

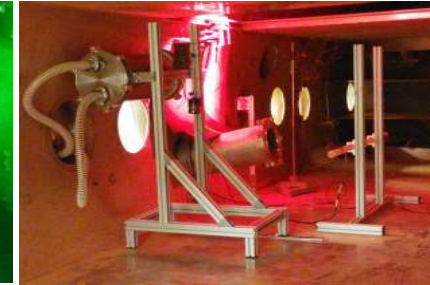
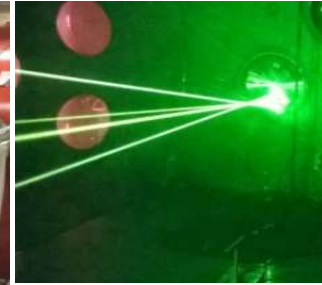


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# An ESA (SciSpace) Ground Based Facility

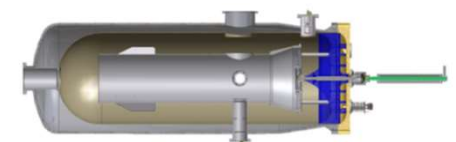
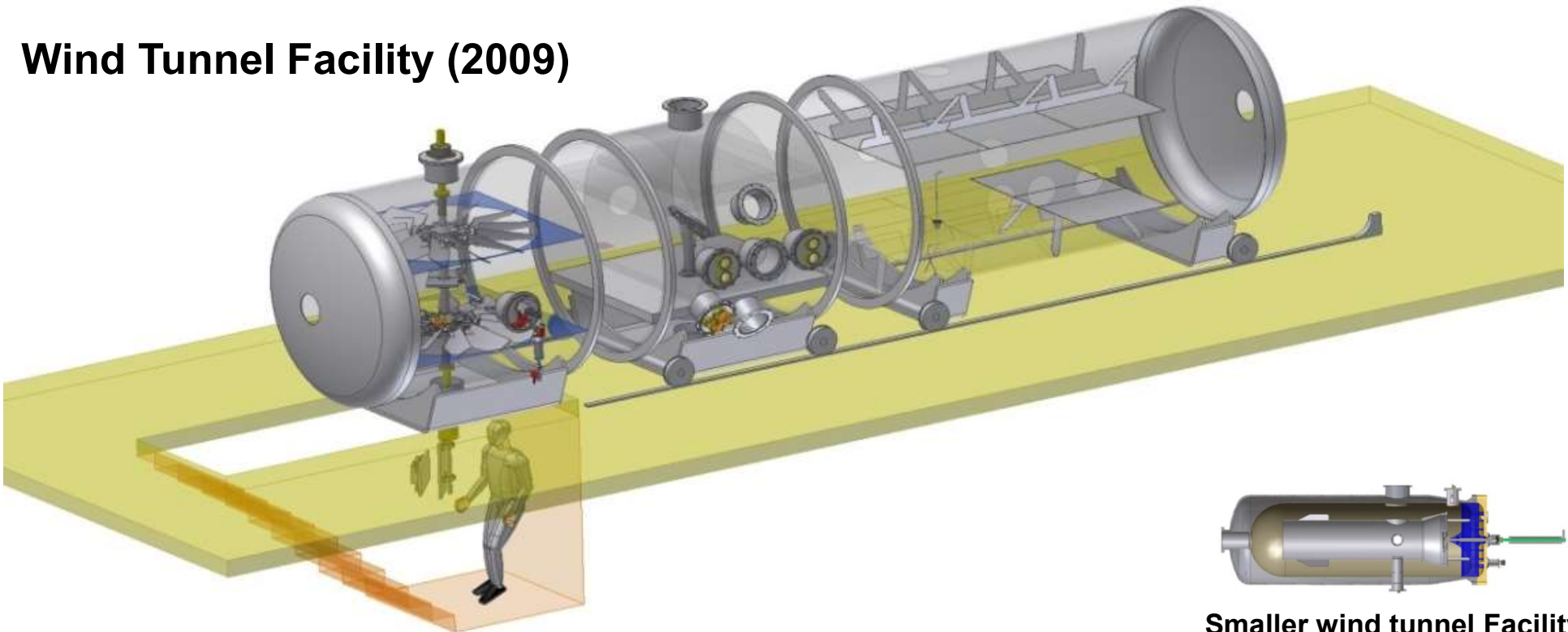
*Jon Merrison, Jens Jacob Iversen, Keld Rasmussen*



## Planetary Environment Facility (PEF)



## Wind Tunnel Facility (2009)



Smaller wind tunnel Facility  
(since 2000)

