PLANLAB

*A Planetary Environment Surface &
Subsurface Emulator Facility*

Presentation
For
Schiaparelli and his legacy symposium

PLANLAB

Agenda of Presentation

➢ **Scenario**

➢ **Definition**

➢ **Major Requirements**

➢ **Elements**

➢ **Martian and Lunar simulant for an indoor rover facility**

➢ **Mars simulant**

➢ **Moon simulant**

➢ **Positioning and modelling**

➢ **Development and conclusions**

Scenario

➢ The creation of an Agency <u>Planetary Environment Surface and Subsurface Emulator Facility</u> within the existing ALTEC-CMFS infrastructure, is feasibility from technical point of view and presents considerable cost-saving with respect to a dedicated building and infrastructure.

➢ The facility includes, in addition to the basic terrain room and infrastructures :

- high performance lighting and position systems
- permafrost refrigeration capability (to simulate portion of subsurface ice field)
- communication infrastructure
- peripheral facilities such as workshops, laboratories, storage space
- virtual reality theatre (Operations engineering/outreach-education)and observation/view windows.

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Scenario

PLANLAB in ALTEC could permit the exploitation of significant synergies:

- **within ESA Exploration related programs:**
    - ✓ **efficaciously streamlining the development of the ExoMars/ROCC MTS enabling development testing on the rover**
    - ✓ **Supporting technological studies**

- **with initiatives and programs at national level (Agency, Universities, Research Centers)**

PLANLAB infrastructure could permit cooperative initiatives with other space agencies in the frame of a long term space exploration vision. The PLANLAB Strategic relevance as hub of a knowledge innovation triangle
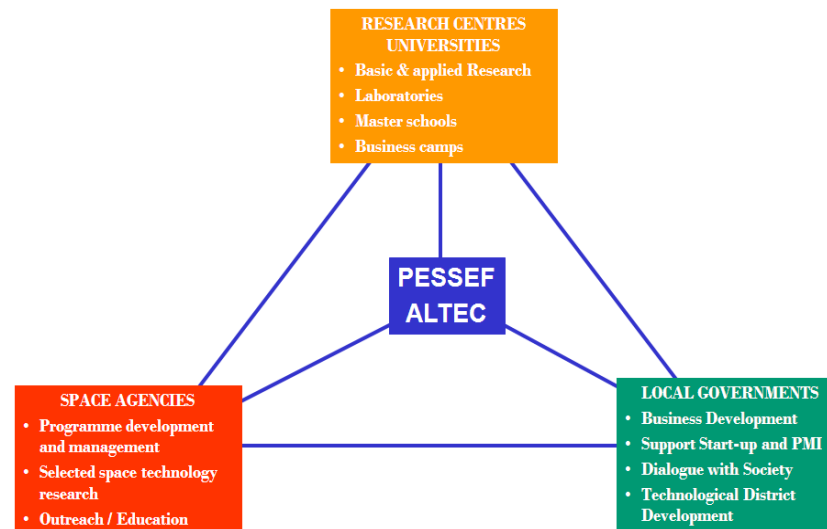
PLANLAB Definition

The PLANLAB Facility will allow the execution of activities aimed to:

- **The confirmation of the suitability of future robotic systems and probes design to the target environment**

- **The understanding and measurement of their real utilization and performance including technological developments, enabling meaningful real hardware testing**

- **The verification of the compatibility of the design and their operations**

- **The support the training of the ground operators, and researches**

- **The execution of significant outreach activities (education and communication) and technologies transfer.**

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PLANLAB major requirements

The PLANLAB can be utilized for Rovers, Landers and Probes (RLP) requiring extensive and short mission operations support and mission verifications under simulated planetary conditions :

- **Allows functional testing of the egress of the rover from the Lander.**

- **Permits the reproduction/simulation, to an adequate level of realism, of specific operations on planetary surface and some interactions with planet's surface.**

- **Permits the support to the development and verification of a rover locomotion performances, maneuvers, obstacles avoidance and autonomous movement in a short/long range.**

- **Can be used for testing at system level of on-board software routines and testing of command sequencing, including rover behavior response and command sequence validation.**

- **Provides a dedicated closed area to simulate extreme planetary temperatures with subsurface ice field or liquid water presence**

- **Can be used to perform mission operations emulation of selected science experiments.**

- **Can be connected with the ROCC Control Room permitting visualization and control of elements operation**

