

BREMEN DROP TOWER GRAVITOWER BREMEN PRO

AT A GLANCE



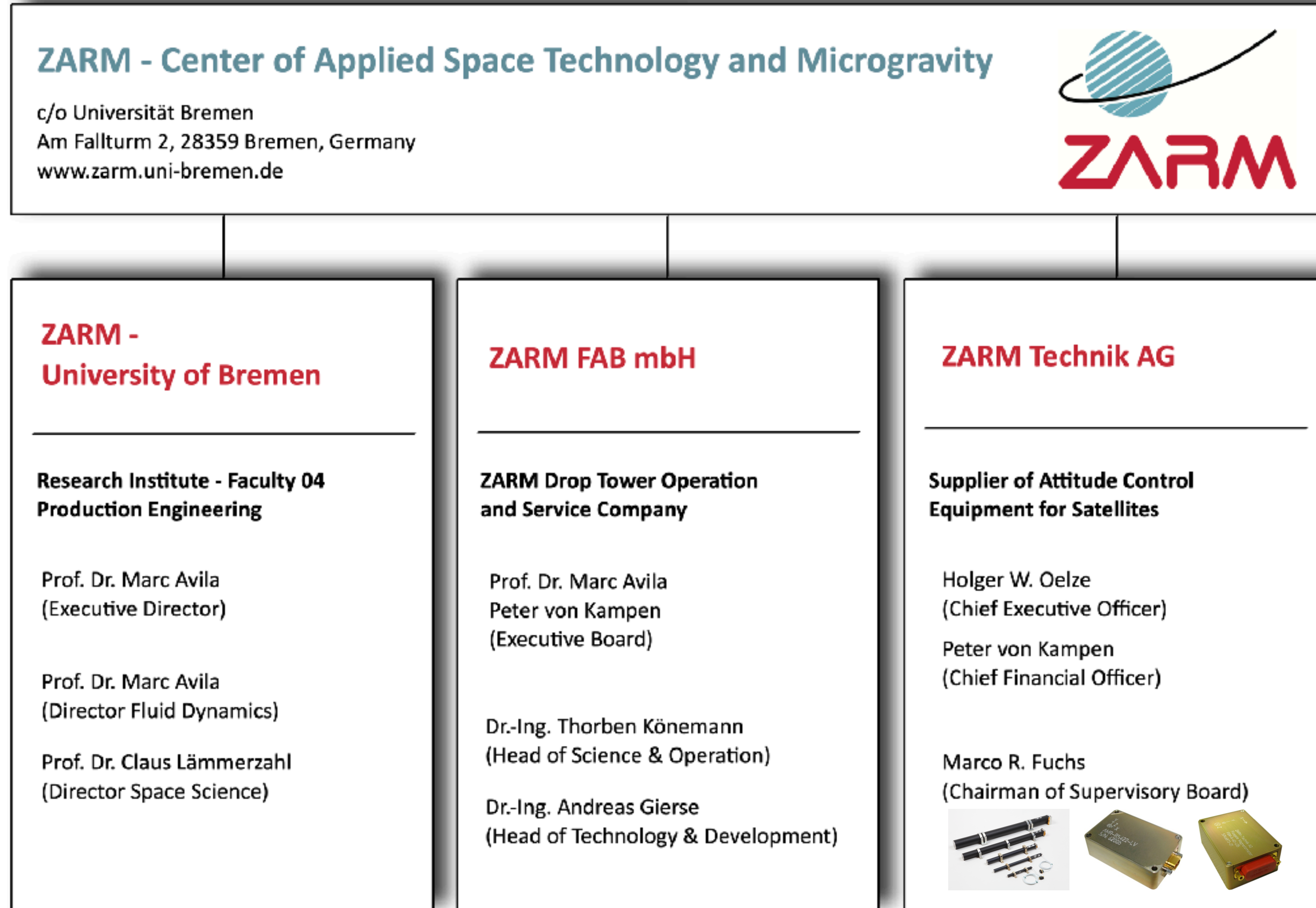
Dr. Thorben Könemann
ZARM Drop Tower Operation and Service Company
DropTES AO Webinar, December 02, 2022

Content

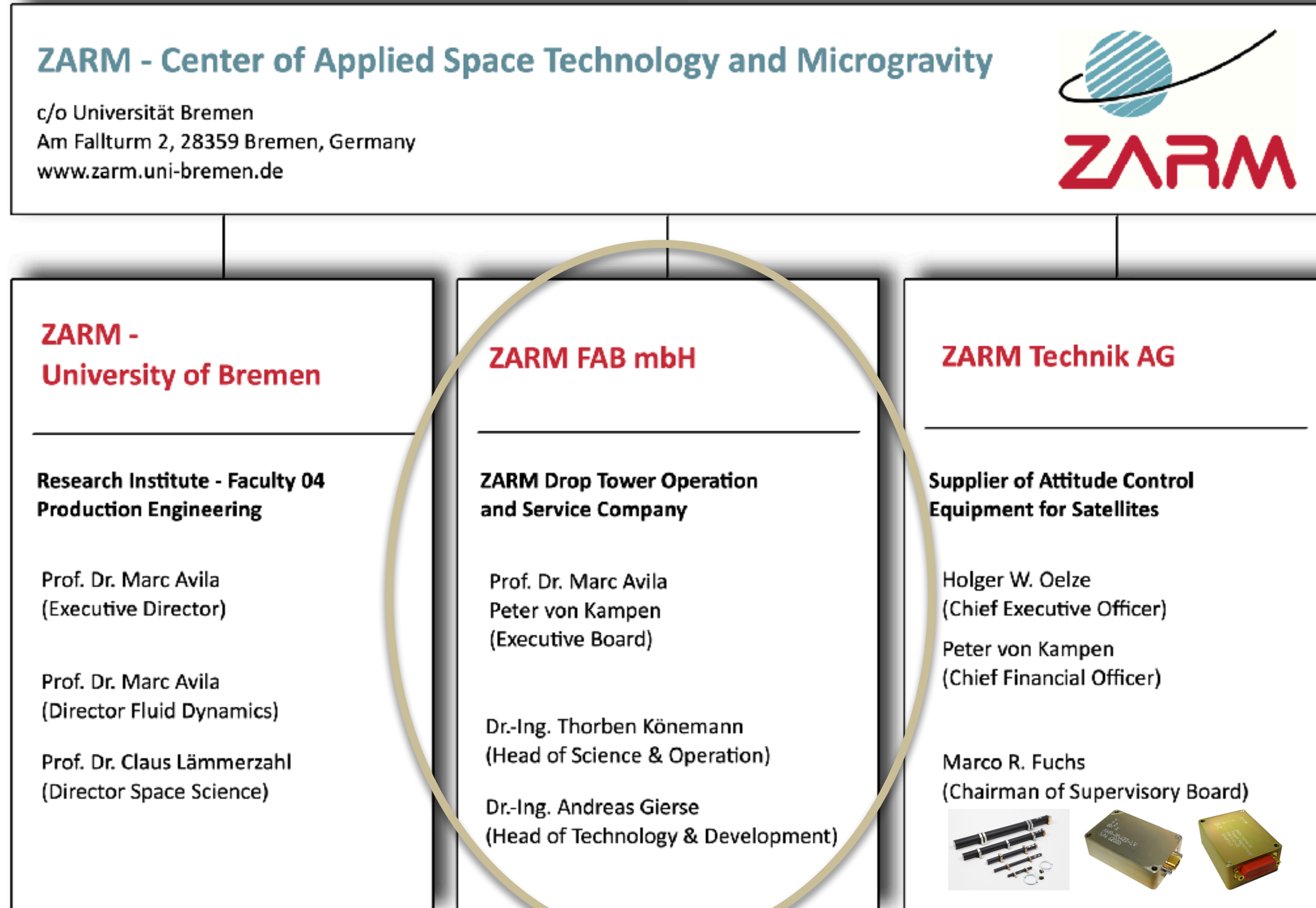
- ▶ About ZARM
- ▶ Bremen Drop Tower
- ▶ GraviTower Bremen Pro
- ▶ Take Home Messages



