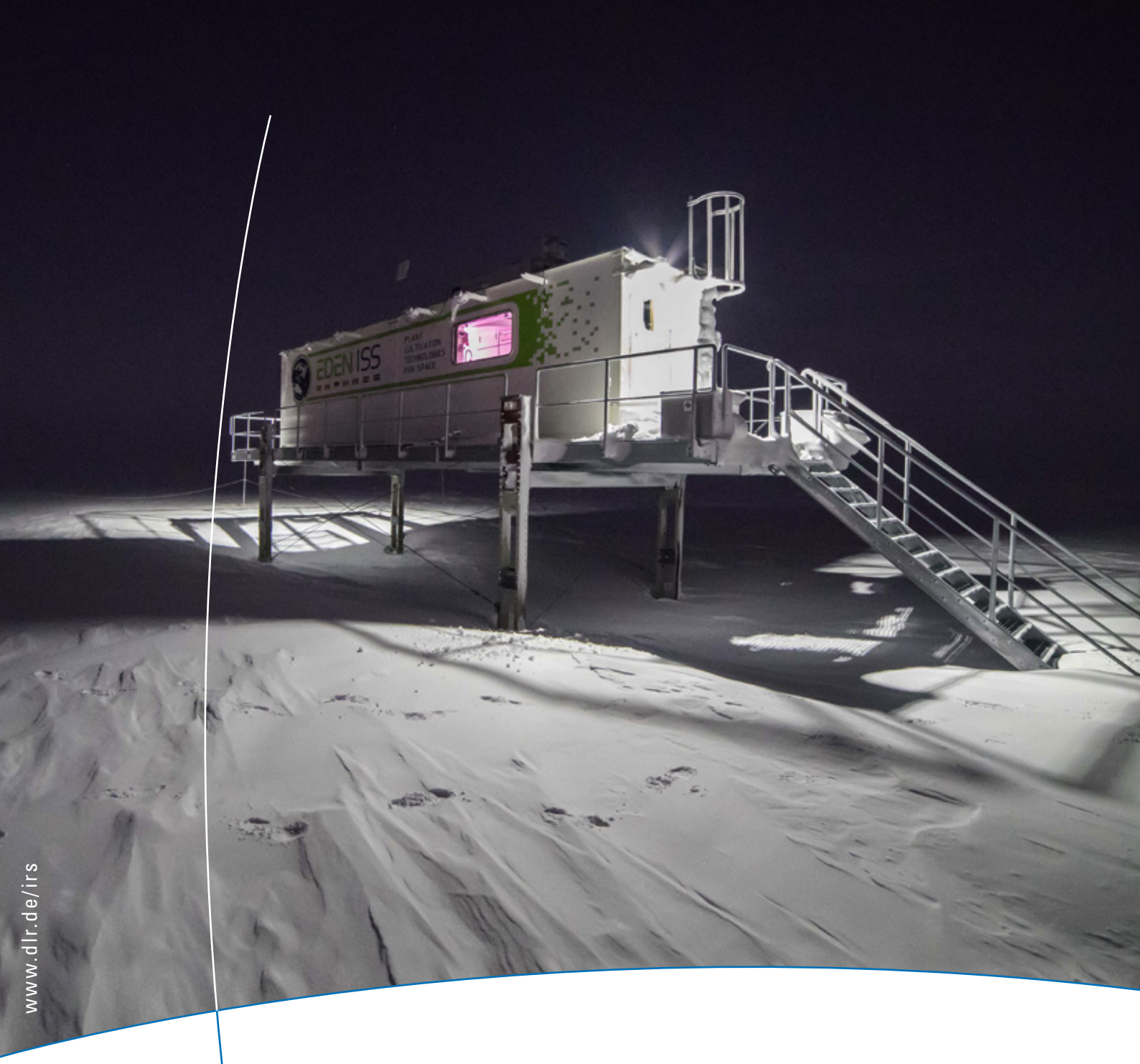

www.dlr.de/irs

HIGHLIGHTS 2018

YEARLY STATUS REPORT
EDEN INITIATIVE

DLR

EDEN ISS Mobile Test Facility containers being installed in the Antarctic

EDEN – THE YEAR 2018

With 60 days of deployment work, 257 days of isolation, more than 20 experiments, more than 15 system- and procedure tests – the EDEN ISS analogue mission clearly served as the main event during the year 2018. Starting with the sea ice offloading procedure of the Mobile Test Facility at the Atka bay of the Ekström ice shelf (Antarctica), the long-planned mission could finally start on January 3rd, 2018. Throughout the isolation phase, Paul Zabel produced over 275 kg of fresh food for the isolated Neumayer Station III crew and worked himself through a demanding and multifaceted science program. Useful data was generated and the lessons-learnt will further push the knowledge base on how to build and operate future greenhouse systems on Moon and Mars. As AWI and DLR agreed to further operate the Mobile Test Facility even after the H2020 project will come to an end, 2018 marks only the initial year of the group's analogue testing at the Neumayer Station III.

With the analogue mission running, 2018 marked an exceptional year for communicating the group's scientific and technological objectives to the public. This was done through the successful organization of press conferences, exhibits, TV documentaries, radio interviews, and countless articles in print- and online media. The dedicated exhibition 'Plants in Space' also took shape, as the EDEN group in collaboration with its partners (Bock Bioscience, Botanika) defined, built and tested the main exhibition elements. The exhibit will have its opening in June 2019 within the botanical garden of Bremen, displaying the latest research results of the EDEN group with respect to future food production on Moon/Mars and Earth. With respect to scientific dissemination, the EDEN group helped to organize the AGROSPACE 2018 workshop in Rome - this time as a joint event with the MELiSSA group of ESA. With over 200 conference participants, the conference clearly set a new record compared to past AGROSPACE workshops.

As already long-planned, at the end of the Antarctic deployment mission, Dr. Matthew Bamsey left the EDEN Group and moved back to his home country Canada. From here, he pursues his career in the space domain with the space exploration division of the Canadian Space Agency (CSA). Matt helped to essentially build up the EDEN group, including the EDEN laboratory, he supervised numerous students, and he was chief systems engineer for the EDEN ISS project. The whole EDEN team wishes him success for his future career path! I personally want to thank Matt for his great work and I am confident that our paths will cross again, as future collaborations between CSA and DLR are envisioned!

Dr. Daniel Schubert

Close-up view of a tomato plant growing in the EDEN ISS Mobile Test Facility (MTF)

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Close-up view of a tomato plant growing in the EDEN ISS Mobile Test Facility (MTF)

THE EDEN INITIATIVE

In 2011, the DLR Institute of Space Systems launched its research initiative called EDEN: Evolution & Design of Environmentally-closed Nutrition-Sources. The research initiative focuses on Bio-regenerative Life Support Systems (BLSS), especially greenhouse modules, and how these technologies can be integrated in future space habitats.
EDEN was established within the DLR internal project CROP (Combined Regenerative Organic-Food Production) – a joint research endeavor between the Institute of Aerospace Medicine (ME) and the Institute of Space Systems (RY).
It is the goal of the EDEN team to further advance the latest cultivation technologies and to adjust these developments into space related applications. Even though present scenarios for future human missions to Moon and Mars are still several years from coming to fruition, the time to develop these technologies needs to start today. Only this way, highly-reliable and resource-efficient BLSS will be ready for implementation into the mission architecture for humanity's journey to the Moon and Mars.
The EDEN Initiative is administered by the Department of System Analysis Space Segment (SARA) at DLR Bremen. The department operates the institutes Concurrent Engineering Facility (CEF) as well as the Space Habitation Plant Laboratory (EDEN Lab). Furthermore, the EDEN group receives support from the institute's Electronic Laboratory (E-Lab), and utilizes the institute's laboratory building (incl. integration hall) in order to foster the development of cutting-edge plant cultivation technologies.