PLANLAB elements

The PLANLAB elements are :

- ➢ **Arena (Mars terrain, Lunar Terrain, movable platform, Gravity compensation device, Planetary illumination system)**

- ➢ **Wind Chamber**

- ➢ **Control Room**

- ➢ **Positioning and modeling**

- ➢ **Virtual reality**

- ➢ **Facility Infrastructures**

| CONCEPT DESIGN | New facility structure | SECTION | Plant | LEVEL | Gound Floor |
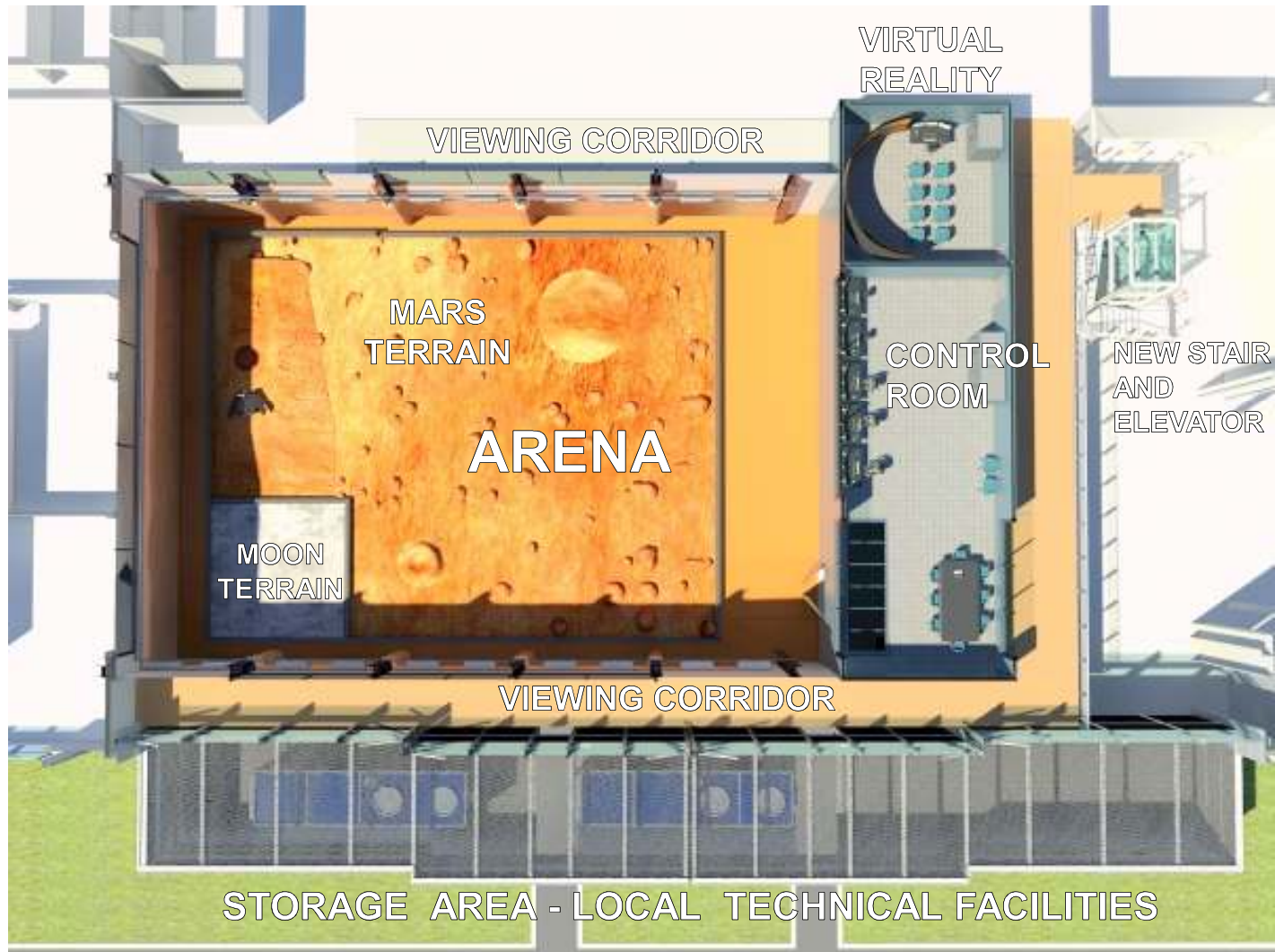
MARS TERRAIN

