The German Aerospace Center

54th European Space Sciences Committee
Plenary Meeting

Planetary Science & Exploration: DLR Highlights

Prof. Dr. Pascale Ehrenfreund

Chair – DLR

Oberpfaffenhofen

23 November 2017

Research Center | **Space Administration** | **Project Management**

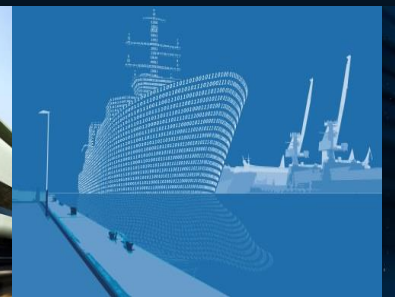
DLR

~8.200 Employees

40 Institutes & Facilities

20 Sites across Germany

Aeronautics | **Space** | **Energy** | **Transport** | **Security** | **Digitalization**



DLR

DLR

Senat

33 Members from Academia, Industry and Politics

Executive Board

2017

3.593 Mio. €

(projected Figures)

Space Administration

1.177 Mio. €

Research & Development

992 Mio. €

HELMHOLTZ
SPITZENFORSCHUNG FÜR
GROSSE HERAUSFORDERUNGEN

Project Management

1.424 Mio. €

Total Revenues 2017

(Projected Figures in Mio. €)

39%	Space
27%	Aeronautics
9%	Energy
8%	Transport
10%	Space Administration
4%	Project Man.
3%	Other

55

Security

174 Large-Scale Research Infrastructures in 2016

Including Europe's largest fleet of research aircrafts
Jointly used with 46 research organizations and 62 industry partners

Wind Tunnels

Research Aircrafts

Simulators

Research Vehicles & Platforms

Control Stations

Test Facilities

Medical Infrastructures

Research Power Plants

Compact Test Range

Energy Storage Test Facilities

High-Performance Computers

Sounding Rockets

Airbus A320-232 D-ATRA

Antares DLR-H2

Cessna 208B Grand Caravan

Dassault Falcon 20E - D-CMET

DG 300 Elan-17

Europe‘s largest fleet of civil research aircrafts

12 Aeroplanes & 2 Helicopters

Discus-2c DLR

Dornier Do 228-101 D-CODE

Dornier Do 228-212

DR 400/200R Remorqueur - D-EDVE

Eurocopter BO 105

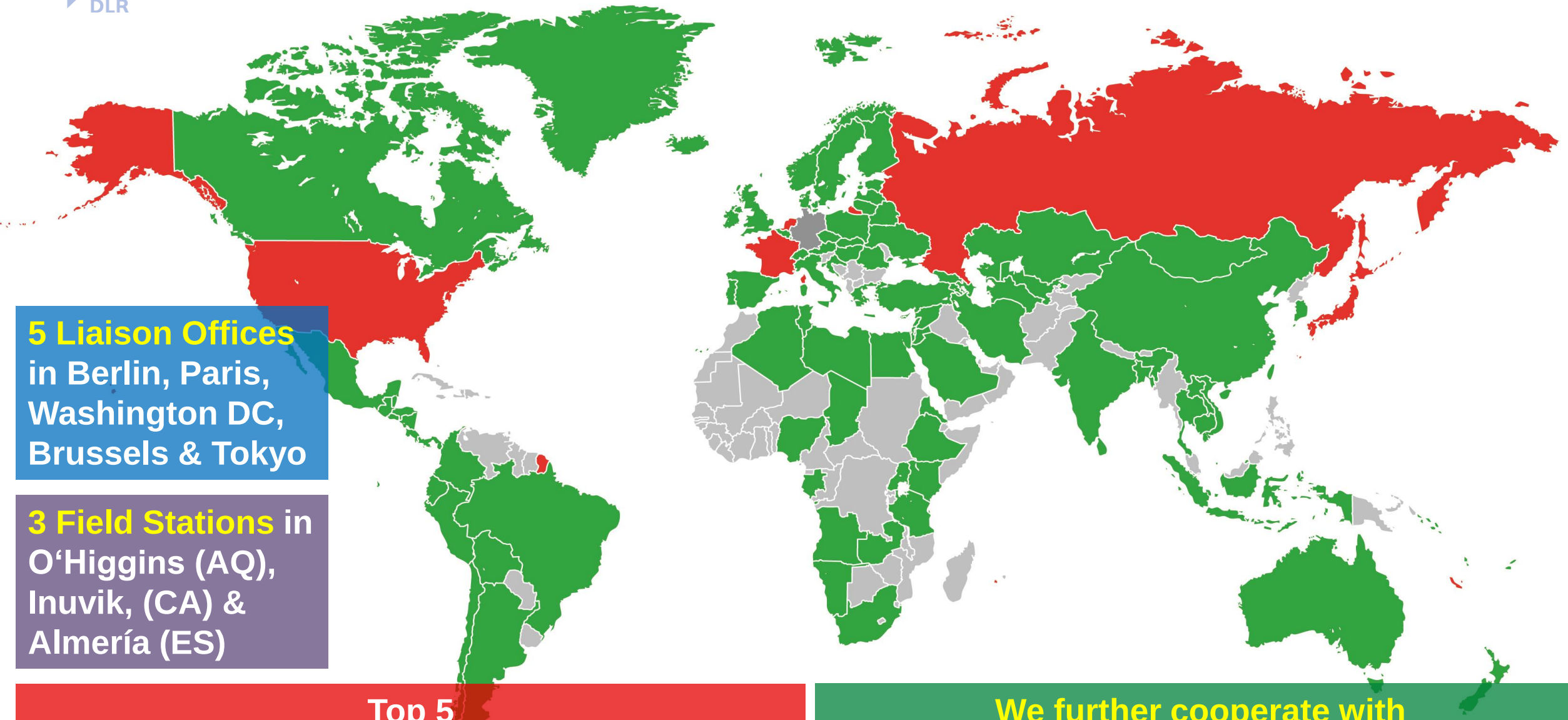
Flying Helicopter-Simulator ACT/FHS

HALO Gulfstream G 550

LFU 205 – out of service

VFW 614 / ATTAS – out of service

International Partners



5 Liaison Offices in Berlin, Paris, Washington DC, Brussels & Tokyo

3 Field Stations in O'Higgins (AQ), Inuvik, (CA) & Almería (ES)

Top 5
bilateral collaboration countries:
USA, Russia, Japan, France, & The Netherlands

We further cooperate with
over 400 Partner-Organisations in
more than 60 countries

DLR-Strategy 2030

Synergies

Unique Research Center

- Aeronautics, Space, Energy, Transport
- Space Agency
- Project Management Agency