DLR Institute of Space Systems, Bremen (Germany)

Matthew Bamsey making up hydroponic nutrient solution within the EDEN Lab analytical room

THE EDEN TEAM

DR. DANIEL SCHUBERT studied at the Technical University of Berlin and has an engineering diploma in industrial engineering with emphasis on aerospace and production techniques. In 2011, he initiated the EDEN group at the DLR Institute of Space Systems for technology investigations on Bio-regenerative Life Support Systems and is since then the team leader of this group. His research expertise is set on habitat interface analysis and plant accommodation and dynamic plant production planning.

CONRAD ZEIDLER has been a member of the EDEN research team since January 2011. Within his Industrial engineering diploma at the Technical University of Braunschweig he specialized on aerospace engineering and has profound knowledge trade-off analysis techniques (e.g. AHP). He is an expert in simulation methods and control software. Within EDEN, he is responsible for monitoring and controlling the plant growth and environment parameters.

DR. MATTHEW BAMSEY holds a M.Sc. in aerospace engineering (University of Colorado, USA) and conducted his Ph.D. in environmental biology with the University of Guelph (Canada). Matthew worked as a postdoctoral researcher at the University of Florida where he supported suborbital plant growth payload developments. He spent over ten years working as an intern at the Canadian Space Agency where he worked with the Arthur Clarke Mars Greenhouse project. Within EDEN, he conducts research related to nutrient delivery systems.

DR. PAUL ZABEL studied aerospace engineering at the Technical University of Dresden. He joined the EDEN team in 2012. Mr. Zabel is the deputy manager of the EDEN Lab and is working on acquiring funding and projects for EDEN. His research expertise is hybrid Life Support Systems containing greenhouse modules and physical/chemical LSS. Funded over NPI (ESA) he is doing his Ph.D. on the dynamic behavior of such hybrid systems.

MARKUS DORN is a horticulture expert and holds a M.Sc. in plant sciences (University of Natural Resources and Life Sciences, Vienna, Austria). He joined the team in 2017 as external consultant and advices the team in horticultural questions. He has evaluated different plant candidates and also developed cultivation methods for fruit trees for use within planetary habitats. He is mainly responsible for the organization of the EDEN plant lab.

VINCENT VRAKKING studied at the Technical University of Delft in the Netherlands and holds a M.Sc. in aerospace engineering. He has worked with the EDEN team on and off since 2012, before joining the team in 2015. Within the EDEN group he investigates the potential use of lightweight inflatable msaterials and structures that can house Bio-regenerative Life Support Systems and greenhouse systems in particular.

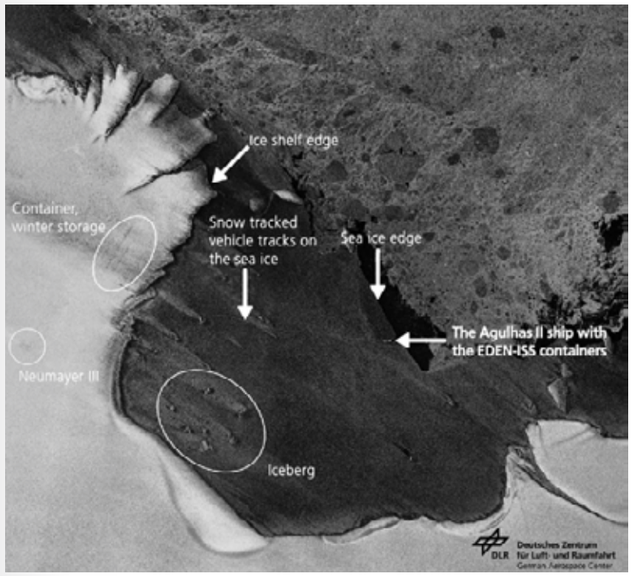
Penguins visiting the EDEN ISS Mobile Test Facility

PICK-UP & ON-PLATFORM INSTALLATION

DELAYED ARRIVAL – BUT STILL ENOUGH TIME!

Due to bad weather conditions, the offloading of the two EDEN ISS containers was shifted by two weeks. This gave the deployment team enough time to prepare for the upcoming events. Finally on January 3rd 2018, the South African research vessel Agulhas II rammed itself into the sea ice of the Atka bay near the Ekström ice shelf (Antarctica). From here, the Neumayer crew pulled the two greenhouse containers and the EDEN ISS storage container to the Neumayer Station III over a distance of 24 km. Already the next day, the construction team placed the two containers on the platform, 400 m south of the station, and implemented the interface between Service Section and Future Exploration Greenhouse (FEG). In the following days, the EDEN team installed all the external hardware, such as stairways, cable channels, thermal piping, safety lights, and the CO2 storage system.

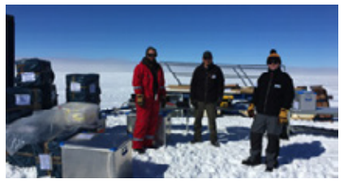
The EDEN ISS containers being installed on a raised platform near Neumayer III



Satellite image of the EDEN ISS containers arriving in the Antarctic

One of the EDEN ISS containers being transported via pistenbully

Paul Zabel working on the free cooler unit on top of the EDEN ISS MTF



The EDEN ISS deployment team organizing cargo in the Antarctic

The EDEN ISS deployment team installing the main entrance light

Conrad Zeidler preparing to transfer supplies to the EDEN ISS MTF via skido

Giorgio Boscheri and Paul Zabel working on an ISPR lighting panel

Matt Bamsey filling up the nutrient delivery tanks

Daniel Schubert labelling the Future Exploration Greenhouse

Giorgio Boscheri and Conrad Zeidler working in the EDEN ISS MTF

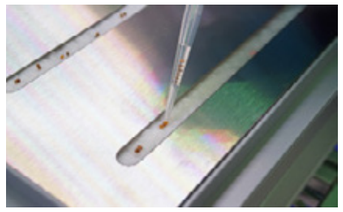
SUBSYSTEM BUILT-UP

CONNECTING, CHECKING, TESTING, REPAIRING, CLEANING....

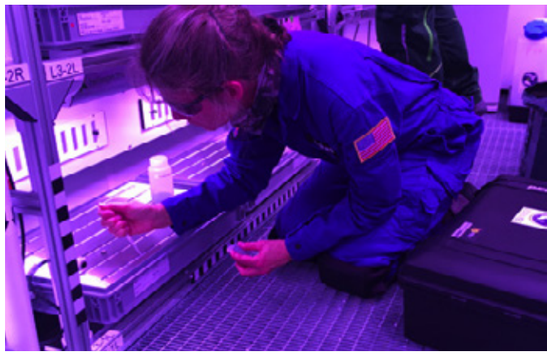
From Mid-January 2018 on, the EDEN ISS deployment team started with the internal subsystem integrations and check-out procedures. All power and sensor connections between the two containers had to be reconnected and tested. Further, the Thermal Control System (TCS) was filled with the necessary working fluid, in order to provide adequate thermal load transfer away from the LEDs and the water recovery unit. After this, the Nutrient Delivery System (NDS) was filled with deionized water, provided by the station. Necessary sensors were calibrated, and the Aeroponic pump system was tested. At the beginning of February, after installing the plant trays inside the Future Exploration Greenhouse, the deployment phase was officially finalized.