ARENA

WIND CHAMBER AREA

MOON TERRAIN

PREPARATION LABORATORY

STORAGE AREA - LOCAL TECHNICAL FACILITIES

VIRTUAL REALITY

VIEWING CORRIDOR

MARS TERRAIN

CONTROL ROOM

NEW STAIR AND ELEVATOR

ARENA

MOON TERRAIN

VIEWING CORRIDOR

STORAGE AREA - LOCAL TECHNICAL FACILITIES

BRIDGE CRANE

SYSTEM BLACKOUT WINDOWS

VIRTUAL REALITY

BACKDROPS WITH LANSCAPE OF MARS

WIND CHAMBER AREA

ARENA

ALTEC

ARENA

RECONFIGURABLE MARS TERRAIN

VIEWING CORRIDOR

VIEWING CORRIDOR

ARENA

STORAGE AREA - TECHNICAL ROOM
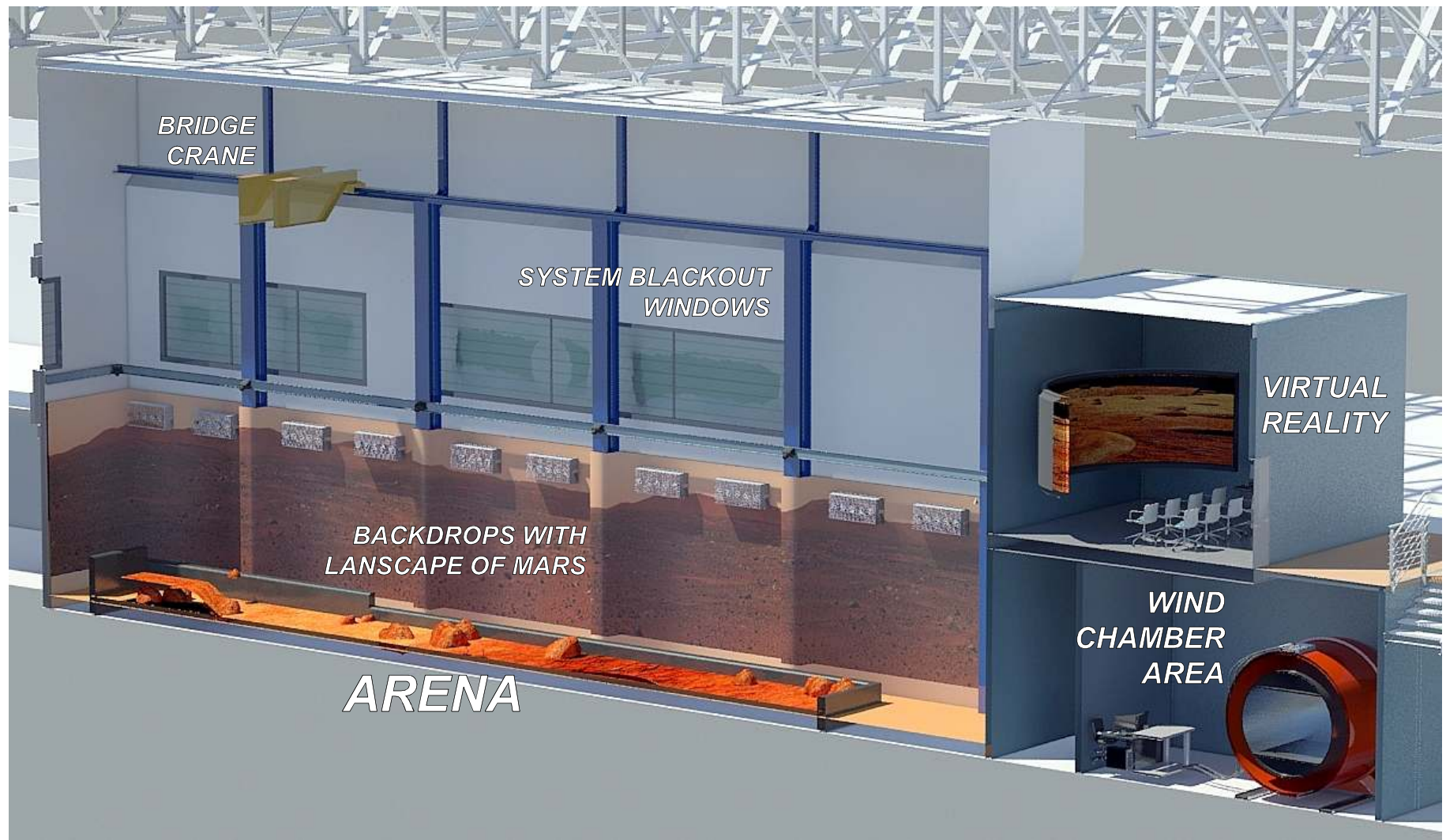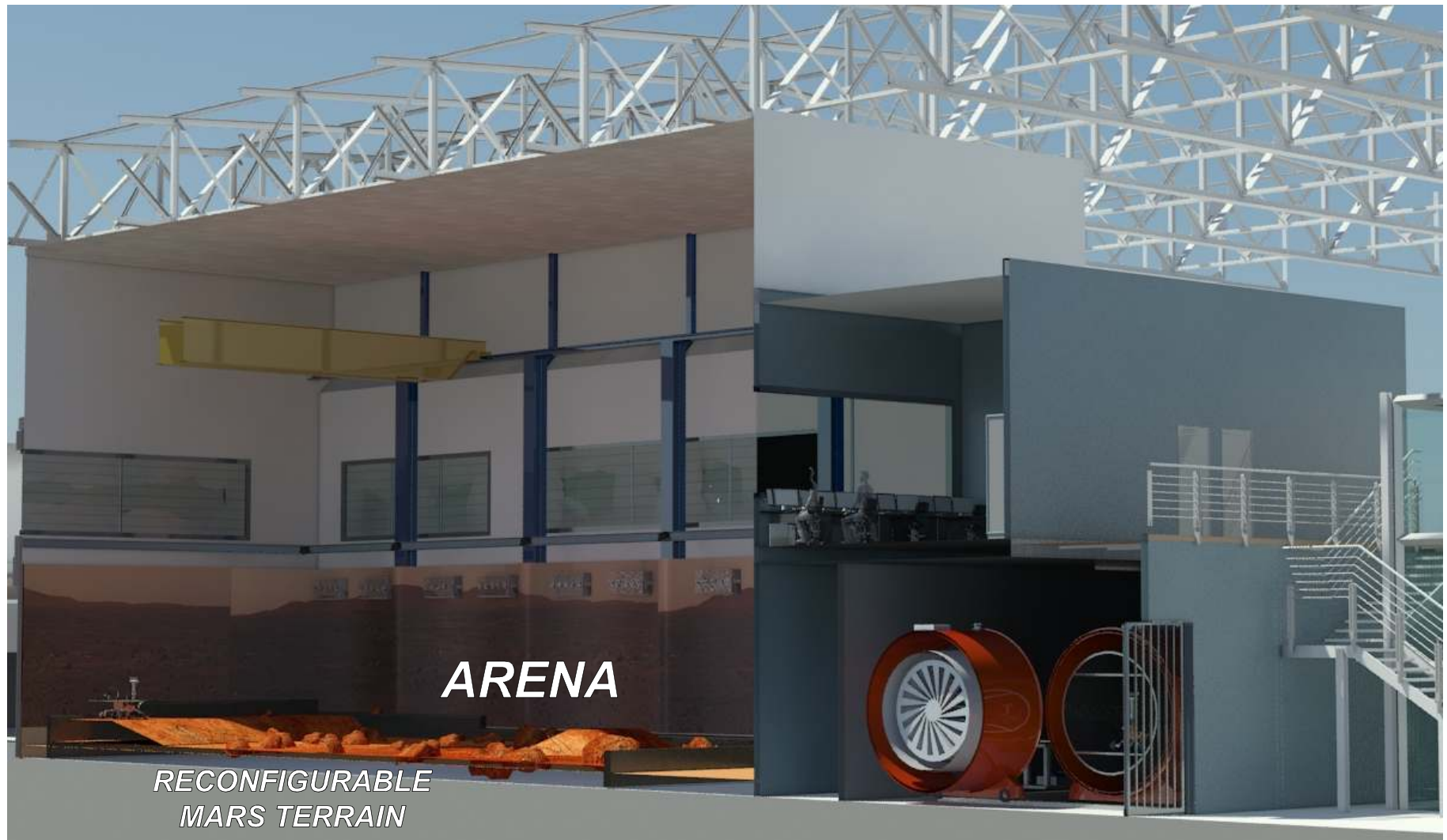
| CONCEPT DESIGN | New facility structure | SECTION | Cross | LEVEL | Gound/First Floor |