BREMEN DROP TOWER



BREMEN DROP TOWER



BREMEN DROP TOWER

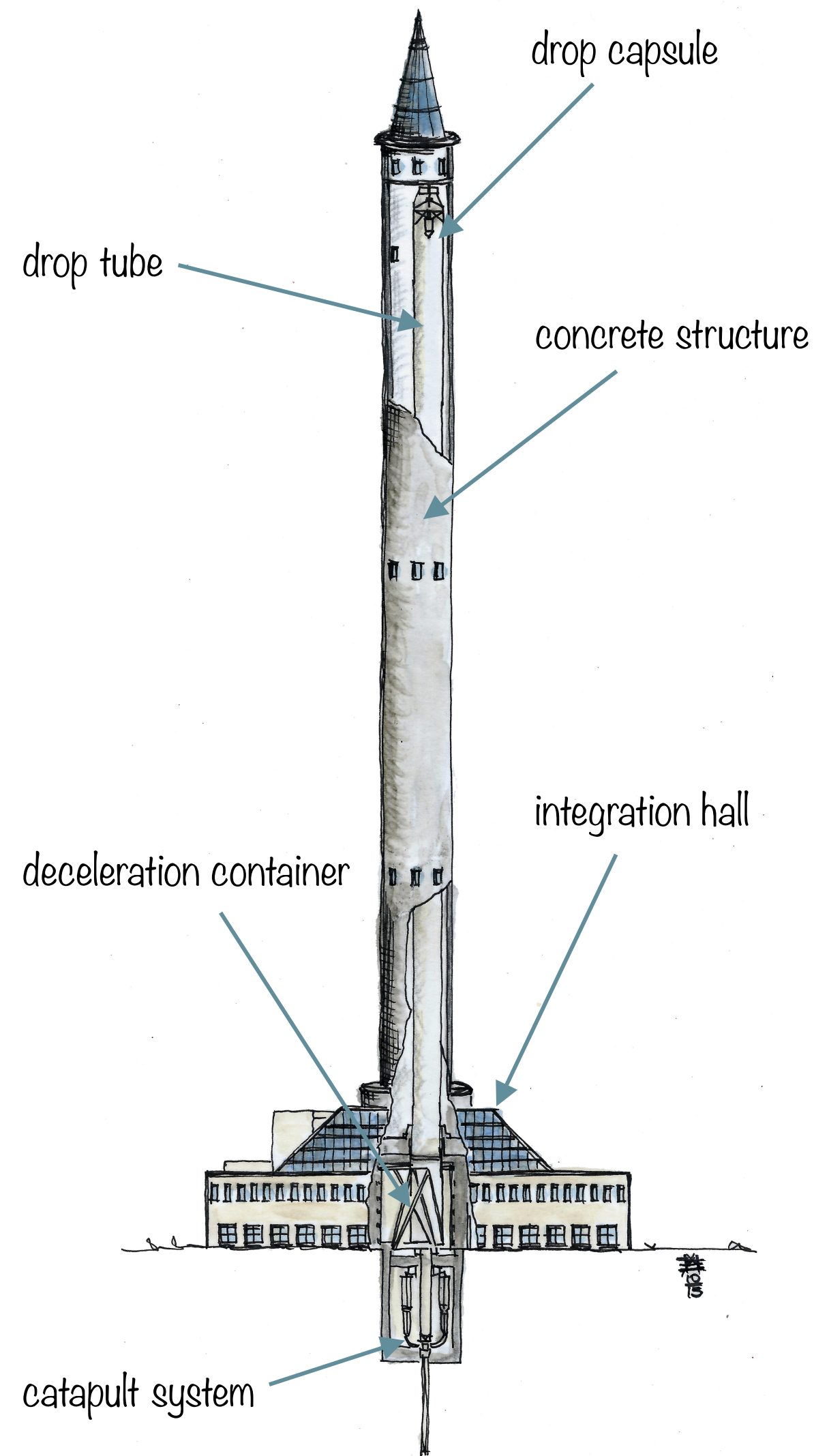
Content

- ▶ About ZARM
- ▶ **Bremen Drop Tower**
- ▶ GraviTower Bremen Pro
- ▶ Take Home Messages



BREMEN DROP TOWER

Bremen Drop Tower



FACTS ABOUT THE DROP TOWER BUILDING

- **height of the Bremen Drop Tower: 146 m**
- diameter of the concrete structure: 8 m
- stairs: about 600 steps until the top

FACTS ABOUT THE DROP TUBE

- height of the drop tube: 120 m
- distance of free fall: 110 m
- diameter of the drop tube: 3.5 m
- deceleration container: filled with 15 m³ of polystyrene pellets up to a height of 8.20 m
- **experiment duration in microgravity:**
drop experiment - 4.7 s
catapult experiment - 9.3 s (worldwide unique)
- maximum capsule speed: 168 km/h
- **gross weight of standard capsule: 500 kg**
- vacuum: 18 pumps draw out 1,700 m³ of air in 1.5 to 2 h
- pressure after evacuation: 10 Pa (0.1 mbar)
- **achievable microgravity quality: 10⁻⁶ g**
- **number of drops or catapult launches:**
up to 3 times a day



