

SMART ICE LAB, ILEWG - IGLUNA PROJECT A. Sitnikova^{1,2}, G vd Sanden^{2,3}, B. Foing^{2,3,5}, T. Benavides⁴, ILEWG Igluna team (M. Grosjean², D. Moritz⁶, M. Löffler⁶, L. Dimova⁶, A. Wanske⁶, I. Schlacht², J. Flache⁶, T. Alvarez⁷, E.P. Montgomery⁷, A. Tomic², A. Zaklinsky¹, C. Felix², J. Preusterink², Y. Gonzalez², B. Pothier²), VU Amsterdam Igluna Team (B. De Winter³, M. Heemskerk³, T. Clement³, B. Albers³, M. Daeter³, A. Kruijver³, D. Beentjes³, S. van Bloois³, I. Brouwer³, M. Berg³, R. Korthouwer³, A. Dingemans³, G. Vaessen³),

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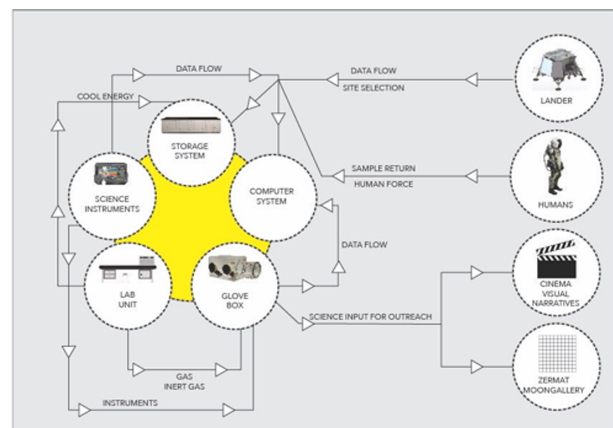
Introduction: IGLUNA, the first ESA_Lab interuniversity demonstrator project, is organized by the Swiss Space Centre with the vision to create an analogue habitat inside the ice present in the polar craters on the Moon. This project brings together 18 teams from 13 universities and 9 countries collaborating to build a habitat in an ice cavity in a glacier in Zermatt, Switzerland [1]. Mission of ILEWG [2] team in this project is to provide scientists (VU group) with the capability to conduct examinations and measurements on ice samples and cores, and to preserve the integrity of these for current and future investigations. We work together with art scientists to visualize scientific data and provide public outreach. We develop astronaut IVA and EVA operation protocols and tests during analogue Moon missions. We want to enable the best science possible during our lunar mission and foster a strong collaboration between different science and engineering disciplines to support "international cooperation towards a world strategy for the exploration and utilization of the Moon - our natural satellite" (International Lunar Workshop, Beatenberg (CH), June 1994).

Scientific Goals: ILEWG developed EuroMoonMars, an evolving pilot research programme starting with a Robotic Test Bench (ExoGeoLab) and a Mobile Laboratory Habitat (ExoHab) at ESTEC, & ExoLaboratory (ExoLab). They can be used to validate concepts and external instruments from partner institutes. [2] Field campaigns have been conducted in ESTEC, EAC, at Utah MDRS station, Eifel, Rio Tinto, Iceland, La Reunion, LunAres base at Pila Poland, and Hawaii (HiSeas, PISCES and upcoming MoonBase Alliance). [6] For Igluna we want to develop a mobile Smart Ice Lab module to provide safe smart environment for VU science experiments and EPFL 3d printed saw experiment. We plan to deliver and preserve samples mined by Aachen and UPB. We develop EuroMoonMars activities with designers & artists expanding awareness of MoonMars benefits to the society at large. This research can benefit Science, Exploration or Application

programs, and International Tasks Groups (space agencies, and research partners).