VIEWING CORRIDOR

VIEWING CORRIDOR

STORAGE AREA - TECHNICAL ROOM
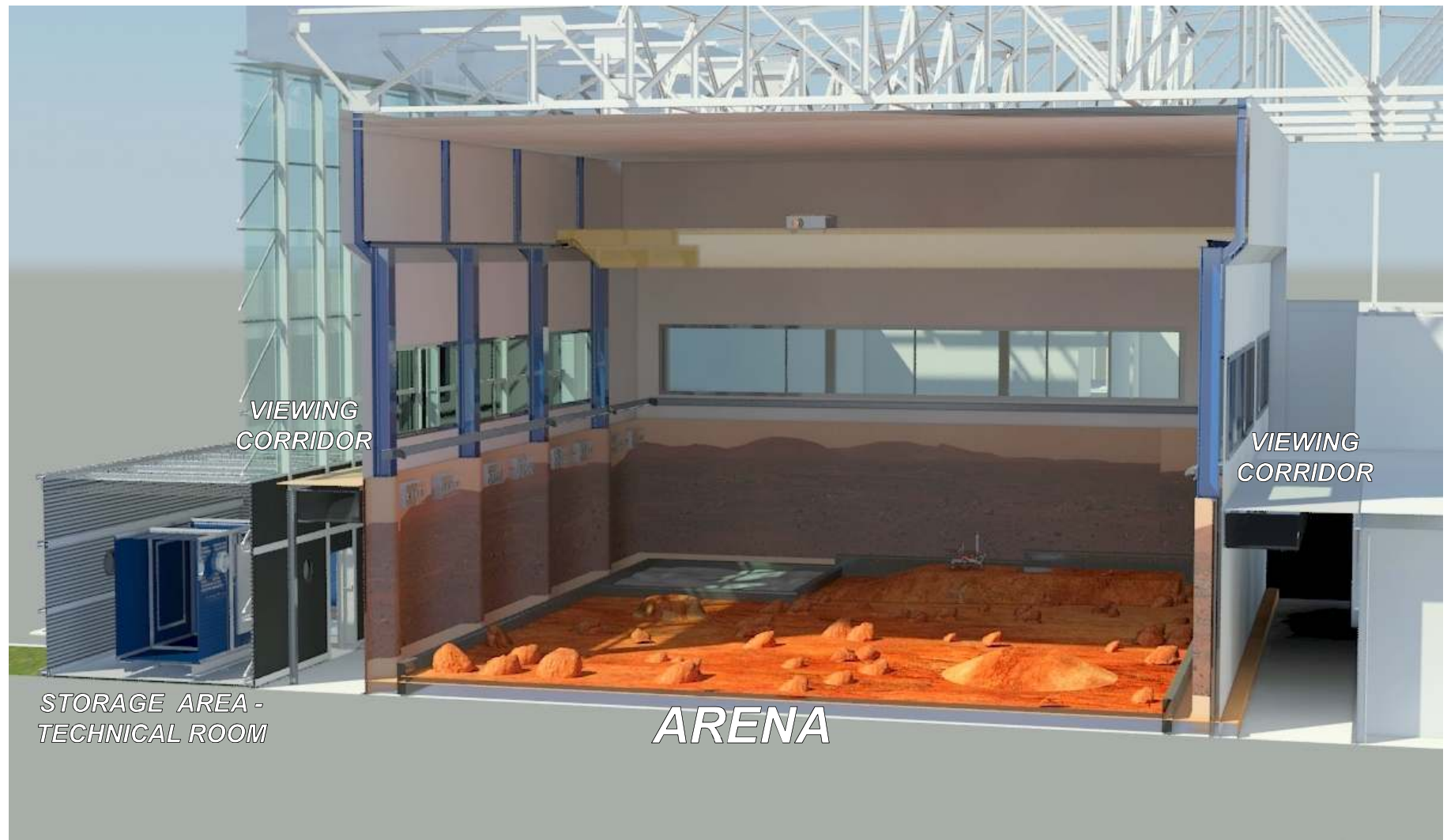
ARENA

FUNCTION **Arena**   LOCATION **In Side**   LEVEL **Ground Floor**

DRILL AREA PERMAFROST

FLEXIBLE RAMP

CRATER

HILL

ALTEC