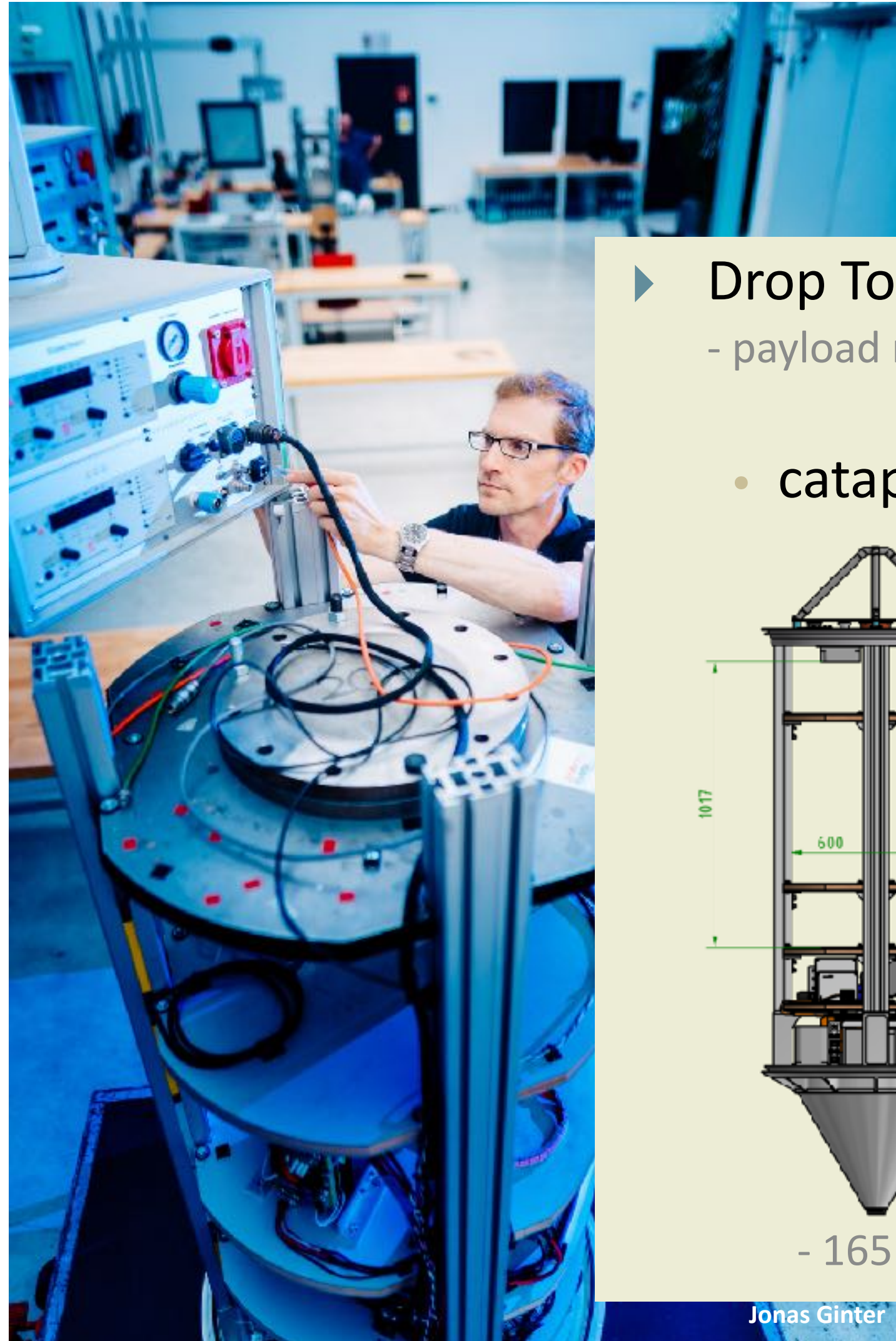
BREMEN DROP TOWER

Bremen Drop Tower



BREMEN DROP TOWER

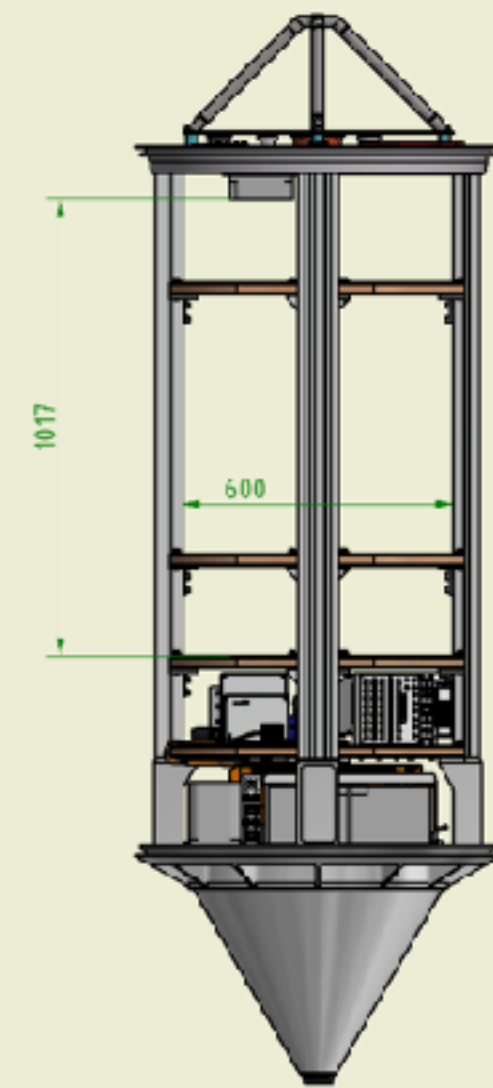
Bremen Drop Tower



Jonas Ginter

Drop Tower Capsule Versions: - payload masses -