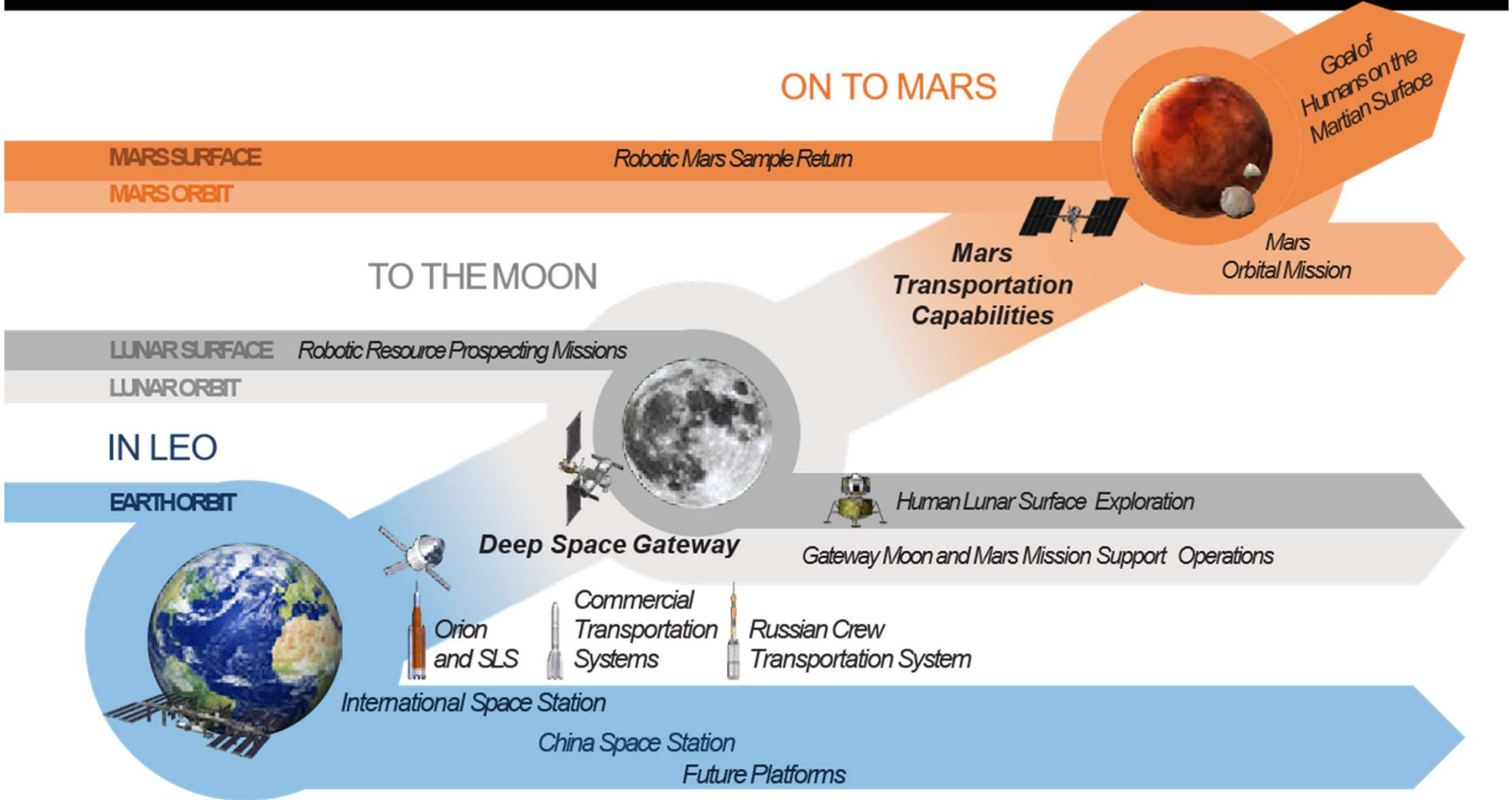


# The Global Exploration Roadmap

2020

2030

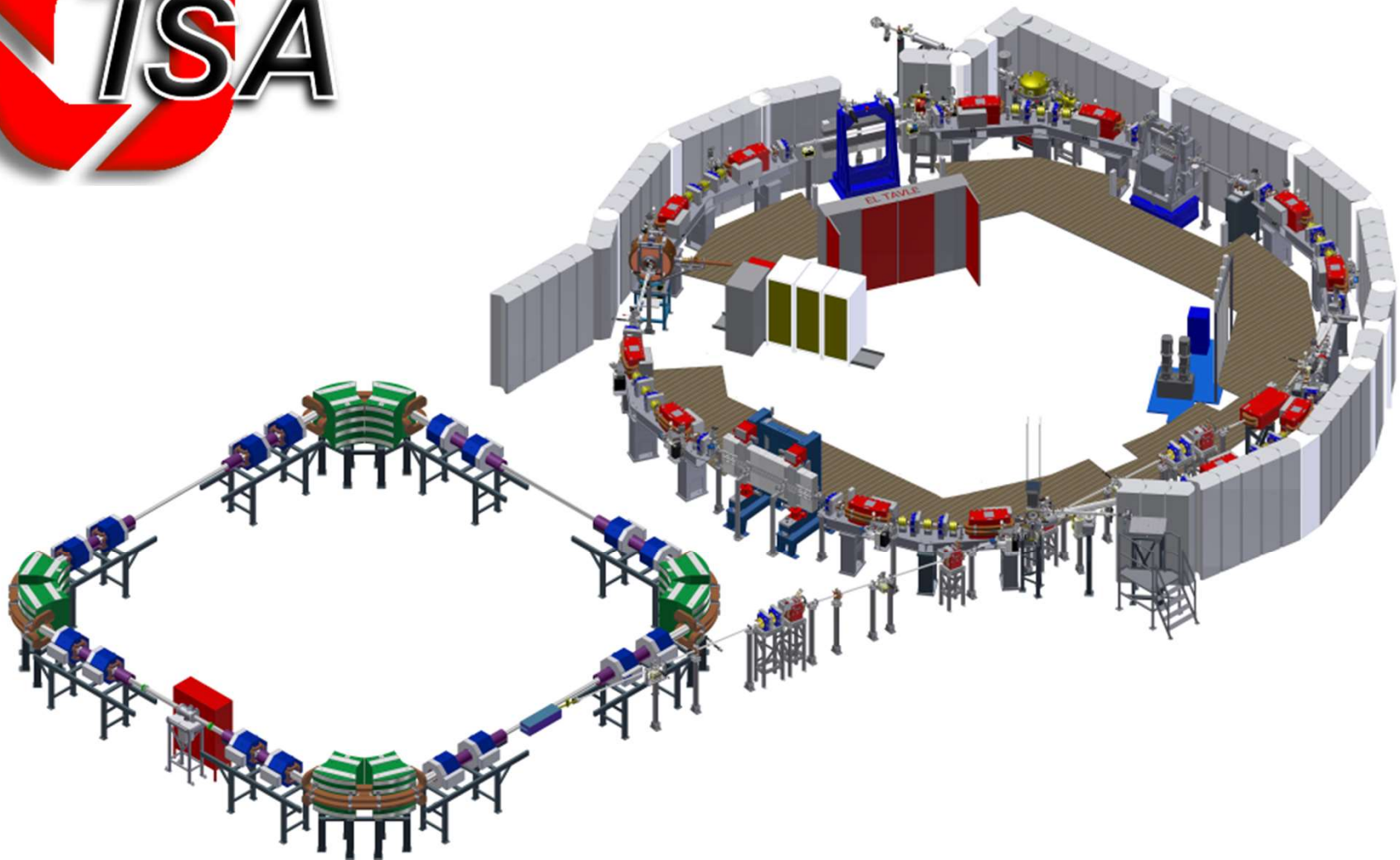
2040





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# Synchrotron light source facility





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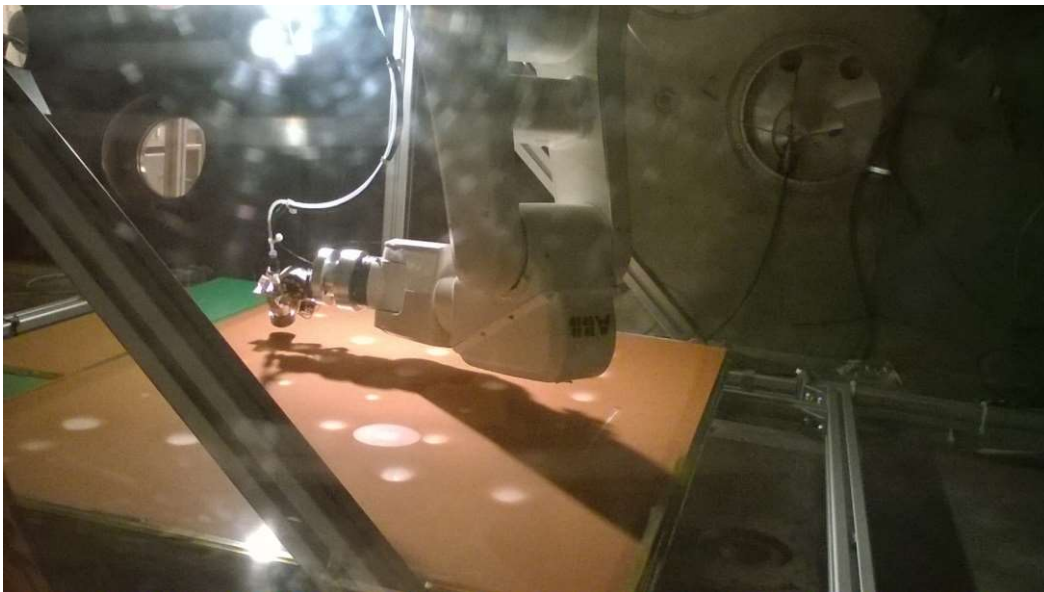
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# Planetary Environment Facility (PEF)

- Volume 35 m<sup>3</sup>, 2x1x6 m
- **Pressure** 0.01 - 1000 mbar
- **Temperature** -170C – +100C
- **Wind** 0 – 40 (15) m/s
- H<sub>2</sub>O 0 – 20 mbar (100% RH)
- **Dust controlled exposure**
- **Dust and Flow sensors**  
e.g. LDV, Opacity, Pitot, Imaging..