Daniel Schubert preparing the Thermal Control System cooling fluid

Matt Bamsey preparing nutrient stock solutions in the multi-purpose lab



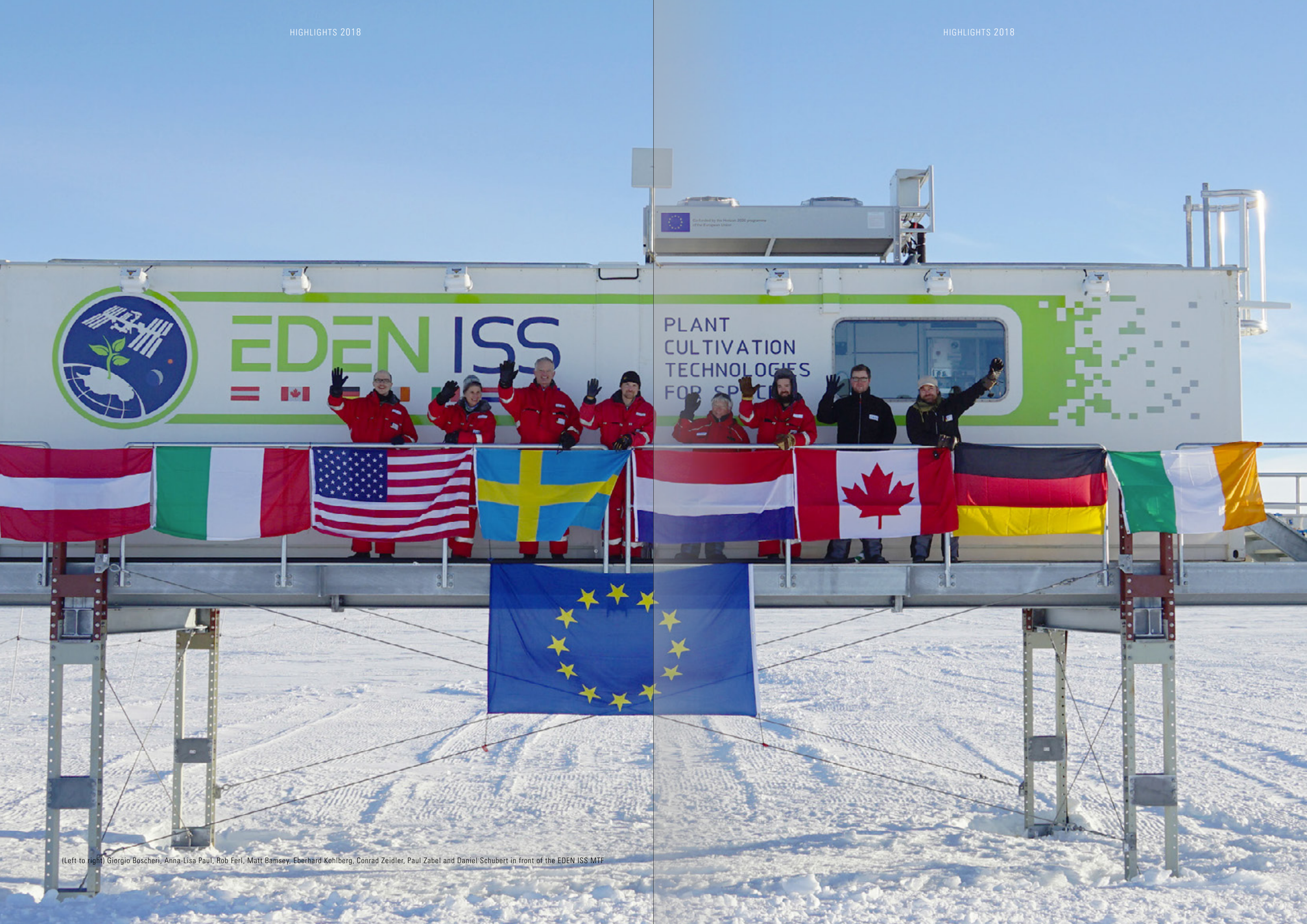
Initial rocket seeding on grow mats in the line cultivation trays



Anna-Lisa Paul seeding line cultivation trays in the Future Exploration Greenhouse

Giorgio Boscheri working on the ISPR cultivation system

HIGHLIGHTS 2018



(Left to right) Giorgio Boscheri, Anna-Lisa Paul, Rob Ferl, Matt Bamsey, Eberhard Kohlberg, Conrad Zeidler, Paul Zabel and Daniel Schubert in front of the EDEN ISS MTF

ISOLATION PHASE

-42°C OUTSIDE TEMPERATURE AND FULL MOON – A PERFECT AUGUST SUMMER AFTERNOON!

The nominal operation phase of the greenhouse started on February 7th with the sowing of tomato, pepper and cucumber plants. The isolation phase began mid of February 2018, after the last summer crew left the station, leaving only a winter crew of 10 people at the station. From that point, Paul had responsibility for handling the on-site operations, performing both the routine activities, such as seeding and harvesting, and off-nominal events, which inevitably occurred during such a mission. Nominal operation of the MTF continued throughout the polar night, which started end of May and ended in July. Outside temperatures dropped below -42 °C and the continuous darkness added to the extreme challenges Paul and the greenhouse system had to face. During the isolation phase, plants were sown and harvested every week. In total, more than 268 kilograms of edible fresh biomass were harvested until mid of November 2019, providing the crew with fresh supplement food every day.

Leafy greens harvested from the EDEN ISS MTF as part of the winter crew meals

Leafy greens harvested from the EDEN ISS MTF awaiting preparation in the Neumayer III kitchen

LED lamps lighting up the Future Exploration Greenhouse [credit: Hanno Müller]