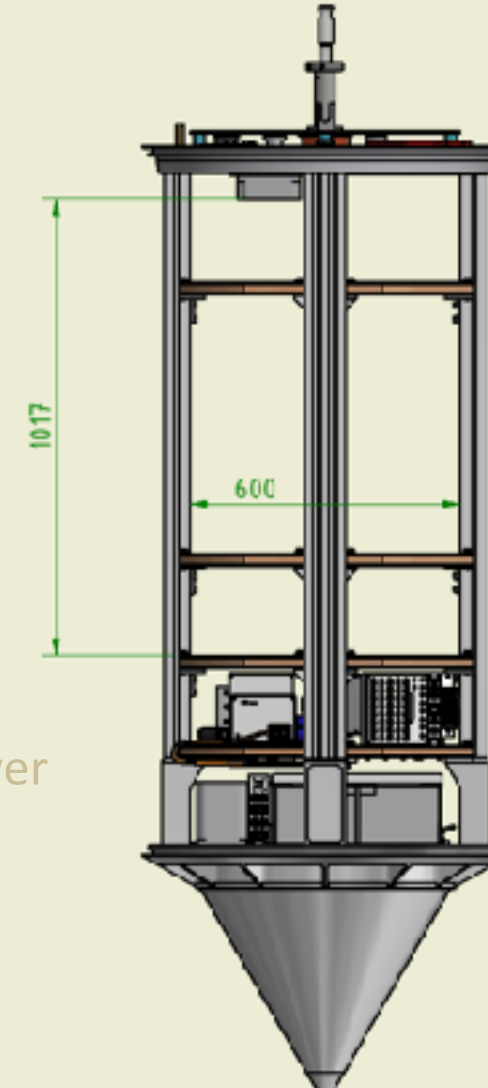
• catapult



- 165 kg -

▸ CCS
▸ power

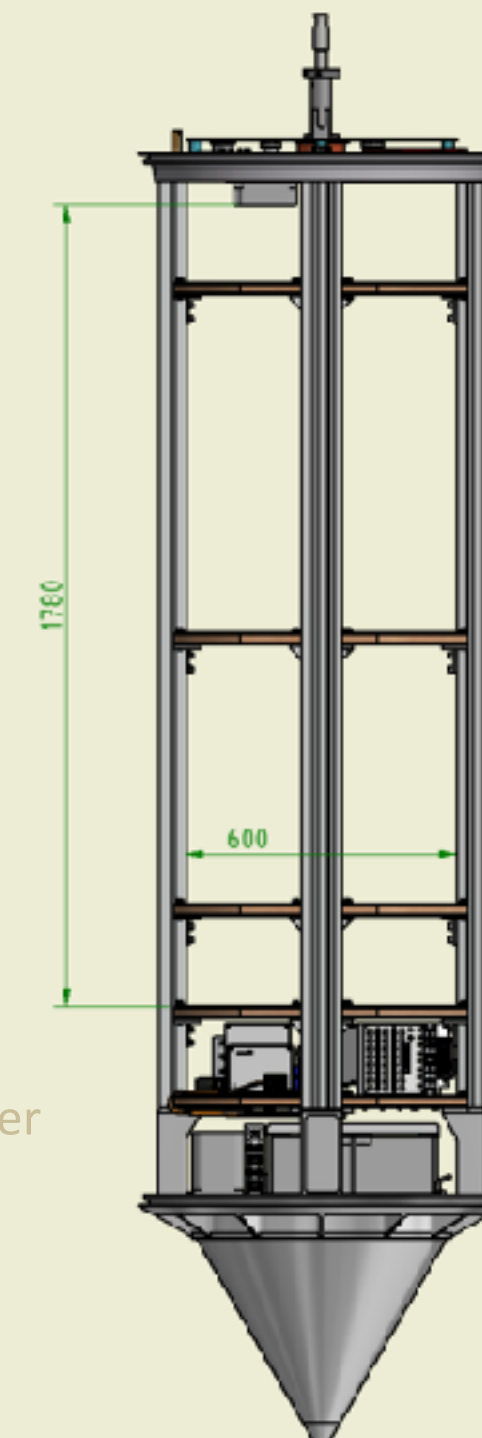
• short



- 265 kg -

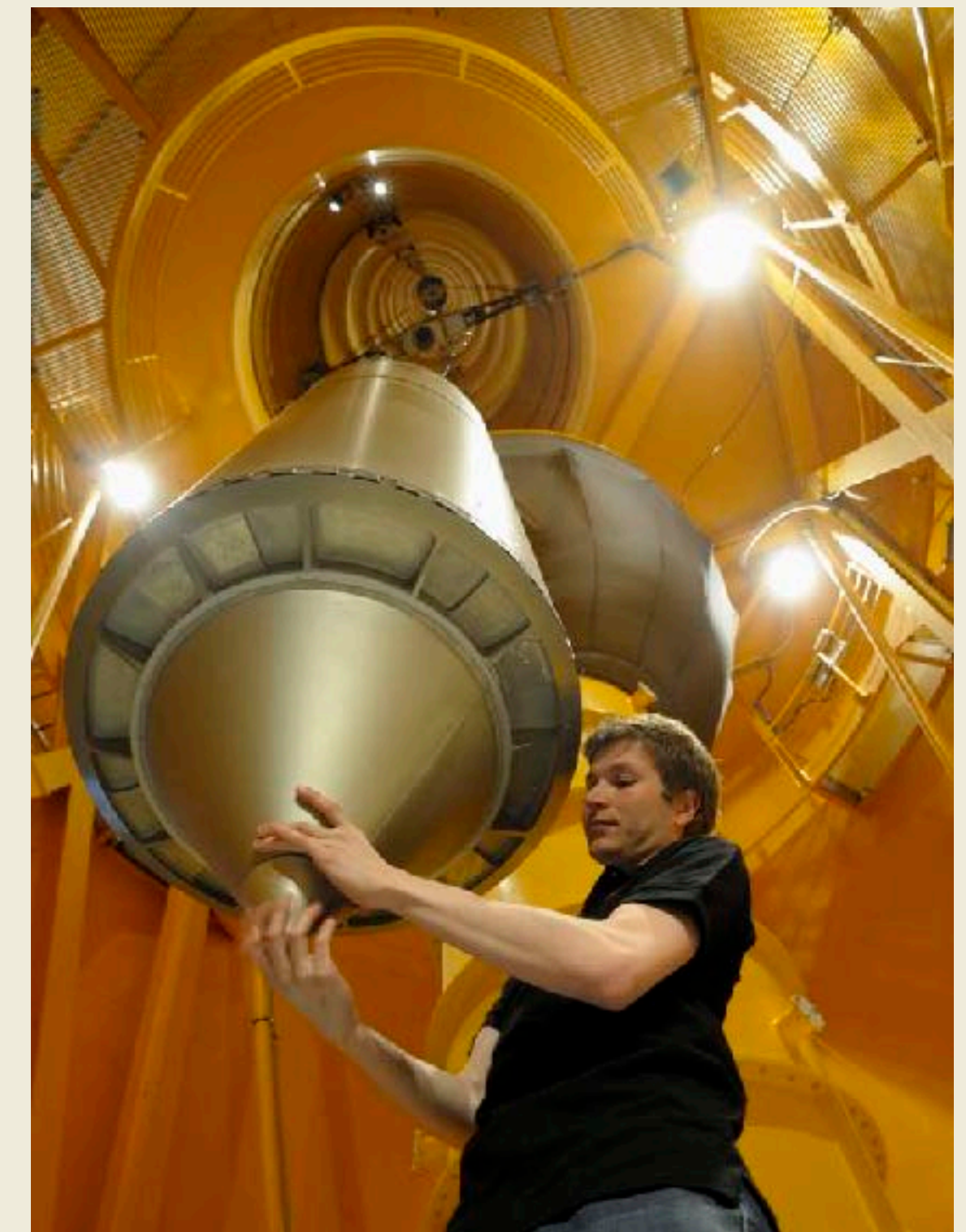
▸ CCS
▸ power

• long



- 225 kg -

▸ CCS
▸ power