## Testing technology (ESA)



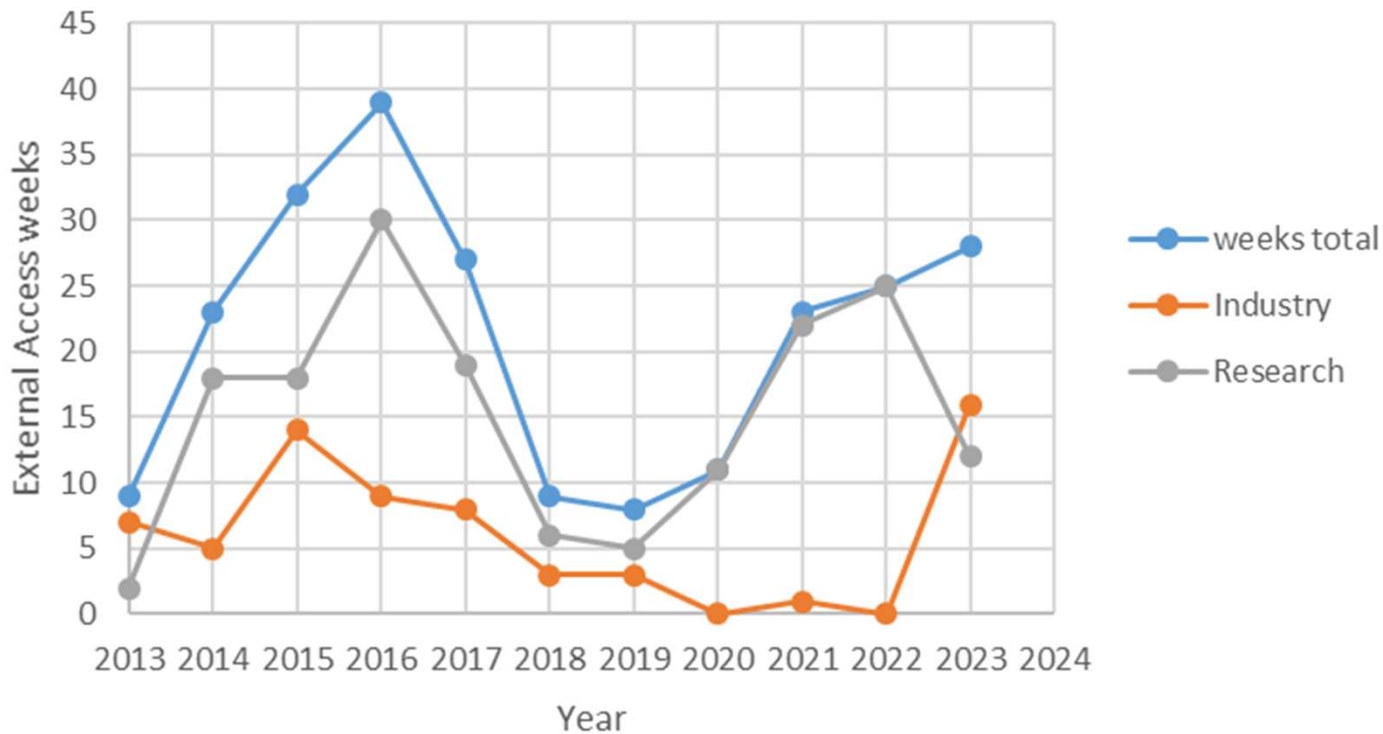
## Collaborative Research



# PEF Utilization Industry/Research



PEF number of weeks External Access per year

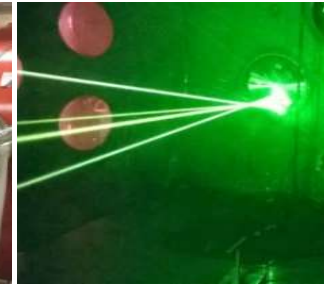


Average = 21 weeks/yr

Research = 15 weeks/yr

Industry = 6 weeks/yr

+ Education, Outreach



## Industrial contracts 26 companies (2013-2023)

### *ESA ExoMars 2020*

**OHB/KayserThrede, Germany**

Airbus UK

NEPTEC Canada

RYMSA ESPACIO Spain

MDA Canada

RUAG, Austria

AXON, France

Leonardo/SELEX, Italy

SENER, Poland

SENER, Spain

Thales Alenia Space, Italy

Tekniker, Spain

Universidad Carlos III Madrid, Esp

Seram Coatings, Norway

### *ESA ExoMars 2016 / AURORA*

INAF/FMI/Oxford

**INAF Italy**

NPL, UK

OU UK

MagnaParva UK

CNES, France

SELEX, Italy

### *NASA Mars 2020*

UPC REMS Spain

JPL USA

CSA Canada

**Imperial London UK**

**ISAE-SUPAERO, France**

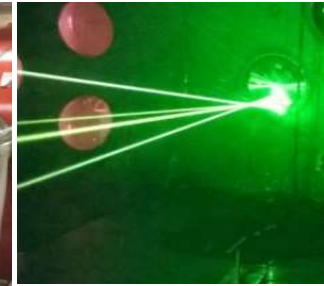
**15 Future projects 2023-;**  
**9 Industrial ESA**  
**6 Industrial NASA.**  
(incl. 4 Lunar simulation).



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# Research Projects



