PREPARING FUTURE ENGINEERS AND ASTRONAUTS FOR MOON EXPLORATION: EMMPOL EUROMOONMARS POLAND 2020 CAMPAIGN.
I. R. Perrier[1,3], B. Foing[2,3,4], A. Kołodziejczyk[3,5], K. Komenda[3] , M. Clain[1], E. Forgues -- Mayet[1] , T.Podolsky[1], J. Bardin-Codine[1], H. Castaing[1], Q. Gouault[1], A. Spilkin[3], R. Landolina[3],
[1]IPSA Toulouse, ioana-roxana.perrier@ipsa.fr , 40 Boulevard de la Marquette, 31000, Toulouse, France,
[2] ESA ESTEC, [3]ILEWG/EuroMoonMars, Netherlands, [4]VU Amsterdam, Leiden & IAS CNRS ,
[5]AATC Analog Astronaut Training Center;

Introduction: The ILEWG EuroMoonMars program includes research activities for data analysis, instruments tests and development, field tests in MoonMars analogue, pilot projects, training and hands on workshops, and outreach activities. [1-10]. EuroMoonMars field campaigns have been organized in specific locations of technical, scientific and exploration interest. Field tests have been conducted in ESTEC, EAC, at Utah MDRS station, Eifel, Rio Tinto, Iceland, La Reunion, LunAres base at Pila Poland [1-10], and HiSEas base in Hawaii, and AATC Poland (EMMPOL).

As an aerospace engineering school, IPSA (Institut Polytechnique des Sciences Avancées) joined the ILEWG Euro Moon Mars program to be more active and closer the future of the space exploration and Particularly the one of the Moon.

EMMPOL 2020 campaign: Our first EMMPOL missions together were focused on studies of the habitability conditions on the Moon and on conducting experiments in lunar simulation habitat, supported remotely by a mission control team and science support . The Analog Astronaut Training Center facility in Poland allowed us to test our experiments in an isolation campaign of one week in October 2020. We shall describe the preliminary results from EMMPOL1 crew campaign, and lessons learned for ARTEMIS mission control and science support.

Fig. 1: EMMPOL 1 & 2 Crew during EuroMoonMars Poland Workshop at Queen Jadwiga Astronomical Observatory

Fig 2: EMMPOL1-2 Crew Briefing during EuroMoonMars Poland workshop

The preliminary results were discussed at EMMPOL workshop (Figs 1 & 2)

Preparing experiments: As part of the project -based learning our students worked on the future habitability conditions on our natural satellite, and performed a set of experiments, that were also monitored form Mission control and science support. This included:

Hydroponics: A greenhouse concept was developed .All the technical aspects were studied: design, automatic systems, energy budget, but not only. A green house is meant to allow humans on the Moon to have a autonomy in growing plants and vegetables, in order to have fresh food and a good nutrient supply. This project allowed us to get familiarized with aquaponics and hydroponics technics, for fish and plants. Concerning the Hydroponic system we propose an improved biofilter with an increased nesting surface meaning an increased surface for nitrifying bacteria.

High pH water studies. We know that water is a key element for our survival. Long-term space missions are challenging when thinking about water budget, its source, and its quality. Hydration is important for humans but necessary for plants too. AquaVia 9.4 pH commercialized water was tested during our isolation campaign. It was compared with neutral pH water impact on the growth of plants but also on the human body. Analog astronauts followed a special diet in order to clearly identify the action of the alkaline water.

Life support system. Algae are the most widespread oxygen producers in the world. They are also resistant to environmental changes, easy to breed and they effectively reduce CO2. In confined and small spaces, the increased amount of CO2 generates a potential risk for the crew [11]. Three types of microalgae consortia were used in the experiment. Arthrospira plantita, Chlorella, Spirulina, Synechocystis spp. were the most dominant algae species selected for this study. The efficiency of CO2 reduction was investigated as a function of time by placing algae consortia in chambers of various volumes in a sealed container. The algae were saturated with the external habitat air rich in CO2. The risks were characterized, and costs related with implementation of this biological method.

Recycling. The recycling awareness came in very naturally. Our daily production of wastes increases and the types of materials we are using is evolving; Thanks to the collaboration with a French environmental friendly association called Zeapack, we could test compost done with recyclable plastic. Laboratory items like plastic gloves and plastic bags were utilized for the study using the Berkley method.

Sample return 3D printed spacecraft. Once humanity will have access to a lunar base, it is likely that we will need a spacecraft to send samples or equipment back into orbit or Earth. To cope with that, we created a micro launcher which is a 3D plastic printed rocket with a purpose of sending moon regolith sample in orbit or to earth. It is composed of three parts: the thruster, the tank and the payload. The main goal was to design a launcher versatile and adaptable to lots of purpose. Being able to 3D print a launcher directly on the Moon base with inexpensive material as plastic, would allow to decrease the complexity and the price of returning samples, such as experiment results, to Earth.

Preparing future astronauts. All the operators of this experiments are analog astronauts. We performed all the activities in isolated conditions and respected the low budget of resources. Also, as part of our analog Moon mission we had no natural light and we were respecting a schedule of science, technical, physical, and social activities that were monitored from mission control and science support team (Fig 3)

Fig. 3: EMMPOL analog astronauts during daily mission reporting

Acknowledgments:

We thank the following partners and sponsors :
-Zeapack Vaisselle Ecologique, 34690 Fabregues, France.
-AquaVia naturally alkaline spring water pH 9.4, Transilvania - Bologa, Cluj county, Romania.
-Zortrax Poland https://zortrax.com/
-Euro Moon Mars/ILEWG team and support
-AATC Analog Astronaut Training Center
https://www.astronaut.center/

References: Use the brief numbered style common in many abstracts, e.g., [1], [2], etc. References should then appear in numerical order in the reference list, and should use the following abbreviated style:

[1] Author A. B. and Author C. D. (1997) *JGR, 90,* 1151–1154. [2] Author E. F. et al. (1997) *Meteoritics & Planet. Sci., 32,* A74. [3] Author G. H. (1996) *LPS XXVII*, 1344–1345. [4] Author I. J. (2002) *LPS XXXIII*, Abstract #1402.

EuroMoonMars References

References: [1] Foing BH (2009) *LPI/LPSC*, *40*, 2567 ; [2] Groemer G & ILEWG Eifel team (2010) *LPI/LPSC 41*,1680 ; [3] Foing B. H. et al. (2011) Special Issue MoonMars, 10, *IJA*, *10*; [4] Ehrenfreund et al. (2011) *IJA 2011*, 10 (3), 239; [5] Stoker C. et al (2011) *IJA 2011*, *10* (3), 269; [6] Kotler et al. (2011). *IJA 2011*, *10* (3), 221; [7] Foing BH. Et al. (2014) *LPI/LPSC 45*, 2675 ; [8] Foing BH et al. (2016) *LPI/LPSC 47*, 2719 ; [9] Offringa M et al (2016) *LPI/LPSC 47*, 2522 ; [10] Kamps OM et al (2016) *LPI/LPSC 47*, 2508 ; [11] Monitoring of CO2 uptake by microalgae in indoor environment, Soreanu G, Cretescu I, Diaconu M, *Glorep 2018*, 255-259.