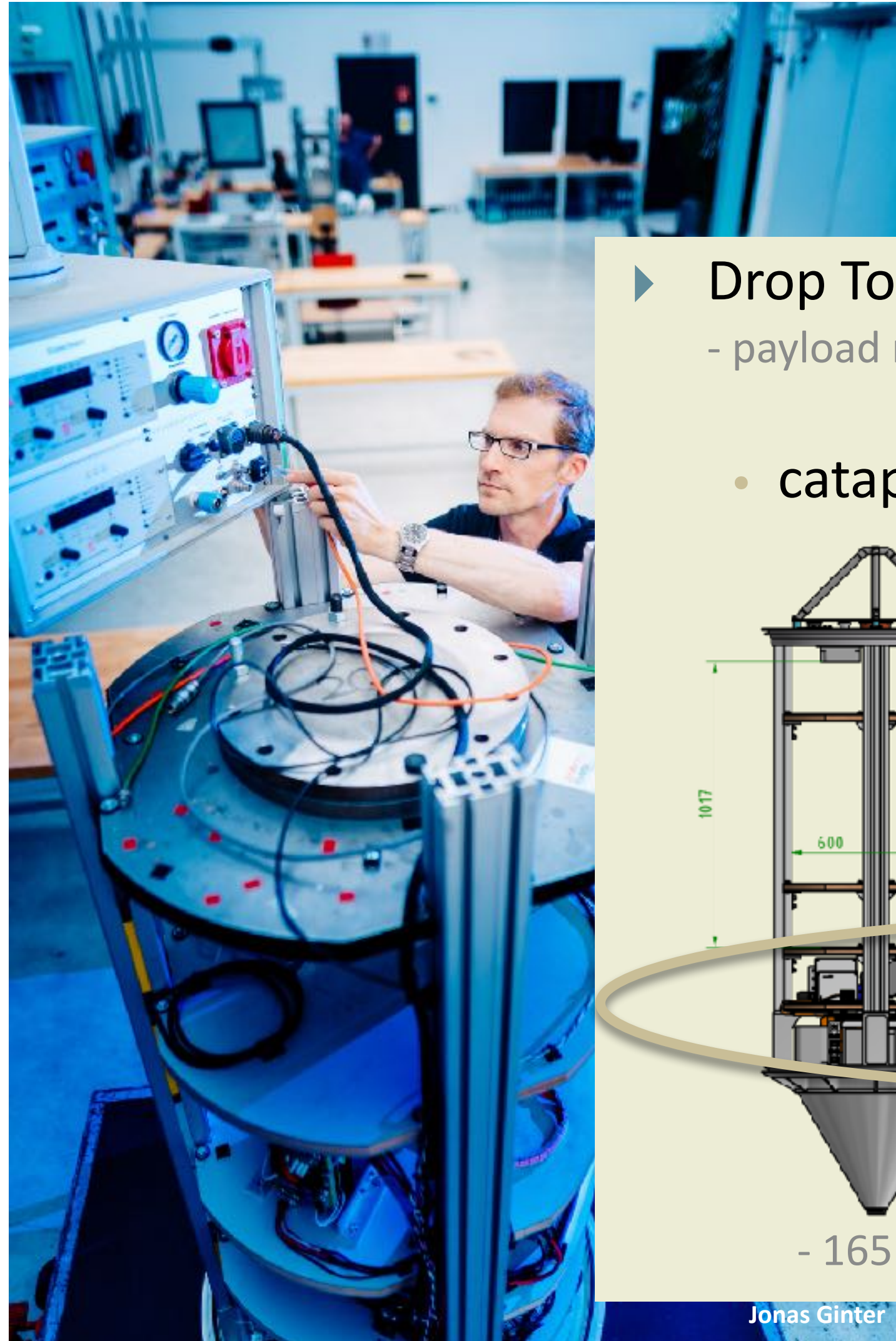


BREMEN DROP TOWER

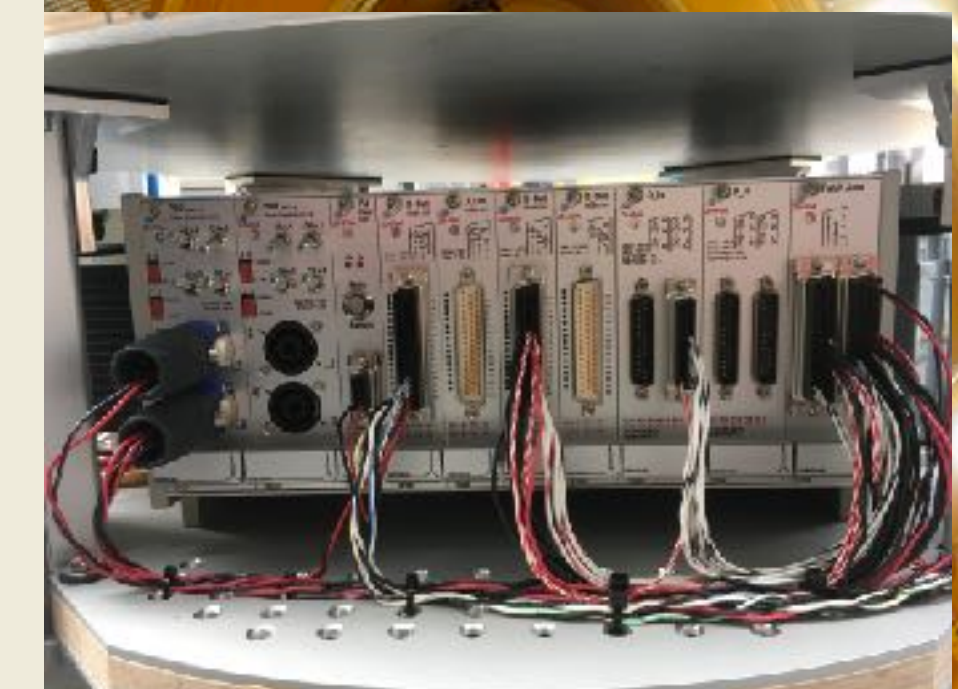
Jonas Ginter

Jonas Ginter

Bremen Drop Tower



Jonas Ginter



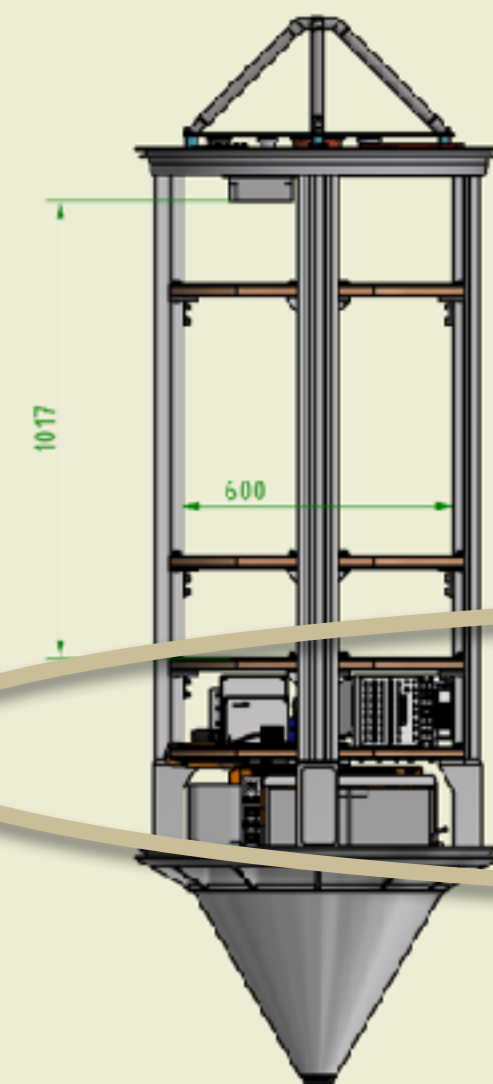
Drop Tower Capsule Versions:

- payload masses -

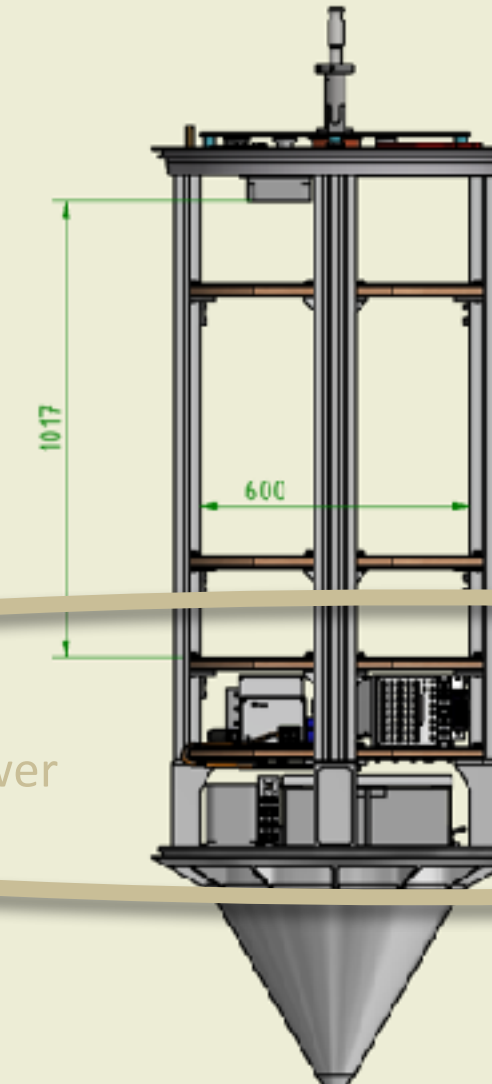
• catapult

• short

• long



- 165 kg -



- 265 kg -



- 225 kg -

- ▶ 24 V DC (27.6 V DC)
- ▶ max. 1500 W (batteries)
- ▶ 4x connectors (switchable)
- ▶ 8x power lines (15 A per line)

Jonas Ginter

Jonas Ginter

Bremen Drop Tower

ZENTRUM FÜR
ANGEWANDTE RAUMFAHRTTECHNOLOGIE
UND MIKROGRAVITATION



BREMEN DROP TOWER

Bremen Drop Tower

FACTS AND FIGURES

- *start of operation: September 1990*
- *number of drops / catapult launches:
over 9700 performed*
- *number of drop tower projects:
over 250 assisted*
- *framework contractor of*

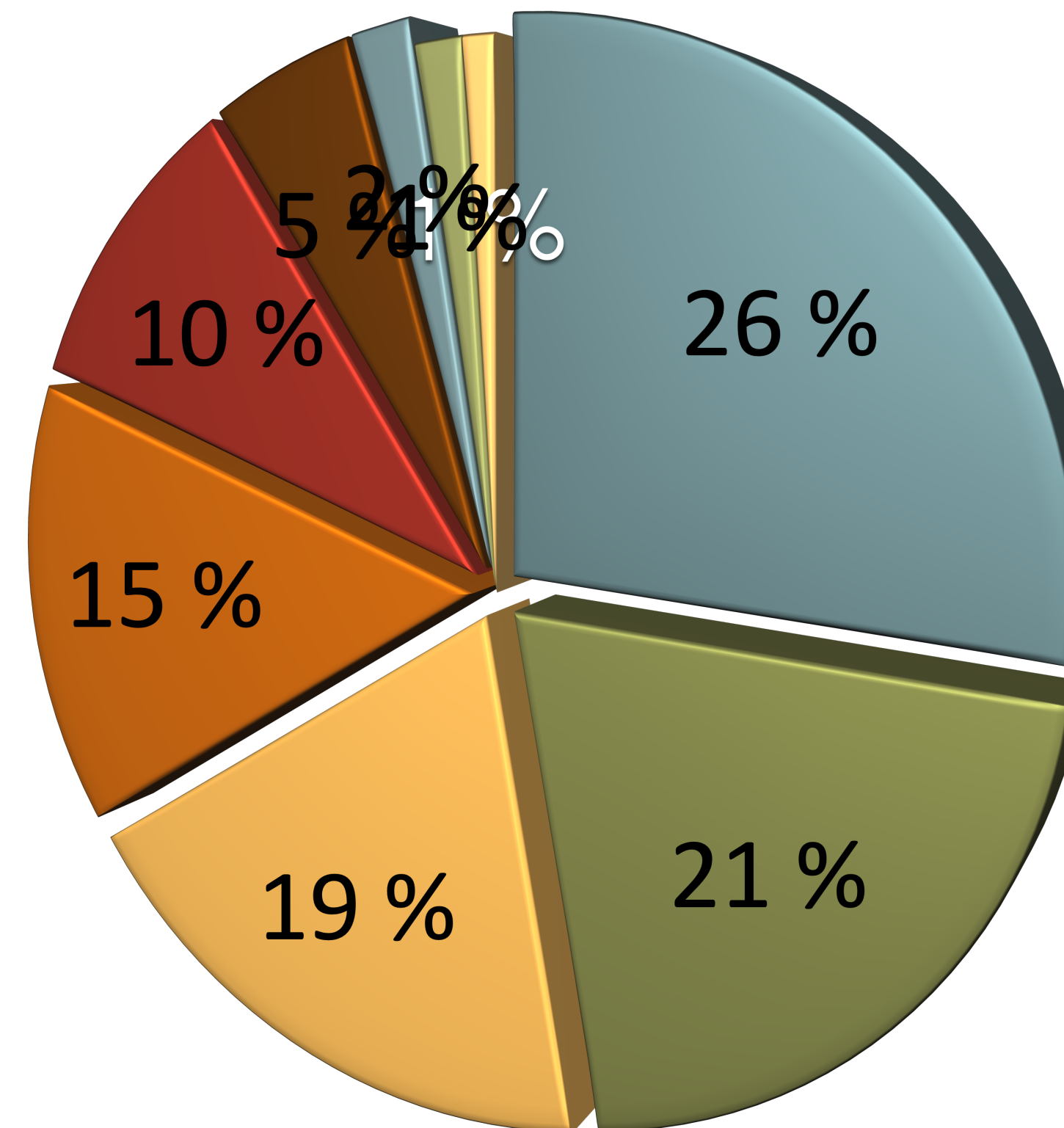


► RESEARCH AREAS

- Combustion
- Fundamental Physics
- Fluid Dynamics
- Astrophysics (Planet Formation)
- Materials Sciences
- Biology
- Hardware Tests
- Student Programs
- Chemistry

