

Digital Workshop – Space Exploration

DOWNSTREAM GATEWAY

Marralla and

Space for Earth

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HUMAN & ROBOTIC EXPLORATION

ExPeRT

Research

and





SciSpacE

Science in Space Environment

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EXPLORATION TECHNOLOGY AREAS OF INTEREST

Challenge: Autonomous Navigation, Extend Human Capability

Artificial Intelligence

- Enabling autonomous Moon and Mars surface
 navigation extends capability with reduced intervention
- Terrain recognition and hazard avoidance during landing will optimize fuel consumption
- Autonomous Failure Detection Isolation & Recovery for rovers/drones/landers optimizes operations







EXPLORATION TECHNOLOGY AREAS OF INTEREST

- Challenge: Clean Propulsion, Unmanned Vehicles Electric Propulsion
- Renewable energy via solar arrays
- Highly efficient thrusters
- Key enabler for long-range return missions

Autonomous Drones

- Autonomous surface mapping capability
- Clean cold-gas and water-based thrusters on the Moon
- Solar-powered propelling blades on Mars







EXPLORATION TECHNOLOGY AREAS OF INTEREST Challenge: Analogues, Field Trials, Operations

Habitation

- Prepare future human surface architectures
- VR for training, exploration, and design aid
- Ops and Robotics Training Expansion (VORTEX) project simulates the lunar surface & habitation modules to prepare and optimize operations
- Analogue Facilities
- Future Lunar Exploration Habitat (FLEXHab),
- and Lunar Analogue (LUNA) facility at EAC
- Concordia station in Antartica







EXPLORATION TECHNOLOGY AREAS OF INTEREST

Challenge: Living Off-Grid, Carbon-Free Energy

Solar Power

- Power plant on lunar surface
- High solar-electrical power efficiency
- Renewable energy for sustainable operations

Fuel Cell Systems

- Regenerative systems store energy for night survival
- Lunar oxygen/water and Mars CO₂ used as ISRU
- Fuel/reactant production plant can supply vehicles that run on Fuel Cell power







EXPLORATION TECHNOLOGY AREAS OF INTEREST Challenge: Resources Management, Teleoperations

5G Technology & Connectivity

- Due to reduced latency, 5G will facilitate teleoperations in the lunar environment
- High bandwidth will allow to process massive amounts of data
- 5G supports lunar operations and organic growth of services in absence of terrestrial GPS





EXPLORATION TECHNOLOGY AREAS OF INTEREST

Challenge: Survive Extreme Environment

Life Support

MELiSSA's scope:





- Closed-loop ecosystems: re-create an artificial environment allowing 100% recycling of waste to produce oxygen, water and food for crew
- Increase knowledge of regenerative life support systems
- Investigate plant and edible biomass growth





EXPLORATION TECHNOLOGY AREAS OF INTEREST

Challenge: Resources Utilization, Sustainability

Space Resources

- Enabling in-situ use of available resources
- Carbon-free technologies to process space material (e.g. lunar soil) for oxygen/water extraction, metal production and in-situ manufacturing
- Synergy with terrestrial sectors to reduce carbon footprint of processes on Earth
- Reuse and recycle approach for tools and materials





EXPLORATION TECHNOLOGY AREAS OF INTEREST

Challenge: Mitigate Climate Change, In-Space Manufacturing

Space-Based Solar Power

- Wireless transmission of power from deployable structures harvesting clean energy in Space
- Demonstration of power provision to Moon (PSRs, night survival) and Mars (dust storms) surface needs (kWs) can be good pilots for scaling up to Earth needs (GWs)
- In-Situ Resources Utilisation (ISRU) of space materials (e.g. metals, alloys) can feed in-orbit (additive) manufacturing of hardware







Partners for Space Exploration

International Space Station

- Opportunity to engage as ESA's strategic partner
- Supports innovative business cases for new commercial services, technologies, and products

MOON

EARTH

→ ESA SUPPORTS SUSTAINABLE DEVELOPMENT



Example projects from Human and Robotic Exploration









6.3







6-6

TARGET



SANITATION SUPPORT

TO DEVELOPING

COUNTRIES





Operational project

Autonomous drinkingwater filtration for University of Kenitra. Standard shippingcontainer sized solarpowered water filtration to remove nitrates.

8-1 00 8-3 6-4 6-5 6-6 6-A 6-8

#Space19plus #SDGs



for results.

Product available

6-1 LOC 6-3 LOC COC LOC LOC

on the market



Bio-mimetic membranes copy nature to purify

water. As it works on a molecular scale, the membrane hardly clogs up and can be used for longer than regular filters. Tested on the International Space Station and available on Earth.

Product available on the market





SEMiLLA Sanitation uses space technology to turn urine and faeces into water and fertiliser. The modular design converts wastewater streams into drinkable water, fertiliser, irrigation water and compost.

Product available on the market



Reduction of 80% of water use in La Trappe brewery in The Netherlands using recycling processes developed for spaceflight. Around 3000 species of bacteria and organisms, including plants are used to purify the water.

Operational project

6-8 6-3 6-4 6-5 6-6 6-8



A modular pilot wastewater treatment plant along the Barapullah drain in downtown New Delhi, India, is being built based on space technology. Innovative but robust technologies, will be incorporated in a modular pilot treatment plant.

Product under development

6-1 8-2 6-3 8-4 6-5 6-6 8-A 6-B



Compact water

treatment technology

where land is scarce

tourist areas or where

treatment installations

must be protected from

harsh weather such as

1-1 11-1 6·3 6·4 6·5 1001 100 6·8

in mountains.

Product available

on the market

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such as high-value

particularly useful



Photobioreactor space know-how recycles water to produce hot water with less energy. The biomass produced can be used for pharmaceutical compounds and protein supplements. The first building with Biofacade is being constructed in Paris.

Product under construction

Space19 💮

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How to engage with ESA



→ THE EUROPEAN SPACE AGENCY

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http://youbenefit.spaceflight.esa.in

Mars

Low Earth Orbit

Moon

we explore. you benefit.

Human Spaceflight and Robotic Exploration