Tomatoes growing in the EDEN ISS MTF

The Mobile Test Facility installed on a raised platform in the Antarctic

Paul Zabel harvesting lettuce during the first operations phase

Paul Zabel transplanting young plants into the cultivation trays

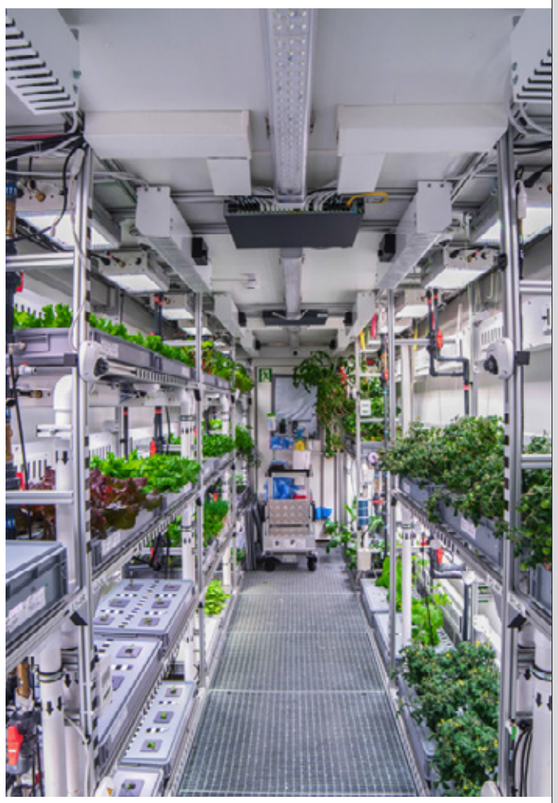
HIGHLIGHTS 2018

The Mobile Test Facility during the first operations phase in the Antarctic

SCIENCE PROGRAM

PERFORMING SCIENCE IN A UNIQUE ENVIRONMENT, ANALOGUE TO MOON AND MARS

Throughout the Antarctic operations phase, Paul took over 400 plant and microbiological samples. They serve as the basis for the upcoming food safety- and quality analysis as well as for the microbiological investigation. The samples were collected and stored throughout the year within a dedicated -40°C freezer. Mid-December, the freezer was then transported back to Europe and the samples have been distributed to the different partners in Germany, Italy, and Ireland. Further, Paul performed multiple handheld food quality- and safety experiments right after harvest within the station. Besides sample-taking and on-site tests, Paul and the Neumayer crew conducted several psychological questionnaires, moderated group discussions, and sensory panels in order to evaluate the psychological impact of fresh produce on the isolated crew. Throughout the isolation phase, Paul tested, in closed collaboration with the Mission Control Center in Bremen, different system performance checks as well as handling- and procedure tests.

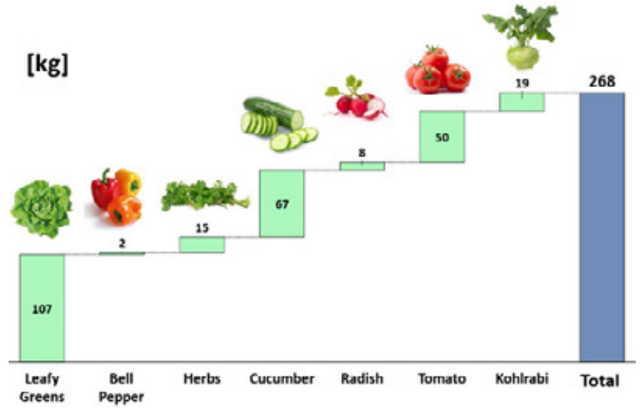


Plants growing in the Future Exploration Greenhouse

Taking microbial samples of leafy greens as part of the EDEN ISS sample return mission

Paul Zabel preparing nutrient stock solutions

The E-nose system being used to detect contamination of leafy greens



An overview of the amount of fresh edible biomass harvested during the first operations phase

Quick tests being used in the multi-purpose lab to check food safety

A freezer being prepared for shipment as part of the EDEN ISS sample return mission

HIGHLIGHTS 2018

Plant Health Monitoring images showing plant growth over time within the FEG

Plant Health Monitoring images showing plant growth over time within the FEG

AGROSPACE 2018

NOT SPERLONGA, BUT ROME!

With high motivation, the EDEN team assisted the AGROSPACE orga team. The workshop was held from the 16th to the 18th of May in Rome. The workshop was organized as a joint conference together with the MELiSSA group of ESA, combining the experts of both communities. With over 200 conference participants, the conference set a new record compared to past AGROSPACE workshops. The EDEN team displayed the Mobile Test Facility (MTF), and the latest research results of the Antarctic analogue mission. The EDEN students presented their research and development work during the poster session.

The EDEN ISS MTF mock-up on display at the Agrospace 2018 workshop

Agrospace 2018 attendants listening to one of the presentations

Layout off the EDEN Display incl. a dedicated AGROSPACE video tour with Paul Zabel inside the MTF

Daniel Schubert and Oliver Romberg at Agrospace 2018

Cover image of the Agrospace 2018 workshop's book of abstracts

GERF & PMARS

DESIGNING A MODULAR, SOLAR-POWERED CEA GREENHOUSE FOR DESERTS

Transforming space-based Controlled Environment Agriculture (CEA) Technologies towards terrestrial applications and markets is the main goal of the two international collaboration projects PMARS and GERF. The EDEN team together with its project partners from Morocco, Egypt, and Tunisia participated in a dedicated project workshop in Egypt from 7-10 of May 2018. In December 2018, the project partners gathered together in Bremen in order to establish the first design of a desert greenhouse prototype. Within the Concurrent Engineering Facility of the DLR Institute of Space Systems the project partners developed a modular-based greenhouse system, with a dedicated solar power energy system and a complete water recovery strategy implemented in the design.

Federal Ministry of Education and Research

DESERTEC UNIVERSITY NETWORK (DUN) e.V

جامعة ابن طفيل
UNIVERSITÉ IBN TOFAÏL

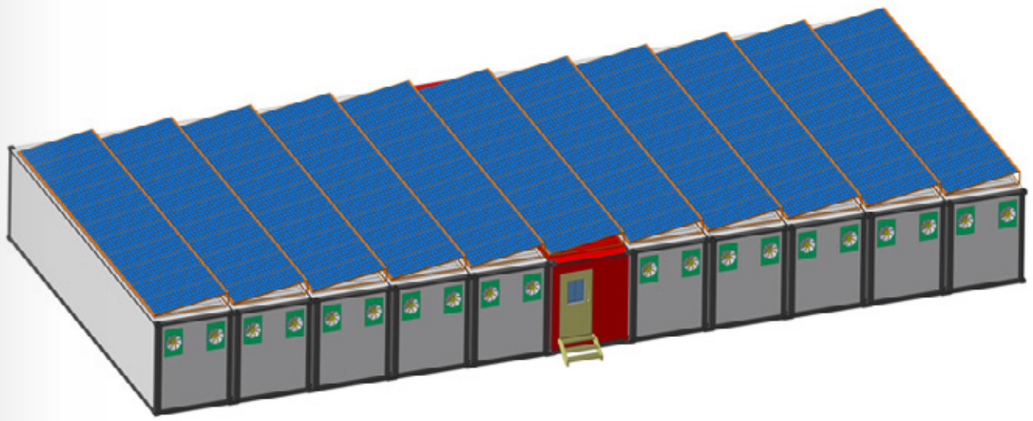
National Research Centre

Group photo of some of the participants of the GERF project workshop in Cairo, Egypt (Left to right) Vincent Vrakking, Prof. Dr. Sayed El Habbasha, Ghada Chibani, Prof. Dr. Ahmed Shaban, Prof. Dr. Tarek Jamil, Dr. Mouldi Miled, Daniel Schubert, Prof. Dr. Mostafa Boshta and Dr. Tarek Abdel Rahman

Project partners from Egypt and Morocco visiting the EDEN Laboratory

Group photo of the participants in the PMARS and GERF Concurrent Engineering study

Welcome to Cairo



Initial CAD model of a modular closed-loop arid greenhouse system developed during the PMARS and GERF design study

Daniel Schubert explaining the EDEN ISS system to young professionals at the DLR stand

The International Astronautical Congress (IAC) took place in Bremen in 2018

Vincent Vrakking explaining the EDEN ISS project to future female astronauts

Daniel Schubert and Vincent Vrakking presenting the EDEN ISS project to Dr. Hemmersbach and Prof. Jordan (DLR-ME)

INTERNATIONAL ASTRONAUTICAL CONGRESS

PRESENTING THE RESULTS OF EDEN ISS

Around 4500 delegates from 90 countries gathered at the Bremen Exhibition Centre between Monday, October 1st and Friday, October 5th, 2018 for the world's largest space congress: The International Astronautical Congress (IAC). Here, the EDEN team presented the latest research results within the scientific sessions and was part of DLR's exhibition pavilion with the EDEN ISS mock-up. Clear highlight was the Public Day, where over 13000 people visited the space exhibition. The EDEN team answered questions to interested members of the public, school classes and the press.

