IAF SPACE EXPLORATION SYMPOSIUM (A3)
Moon Exploration – Part 2 (2B)

Author: Dr. Armin Wedler
German Aerospace Center (DLR), Germany, armin.wedler@dlr.de

Mr. Marcus Müller
German Aerospace Center (DLR), Germany, Marcus.Mueller@dlr.de
Dr. Martin Schuster
German Aerospace Center (DLR), Germany, martin.schuster@dlr.de
Mr. Peter Lehner
German Aerospace Center (DLR), Germany, Peter.Lehner@dlr.de
Mrs. Hannah Lehner
German Aerospace Center (DLR), Germany, Hannah.Lehner@dlr.de
Mr. Dömel Andreas
German Aerospace Center (DLR), Germany, Andreas.Dömel@dlr.de
Mr. Mallikarjuna Vayugundla
DLR (German Aerospace Center), Germany, mallikarjuna.vayugundla@dlr.de
Mr. Florian Steidle
German Aerospace Center (DLR), Germany, Florian.Steidle@dlr.de
Mr. Ryo Sakagami
German Aerospace Center (DLR), Germany, Ryo.Sakagami@dlr.de
Mr. Lukas Meyer
DLR (German Aerospace Center), Germany, Lukas.Meyer@dlr.de
Dr. Michal Smisek
German Aerospace Center (DLR), Germany, Michal.Smisek@dlr.de
Mr. Wolfgang Stürzl
German Aerospace Center (DLR), Germany, Wolfgang.Stuerzl@dlr.de
Ms. Nicole Schmitz
Deutsches Zentrum für Luft- und Raumfahrt e.V. (DLR), Germany, Nicole.Schmitz@dlr.de
Mr. Bernhard Vodermayer
German Aerospace Center (DLR), Germany, Bernhard.Vodermayer@dlr.de
Dr. Emanuel Staudinger
German Aerospace Center (DLR), Germany, Emanuel.Staudinger@dlr.de
Mr. Rainer Krenn
German Aerospace Center (DLR), Germany, rainer.krenn@dlr.de
Dr. Enrico Dietz
German Aerospace Center (DLR), Berlin, Germany, Enrico.Dietz@dlr.de
Mr. Christian Braun
Karlsruhe Institute of Technology, Germany, christian.braun@kit.edu
Mr. Bernhard Rebele
DLR (German Aerospace Center), Germany, bernhard.rebele@dlr.de
Dr. Riccardo Giubilato
German Aerospace Center (DLR), Germany, Riccardo.Giubilato@dlr.de
Dr. Josef Reill

German Aerospace Center (DLR), Germany, Josef.Reill@dlr.de
Mr. Maximilian Durner
German Aerospace Center (DLR), Germany, Maximilian.Durner@dlr.de
Mr. Andre Fonseca Prince
German Aerospace Center (DLR), Germany, Andre.FonsecaPrince@dlr.de
Mr. Moritz Fischer-Gundlach
German Aerospace Center (DLR), Germany, Moritz.Fischer-Gundlach@dlr.de
Mr. Jongseok Lee
German Aerospace Center (DLR), Germany, Jongseok.Lee@dlr.de
Mr. Alejandro Fontan Villacampa
DLR (German Aerospace Center), Germany, Alejandro.FontanVillacampa@dlr.de
Mr. Giacomo Franchini
German Aerospace Center (DLR), Germany, Franchini.Giacomo@dlr.de
Dr. Susanne Schroeder
DLR (German Aerospace Center), Germany, Susanne.Schroeder@dlr.de
Mrs. Sven Frohmann
German Aerospace Center (DLR), Germany, Sven.Frohmann@dlr.de
Dr. Rudolph Triebel
German Aerospace Center (DLR), Germany, Rudolph.Triebel@dlr.de
Mrs. Esther Bischoff
Karlsruhe Institute of Technology, Germany, esther.bischoff@kit.edu
Mr. Kjetil Wormnes
European Space Agency (ESA), The Netherlands, kjetil.wormnes@esa.int
Dr. Aaron Pereira
DLR (German Aerospace Center), Germany, aaron.pereira@dlr.de
Dr. William Carey
European Space Agency (ESA-ESTEC), The Netherlands, william.carey@esa.int
Dr. Angelo Pio Rossi
Jacobs University Bremen, Germany, an.rossi@jacobs-university.de
Mr. Thorsten Graber
Solenix GmbH, Germany, thorsten.graber@solenix.ch
Dr. Thomas Krueger
European Space Agency (ESA), The Netherlands, thomas.krueger@esa.int
Dr. Anko Börner
Deutsches Zentrum für Luft- und Raumfahrt e.V. (DLR), Germany, Anko.Boerner@dlr.de
Mrs. Kristin Bussmann
German Aerospace Center (DLR), Germany, Kristin.Bussmann@dlr.de
Mr. Gerhard Paar
Joanneum Research, Austria, gerhard.paar@joanneum.at
Mr. Arnold Bauer
Joanneum Research, Austria, arnold.bauer@joanneum.at
Dr. Stefan Völk
German Aerospace Center (DLR), Germany, Stefan.Voelk@dlr.de
Prof. Heike Rauer
Deutsches Zentrum für Luft- und Raumfahrt e.V. (DLR), Institute for Planetary Research, Germany, heike.rauer@dlr.de
Mr. Fabian Seel
German Aerospace Center (DLR), Berlin, Germany, fabian.seel@dlr.de
Dr. Neal Y. Lii
German Aerospace Center (DLR), Germany, neal.lii@dlr.de

