

Highlights  
2019

INNO  
space

MASTERS

# Space Moves! New ideas for the next space generation

The competition is embedded in DLR Space Administration's  
INNOspace® initiative.

Host



Federal Ministry  
for Economic Affairs  
and Energy

INNO  
space

Partners

AIRBUS

OHB

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Space of Innovation



## INTRO

The aerospace sector plays a significant role in social and technological progress in many areas of not only the economy, but life in general. Many solutions developed for the aerospace industry have the potential for adaptation to other, seemingly unrelated fields. This presents major opportunities for companies in a wide variety of industries to create innovative products and technologies. At the same time, however, there are many possible ways for those in the aerospace sector to benefit from the expertise of these other industries, as well. Under the theme “Space Moves!”, the 2018/19 INNOspace Masters competition put out the call for solutions and concepts like these. The aim was to identify innovative approaches to solve current problems in the aerospace industry and the challenges other industries are facing through mutual transfers of knowledge and technology.

This was the fourth time that the German Aerospace Center (DLR) conducted the INNOspace Masters, and the competition once again attracted a great many high-quality ideas that further illustrate its relevance and capacity for innovation.



Dr Walther Pelzer  
Member of the DLR Executive Board  
German Aerospace Center (DLR), Space Administration

We saw a number of forward-thinking approaches to research and development this year, particularly in software technology and intelligent materials. On the whole, the broad array of topics covered underscores the tremendous potential of cross-industry transfer projects.

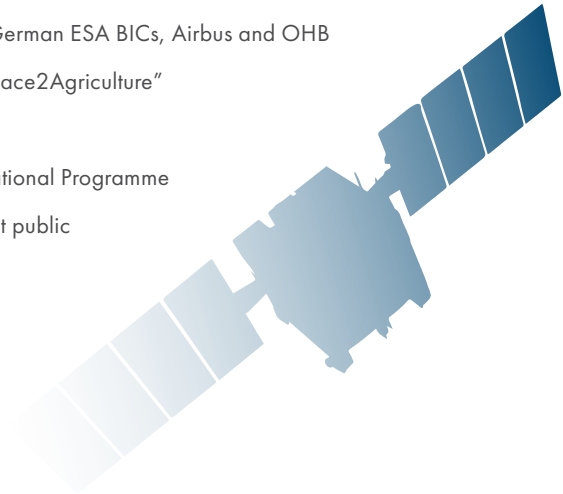
I'd like to extend my heartfelt congratulations to this year's INNOspace Masters finalists – I look forward to following the ongoing development of the winner's ideas along with the competition's partners! I also wish to thank Airbus, OHB, and the ESA Business Incubation Centres (BICs) of Bavaria and Hesse & Baden-Wuerttemberg for helping us running the the competition. Finally, my thanks go out to AZO Anwendungszentrum GmbH Oberpfaffenhofen for their excellent work in organising the INNOspace Masters 2018/19.



Space is an important driver of innovation for Germany and a key to open new markets. In order to use and exploit the innovation potential and cross-industry technology synergies more goal-oriented and efficiently, the Space Administration of the German Aerospace Center (DLR) has launched the INNOspace® initiative in 2013.

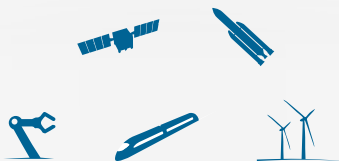
INNOspace® is an initiative in the framework of the Federal Ministry for Economic Affairs and Energy (BMWi)s “National Programme for Space and Innovation” and part of the German government’s new high-tech strategy 2025. In close coordination with the BMWi as well as with various federal states, INNOspace® comprises the following instruments:

- › Interdisciplinary conferences to initiate cooperation projects
- › Ideas competition INNOspace Masters in cooperation with the German ESA BICs, Airbus and OHB
- › Technology and cooperation networks “Space2Motion” and “Space2Agriculture”
- › Expert and user workshops on “new markets”
- › Promoting innovation and transfer projects with funds from the National Programme
- › The mobile Exhibition INNOspaceEXPO “ALL.täglich!” for efficient public presentation of space applications in everyday life
- › Further information on [www.dlr-innospace.de](http://www.dlr-innospace.de)





spin-in



spin-off



DLR  
Space Administration



AIRBUS



Business Models  
for User Needs

**Pre-competition phase**  
Research, development, demonstrators

**Target group:**  
Companies (especially SMEs),  
universities, and non-university  
research institutions

**Initial phase**  
Proof of market, near-to-market prototypes

**Target group:**  
SMEs, startups, research teams,  
students

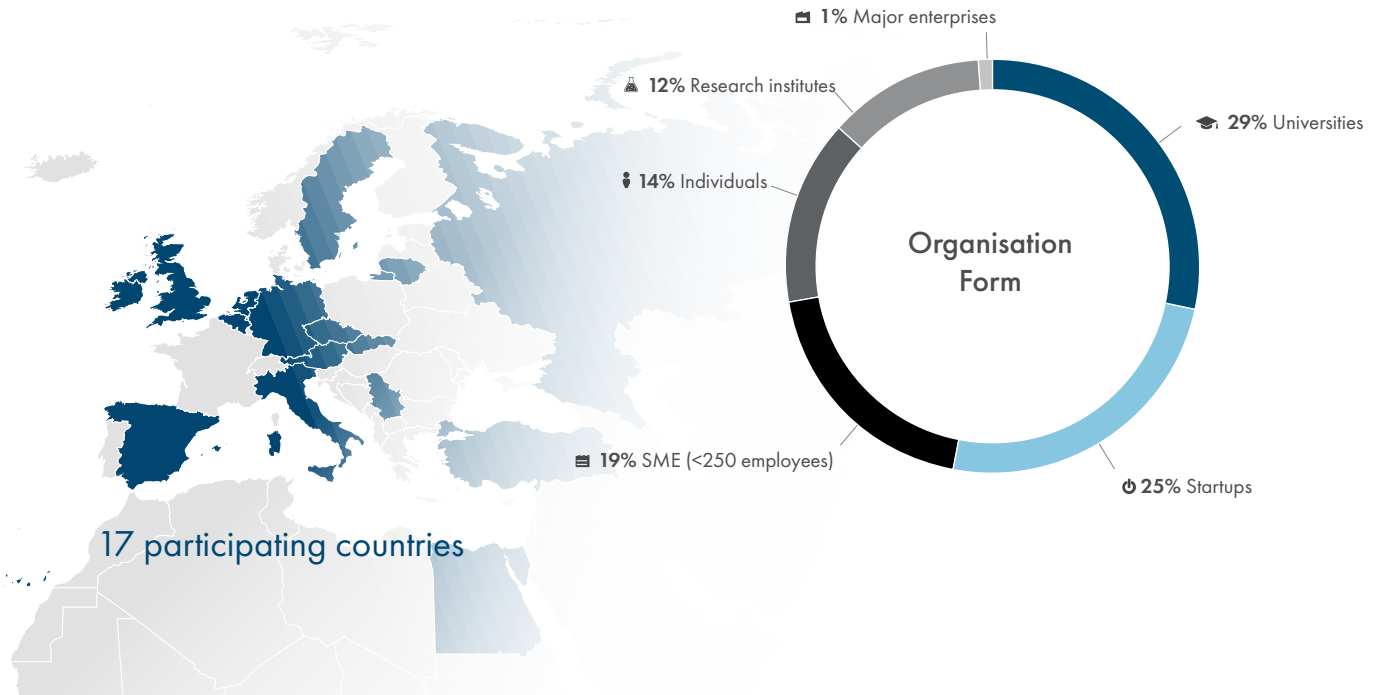
**Innovation and integration phase**  
Technologies, systems, services & solutions