Aeronautics & Space Research

- Largest Research Center in Europe
- System Competence

Energy & Transport Research

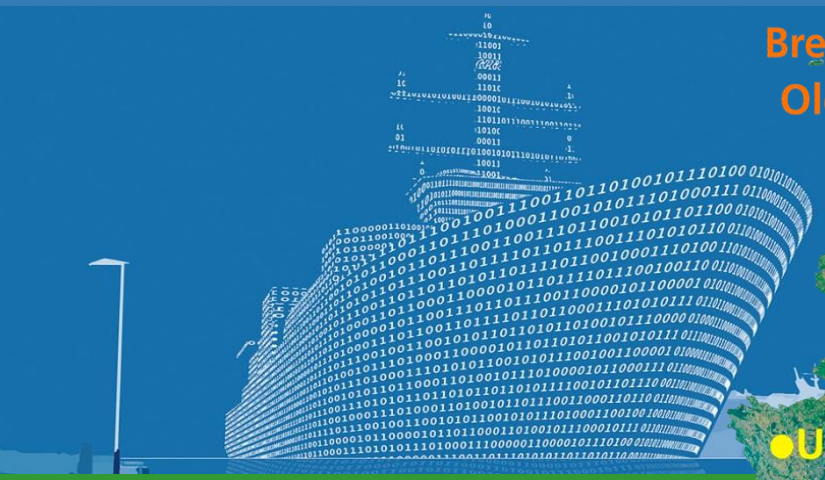
- Key Technologies
- Systemic Competence

Interdisciplinary Research
Security and Digitalization

Digitalization

… is expanding

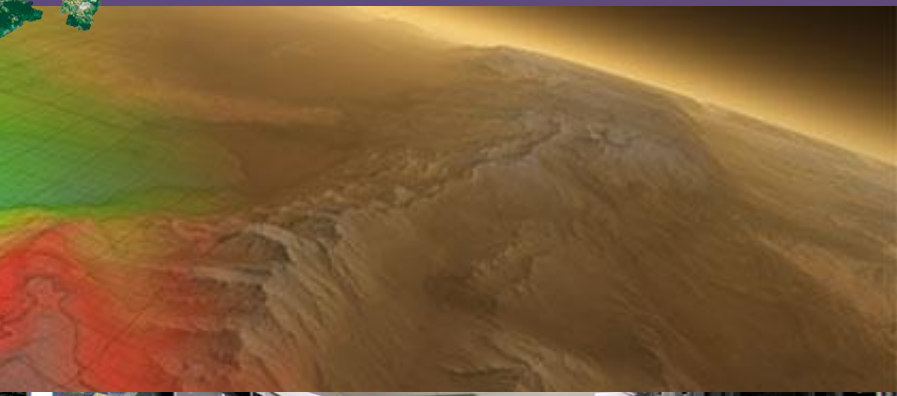
Digitalization of Aeronautics Research



Bremerhaven
Oldenburg
Stade
Hamburg
Neustrelitz
Bremen
Trauen
Braunschweig
Berlin
Göttingen
Uedem
Jülich
Köln
Bonn
Jena
Dresden
Bad Neuenahr-Ahrweiler
Lampoldshausen
Stuttgart
Ulm
Augsburg
Oberpfaffenhofen
Weilheim

Maritime Infrastructure Security

Big and Smart Data



Networks of Energy Systems

DLR's unique position in the German research landscape

HELMHOLTZ
RESEARCH FOR GRAND CHALLENGES

Federal Ministry of Education and Research

17 Research Centers

AWI
DESY
dkfz.
DZNE Deutsches Zentrum für Neurodegenerative Erkrankungen in der Helmholtz-Gemeinschaft
JÜLICH FORSCHUNGSZENTRUM
GEOMAR
GFZ Helmholtz-Zentrum POTSDAM
GSI
HelmholtzZentrum münchen Deutsches Forschungszentrum für Gesundheit und Umwelt
HZB Helmholtz Zentrum Berlin
HZDR
Helmholtz-Zentrum Geesthacht Zentrum für Material- und Küstenforschung
HELMHOLTZ ZENTRUM DRESDEN ROSSENDORF
HELMHOLTZ ZENTRUM FÜR INFEKTIONSFORSCHUNG
IPP Max-Planck-Institut für Plasmaphysik
KIT Karlsruher Institut für Technologie
MDC MAX-DELBRÜCK-CENTRUM FÜR MOLEKULARE MEDIZIN IN DER HELMHOLTZ-GEMEINSCHAFT
HELMHOLTZ ZENTRUM FÜR UMWELTFORSCHUNG UFZ

Federal Ministry for Economic Affairs and Energy

1 Research Center

DLR
Deutsches Zentrum für Luft- und Raumfahrt
German Aerospace Center

DLR Space Administration

- Helps implement the German Space Strategy on behalf of the Federal Government (RAÜG)
- Responsible for Germany's space interests in the international context, especially in the ESA context
- Distributes research and development assignments and grants in the National Space and Innovation Program
- Consultation from funding decisions to technology transfer

German Space Industry

Key data of the German space industry

- **Employees: ~ 8.400**
- **Total revenue: ~ 2,4 Bln. €**

Industrial structure

- **Two large system providers (Airbus D&S, OHB)**
- **approx. 80 ‘pure' Space SMEs**
- **approx. 200 to 300 companies/small space business**

Regional concentrations

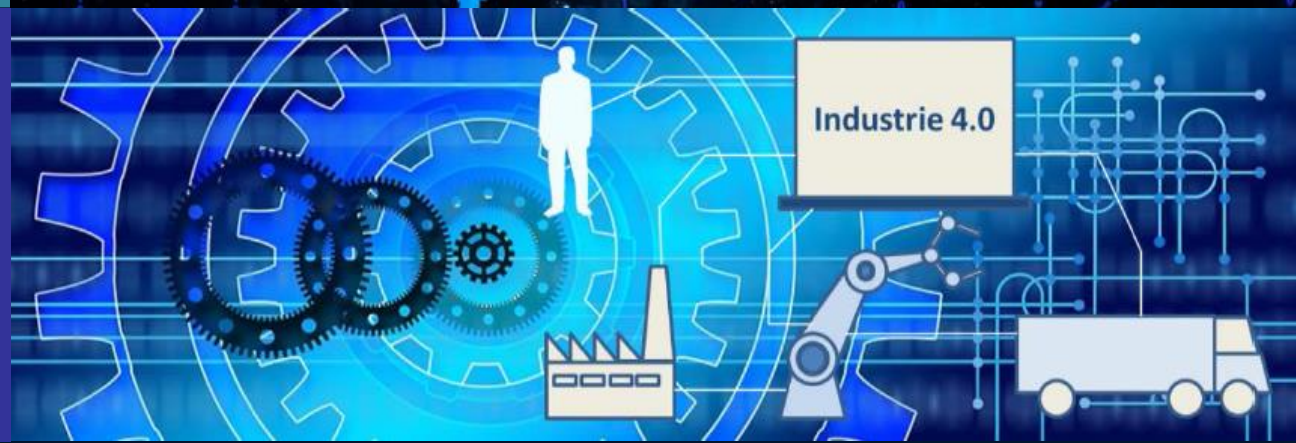
- **Baden-Württemberg: ~ 2.700 employees**
  (e.g. Airbus D&S, Tesat, Thales, SpaceTech, vH&S, ND SatCom, numerous SMEs)
- **Bavaria: ~ 1.700 employees**
  (e.g. Airbus DS, MT Aerospace, OHB, numerous SMEs)
- **Bremen: ~ 1.500 employees**
  (e.g. Airbus D&S, OHB, SMEs)