FUNCTION	LOCATION	LEVEL
Arena	In Side	Ground Floor

CRATER

HILL

FLEXIBLE RAMP

CONCAVE BENDING

PLANAR

CO NVEX BENDING

DRILLAREA PERMAFROST
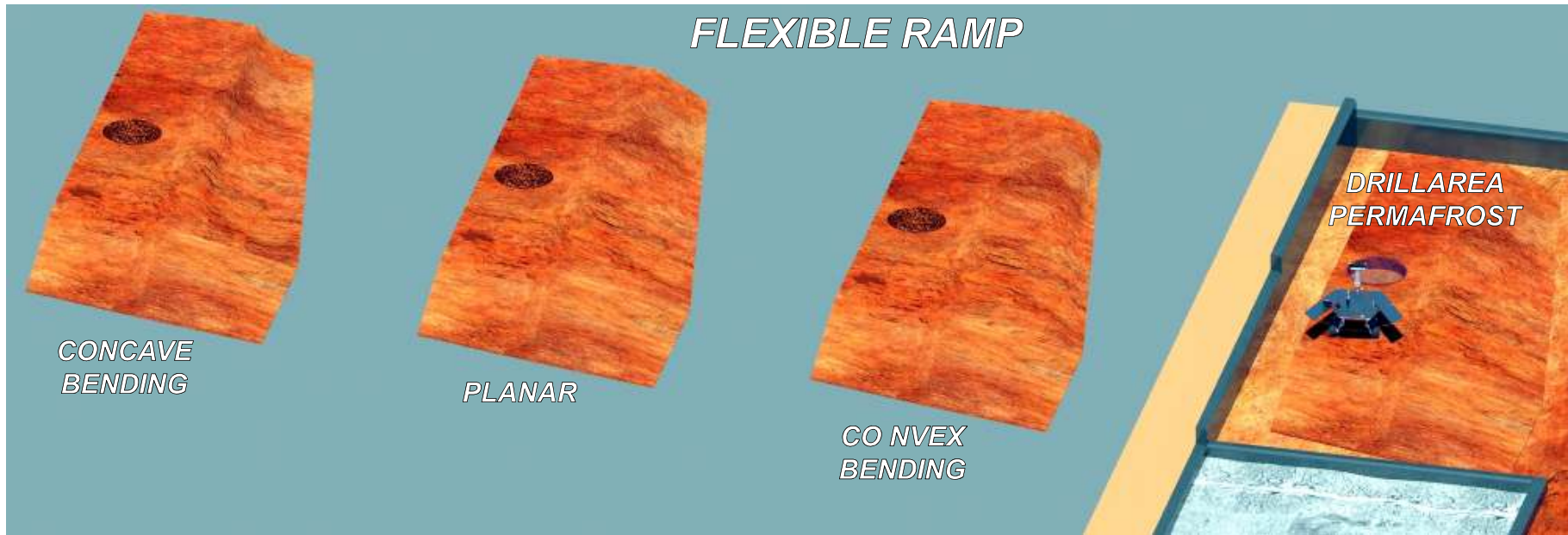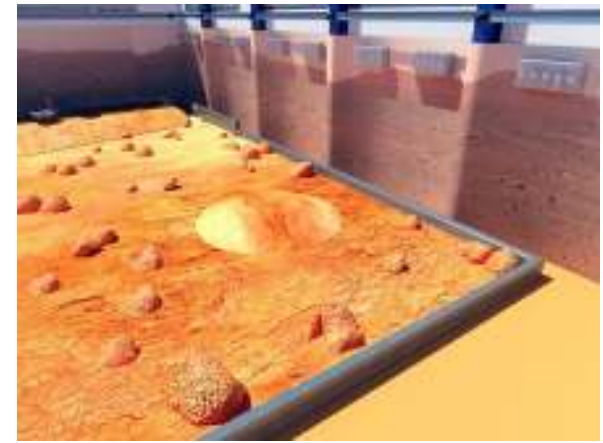
FUNCTION Wind chamber area