## Research/Training Projects

- 6 EU research networks
- 82 publications,
- >300 users,
- >1000 visitors/year

## 40 collaborative research projects

### Research Collaborations

Oxford University UK  
 Cornell University USA  
 Open University UK  
 JPL USA  
 Bern CH  
 PSI CH  
 UNIGE CH  
 FMI Finland  
 Oxford University UK  
 INAF Italy  
 Naples University Italy  
 John Hopkins University USA  
 TUB Germany  
 UPC Spain  
 SETI USA  
 ISAE-SUPAERO France  
 University Bordeaux France  
 IRAP France  
 Sorbonne, France  
 CNRS, France

Uni. Rennes  
 Uni. Nantes  
 DLR Germany  
 LMU Germany  
 INGV Italy  
 UCL Belgium  
 Imperial College London UK  
 IRSN France  
 SWRI USA  
 University of Rome T. Vergata, Italy  
 PSI CH  
 KU DK  
 DTI DK  
 NLL Risø, DK  
 Tufts University, USA  
 University Amsterdam, NL  
 Utrecht University, NL  
 Ben Gurion University, Israel  
 University of Tuscia, Italy  
 University Manchester, UK

## International Research networks

- Planetology (Europlanet)
- Volcanology Network
- Meteorology Network
- Aerosol
- Aeolian

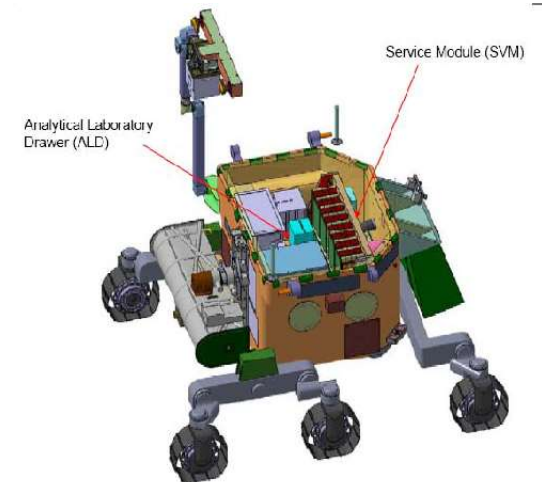
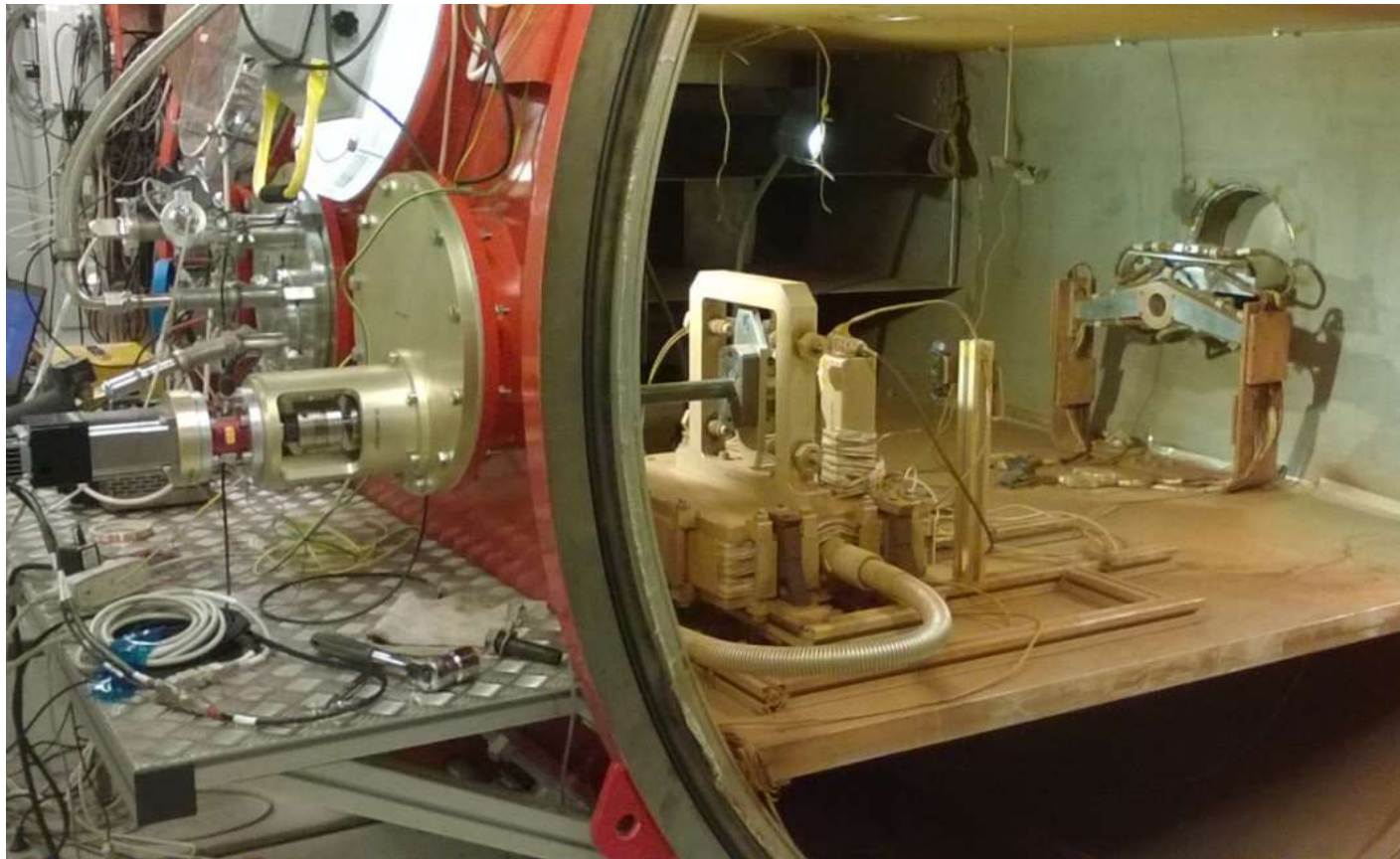