**Target group:**  
Science and industry,  
startups and individualists

Utilisation &  
Application Phase

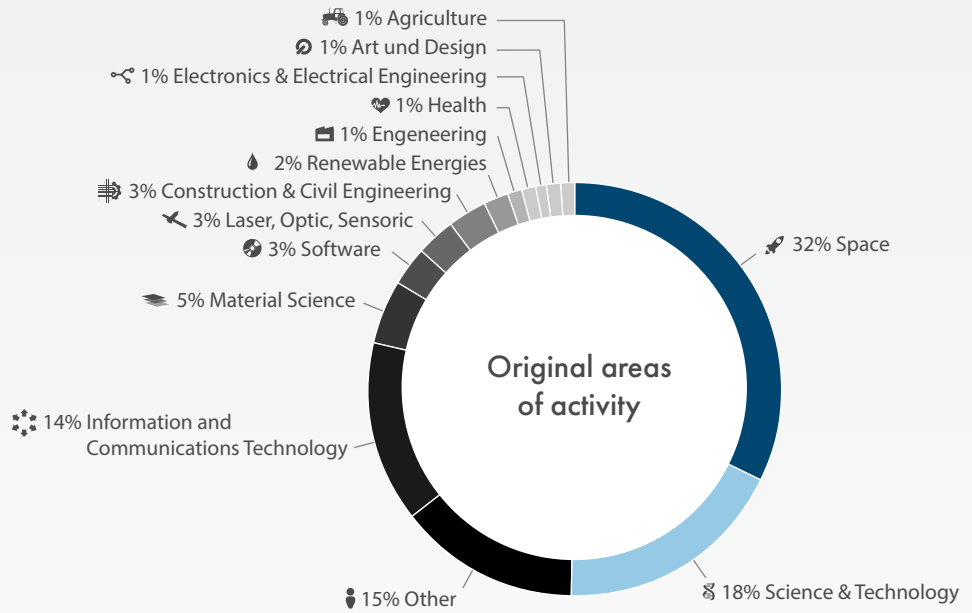
## STATISTICS

The INNOspace Masters 2018/19 addressed companies, startups, universities and non-university research institutions worldwide. Overall, 253 participants from 17 different countries submitted 98 ideas. The ideas competition was looking for future-oriented ideas and solutions that can be transferred with know-how and technology transfer from non-space sectors into space ("spin-in") and vice versa ("spin-off").



## STATISTICS

The fourth INNOspace Masters tackled current user challenges with the objective of finding innovative concepts and solutions related to the space industry. The finalists developed specific research methods, innovative business models and new technology and communication solutions for aerospace systems.



# „Space Moves!“ Challenge by the DLR Space Administration

The space industry and the mobility sector are currently in transition. Increasing digitisation, complex and networked production processes, heavier automation and autonomous systems, and new global players and their business ideas are seriously challenging established manufacturers.

## CHALLENGE

This challenge was looking for innovative ideas and concepts for technologies, processes, and applications with transfer potential into space and vice versa in the following categories:

- › Materials, Components & Production
- › Sensor Technology & Miniaturisation
  - › Communication & Networks
- › Propulsion Technology, E-Mobility & Energy Storage
  - › Simulation & Testing



**DLR**

Space Administration

## PRIZE

- › Verifiable applications involving individual or joint proposals are eligible for funding from Germany's national space and innovation programme
- › Up to 400,000 Euro in possible funding for each project. This funding is subject to the general funding guidelines of the German federal government



## SmartSpace – A Module for Global IoT Cloud Service Operations

Existing cellular network infrastructure is not sufficient for the widespread use of Internet of Things (IoT) applications outside metropolitan areas. A functional data connection forms part of the core of any IoT application. Currently, transmitting data to IoT devices via satellites is uneconomical and complex because the devices are designed with a small form factor (i.e. small antennas), which facilitates low-power consumption and minimal data throughput. The SmartSpace concept provides for dedicated communication modules on the ground and in the space segment to enable data collection and transmission. Within this concept, SmartSpace modules serve as a data collector for multiple IoT devices and their applications and relay the collected data via a superior satellite backbone network. It is no longer necessary to operate a dedicated ground station, the intermediate SmartSpace network acts as a connecting link. This will facilitate the use of SmartSpace in remote areas and large infrastructures.