Model of a launcher outside of the main conference hall during the IAC 2018

The DLR booth took center stage at the IAC 2018 in Bremen, Germany

Conrad Zeidler presenting the EDEN ISS project at the IAC 2018 in Bremen

High level visit to the EDEN ISS Mission Control Center(Left to right) Prof. Dr. Eva Quante-Brandt, Prof. Dr. Hans-Jörg Dittus, Dr. Daniel Schubert, Prof. Dr. Antje Boetius, Prof. Dr. Joachim Block, Dr. Eberhard Kohlberg, Prof. Dr. Andreas Rittweger, Dr. Oliver Romberg, Dirk Mengedoht

OUTREACH

COMMUNICATING THE NEED FOR BIO-REGENERATIVE LIFE SUPPORT SYSTEMS

The year 2018 marked an extraordinary year for outreach and scientific dissemination. From organizing press conferences, to multiple interviews for radio and TV, to countless print- and online media articles, the EDEN ISS project received a huge amount of media attention worldwide. The display of the EDEN ISS mock-up also attracted immense attention at multiple occasions (Haus der Wissenschaft, GreenTech, Agrospace, ILA, and IAC). A unique outreach tool is the online EDEN ISS Monitor. It allows the public to stream daily pictures of the 34 cams that have been installed in the Antarctic greenhouse system, which should further improve the outreach to the general public.

Daniel Schubert giving an interview in the EDEN ISS Mission Control Center

A camera crew filming Daniel Schubert talking with Paul Zabel in the Antarctic

Screenshot of Daniel Schubert in one of many EDEN ISS-related videos

(Left to right) Falk Dambowsky, Prof. Dr. Andreas Rittweger, Dr. Eberhard Kohlberg and Dr. Daniel Schubert at a press conference for the EDEN ISS project

Daniel Schubert and Eberhard Kohlberg with the EDEN ISS MTF mock-up

Interview with Paul Zabel in the Antarctic via the Mission Control Center

Paul Zabel and Daniel Schubert holding the bag of 50k lettuce seeds for the EDEN ISS seed campaign

KEY FIGURES - 2018

JOURNALS

V. Vrakking, S. Jahnke, V. Maiwald, C. Philpot, D. Quantius, O.Romberg, *Orbital Hub: A concept for human spaceflight beyond ISS operations,* CEAS Space Journal, Vol. 10, Issue 3, pp. 355-379, 2018

BOOK CONTRIBUTIONS

P. Zabel: *„Designing a Closed Ecological Life Support System for Plants, Overview"* in Handbook of Life support Systems for Spacecraft and Extraterrestrial Habitats, Springer Verlag; doi:10.1007/978-3-319-09575-2_103-1;
Buch ISBN: 978-3-319-10458-4, Kapitel ISBN: 978-3-319-09575-2

PEER-REVIEWED CONFERENCE PROCEEDINGS

D. Schubert, M. Bamsey, P. Zabel, C. Zeidler, V. Vrakking, *„Status of the EDEN ISS Greenhouse after on-site installation in Antarctica"*, 48th International Conference on Environmental Systems, Albuquerque, New Mexico, USA, 8-12 July, 2018.

G. Boscheri, G. Marchitelli, M. Volponi, P. Zabel, *„Status of the EDEN ISS Rack-like food production unit after five months in Antarctica"*, 48th International Conference on Environmental Systems, Albuquerque, New Mexico, USA, 8-12 July, 2018.

CONFERENCE PROCEEDINGS

D. Schubert, C. Zeidler , M. Bamsey, V. Vrakking, P. Zabel, E. Kohlberg, G. Boscheri: *„The EDEN ISS Antactic Greenhouse Project - 9 Month Mission Status after Deployment in Anatctica"*, space life sciences symposium, International Astronautical Concress (IAC), Bremen (Germany), 2018

D. Schubert, C. Zeidler, M. Bamsey, V. Vrakking, P. Zabel: *„Ground-based Analogue Testing: Status of the EDEN ISS Greenhouse System after a Successful Deployment Phase in Antarctica"*, 1st joint AgroSpace-MELiSSA workshop, 16.-18. May 2018, Rome (Italy)

V. Vrakking: *„Plant cultivation in space"*, CEG Project Workshop, 8.-9. May 2018, Cairo (Egypt)

D. Schubert: *„EDEN ISS - Ground demonstration of plant cultivation technologies for space"*, CEG Project Workshop, 8.-9. May 2018, Cairo (Egypt)

INVITED TALKS

C. Zeidler: *„EDEN ISS - Project Overview"*, Skyberries Conference, Vienna, 01.03.2018

C. Zeidler: *„Future of Farming"*, Fachtagung der Deutschen Gesellschaft für Internationale Zusammenarbeit (GIZ) , Bad Neuenahr, 21.06.2018

P. Zabel, *„Bio-regenerative Life Support Systems for Human Space Exploration"*, invited talk in lecture Space Stations, Technical University Dresden, 05.06.2018.

P. Zabel, *„EDEN ISS – Advancing plant cultivation in space"*, invited talk in lecture Human Spaceflight, Technical University Munich, 16.10.2018

POSTERS

A. Pande: *„Design of a Microgravity Aeroponics Root Chamber"*, 1st joint AgroSpace-MELiSSA workshop, 16.-18. May 2018, Rome (Italy)

M. Rosello Petit, D. Schubert, A. Pande, M. Dorn: *„The Botanika Project"*, 1st joint AgroSpace-MELiSSA workshop, 16.-18. May 2018, Rome (Italy)

DIPLOM-/ MSC.-/ BSC.-THESIS

Victor Garcia Tapia: *„Hybrid Renewable Energy System for Controlled Environment Agriculture"*, Master Thesis, KTH, School of Industrial Engineering and Management (ITM), Energy Technology, 2018

Mohammed Monis Khaleel: *„Development of an atmosphere management system for greenhouses in arid regions"*, Master Thesis, Technische Universität Berlin, Department of Energy Engineering, 2018

PHD THESIS

D. Schubert: *„System Analysis of Plant Production in Greenhouse Modules as an Integrated Part of Planetary Habitats"*, PHD-thesis; University of Bremen, FB 4: Produktionsmanagment, 2018.