Mr. Sean Kille
Karlsruhe Institute of Technology, Germany, sean.kille@kit.edu
Prof. Heinz-Wilhelm Hübers
German Aerospace Center (DLR), Berlin, Germany, Heinz-Wilhelm.Huebers@dlr.de
Prof. Johann Bals
German Aerospace Center (DLR), Germany, Johann.Bals@dlr.de
Prof. Sören Hohmann
Karlsruhe Institute of Technology, Germany, soeren.hohmann@kit.edu
Prof. bernard foing
ILEWG "EuroMoonMars", The Netherlands, foing@strw.leidenuniv.nl
Prof. Laurenz Thomsen
Jacobs University Bremen, Germany, l.thomsen@jacobs-university.de
Prof. Tamim Asfour
Karlsruhe Institute of Technology, Germany, asfour@kit.edu
Dr. Hiesinger Harald
Westfalische Wilhelms-Universitat, Germany, hiesinger@uni-muenster.de
Prof. Alin Olimpiu Albu-Schäffer
German Aerospace Center (DLR), Germany, Alin.Albu-Schaeffer@dlr.de

FINALLY! INSIGHTS INTO THE ARCHES LUNAR PLANETARY EXPLORATION ANALOGUE CAMPAIGN ON ETNA IN SUMMER 2022

Abstract

Teams of mobile robotic assets will play important roles in future planetary exploration missions. Plans for upcoming missions for lunar exploration and to other extraterrestrial bodies consider the extensive use of robots to fulfil their scientific and technical goals. Human-robot cooperation will be a key aspect, not only with regard to humans cooperating with robots on surface missions, but also regarding the operation of intelligent robots during different tasks and applications to achieve the mission goals in a safe and efficient manner.

The ARCHES (Autonomous Robotic Networks to Help Modern Societies) project focuses on the development and validation of robotic key technologies to achieve autonomy with a high degree of local perception and task execution capabilities. Besides performing fundamental research, it highlights the advantages of cooperative aspects of heterogeneous robotic teams.

The ARCHES partners cooperate with the ESA ANALOG-1 mission team in order to internationally widen the scope of ARCHES: Both field campaigns will be performed in partnership between the June 13th and July 9th 2022 on Mt. Etna (Sicily, Italy). The analogue mission consists of three parts, focusing scientifically on geological research and radio astronomy, which are relevant scenarios for future exploration activities.

In the first two scenarios, technical and operational aspects of in-situ geological analysis and sample return will be investigated. The first scenario focuses on a cooperative heterogeneous team of two wheeled rovers (LRU1 and LRU2) and a flying drone (ARDEA), which will fully autonomously explore sites of interest and perform scientific-triggered remote spectral imagery, LIBS spectroscopy as well as sample selection, analyses, and collection tasks.

In the second scenario, another robotic asset, the Interact rover, will survey sites via supervisory control from a control room at ESOC (European Space Operations Centre) in Darmstadt, Germany. The focus is on interactions of a trained astronaut with operations and science teams in a control room on Earth, while teleoperating a highly dexterous rover with a robotic arm. Shared autonomy with visual and haptic feedback is used to enhance the astronaut's capabilities when operating the rover. Furthermore, a second scout rover will provide communication links required for haptic feedback of the Interact rover during teleoperation.

In the third scenario, the installation and maintenance of a low-frequency radio antenna array will be demonstrated with the LRU rovers and ARDEA drone. The array consists of four antenna elements and includes a novel technique for precise positioning based on radio communications.