► *fundamental research*

► *technology development
(mission preparations)*



BREMEN DROP TOWER

Bremen Drop Tower

FACTS AND FIGURES

- *start of operation: September 1990*
- *number of drops / catapult launches:
over 9700 performed*
- *number of drop tower projects:
over 250 assisted*
- *framework contractor of*

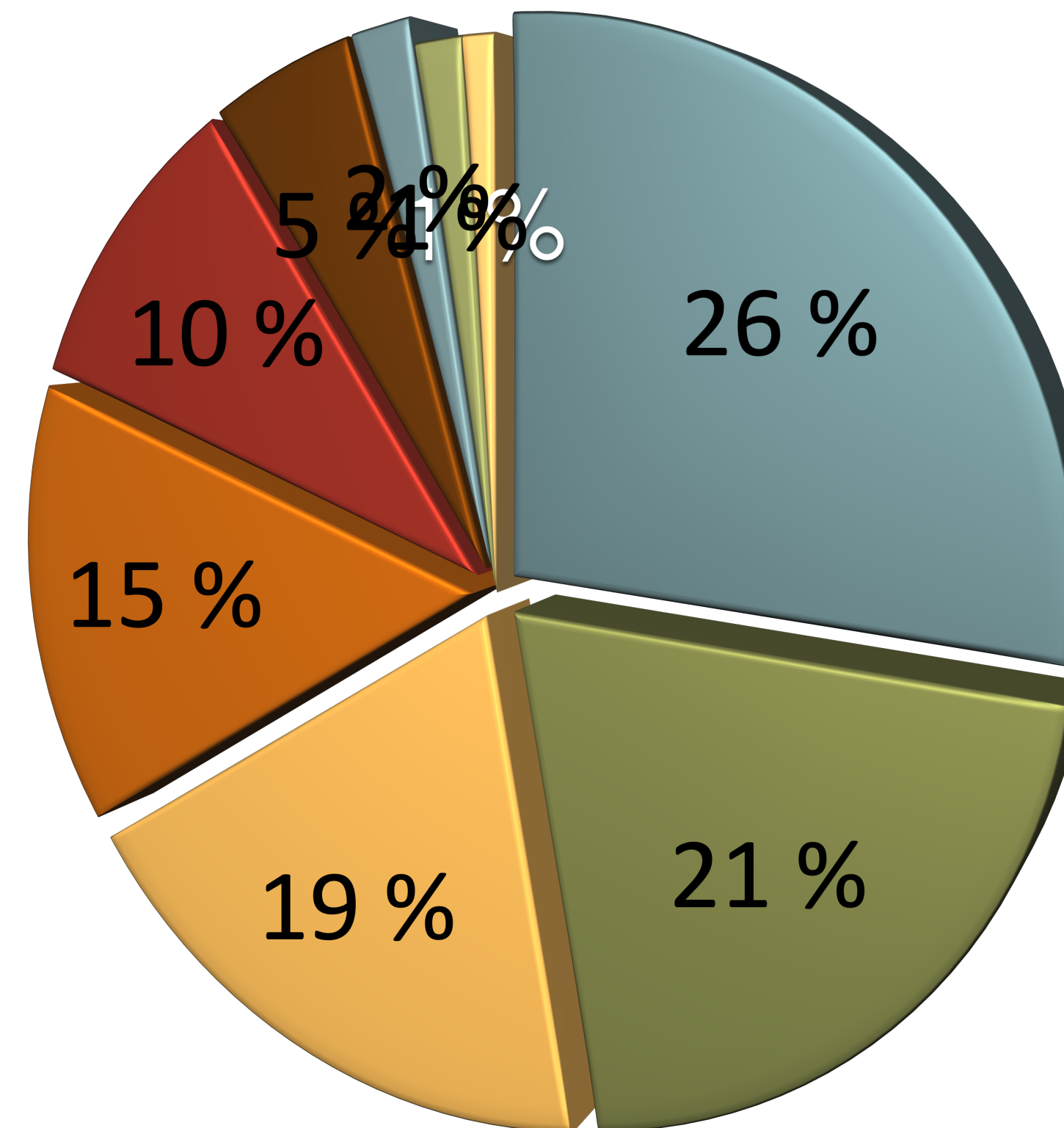


► RESEARCH AREAS

- Combustion
- Fundamental Physics
- Fluid Dynamics
- Astrophysics (Planet Formation)
- Materials Sciences
- Biology
- Hardware Tests
- Student Programs
- Chemistry

► *fundamental research*

► *technology development
(mission preparations)*



BREMEN DROP TOWER

Bremen Drop Tower

► RESEARCH AREAS

- Combustion
- Fundamental Physics
- Fluid Dynamics
- Astrophysics (Planet Form)
- Materials Sciences
- Biology
- Hardware Tests
- Student Programs
- Chemistry

- *fundamental research*
- *technology development
(mission preparations)*

DROPTES

- DROP TOWER EXPERIMENT SERIES -



UNITED NATIONS
Office for Outer Space Affairs



Bremen Drop Tower



PETRI

- PRACTICAL EDUCATION IN TECHNOLOGY, RESEARCH AND INNOVATION -



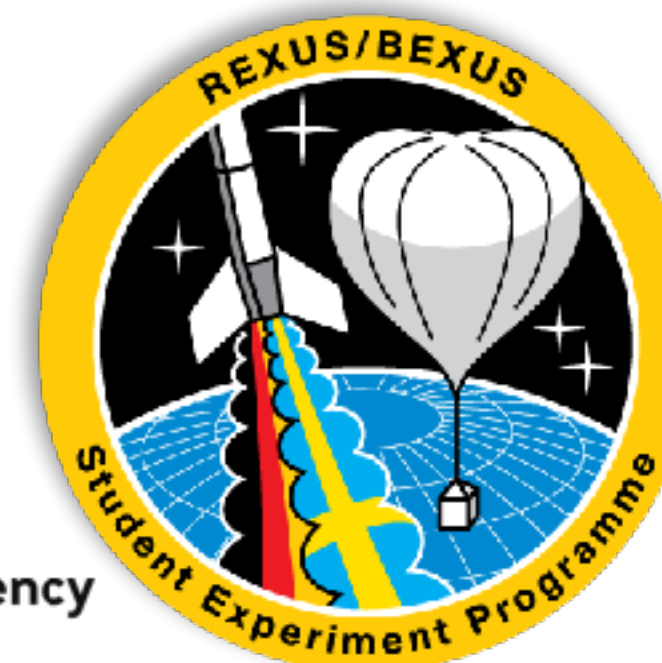
Bremen Drop Tower



REXUS / BEXUS



Rymdstyrelsen
Swedish National Space Agency



Kiruna, Sweden



Bremen Drop Tower

► RESEARCH AREAS

- Combustion
- Fundamental Physics
- Fluid Dynamics
- Astrophysics (Planet Form)
- Materials Sciences
- Biology
- Hardware Tests
- Student Programs
- Chemistry