… envisages the Future role of Space

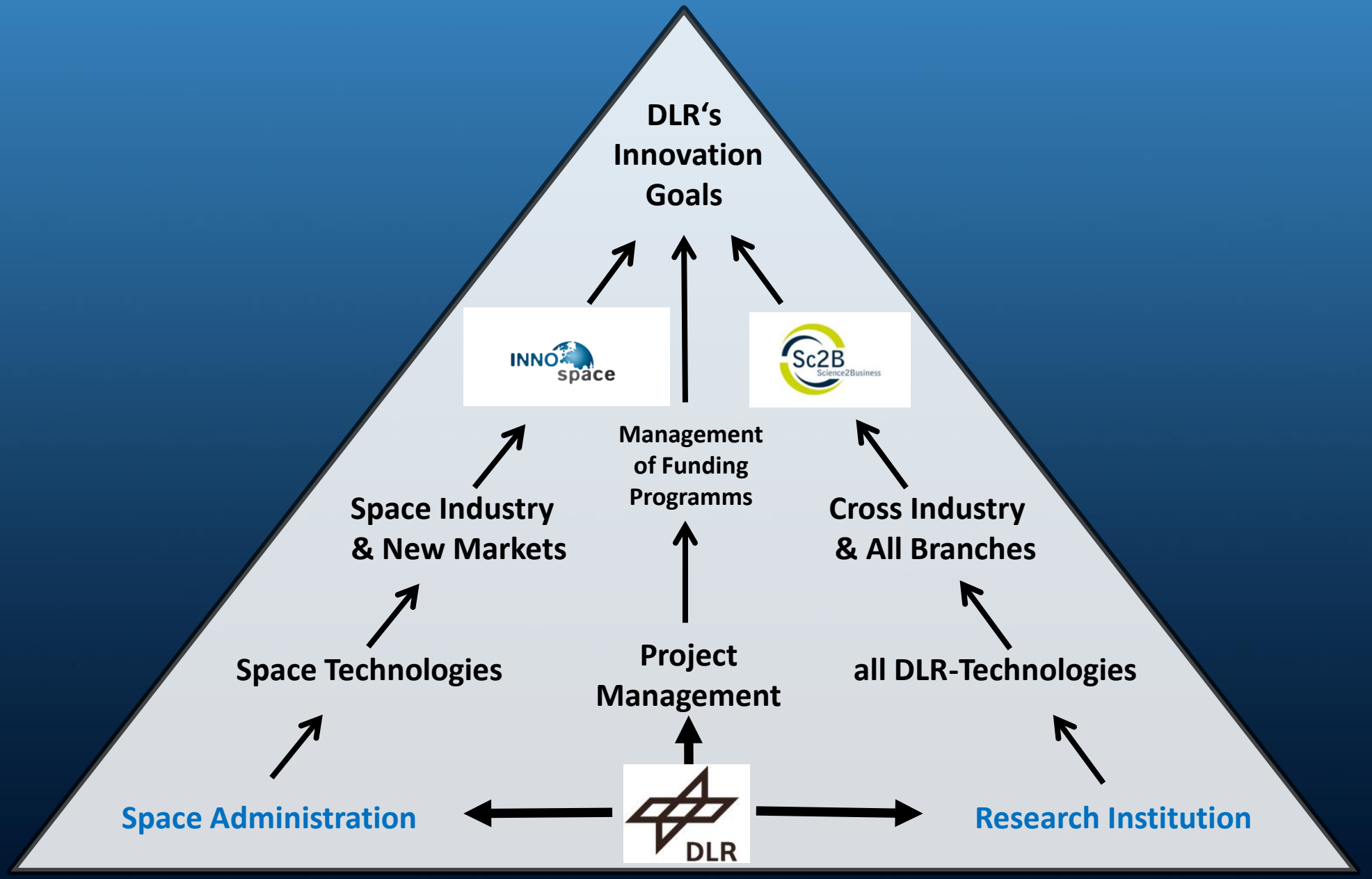
Space & Mobility

Global Connectivity & Cyber Security

Space & Industry 4.0



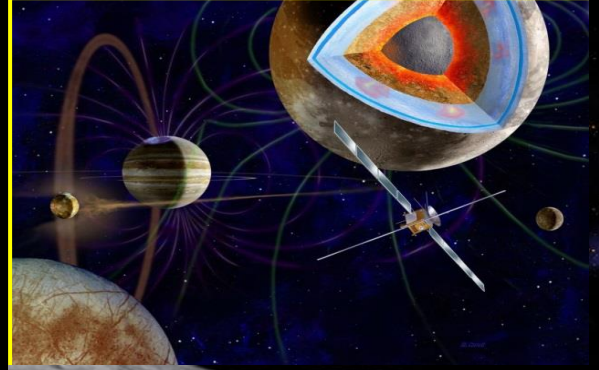
German Aerospace Center (DLR)

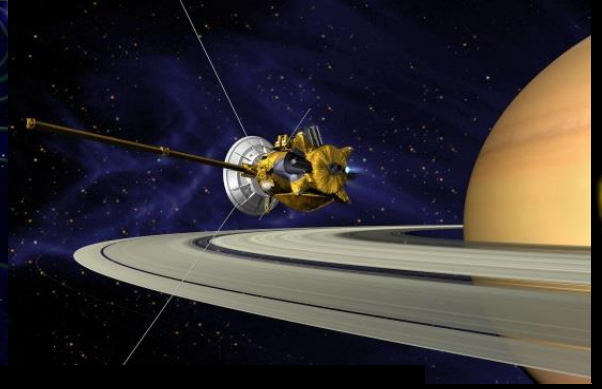


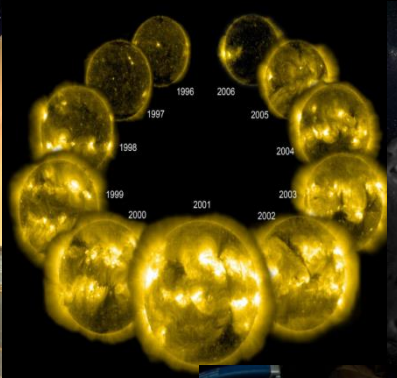
European Space Activities - ESA C-MIN 2016

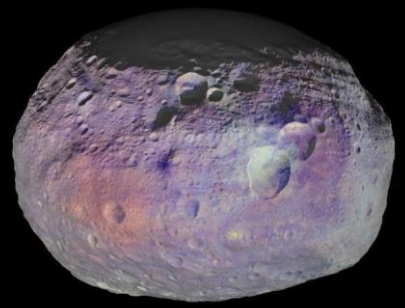
- Important Signal for European Cooperation
- German Contributions - Continuity in all Areas
- Maintaining & Strengthening Space Applications & Technology Programmes