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# Industrial Contract



The MDA team for the ExoMars rover on one of their test campaigns



E X O M A R S

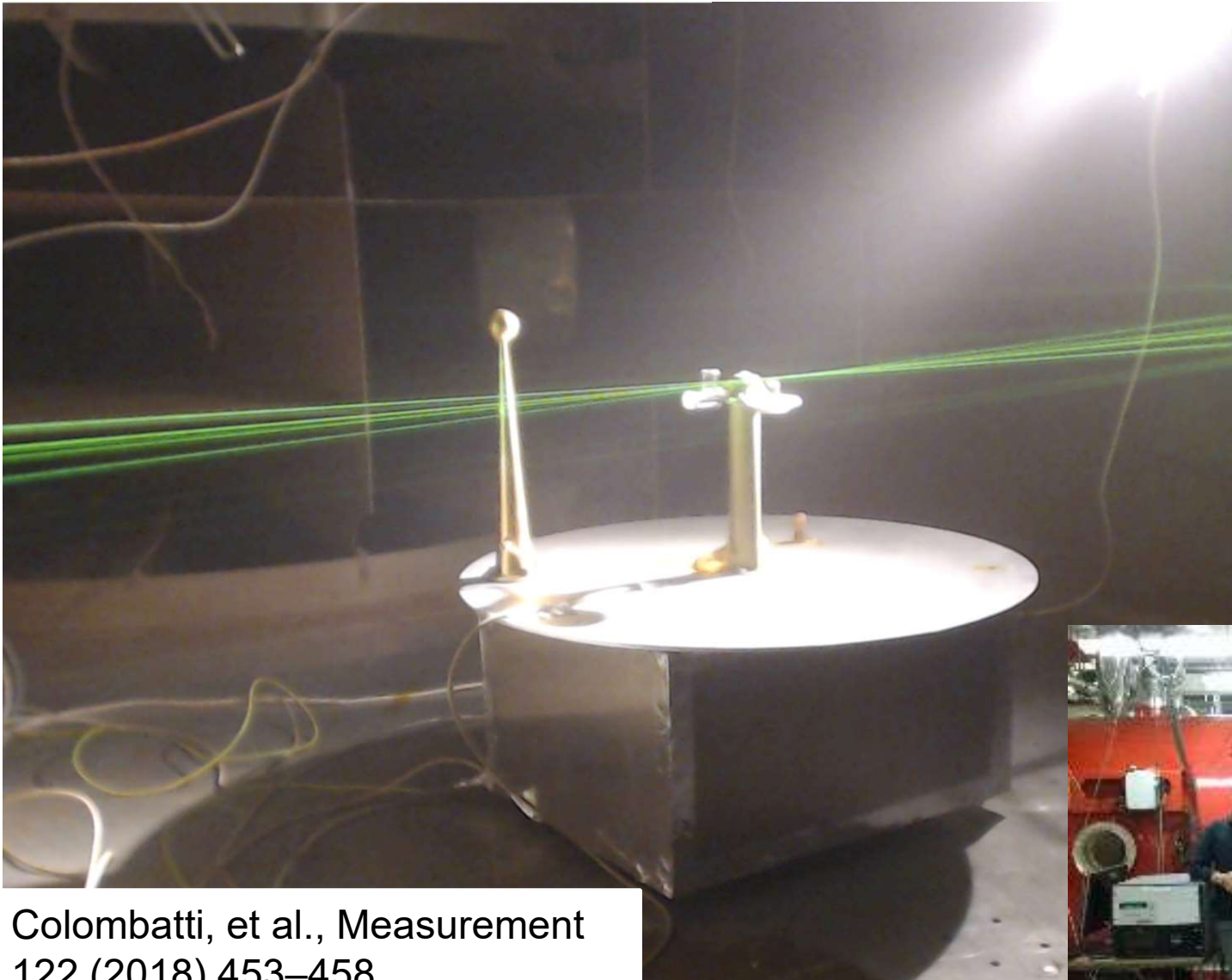
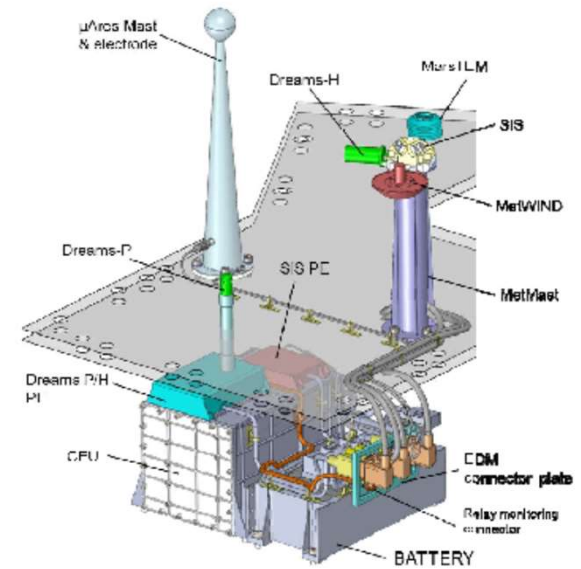