MISCELLANEOUS

D. Schubert, session chairman function, Session: Ground demonstration and analogue testing, *1st joint AgroSpace-MELiSSA workshop*, 16.-18. May 2018, Rome (Italy)

D.Schubert: BUILDING BEYOND, Panel discussion, *International Astronautical Concress (IAC)*, Bremen (Germany), 30.9.2018

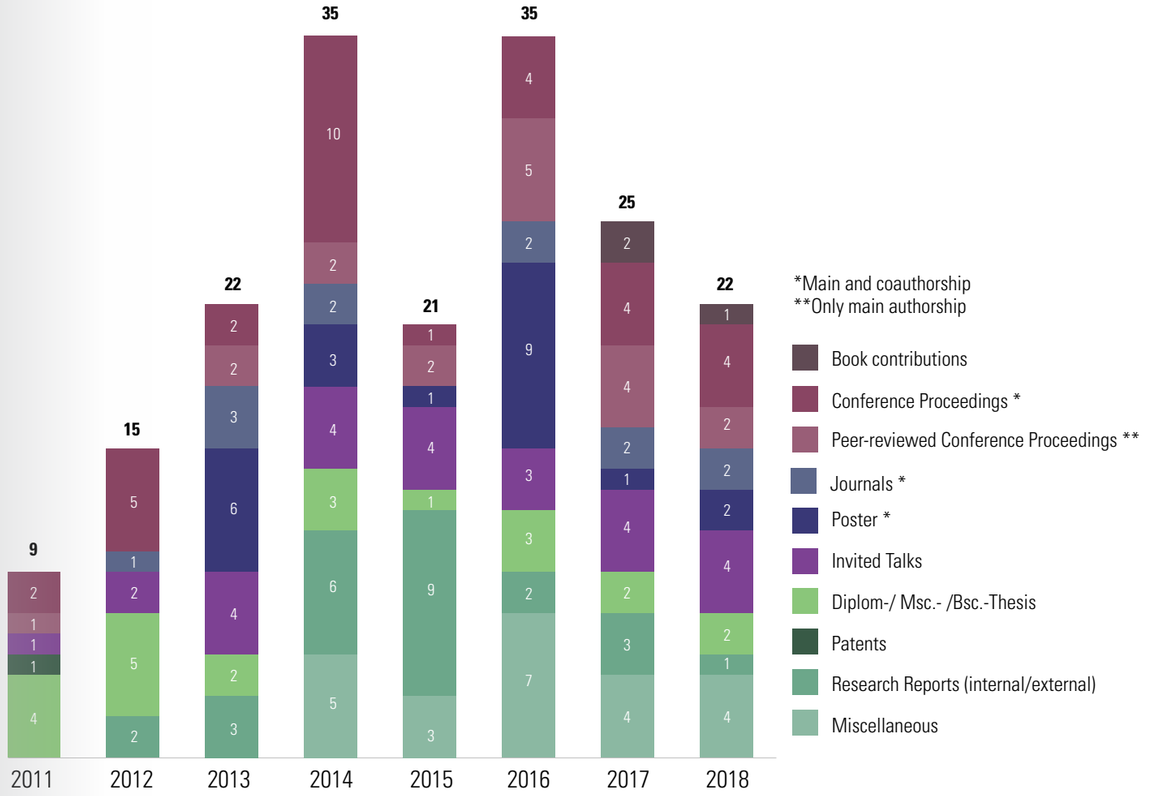
D. Schubert, session chairman function, *CEG Project Workshop*, 8.-9. May 2018, Cairo (Egypt)

EDEN ISS press conference - 13. September 2018;

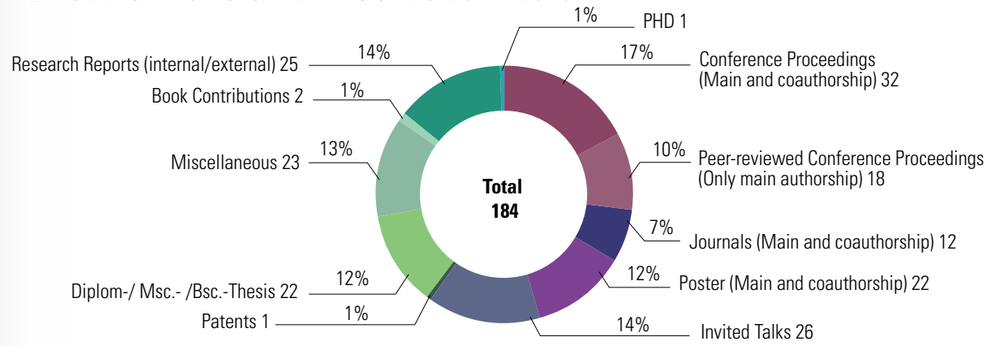
M.T. Bamsey: *Membership on the AIAA Life Sciences and Systems Technical Committee.*

SUMMARY KEY FIGURES (2011-2020)

