ILEWG Eifel 2009 Campaign: Astronaut Extravehicular Surface/Subsurface Activities & Human Aspects.

G. Groemer[1] , W. Stumptner[1], B. Foing[2,5], J. K. Blom[3], A. Perrin[2], M. Mikolajczak[2], S. Chevrier[2], S. Direito[2], A. Olmedo-Soler[4], T. E. Zegers[5], D. Scheer[1], K. Bickert[1], D. Schildhammer[1], B. Jantscher[1], P. Mahapatra[5,2] and the MECA Team[6], [1]Austrian Space Forum (OEWF Innsbruck c/o Institute for Astro- and Particle Physics, Univ. Innsbruck, Technikerstr. 25/8, A-6020 Innsbruck, Austria; gernot.groemer@oewf.org), [2]International Lunar Exploration Working Group (ILEWG, c/o Chief Scientist, ESTEC / SCI-SR, PO Box 299, 2200 AG Noordwijk, The Netherlands), [3]TU Delft (Faculty of Civil Engineering and Geosciences,Department of Geotechnology, Stevinweg 1, 2628 CN Delft, The Netherlands), [4]Olmedo Knowledge Systems S.L. (Apartado 290, 46410 Sueca, Valencia, Spain), [5]European Space Agency (European Space&Technology Centre ESTEC, P.O. Box 299, 2200 AG Noordwijk, The Netherlands), [6]Mission Execution Crew Assistant Team (c/o TNO Human Factors, P.O. Box 23, 3769 ZG Soesterberg, The Netherlands).

Introduction: The International Lunar Exploration Working Group (ILEWG) is a public forum sponsored by the world's space agencies to support "international cooperation towards a world strategy for the exploration and utilization of the Moon". It brings together: (i) delegates and representatives of the participating Space Agencies and organizations; (ii) team members of the relevant space projects, (iii) members of the general public and of the Lunar Explorer's Society who are interested to contribute
ILEWG has a number of task groups coordinating support activities and research in the following areas: Science, Technology and Resource Utilization, Human Bases, Society, Education Outreach, Young Lunar Explorers. ILEWG has contributed to pilot projects for robotics (ExoGeoLab), habitats (ExoHab) and analogue field campaigns (EuroGeoMoonMars 2009 in Utah, ILEWG/ESTEC 2009, CAREX Rio Tinto 2009, Eifel 2009) [1-7].
During a 5 day field campaign from 26th -30th September 2009 the ILEWG invited a number of organizations to work together in Mendig, Germany, in the volcanic Eifel region. In a cascading exploration regime, different hardware and software systems from various groups worked together to achieve remote sensing, robotic and human exploration objectives. Researchers from ESA/ESTEC, the Austrian Space Forum, the French Ecole de l'Air, the University of Delft and the MECA Team tested their systems in a setting that is well suited for the simulation of lunar or planetary mission operations [Figs 1-3]. In addition for the first time a simulation spacesuit and a rover have undergone trials in a subterranean settings (the Mendig Lavadome) intended to emulate a typical lunar or Martian lava tube exploration scenario [Fig 4].

Spacesuit simulator: The Aouda.X suit created by the Austrian Space Forum is designed to study contamination vectors in planetary exploration analogue environments [8, 9] using a special surface coating. It facilitates the simulation of variable suit pressure regimes using tension belts. An advanced human-machine interface, a set of sensors and a purpose designed software act as a local virtual assistant to the crewman. It is designed to interact with other field components like rovers and lander instruments. (Fig. 1)

Aouda.X System Overview:
The Aouda.X suit contains the following sub-systems:
• <45 kg, Hard-Upper-Torso suit, ambient air ventilation, Outer hull: Panox/Kevlar tissue with aluminium coating
• Modifiable exoskeleton able to simulate various pressure regimes for all major human joints & fingers
• Biomedical and engineering telemetry with W-Lan (including continuous video & audio, various temperatures, CO2, GPS, air pressure, humidity, acceleration), human waste management.

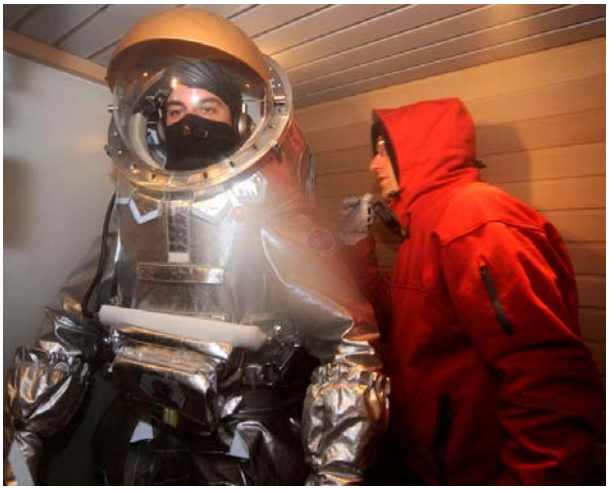


Fig. 1: Aouda.X spacesuit simulator at cryotests at -110°C prior to the Eifel field campaign

Rovers: Two rover systems – one small scale lunar rover with a high quality camera and one planetary rover with a griper system – have been used independently and in conjunction with the Aouda suit. A full scale lander model equipped with cameras and

instruments has been inspected for damage both with rovers and a human simulation astronaut. A rover has brought samples back to the lander for further analysis with spectrometers. Hand held Raman spectrometer measurements have been taken by the suit tester at the local Wingertsbergwand, a stratified volcanic site. Simulated repair and recovery activities have taken place, greatly aided by the MECA investigation.