DLR

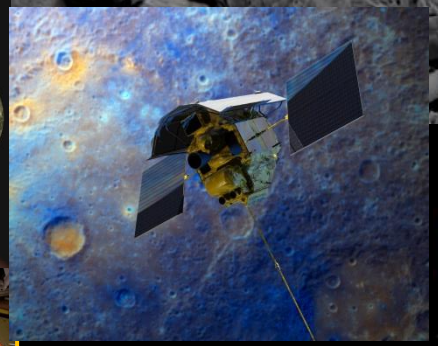


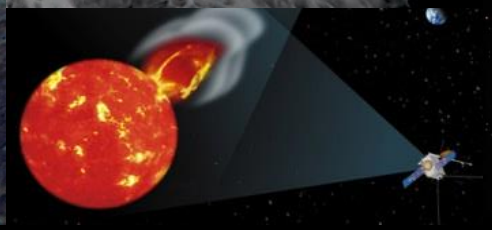


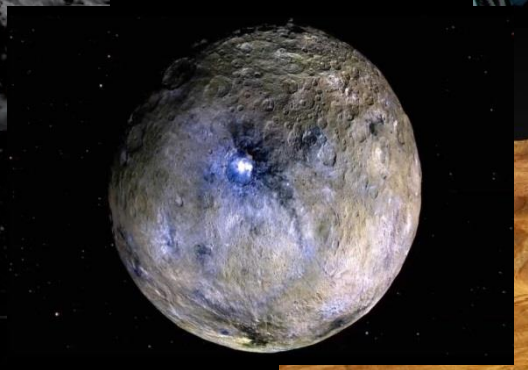


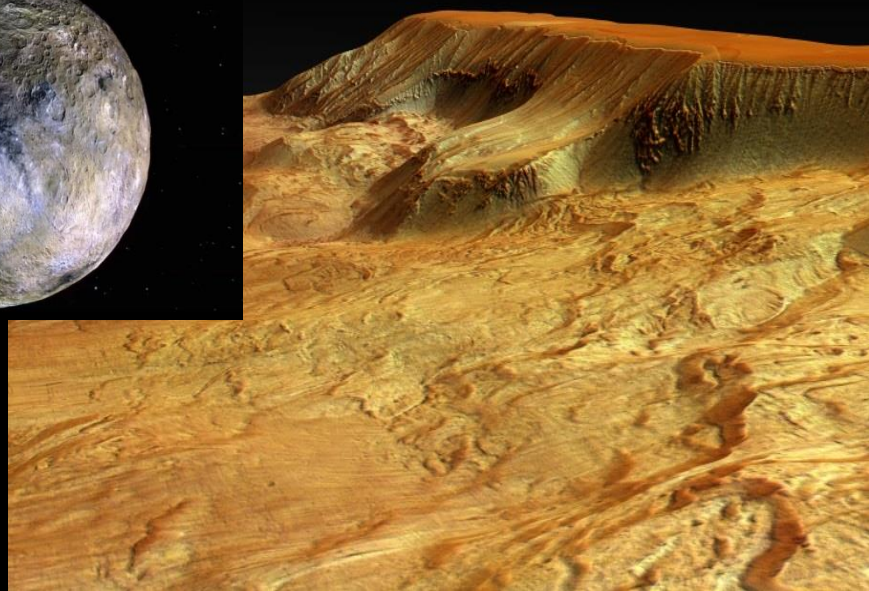


blue dot

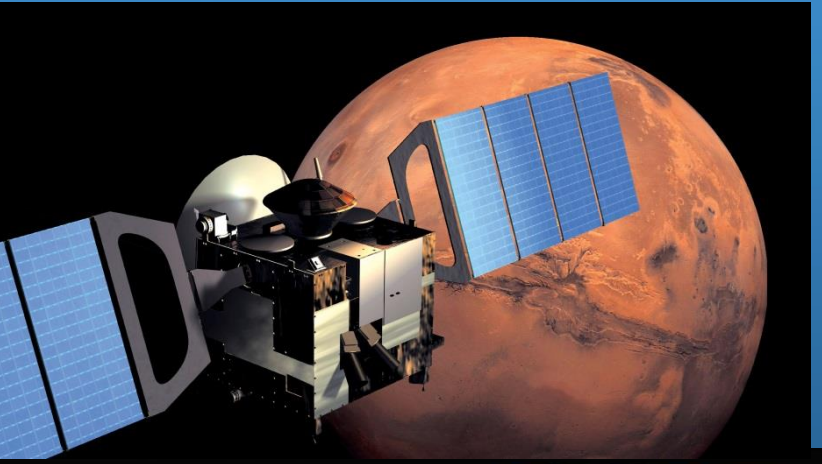






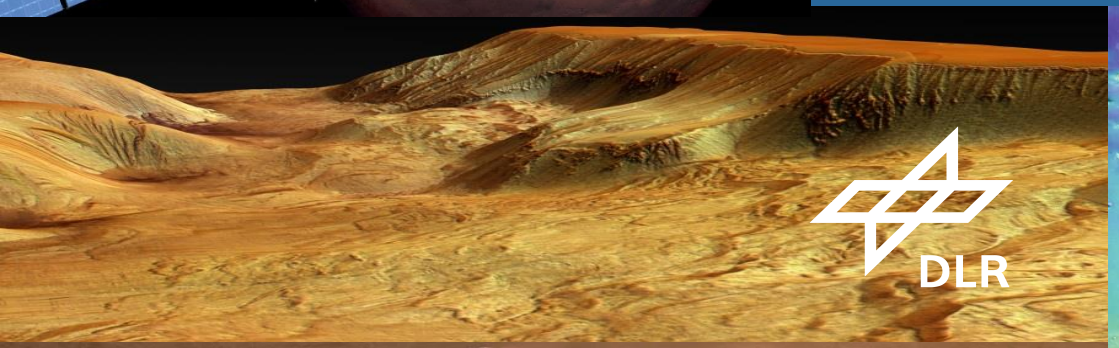


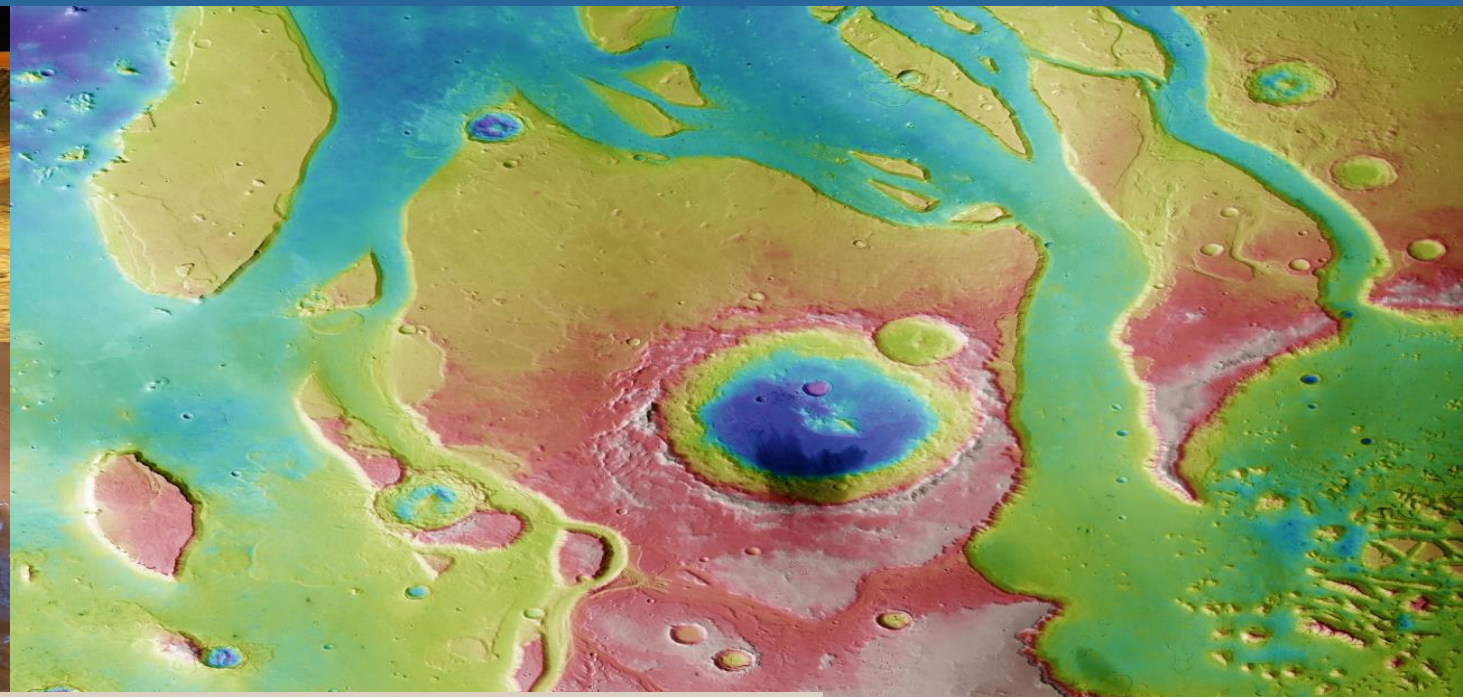
DLR's active research programs on the internal structure, formation and evolution of planets, their moons, asteroids and comets and the ISS

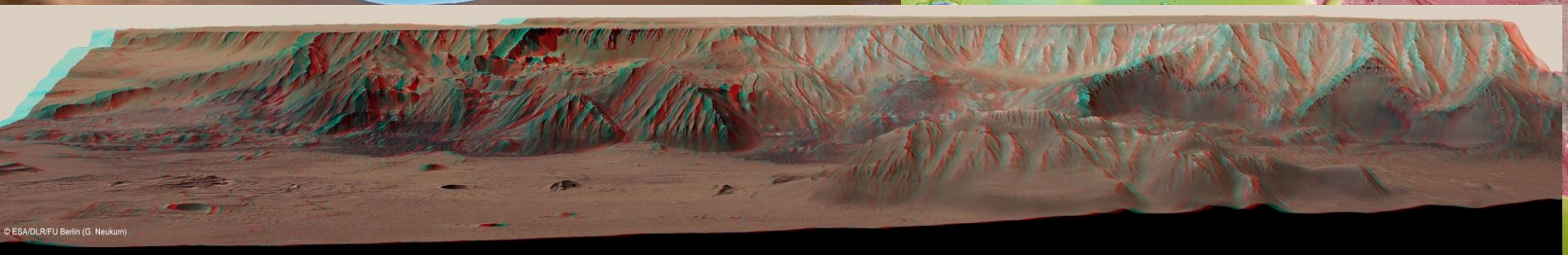


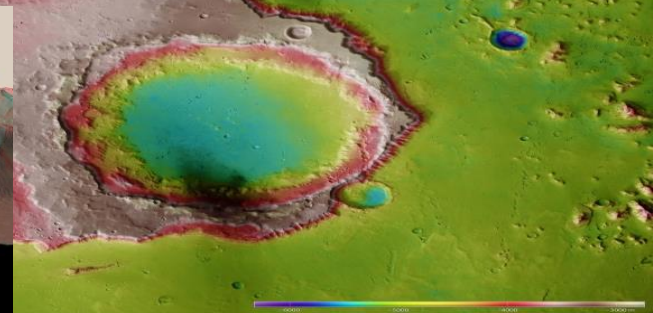
Mars Express

- Launch: 02.06.2003 - Arrival at Mars: 25.12.2003
