

IAF SPACE EXPLORATION SYMPOSIUM (A3)
Moon Exploration – Part 1 (2A)

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. Sebastian Brunner

German Aerospace Center (DLR), Germany, Sebastian.Brunner@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 Vodermayr

German Aerospace Center (DLR), Germany, Bernhard.Vodermayr@dlr.de

Mr. Andre Fonseca Prince

German Aerospace Center (DLR), Germany, Andre.FonsecaPrince@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

German Aerospace Center (DLR), 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. 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. Ingo von Bargaen

German Aerospace Center (DLR), Germany, Ingo.Bargaen@dlr.de
Dr. Susanne Schroeder

DLR (German Aerospace Center), Germany, Susanne.Schroeder@dlr.de
Dr. Sven Frohmann

German Aerospace Center (DLR), Berlin, Germany, Sven.Frohmann@dlr.de
Dr. Rudolph Triebel

DLR (German Aerospace Center), 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
Prof.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. Peter Kyr
Germany, peter.kyr@online.de
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

DLR (German Aerospace Center), Germany, stefan.voelk@dlr.de
Mr. Andreas Kimpe

German Aerospace Center (DLR), Germany, Andreas.Kimpe@dlr.de
Prof. Heike Rauer

Deutsches Zentrum für Luft- und Raumfahrt e.V. (DLR), Institute for Planetary Research, Germany,
heike.rauer@dlr.de
Prof. Heinz-Wilhelm Hübers
German Aerospace Center (DLR), Berlin, Germany, Heinz-Wilhelm.Huebers@dlr.de
Dr. 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. Alin Olimpiu Albu-Schäffer
German Aerospace Center (DLR), Germany, Alin.Albu-Schaeffer@dlr.de

FIRST RESULTS FROM THE MULTI-ROBOT, MULTI-PARTNER, MULTI-MISSION, PLANETARY EXPLORATION ANALOGUE CAMPAIGN ON MT. ETNA IN SUMMER 2021

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, validation and simulation 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 14th and July 10th 2021 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.