MECA: The Mission Execution Crew Assistant (MECA) is an electronic assistant that supports the astronauts during their activities. The assistant should help the astronaut to: (i) assess the situation; (ii) determine his or her next actions in solving a problem by generating alternative solutions or by evaluating the different approaches available to the astronaut; and (iii) to safeguard the astronaut from failures during the execution of a plan. It requires the application of emerging technologies such as multi-agent system technology, automatic planning and scheduling, and model-based health management.

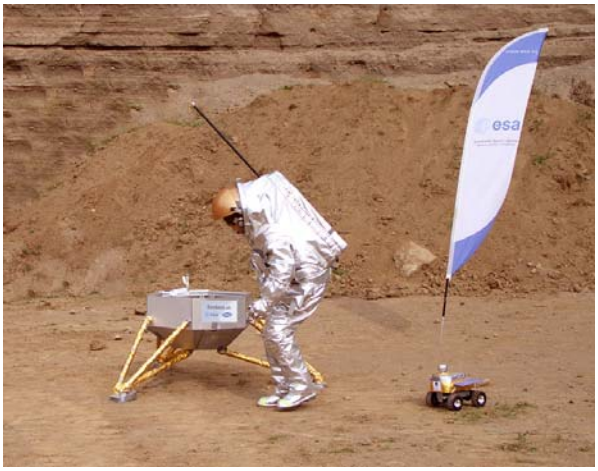
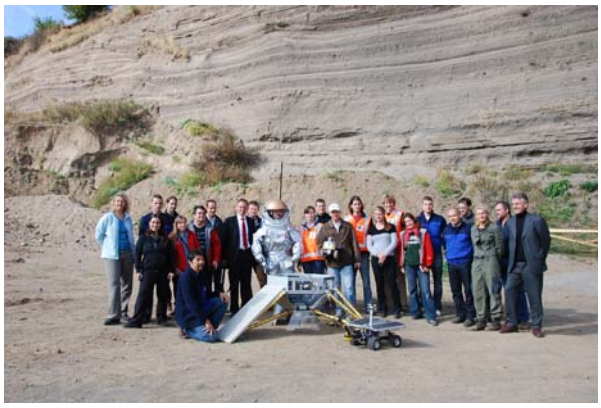


Fig. 2: The ExoGeoLab lander simulator is being inspected by the crew explorer in Aouda.X EVA suit

Human aspects like stress, heavy workload, tight schedules, equipment failure, poor communication quality and fatigue have been simulated. Lessons learned from this field campaign – especially in the area of placing, ease of use during manual activities and the effective range of communication equipment - are being applied to modify the existing hardware to make it more user friendly. These experiences were compared to the data obtained during the AustroMars mission simulation of the Austrian Space Forum in 2006 in the Moab desert in Utah [10,11].

A significant amount of outreach activities with local media, politicians and citizens have taken place during this field campaign including hands-on experience with the featured hard- and software for the interested public [Fig 3].



Fis. 3 & 4: The ILEWG Eifel campaign team during surface and sub-surface EVA activities

References: [1] Foing, BH et al . (2009) LPI, 40, 2567; [2] Foing BH and the ExoGeoLab Team, EGU2009-13122; [3] ILEWG http://sci.esa.int/ilewg ; [3] Foing, B.H., Pletser, V., Boche-Sauvan L. et al , Daily reports from MDRS (crew 76 & 77) on http://desert.marssociety.org/mdrs/fs08/.; [4] Boche-Sauvan L., Pletser V. , Foing BH and EurGeoMars Team, EGU2009-13323; [5] S.T.M. Peters, A. Borst, L. Wendt, C. Gross, C. Stoker, J. Zhavaleta, P. Sarrazin, E. Slob, V. Pletser, B. Foing and the ExoGeoLab team & EuroGeoMars Team, EGU2009-13353; Peters S, Borst A, Foing, Stoker et al, LPSC, (2010) LPI, 40 ; [6] C. Thiel, D. Wills, B. Foing, and the ExoGeoLab team, the EuroGeoMars Crew and Support Team, EGU2009-13414; [7] Mahapatra P, Direito S, Foing BH and CAREX Rio Tinto workshop team, (2010) LPI, 41, 1374; [8] Rummel, J.D. (2001), PNAS 98, 2128-2131, 2001. [9] Grömer, G. (2008), Planet. Space Sci., doi:10.1016/j.pss.2008.07.021. [10] Sattler, B., Selch, F., Klammer, S., Grömer, G., Sipiera, P. (2007), Mars 2030 Peer reviewed Conf. Proceedings, 2007, pp 13-17. [11] Grömer, G., Frischauf, N., Soucek, A., Sattler, B. (2007), Mars 2030 Peer reviewed Conf. Proceedings, 2007, pp 4-12.