LOCATION In Side

LEVEL Ground Floor

WIND CHAMBER AREA

WIND TUNNEL

WIND TUNNEL

FIXED PART

CLOSED

MOVABLE PART

OPEN

| FUNCTION | Virtual reality room | LOCA TION | In Side | LEVEL | First Floor |
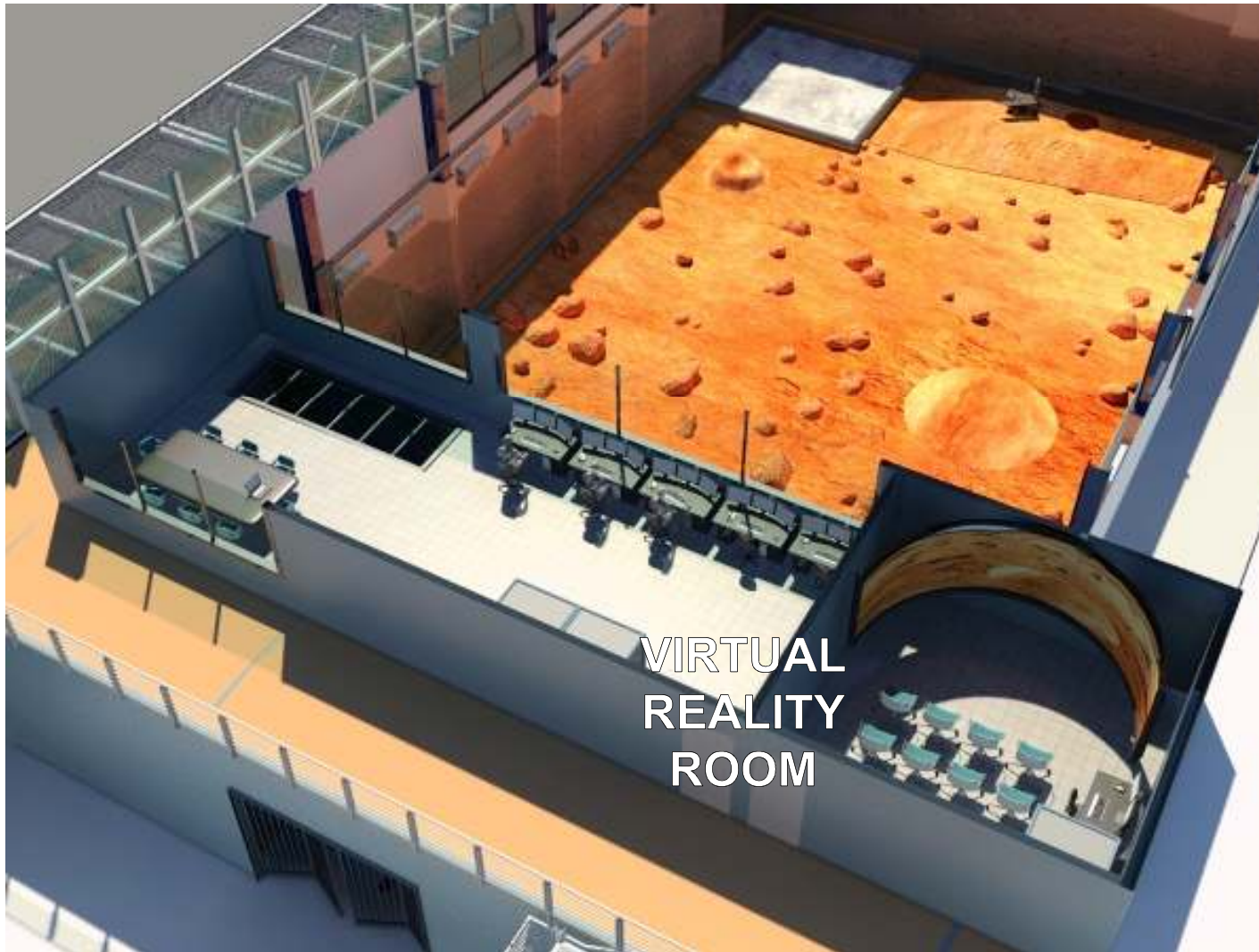
VIRTUAL
REALITY
ROOM

FUNCTION	Virtual reality room	LOCATION	In Side	LEVEL	First Floor

CONCEPT DESIGN	New facility structure	VIEW	Visual Flight	LEVEL	First Floor

PESSEF elements (Overview)