### Benefits:

- › Enable terrestrial and space-borne IoT applications
- › Cloud-based monitoring and control for satellites
- › Big data analytics for small satellite missions and turnkey CubeSat operations
- › Terrestrial SmartSpace network to grow incrementally via new module launches



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## STMF – Satellite Thermal Management with Ferrofluids

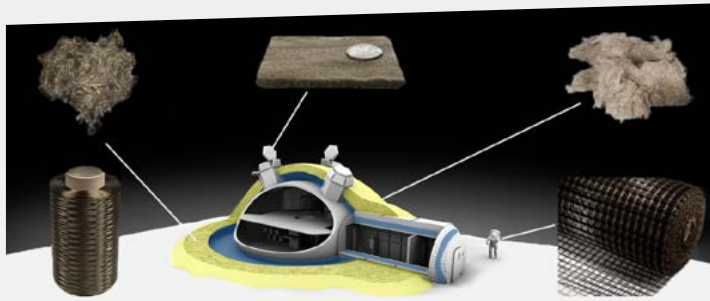
The thermal control system (TCS) is a critical component of satellites, one that is supposed to regulate the temperature of payloads and satellite buses under varying internal and external heat loads. Conventional TCSes use cooling fluids and mechanical pumps whose vibrations disturb payloads and sensors onboard a satellite. ZARM proposes a TCS technology based on ferrofluid cooling liquid that is pumped by magnetic fields to avoid mechanical vibrations. This TCS consists of pumping modules that are constructed from a minimum of four magnetic coils to transfer the ferrofluid. To avoid magnetic disturbances in other parts of the satellite, a  $\mu$ -metal shield is placed around the pump. Since ferrofluids take on different magnetic properties when cooled or heated, permanent magnets can be employed to define prominent places where heat is absorbed. The focus lies on a scalable and modular design that can be included in a broad range of satellite missions. In particular, such missions will likely involve concepts with strongly varying thermal boundary conditions and high-precision measurements, such as for geodesy, Earth observation, or fundamental physics applications.

### Benefits:

- › Decreased vibrations within the thermal control system
- › Improved noise environment
- › Scalable, flexible, modular design that can be adapted to a broad range of thermal boundary conditions



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## MoonFibre – Spinning Technology Fibres from Lunar Rock for Direct Use on Earth’s Satellite

Private and public institutions all over the world pursue one common mission: a manned station on the moon. The costs of rocket flights alone to transport such a station to the moon would be approximately EUR 1,000,000 per kilogramme. This is why numerous research teams around the world are working on solutions to use moon rock to manufacture 3D-printed structural components on-site. The MoonFibre project at RWTH Aachen University is developing a spinning system that will be able to produce fibres directly from lunar rocks. These fibres could be used not only to stabilise the 3D-printed structure of the lunar station, but also for thermal isolation, filter systems, or the textiles of astronaut suits. RWTH Aachen intends to further develop a spinning process already used in industry for basalt fibres as a compact and easily transportable system for use on the lunar surface. The spinning process is to be tested under zero gravity within an in-orbit demonstration experiment. The proof-of-concept will serve as the basis for the future on-site production of fibres and textiles on the moon.

### Benefits:

- › Permanent settlements on the moon and technology transfer into space
- › Cost-effective on-site production of fibres and textiles on the lunar surface
- › Development of a robust, automated, and miniaturised spinning technology



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## ESA BIC Start-up Challenge

Space creates innovations that are used in many industries and in everyday life – the universe is the marketplace of the future. The ESA

BICs (Bavaria and Hessen & Baden-Württemberg) have already supported more than 250 start-ups, thereby fostering technology transfer

from space to a wide variety of commercial applications.