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# Industrial Contract ESA ExoMars 2016



Colombatti, et al., Measurement  
122 (2018) 453–458

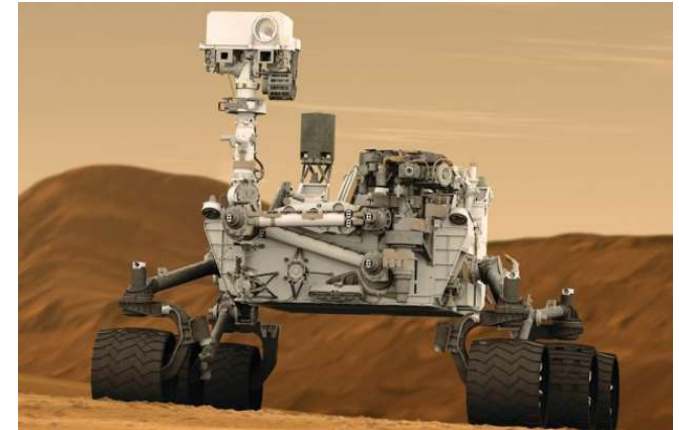


EXOMARS



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# Industrial Contract



NASA Mars 2020  
Supercam team testing  
campaigns at the PEF

- C. Baptiste et al. 2021
- N. Murdoch et al. 2019



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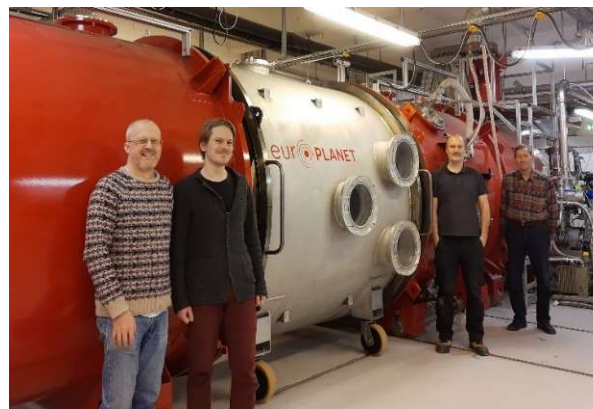
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# Recent Improvements