- More than 98 % of the Martian surface has been mapped by the High Resolution Stereo Camera (HRSC) from DLR
- A large part of it are already covered by high resolution digital terrain models (DTMs)



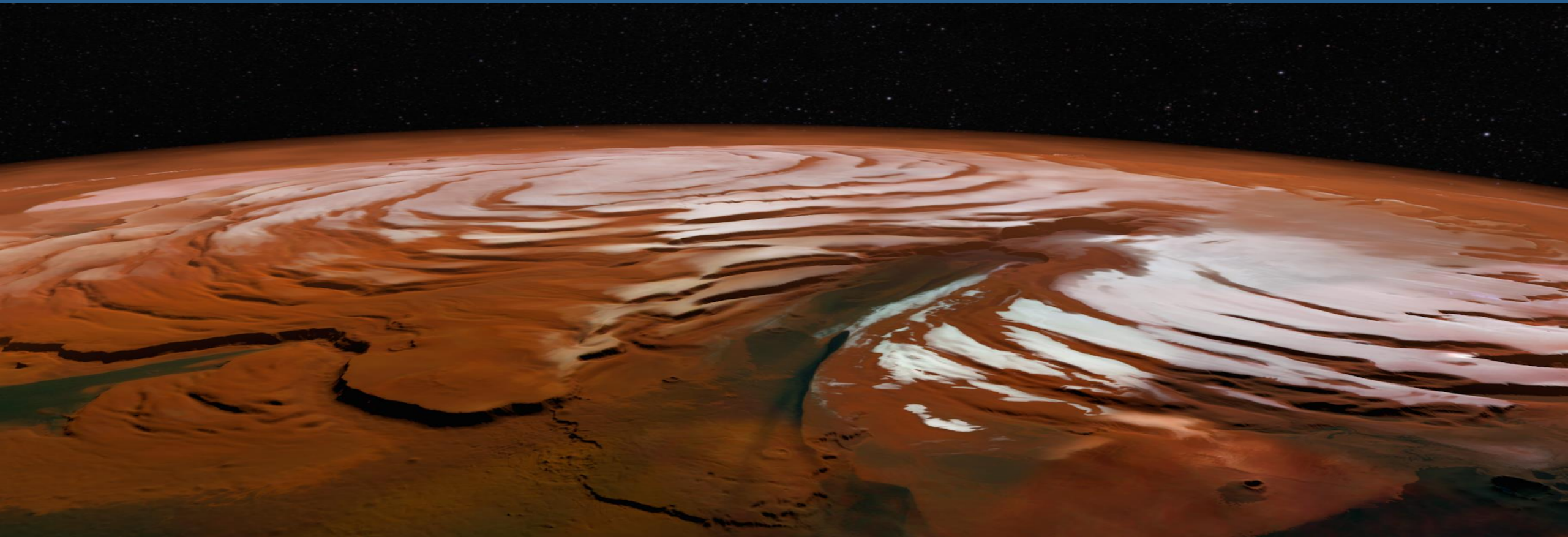






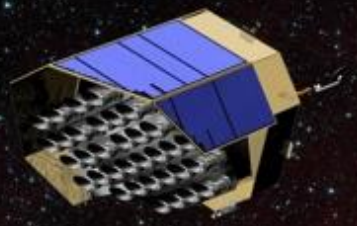
Chasma Boreale canyon – Mars North pole

Colour mosaic of Mars north polar cap - water and CO_2 ice – the dust deposited into the frozen CO_2 by Martian winds explains the spectacular colour changes. The large 'Chasma Boreale' canyon at the North Pole allows the investigation of the various layers of the ice cap and thus the study of Martian climate.