**business  
incubation  
centre**

### CHALLENGE

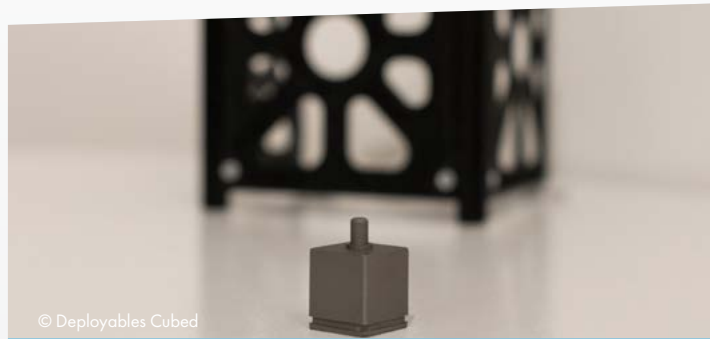
The ESA BIC Start-up Challenge by the INNOspace Masters was looking for new technology transfer ideas and business models from Earth into space and vice versa, for example:

- › Mobility applications/solutions
- › Innovative optimisation solutions
- › Increased efficiency and customer orientation solutions
  - › Components or subsystems
- › Or any other ideas in the space sector

### PRIZE

The winning proposal receives a support package tailored to the requirements of its realisation:

- › Assistance in transforming the business concept into a viable business plan
- › Support of the application in one of Germany's ESA BIC facilities. If accepted, the startup will benefit from EUR 50,000 in funding
- › Access to the Europe-wide network of experts, which can assist in both, technological and business-related aspects



© Deployables Cubed



## Deployables Cubed – Actuator for Nanosatellite Applications

The aerospace sector is trending towards small, standardised satellites (CubeSats) that offer affordable access to space. Their standard edge length of 10 cm does present a disadvantage, however, as it significantly limits the missions these satellites can support. To get around these limitations, deployable structures like antennas or sails are being used, that are deployed once a satellite is in orbit. This opens the door to high-performance applications that are typically only possible with large satellites. Initiating this deployment requires special actuators such as hold-down and release mechanisms. Unfortunately, European actuators are too large for this purpose, and American products are subject to export restrictions. To solve this problem Deployables Cubed – a new space company at ESA BIC Bavaria – is developing pin-puller and release nut actuators to ensure Europe's independence with regard to these small actuators and the deployable structures that they make possible. The company plans to establish for simple, light, and reliable aerospace actuators on the market and offer them to a broad range of customers.

### Benefits:

- › Nanosize actuator (optimised for cubesat applications)
- › Fraction of the cost of existing actuators
- › Not subject to export regulations



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## Space Surveillance and Tracking (SST) as a Service for New Space

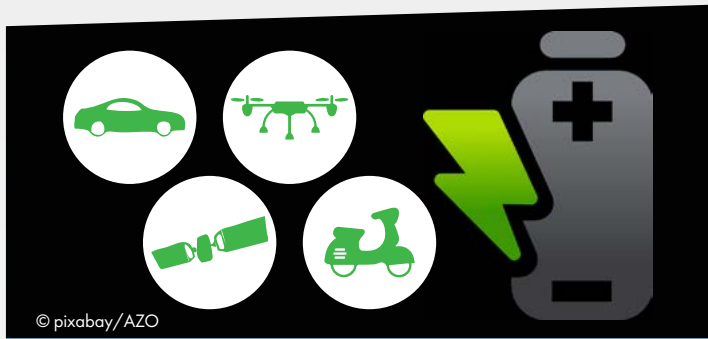
Due to the increasing amount of activities in space, the number of objects is becoming dangerously high and presenting a potential hazard to all satellites – especially in low Earth orbit. Since existing solutions are neither customer-friendly nor usable for the broader masses, new space market players are being forced to accept the risks of loss or damage. OKAPI:Orbits has developed a software-as-a-service (SaaS) solution that is dedicated to making satellite missions more sustainable and cost-efficient by offering customers space surveillance and tracking (SST) solutions as a service. It is a modular, customisable, and scalable software provided via a web interface and APIs. Due to the fact that this software is based on a data stream management system (DSMS), it offers several advantages. It can be used to operate all the relevant aspects of SST and supports integration into existing solutions.