System overview: Smart Ice Lab project consists of several subsystems: Laboratory unit, portable unit, EuroMoonMars ExoGeoLab lander, IVA/EVA protocols, Art-Science projects (Moon Gallery [7], Visual Narratives movie)

Fig 1: Smart Ice Lab system overview



Subsystem 1 – laboratory unit: Laboratory unit shall provide stable anti-contamination environment for VU science experiments (ice core, ice samples analysis). It shall integrate glove box workspace at least 100x40x50cm, airlock at least 40x40x40 cm, storage facility at least 60x40x35cm, science instruments (scale, thermometer, computer, cameras, lamps, pulveriser, saw, spectrometer VNIR/VISNIR, polarized microscope, microtome knife, heater pad, EC- and pH-meter, glass beakers etc.) For design of the lab unit we work with BTU Master architecture students. Design we're aiming for:

- portable science working station and storage units with an envelope of 2,5 x 1 x 1,5m
- Integrated systems
- Self explanatory usage
- Adaptable functions

- Clear infrastructure
- Easy to assemble: 1 h. with 2 people
- Compact to transport:
 - a. light version to transport by plane
 - b. heavy version to transport by Toyota Verso
- a combination of practical design and visual narrative for public outreach

A number of solutions is currently being elaborated by students based on modular designs, telescope principle, origami techniques and railing systems.

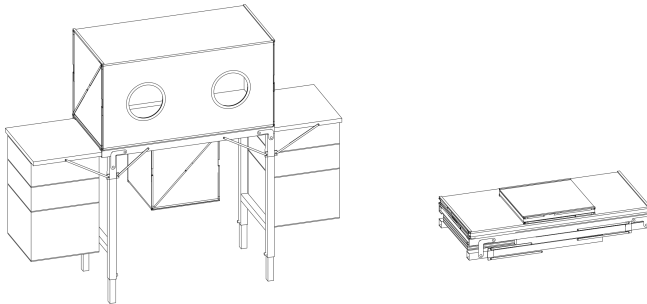


Fig 2: Deployable design option by L. Dimova & A. Wanske

Subsystem 2 – portable unit: Portable unit – capsule to transport ice samples. Portable unit shall be designed in compliance with ice core dimensions of 40 cm x 15cmØ and enable safe sample return operations.

Subsystem 3 – ExoGeoLab lander: The ExoGeolab will be equipped with telescopes and cameras and teleoperated [3] by VU students from ground control center in Zermatt. Instruments will also be operated during EVA by analogue astronauts. This will help to map the area and scout interesting locations for deploying ice drill by RWTH Aachen students.



Fig 3: ILEWG lander at Eifel

Subsystem 4 – IVA/EVA protocols: ILEWG analogue astronauts will develop IVA protocols for laboratory unit operations, EVA protocols for sample return missions and lander operations. ILEWG

analogue astronauts got their training at PoSSUM [4] and currently planning space simulation mission at HI-SEAS [5] base in Hawaii, where they will test some IGLUNA Smart Ice Lab instruments and prepare first protocols. We tested Smart Ice Lab instruments in the volcanic Eifel region in Germany together with VU team in October. We will give an update on tests we run at ESTEC simulation site, HI-SEAS mission, remote support to MDRS-205 in the Utah desert. [6]

Public outreach: One of main objectives of ILEWG in IGLUNA project is inspiring space exploration and providing public outreach. We will give an update on the events/workshops we organized or presented at:

- “Space Music & 100 hours of Astronomy” Space Expo Noordwijk Jan 2019
- “Moon Gallery Future Past” Space Expo exhibition Noordwijk 2018-2019
- “VU Space Day” Space Symposium Amsterdam Nov 2018
- “Moon Gallery exhibition” ESTEC Noordwijk Nov 2018
- “Dutch Weekend of Science event – Art in Space” Copernicus Observatory Overveen Oct 2018
- “Moon Gallery ArtMoonMars program for public engagement, outreach, international cooperation, space exploration through art” The Ninth Moscow Solar System Symposium Sep 2018
- Alumni Event at KABK Royal Academy of Art, Space exploration through Art lecture & workshop, The Hague Sep 2018
- “Moon simulations, Moon Gallery workshop & IGLUNA introduction” Iceland University of the Arts Sep 2018
- Sparthabitat at Spektrum Berlin, Sep 2018 –Origami, Igluna & Moon Gallery lecture

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References:

- [1] <https://www.spacecenter.ch/igluna/>, [2] Foing, B.H (2017) LPS49, Abstract #5073 [3] Lillo, A (2018), LPS49, Abstract #1242, [4] <https://projectpossum.org> , [5] <https://hi-seas.org>, [6] Foing, B.H (2011) Analogue Sites for Mars Missions: MSL and Beyond (2011), Abstract #6029, [7] <http://www.moongallery.space>