Space telescope PLATO 2.0 to search for a 'second Earth'

DLR



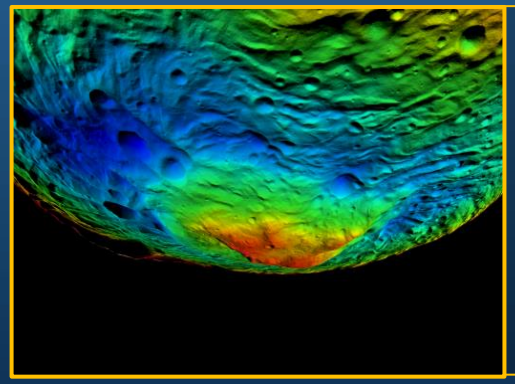
PLATO will observe the sky for at least six years from the second Lagrange point of the Earth-Sun system

- PLATO will discover and characterise thousands of new planets around other stars
- PLATO will also measure the stars' seismic activity, and coupled with ground-based radial velocity measurements, planetary researchers will not only be able to identify the existence of planets outside of the Solar System, but also to determine the mass, radius and age of the host stars
- The mission will observe approximately one million stars

Small Bodies: Rosetta, DAWN and MASCOT

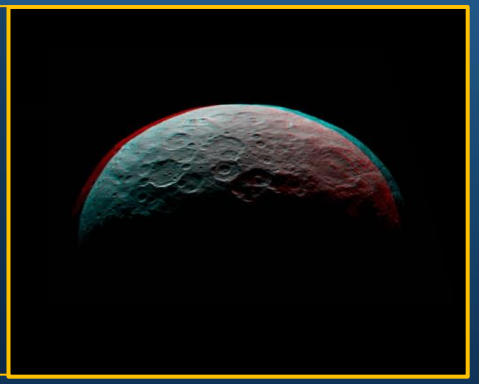
Rosetta (with Philae):

Already historic mission to comet 67P
Very high D/H-ratio of $5{,}3 \times 10^{-4}$ (unlike Earth)
Many new cometary molecules detected, among them the amino acid Glycine, N_2
Volatile ices (O_2 and CO), high porosity (70%)



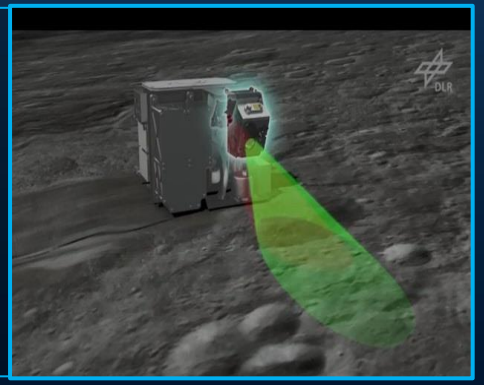
DAWN: NASA Mission to Main Belt: Vesta and Ceres

@Vesta 2011-2012, @Ceres since 2015
DLR Framing Camera System: visual mapping of the surface, navigation
Investigates 2 proto planets: „dry“ Vesta and „wet“ Ceres



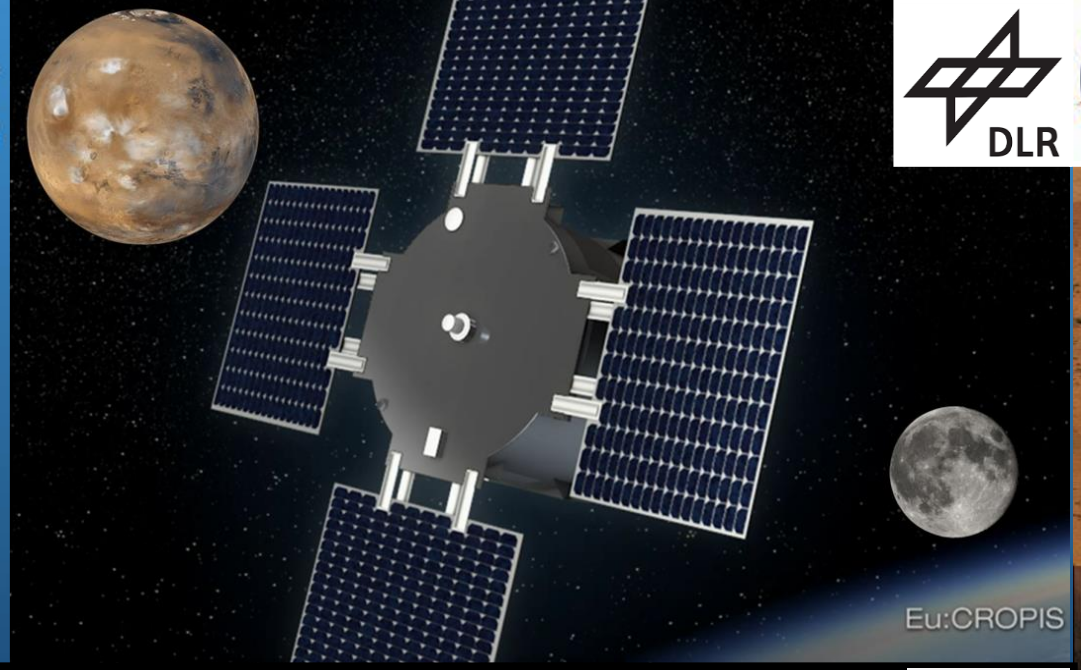
MASCOT on Hayabusa-II: JAXA Sample Return Mission

Target is asteroid Ryugu (NEO, C-Type, Arrival 2018)
MASCOT: 10kg in situ science mobile lander with high P/L to mass ratio
carries a camera, radiometer, magnetometer and IR imaging spectrometer