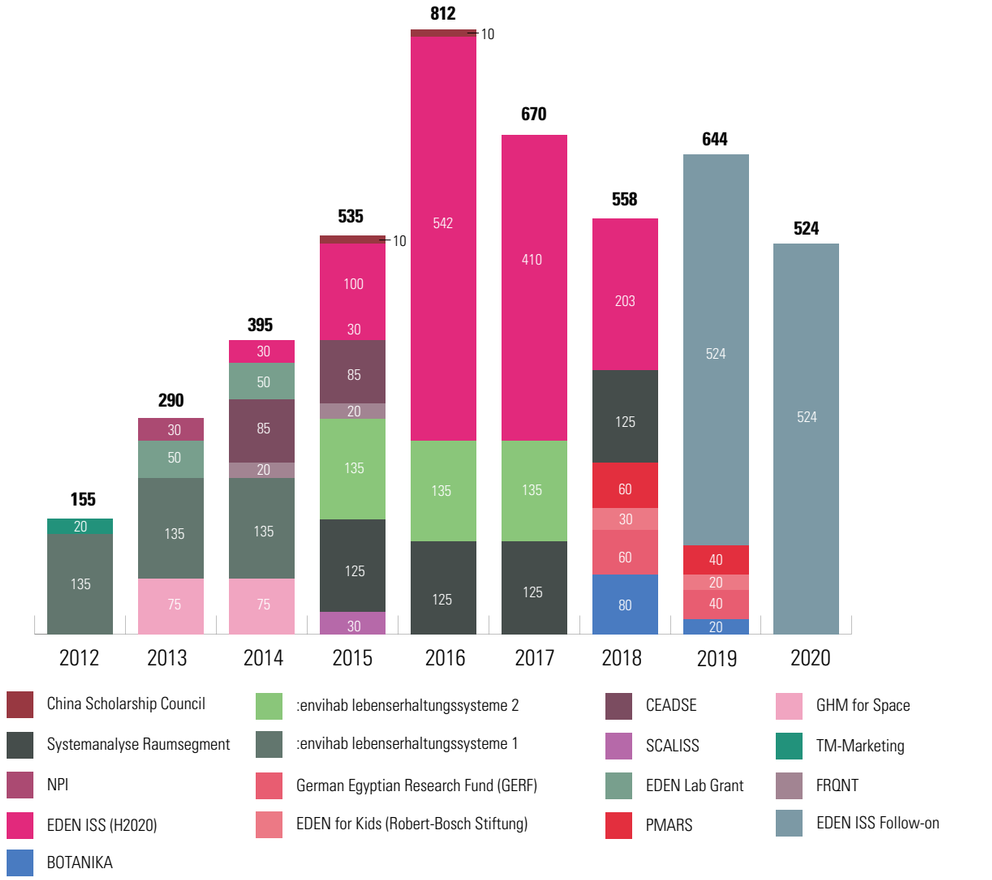
PUBLICATIONS & KEY FIGURES 2011-2018



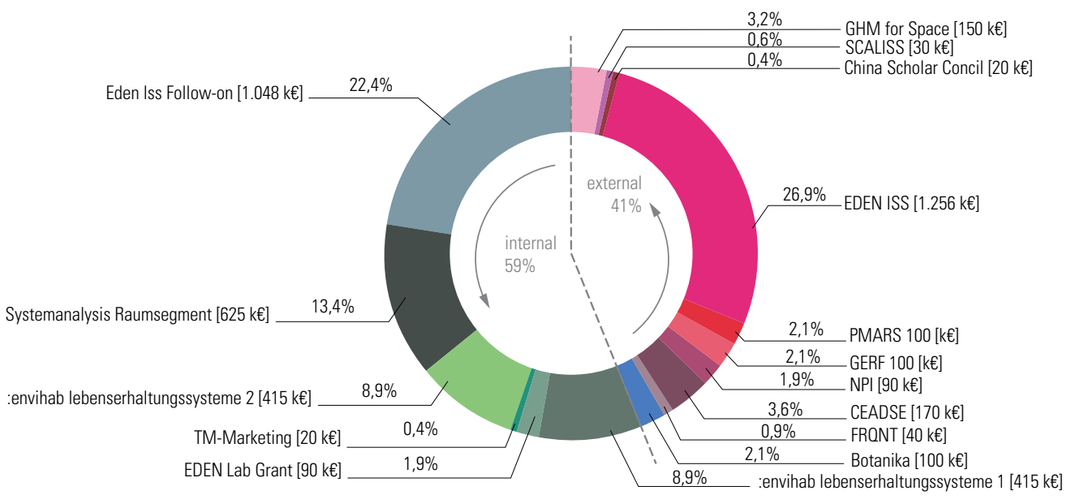
TOTAL PUBLICATIONS & KEY FIGURES 2011–2018



BUDGETS OVERVIEW & FORECAST 2012-2020 [in k€]



TOTAL BUDGETS DISTRIBUTION 2012-2020 [in k€]



Note: Pink represent third-party money (total 56%); Green pies represent DLR internal budgets (total 44%); Budgets of proposals are not included in this chart.

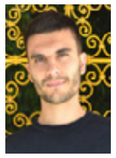
THE EDEN STUDENTS

Without the assistance and help of highly-motivated students, the success of the EDEN Initiative would not have been possible! Therefore the entire EDEN team would like to say thank you. See below what the student's tasks were and what they are doing now:

Maria Rosello Petit is an Electrical Engineering student from the University of Bath. During her year-long internship, Maria was involved in the shipment of the MTF to Antarctica, Mission Control operations and the Botanika project. Next year, Maria will start her Master degree program in Computer Science at University College London.

Stella Unruh holds a B.Sc. in biotechnology and joined the EDEN Team from April till September 2018 for her bachelor thesis. Within her work at DLR she worked on the analysis of different soilless substrates for use in the MEPA system. Currently, she continues her studies at TU Berlin in Environmental Science and Technology M.Sc.

Mohammed Monis Khaleel has a B.Sc. in Mechanical Engineering and is doing a master degree in Energy Engineering at the TU Berlin. From April to December 2018, he worked on his Master thesis titled 'Development of an Atmosphere Management System for Greenhouses in Arid Regions' in which he focused on the potential application of Phase Change Materials to reduce the cooling and heating loads of atmosphere management systems for closed-loop greenhouses. In April 2019 he will begin work as an Energy Modeling Engineer for HVAC designs at the Bangkok office of Oairo.



Victor Garcia Tapia is an Energy Data Officer at the International Energy Agency (IEA). He holds a Bachelor degree in industrial engineering from the UPC of Barcelona and a double MSc degree in Energy engineering and innovation from the UPC of Barcelona and the KTH Royal Institute of Technology in Stockholm. During his time at the DLR, from February to May 2018, he completed his Master thesis within the framework of the German-Moroccan bi-lateral cooperation project. His topic was focused on hybrid renewable energy systems for controlled environmental agriculture in arid regions; including a techno-economic and sustainability analysis for a system in Morocco.

Aditya Amonker is a Mechanical Engineering bachelor student at the University of Bath, UK. During his six-month internship with EDEN, he helped integrate many components in the Future Exploration Greenhouse including elements of the Nutrient Delivery System, and also supported the EDEN team with packaging and EDEN ISS shipment preparation. He has since then returned to university to finish his Bachelor degree.

Aditya Pande is an Aerospace Engineering bachelor student at the University of Bath, UK. He also has a bachelor degree in Natural Sciences Biology. During his year with the EDEN ISS team he was involved in the final stages of the AIT for the MTF, participating in the final harvesting, transport preparations and assisting in the set-up and initial check out of the Mission Control Center in Bremen. Furthermore, he was involved with the construction of the display model for the Botanika exhibit, rebuilding efforts in the EDEN Lab and plant growth tests during the year.

IMPRESSIONS 2018

THE YEAR THE JOURNEY BEGAN

Initial set-up of the EDEN ISS MTF on a raised platform in the Antarctic

Daniel Schubert working in the Future Exploration Greenhouse during the Antarctic deployment phase

The Antarctic landscape

The EDEN ISS Mobile Test Facility with the Neumayer Station III in the background

Snow and ice build-up around the EDEN ISS MTF

The EDEN ISS Mobile Test Facility during the dark Antarctic winter

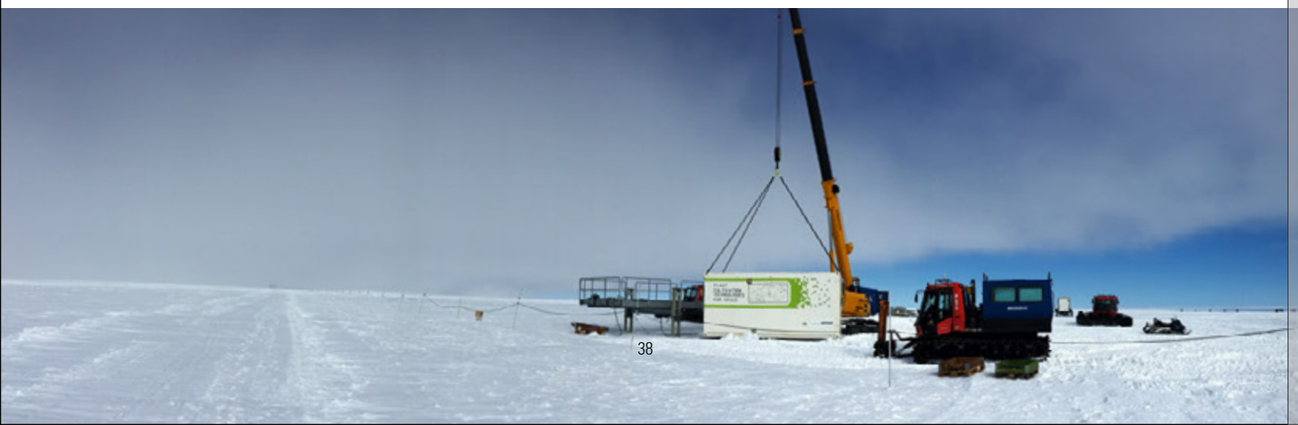
Giorgio Boscheri posing with the ISPR cultivation system

The deployment team preparing to depart from the Neumayer Station III

The S.A. Agulas I delivering the MTF system

The Service Section container being lifted onto the elevated platform, a short distance South of the Neumayer Station III