Benefits:

- › Reduced risk of loss or damage to satellite constellations and lower mission costs overall
- › Very short access times through DSMS
- › Processes large amounts of data that define customer procedures that need to be followed
- › Efficient, sustainable utilisation of space



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## AC Biode – The World’s First Standalone AC Battery

The demand for high-capacity batteries in the space industry has significantly increased and battery capacity is still insufficient in terms of mobility and safety. AC Biode Ltd. is developing the first-ever standalone battery based on alternating current (AC). Biode features the characteristics of both anodes and cathodes. Thanks to a special electric circuit also found in particle accelerators, the system offers more V/Ah flexibility, requires 30% less space, and is safer than every type of regular direct-current (DC) battery. Conventional batteries use DC, which leads to power loss when electricity is converted from AC to DC. AC Biode Ltd. will utilise existing materials and battery production lines to penetrate the market faster than competitors that use new materials or types. Applications are possible in space and in connection with drones, electric vehicles and scooters, and energy storage.

### Benefits:

- › Battery is up to 30% more compact and reduces conversion losses
- › Uses existing materials/battery production lines
- › Safer than conventional Li-ion batteries
- › Lower electrical resistance (safer/longer-lasting)



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## Airbus Challenge

Exceptional applications that – using aerospace – are capable of having a lasting positive influence on our daily lives.

### CHALLENGE

Airbus was looking for exceptional ideas (technical solutions, products, services & business models) that – using aerospace (satellites, ISS, HAPS) – are capable of having a lasting positive influence on our daily lives.

This includes topics such as:

- › Mobility
- › 5G connectivity and IoT/M2M
- › Microgravity Sciences
- › Material Research
- › New technologies and services

# AIRBUS

### PRIZE

The winning idea receives a customised Airbus support package with elements from the following components:

- › Access to the global Airbus expert network
- › Possibility of pitching to Airbus Ventures
  - › Consulting for a mission proposal
- › Development of a crowd-investing campaign for a space experiment



## Real-Time Container Tracking and Monitoring

Modern transport and logistics require real-time tracking and monitoring of shipping containers worldwide. Many applications on the market track only the location of the vessel on which a container is transported – not the container itself. Therefore, the tracking signal is lost when the container is transferred between ships, trains, trucks and aircraft, or if it happens to be lost at sea. Callwise Ltd. addresses these issues using an innovative combination of satellite communication and a 5G LoRaWAN (Low Range Wide Area Network) IoT solution. This solution enables real-time tracking and monitoring of individual shipping containers from start to finish during multimodal transport. The concept is based on a novel architecture in which satellite and cellular tracking is combined with LoRaWAN tracking and monitoring of individual shipping containers. Callwise Ltd. is targeting logistics and shipping companies that can offer this end-to-end solution to customers as a value-added service in their product portfolios. Furthermore, the system is able to generate alerts for a wide range of events (unauthorised door opening, deviation from a predefined route, changes in container temperature, etc.) and also track down containers lost at sea.

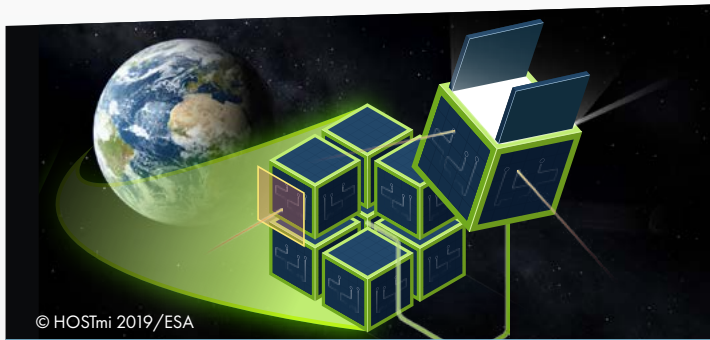
### Benefits:

- › Real-time location information on shipping containers from start to finish
- › Ability to monitor several parameters inside containers (e.g. temperature, air pressure, air moisture)
- › Ability to trace containers that are lost at sea



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HOSTmi



## HOSTmi – Independent, Automated & Global Broker

The traditional space sector does not offer fast, simple, low-cost access to space for the commercially driven new space economy. HOSTmi is the first neutral digital B2B platform for payload owners and space mission providers that matches the growing commercial and scientific demand. This standardised online platform offers efficient, user-friendly, and global mediation of flight options aboard various space-based systems, from suborbital vehicles to deep space platforms. Payload owners receive real-time product and service information, along with the ability to search for potential hosting opportunities for their payload. Besides being available to payload owners for an annual subscription fee, HOSTmi operates on a contract- and success-based commission model for space mission providers. It is thus digitising the global market for space payloads in a scalable fashion.

Benefits:

- › Digital one-stop-shop bundles services such as technical support, financing, and insurance
- › Efficient automated processes significantly reduce time and cost requirements for payload owners
- › Space mission providers will be able to sell their services and unused capacity, which will reduce the direct cost of sales and customer acquisition based on an automated influx of prospects
- › Fosters the transition from conservative value chains to a modern, customer-oriented value network



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## AgSat – An Ideal Optical-Thermal Platform for Agricultural and Environmental Remote Sensing

The growing human population, associated challenges related to climate change, and the insufficiency of existing terrestrial sensing systems require new sources of Earth observation (EO) data. Critical parameters like non-photosynthetic vegetation (NPV) and evapotranspiration (ET) are not properly estimated by existing operational EO systems. NPV is important for estimating fire risk, tillage intensity, and the risk of soil erosion due to water and wind. ET is important for agricultural production and water usage. AgSat will offer an advanced multispectral satellite concept that will not only measure those parameters, but also include on-board artificial intelligence and data processing to minimise data downloads while using laser-based systems for more efficient data transmission. AgSat will deliver custom, need-driven, cloud-free data products directly to stakeholders within minutes of acquisition. Science data will be available to end users under an open data policy.

### Benefits:

- › Data continuity with Sentinel-2/Landsat missions
- › Open data for science products
- › On-board anomalous event detection (fires, floods) and data product creation, including downlinking to end users



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## OHB Challenge

If you wish to give the aerospace of tomorrow new impetus, if you are able to combine creativity with interdisciplinary work to develop visionary ideas and get them off the ground, the second OHB Challenge was just right for you!

### CHALLENGE

OHB was looking for solutions for the future space sector:

From novel concepts to competitive solutions, since technologies and processes from space and non-space sectors could be exploited for greater benefits in the future. The OHB challenge was intended to identify innovative, promising ideas and concepts to support the implementation and use of space solutions.

Topics included: Robotics, smart materials, new technologies, asteroid mining, commercial space services, transport applications (railway, aviation...), the Low Earth Orbit commercialisation... and any other inspiring idea in the space sector. OHB aims at fostering efficiency!



**We. Create. Space.**

### PRIZE

- › Support from relevant experts from the OHB Group
- › Cooperation opportunities at a European level through the companies in the OHB Group
- › Possibility of a joint technology development programme
- › Pitch opportunity at OHB Venture Capital
- › Invitation to meet the OHB Group and the Space Community at the Paris Air Show 2019 in Le Bourget



**ESDA**<sup>®</sup>  
Technologie GmbH



## PCM-Polymer Compound – Novel Material for Thermal Stabilisation of Component Systems

Spacecraft components are constantly subjected to thermal variations. To avoid overheating or undercooling of these components, ESDA-Axiotherm GmbH is developing a phase-change material (PCM) polymer compound for the thermal stabilisation of space components and systems. The PCM polymer compound features a high capacity for absorbing accumulating amounts of heat and releases the heat energy into the system during an undercooling period in order to stabilise the temperature. This material will prevent temperature peaks and produce a smoothed temperature curve. Its unique feature is a mix of materials that remains gelatinous when melted. The compound is leak-proof and well-suited to processing. Furthermore, it is possible to use additives to make permanent, stable modifications to properties such as thermal conductivity, fire protection, and radiation resistance. In particular, batteries (and by extension, the field of e-mobility) should benefit from this life-prolonging technology.