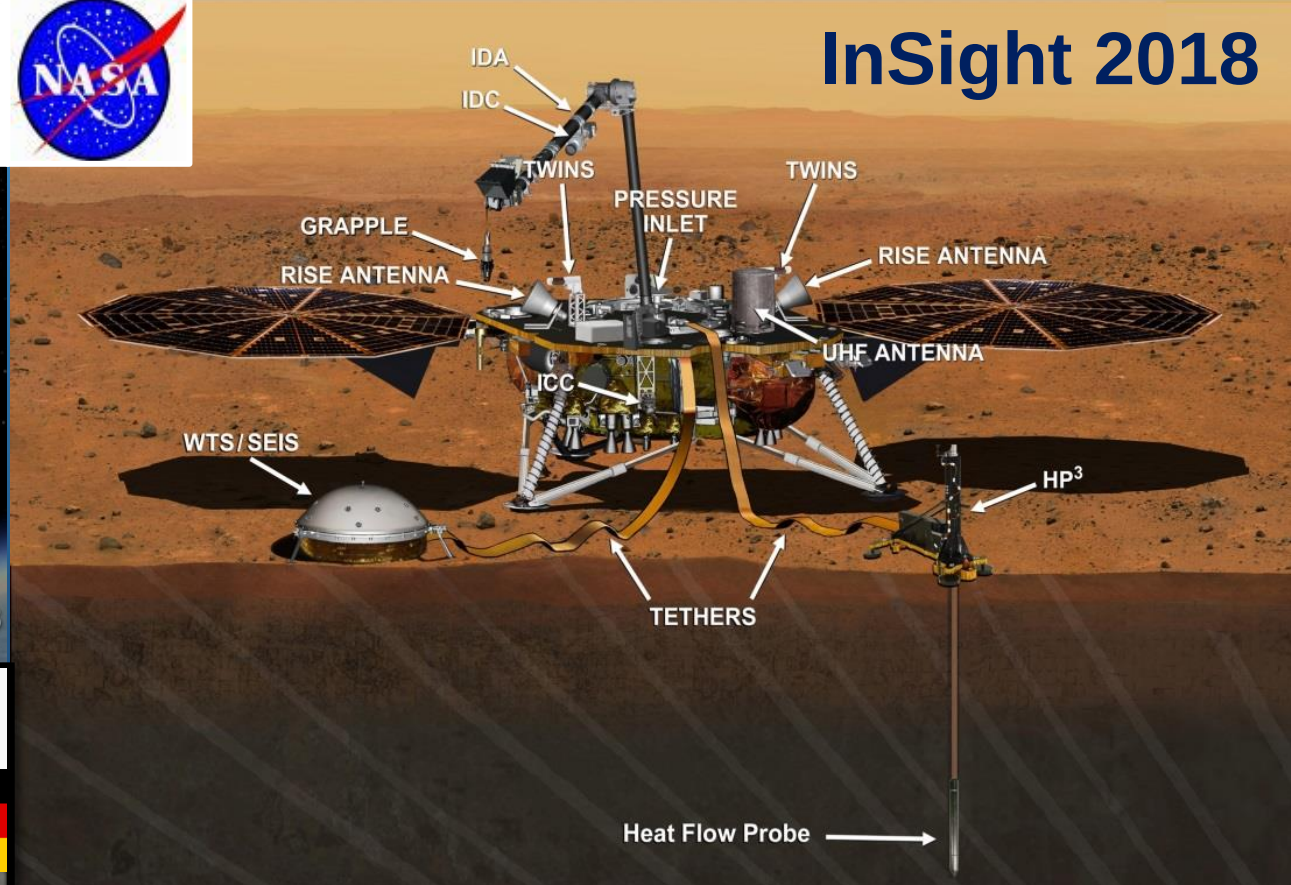
DLR

2018



DLR NASA

InSight 2018



HP³ has a self-penetrating "mole" that burrows down to five meters below the surface

Hayabusa-2

MASCOT

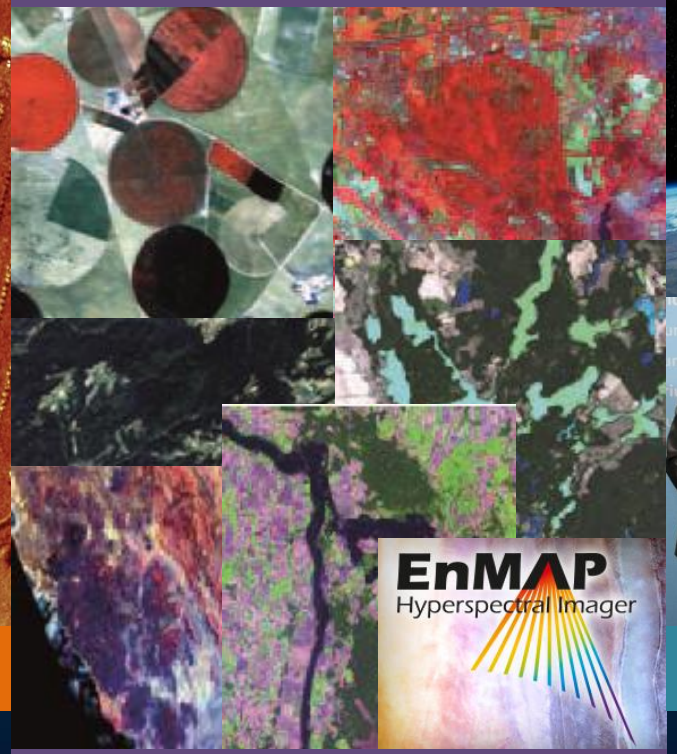
German Space Missions

Contributions to Climate Change Research & Societal Needs

TerraSAR/TanDEM

Launched 2007/2010

EnMAP

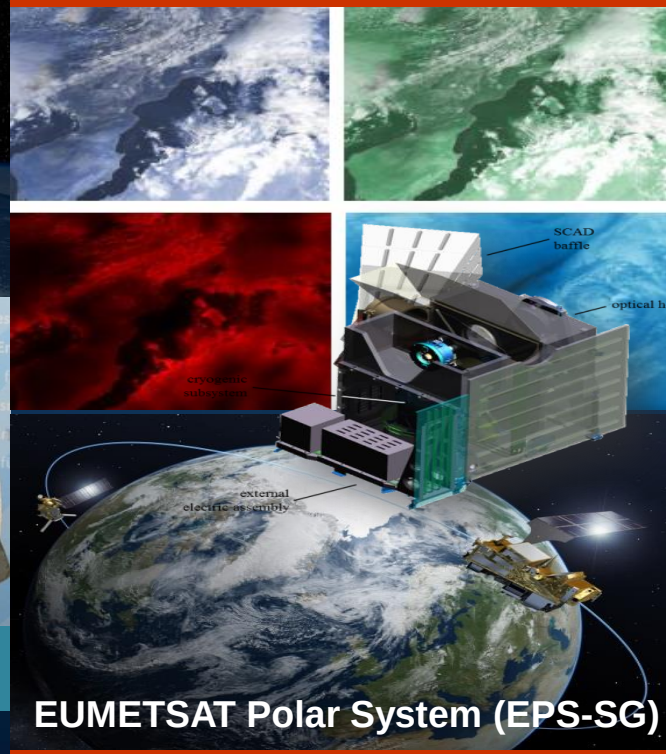


Launch in 2020

MERLIN

Launch in 2022

METimage



EUMETSAT Polar System (EPS-SG)

Launch in 2021

SOFIA

- GREAT (German Receiver at Terahertz Frequencies)
- FIFI-LS (Far Infrared Field Imaging Line Spectrometer)

Commander Alexander Gerst: 2018 – Horizons

In **June 2018**, the Horizons mission will take Germany's ESA astronaut **Alexander Gerst** on his second 'research voyage' to the **International Space Station** ISS.