RECONFIGURABLE
MARS TERRAIN

MARS SIMULANTS

PLANETARY TERRAIN SIMULANTS

Type 3

Type 1

Type 4

Type 2
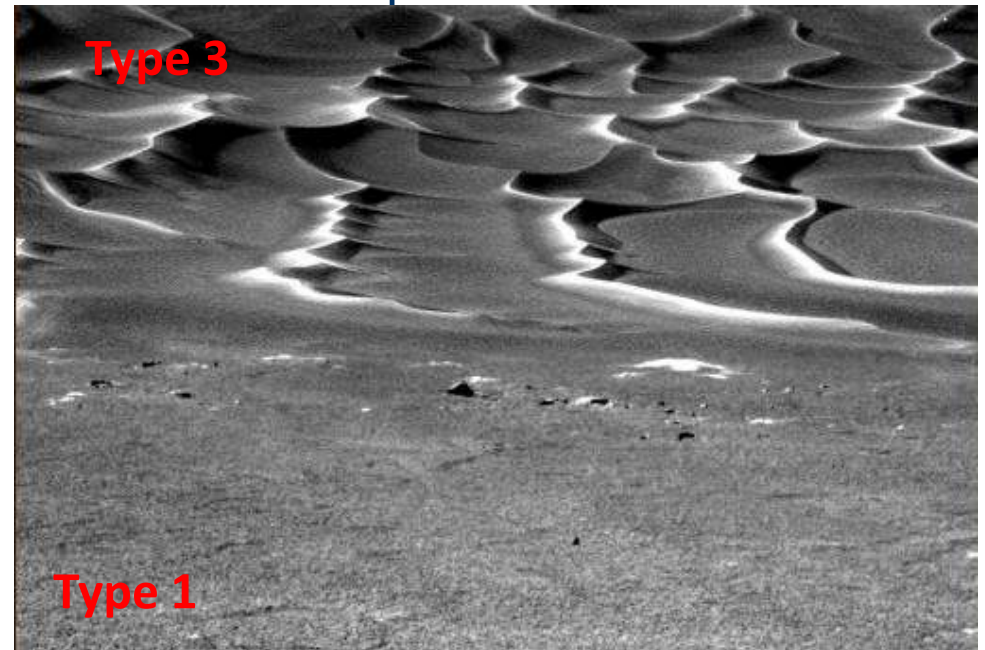
Positioning and modelling

The PLANLAB positioning system utilize cameras to track the rover/probe movements by means of targets on it; the built-in digital reconstruction software will provide a model of the tracked object, to be superimposed to the terrain Digital Elevation Model (DEM) received.
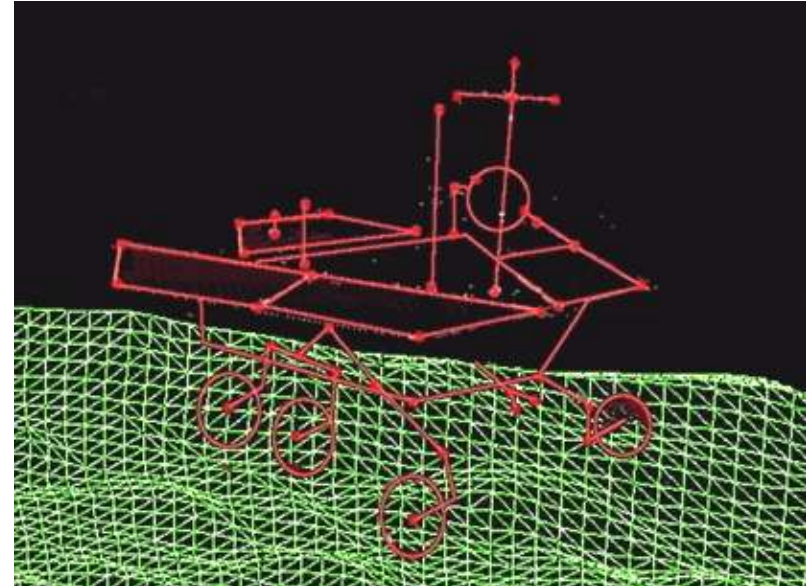
The rover/probe movement will be simulated before operations using Computer Aided Design (CAD) and Finite Element Modelling (FEM), reproducing the terrain contact reactions and/or the structural deformation on the reduced pressure on wheels and the thermal loading effects.

PLANLAB development and conclusions

➢ **The development phase lasts about 18 months including the final testing and verification of the system. At the end of the development phase the operative phase can start immediately**

➢ **PLANLAB represents a unique opportunity for testing, verification of robotic elements on different planetary surfaces. It permits the representation of planetary environment (wind tunnel) with good fidelity**

➢ **PLANLAB represents a valuable opportunity for virtual reality implementation for engineering and outreach purpose.**