### Benefits:

- › Effective smoothing of temperature peaks and reduced thermo-mechanical stress
- › Increased useful life of batteries and electronic components, plus increased operational safety
- › Low mass, high capacity & directly applicable to all battery sectors (automotive/maritime/aviation)



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**T4i** TECHNOLOGY  
FOR PROPULSION  
AND INNOVATION



## MERIT – Disruptive Propulsion System for Microsatellites

Miniaturised satellites have become increasingly common in recent years. In order to enable different mission scenarios, satellite platforms as small as CubeSats require propulsion systems that are small, versatile, cost-effective, and reliable. Since existing propulsion systems are too expensive and lack intense development and physical comprehension, T4i started MERIT, a project that aims to upgrade their own REGULUS propulsion system in terms of cost and performance. Based on helicon plasma technology, it also leverages a modular approach, non-aerospace supply chains, and smart adoption of additive technologies. MERIT's main target customers include small-satellite (up to 150 kg) platform manufacturers. T4i plans not only to provide the propulsion system to be integrated into satellites, but to become a potential partner as well. Its technology will also be exploited in other fields, such as medical and industrial applications and in the development of smart plasma antennas.

Benefits:

- › Increased profitability and efficiency through the functionality of the satellite platform
- › Easy integration of the REGULUS propulsion system into satellite platforms
- › Better performance and cost reductions of up to 83%
- › Reliable and versatile propulsion system thanks to helicon plasma technology



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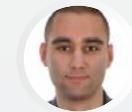


## Celestial – Products and Services for Deep Space Communication

Moon missions are facing many challenges in new space exploration, and communication is one of them. The fact that not all locations on the moon are accessible to transmissions from Earth creates an obstacle to cislunar communication. Celestial aims to deploy a small satellite relay constellation in lunar polar orbit to overcome this barrier. A total of three satellites (plus one redundant satellite) will be deployed. Working on the S and X bands, this constellation will be able to communicate and relay data from lunar missions to ground stations on Earth. In addition, Celestial aims to provide its satellite communication system to missions seeking to explore high-radiation Earth orbits. This payload will be lightweight and radiation-hardened, ensuring longer life than the similar communication systems currently available. The biggest benefit for lunar missions lies in the reduced costs made possible by a low-weight communication system and the ability to reach lunar locations that are otherwise inaccessible.

### Benefits:

- › Increased data transmission rates and continuous communication coverage of the lunar poles
- › Low power consumption for low-cost lunar missions
- › Access to lunar regions beyond the direct line of sight



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#### Dr. Susanne Heckrodt

Head of National Launcher Program, Department Launcher Systems  
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#### Frank Meures

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#### Daniel Nölke

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#### Dr Peter Vits

State Coordinator for Space Activities  
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#### Dr Alexander Weiß

Scientific Expert, Department of Navigation  
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#### Dr Franziska Zeitler

Head of Department Innovation & New Markets  
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### ESA BIC Startup Challenge

#### Stefanie Herrmann

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AZO Anwendungszentrum GmbH Oberpfaffenhofen

#### Dr Robert Klarner

Head of Technology Marketing Branch Office Oberpfaffenhofen  
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#### Ulrich Kübler

Space System Strategy  
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#### Thorsten Rudolph

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Dr Timo Stuffer  
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### Airbus Challenge

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Jochen Harms  
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Heiko Höfers  
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