35 Experiments planned with a Focus on **Aerospace** & **Industry 4.0**

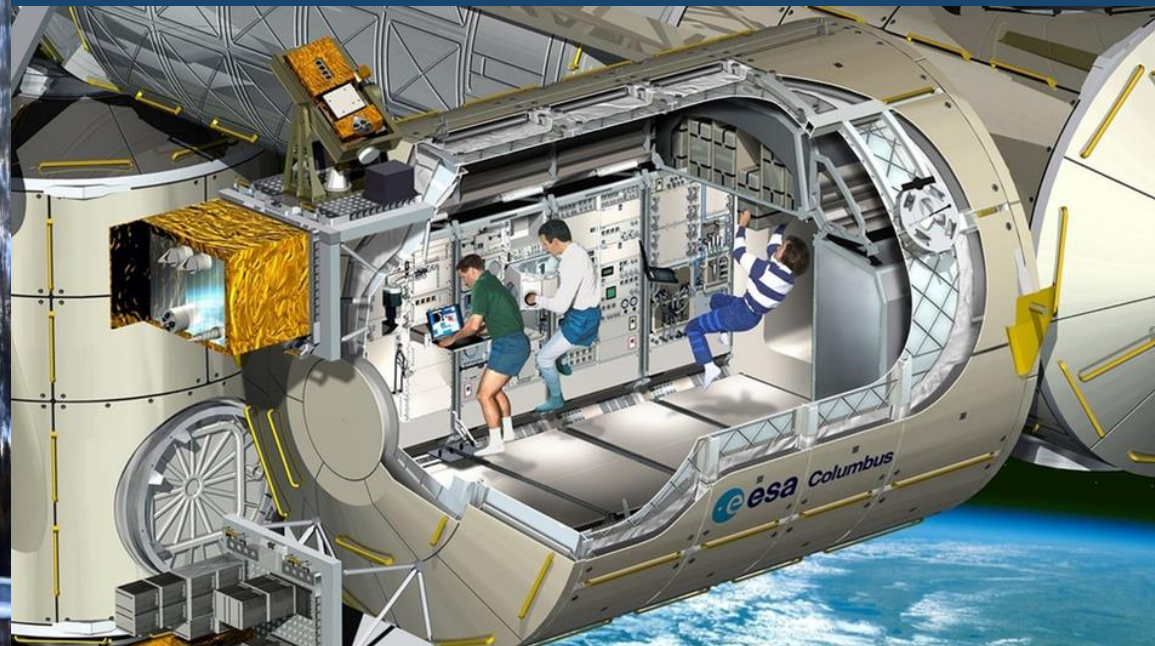
High-Resolution Earth Imaging from ISS

Teledyne's MUSES system precisely points high-resolution earth imaging instruments from the ISS.

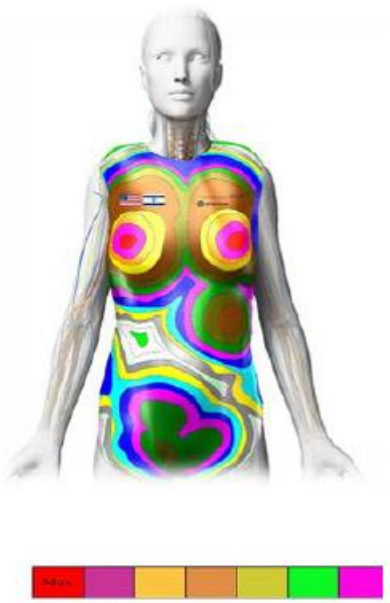
- **Frequent overpasses**
- **95% of Earth's populated landmasses**
- **Millions of km² imaged annually**

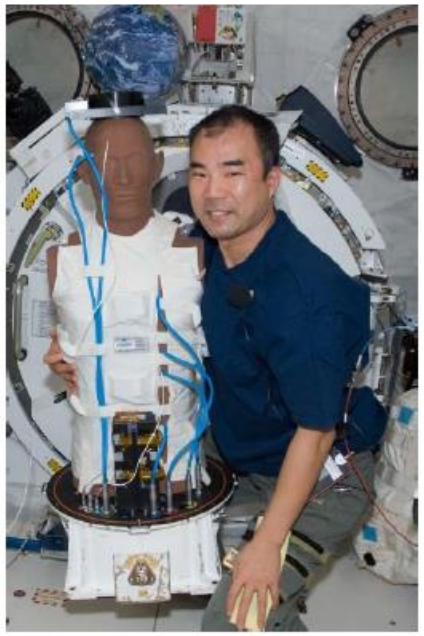
Low Earth Orbit

- Microgravity research has a direct benefit for humans on Earth
- Germany has a very agile Microgravity Science Community, active in droptower experiments, parabolic flights, sounding rockets, and on Columbus
- To support that Community is an essential element of the German space programme



DLR / Lockeed Martin – NASA / ISA
Radiation Protection from Space for Occupational Health





MATROSHKA2 Shield

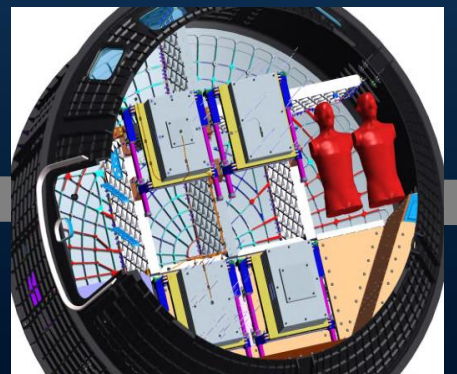
on EM–1 ORION around the moon

LOCKHEED MARTIN

ORION

DLR

STEMRAD



ROBEX Lunar Analog Experiment on Mt. Etna

Rover uses its camera eyes to scan the environment and to plan its route autonomously x3

Extended Galileo Operations by DLR

Continuing Galileo System Operation & Maintenance for the next 10 Years

spaceopal
a DLR GfR and Telespazio company

ein Unternehmen des DLR
DLR Gesellschaft für Raumfahrtanwendungen (GfR) mbH

Spaceopal GmbH, the joint venture of the DLR subsidiary DLR-GfR with Telespazio (I), has been awarded the **contract for Galileo system operation and maintenance**
(Brussels, 15.12.2016)

The DLR Gesellschaft für Raumfahrtanwendungen mbH (DLR-GfR) operates the control center in Oberpfaffenhofen

- Upgrading the Oberpfaffenhofen site as one of the leading GNSS centers worldwide by setting up a complete system platform

DLR's research policy objective

- Expansion as a satellite navigation center for the strategic positioning of Germany for system competence and technology development as well as a link between research, industry and service

German Aerospace Center

Thank you!

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