The main innovation of SMS is a completely **new EDL profile**, which exploits a deployable aeroshield, for aerobraking and thermal protection at entry, a subsonic-only parachute during descent, and a vented airbag at touchdown

SMS @ **Launch:** 304 kg

SMS @ **Entry**: 200 kg
Cruise Stage separated

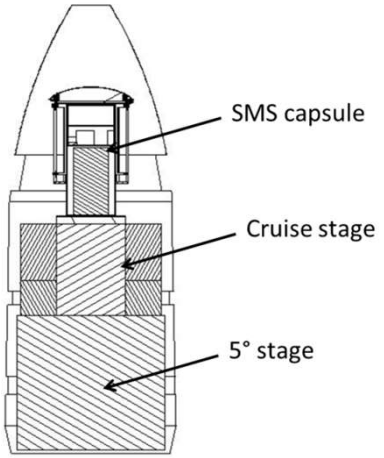
SMS @ **Landing:** 132 kg
Heat Shield & Parachute separated

TPS diameter at deployed configuration of 3 [m]



SMS EDL Profile

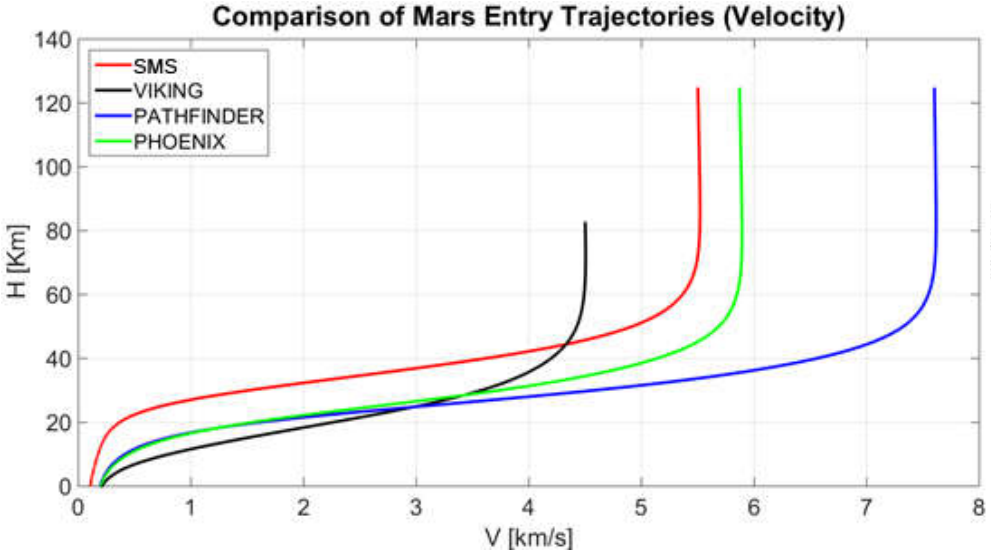
In the first phase of the mission the SMS capsule, connected with the 5th stage and the cruise stage, is housed inside the VEGA Fairing