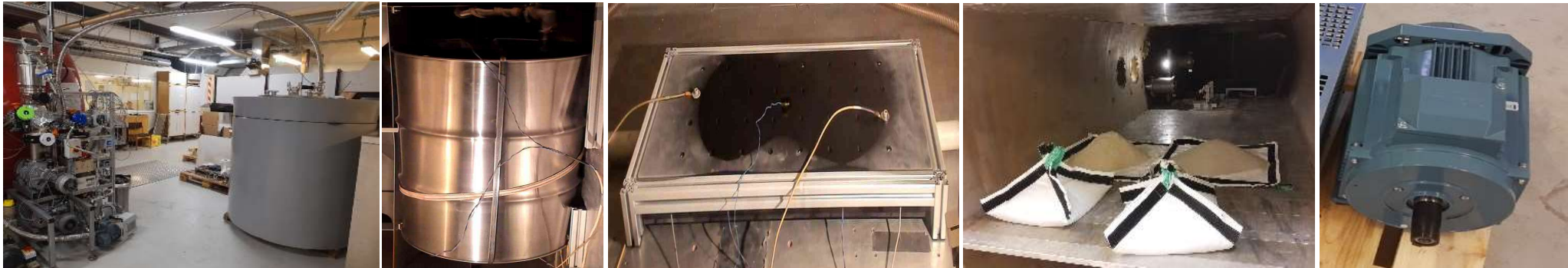
eur  PLANET

- Air cooler
- Extra pumps (lunar simulation)
- New Test section (+2m)
- New wind generator
- High speed windtunnel sections



2020 - 2024

# Feasibility study on the development of Moon / Mars planetary surface simulator subsystems (ESA RFP/3-17857/22/NL/GLC/my)-6/6/2023



## **Concrete Vacuum Chamber:**

Successfully evacuated (to 0.14mbar) and showed low ultimate outgassing rate.

## **High Vacuum Chamber (sub-system):**

Demonstrated > 5 orders magnitude reduction in pressure to (below  $10^{-6}$ mbar).

## **Cooling/Heating Unit:**

Efficient, effective cooling/heating module demonstrated (-120C to +110C)

## **Regolith Module**

A simple, easily manufactured, effective system successfully demonstrated (1m<sup>2</sup>/min)

## **Fan Motor Module**

Solution: a commercial high power AC motor can be driven at low voltage.



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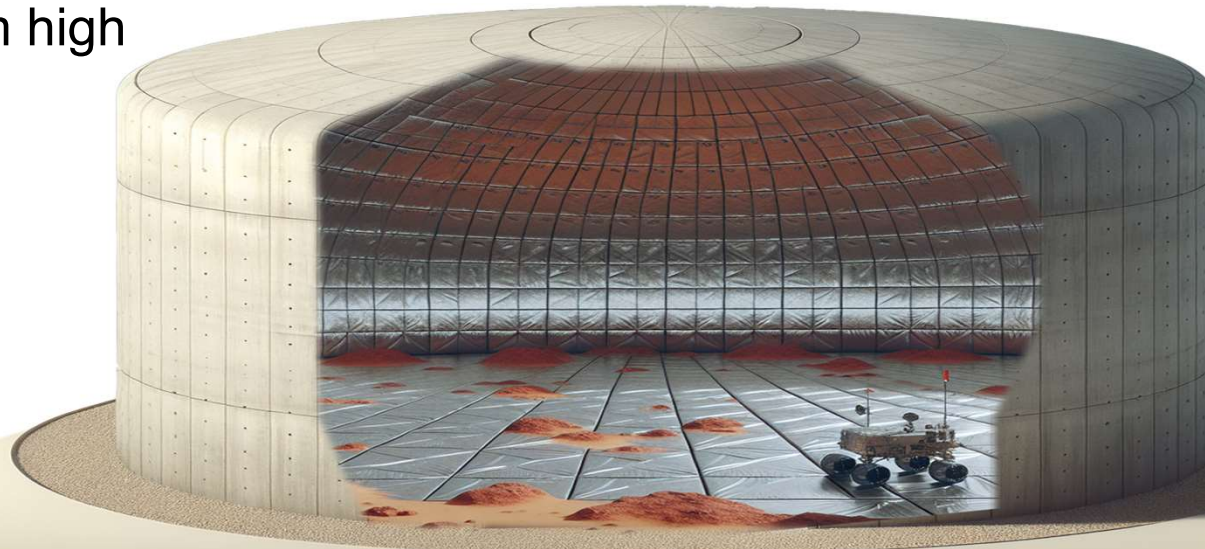
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DANISH  
TECHNOLOGICAL  
INSTITUTE

# Large Scale Mars-Moon test Facility (DWTVAC)

30m wide x 6m high



**Large = 4000m<sup>3</sup>, P <10<sup>-4</sup> mbar**

**New ESA contract: business case  
Led by Christian Dalsgaard, DTI**

**Full Scale landed Mission  
simulations (Test/calibrate)**

- Rovers / manned vehicles
- Drones
- 'Space/Lunar/Mars' EVA
- Mars/Lunar habitat



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