The elevated platform, awaiting arrival of the EDEN ISS containers

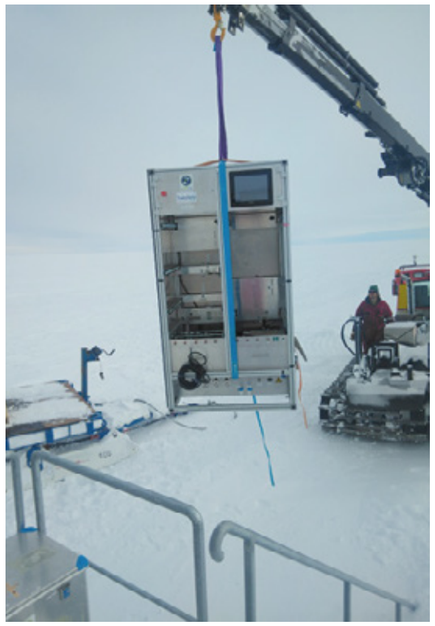


Paul Zabel – A long way from home

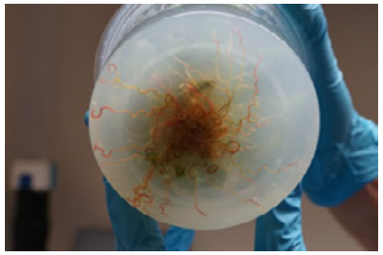
A flower blooming in the EDEN ISS Mobile Test Facility

A penguin inspecting the arrival of the S.A. Agulhas II

A food storage room in the Neumayer Station III



The ISPR cultivation system being lifted out of the MTF for transport back to Europe



Strawberry root growth inside an agar substrate

Arrival of the EDEN ISS plant samples at the CNR (Italy) after the long journey from Antarctica!

A collection of seeds for use in the EDEN ISS Mobile Test Facility

A top view camera image of plants growing in the EDEN ISS MTF

After many years with the EDEN Group, Matt went back to Canada. He now works for the Canadian Space Agency (CSA).

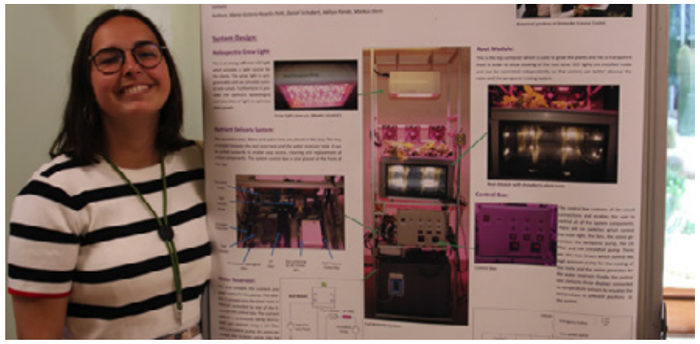
Matt Bamsey during his farewell party

Matt after building his fare well present – a Saturn 5 rocket out of LEGO!

(Left to right) Vincent Vrakking, Conrad Zeidler, Maria Rosello Petit, Aditya Pande, Daniel Schubert and Oliver Romberg at the Agrospace 2018 workshop

Aditya Pande presenting a poster at the Agrospace 2018 workshop

Oliver Romberg listening to an EDEN ISS video at the Agrospace 2018 workshop



Maria Rosello Petit presenting a poster on the Botanika project at the Agrospace 2018 workshop

German Night at the Park Hotel in Bremen during the IAC 2018

Prof. Dr. Andreas Rittweger attending the German Night during IAC 2018

Time to unwind with the German Night after a long conference day

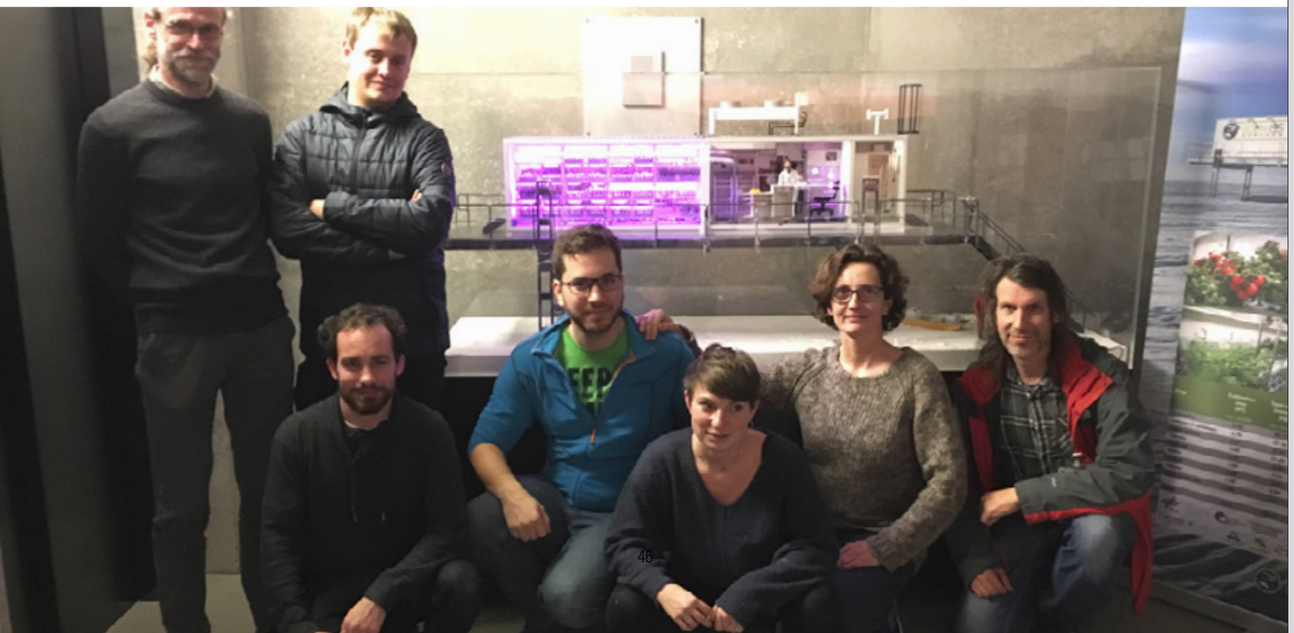
DLR employees and other invited guests attending the German Night during IAC 2018

Bottle crops installed as part of the Botanika exhibit

Doing a test-fitting with the Botanika plant cultivation

Daniel Schubert and Prof. Dr. Eva Quante-Brandt with the EDEN ISS MTF mock-up during an exhibit at the Haus der Wissenschaft in Bremen

Part of the 2019 Neumayer Station III winter crew with the EDEN ISS MTF mock-up



EDEN Group BBQ

Dr. Daniel Schubert with his doctor hat, after his successful PhD defense

Daniel Schubert visiting the pyramids during the GERF project workshop

Vincent Vrakking enjoying dinner on a Nile cruise boat during the GERF project workshop

DLR at a glance

DLR is the national aeronautics and space research centre of the Federal Republic of Germany. Its extensive research and development work in aeronautics, space, energy, transport and security is integrated into national and international cooperative ventures. In addition to its own research, as Germany's space agency, DLR has been given responsibility by the federal government for the planning and implementation of the German space programme. DLR is also the umbrella organisation for the nation's largest project management agency.

DLR has approximately 8000 employees at 20 locations in Germany: Cologne (headquarters), Augsburg, Berlin, Bonn, Braunschweig, Bremen, Bremerhaven, Dresden, Goettingen, Hamburg, Jena, Juelich, Lampoldshausen, Neustrelitz, Oberpfaffenhofen, Oldenburg, Stade, Stuttgart,Trauen, and Weilheim. DLR also has offices in Brussels, Paris, Tokyo and Washington D.C.

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German Aerospace Center

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