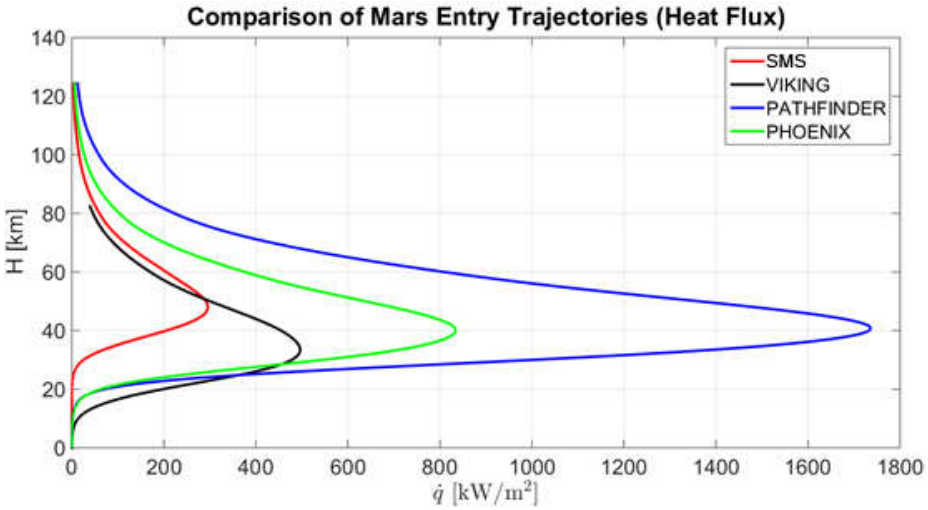


Section A-A

SMS Innovations – EDL Profile

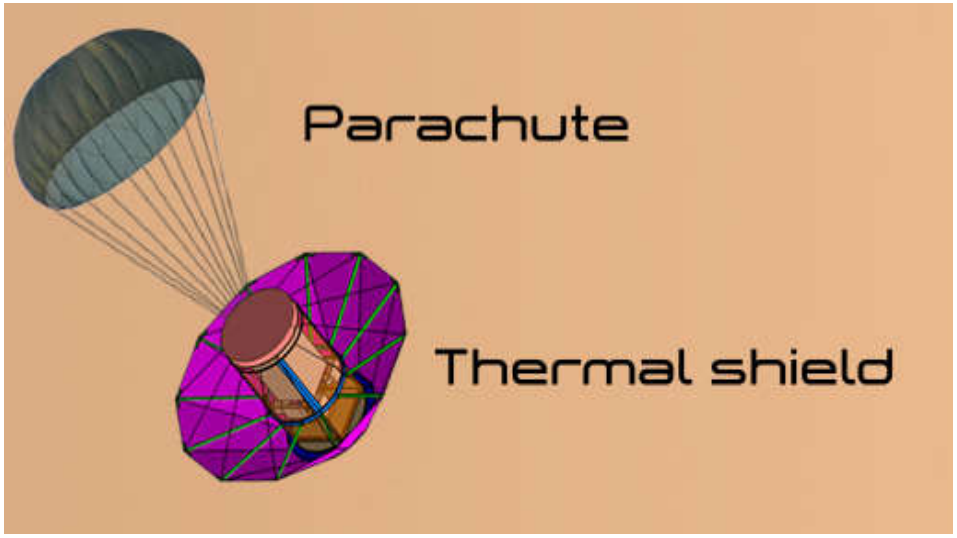
- Thanks to the deployable shield, the ballistic coefficient is much lower than in previous missions (about 1/3). This allows:
  - ✓ To reach subsonic conditions at much higher altitudes (about 10 km), thus making possible to land at higher elevation sites (ancient sites, attractive for life search).
  - ✓ To exploit only a subsonic parachute to reach a vertical speed at touchdown compatible with using an airbag for soft landing (<25 m/s)





SMS Innovations – Parachute and Airbag

In SMS, the "deployable" protective shield IRENE, the Parachute and the Vented Airbag will be applied together in a unique system. Such a descent profile has never been attempted by a Mars mission.



- With respect the conventional entry system based on Single and multistage, supersonic and subsonic parachute, SMS will use the umbrella for the supersonic phase
- The proposed subsonic Parachute has, differently form common systems, guidance capabilities based on Italian own technologies

SMS Innovations – Cost Breakdown and Funds

The use of proprietary technology and the highly miniaturized probe design allow to reduce the cost for the realization of the SMS mission to US$ 120million, including launch.

This remarkably lower budget, with respect to previous Mars missions, is made possible by the use of patented technology and by the know-how gained by the partners with the «intelligent reuse» of solutions and products developed for other space programs.

The European Space Agency funded the feasibility study of the mission in 2016 as part of its General Studies Program, while the technological development activities of critical subsystems, corresponding to about US$ 12.8million, have been partially supported by Italian national and EU funds.

Further technological developments will mainly focus on the study, implementation and testing of the spacecraft descent and landing system (EDL) which constitutes the most critical element of the mission.

In this context **a Memorandum of Understanding** in collaborating in academic and research programs in the areas of Space Systems and related technologies is being signed between the **Khalifa University** and the **University of Naples**, the latter partner of the SMS project.