► *fundamental research*

► *technology development*
(mission preparations)

DROPTES

- DROP TOWER EXPERIMENT SERIES -



UNITED NATIONS
Office for Outer Space Affairs



Bremen Drop Tower



PETRI

- PRACTICAL EDUCATION IN TECHNOLOGY, RESEARCH AND INNOVATION -



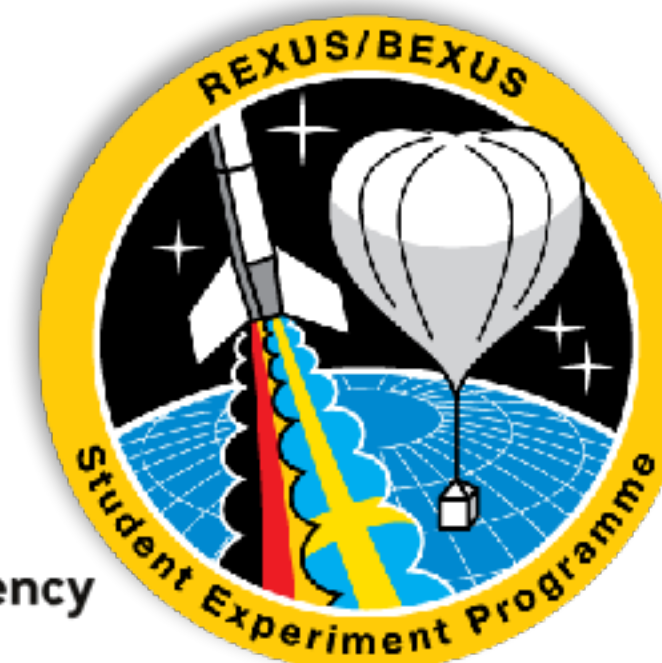
Bremen Drop Tower



REXUS / BEXUS



Rymdstyrelsen
Swedish National Space Agency



Kiruna, Sweden



Bremen Drop Tower

- Stepping Stone into Space -



FROM SUBORBITAL
TO SPACE MISSIONS



INTEGRATION, PREPARATION, AND QUALIFICATION
- SCIENTIFIC EXPERIMENTS / TECHNOLOGY TESTS -



BREMEN DROP TOWER

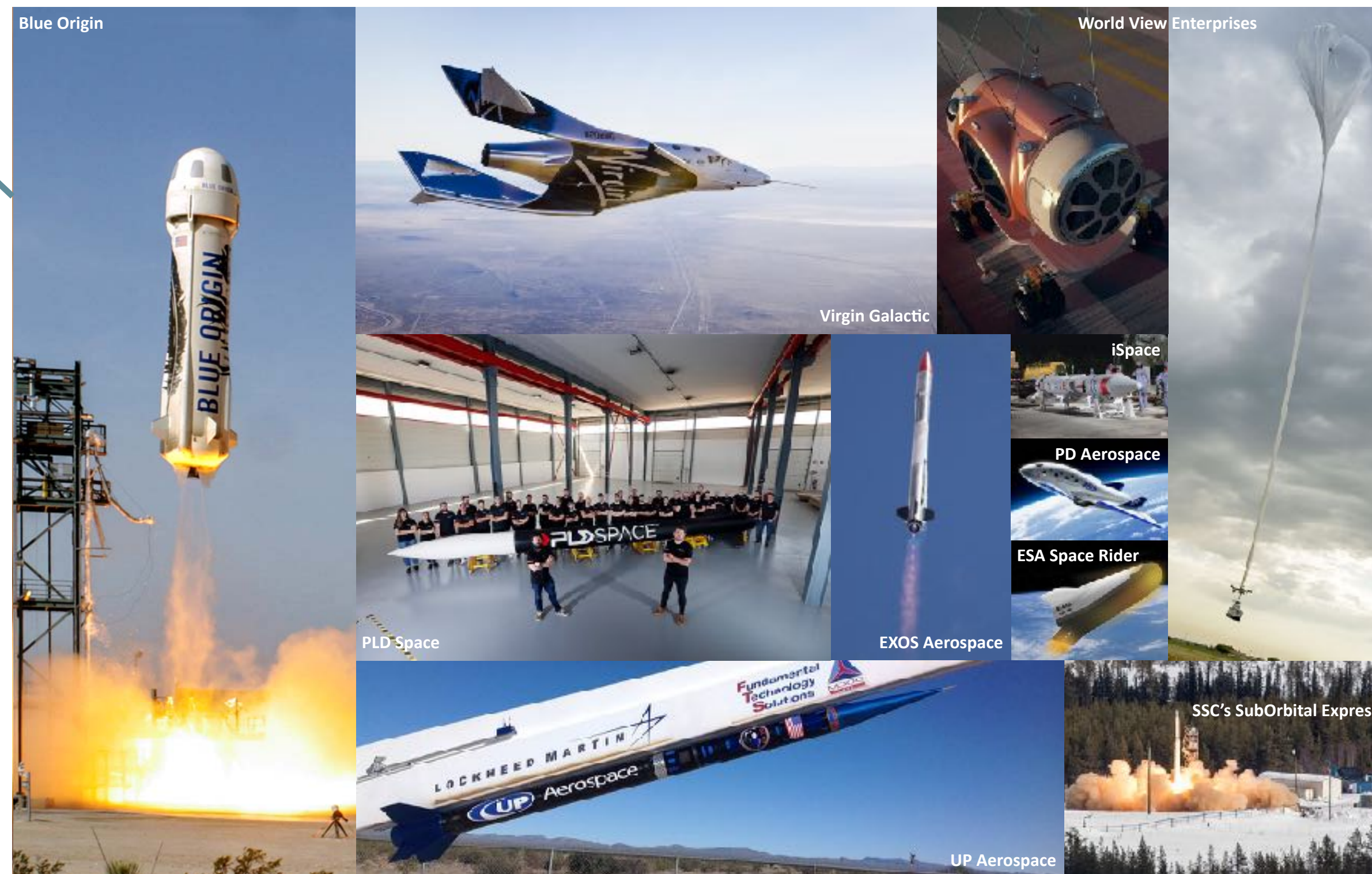
Bremen Drop Tower

- Stepping Stone into Space -



► "New Kids on the Block"

FROM SUBORBITAL
TO SPACE MISSIONS



INTEGRATION, PREPARATION, AND QUALIFICATION
- SCIENTIFIC EXPERIMENTS / TECHNOLOGY TESTS -



BREMEN DROP TOWER

Bremen Drop Tower

- Stepping Stone into Space -



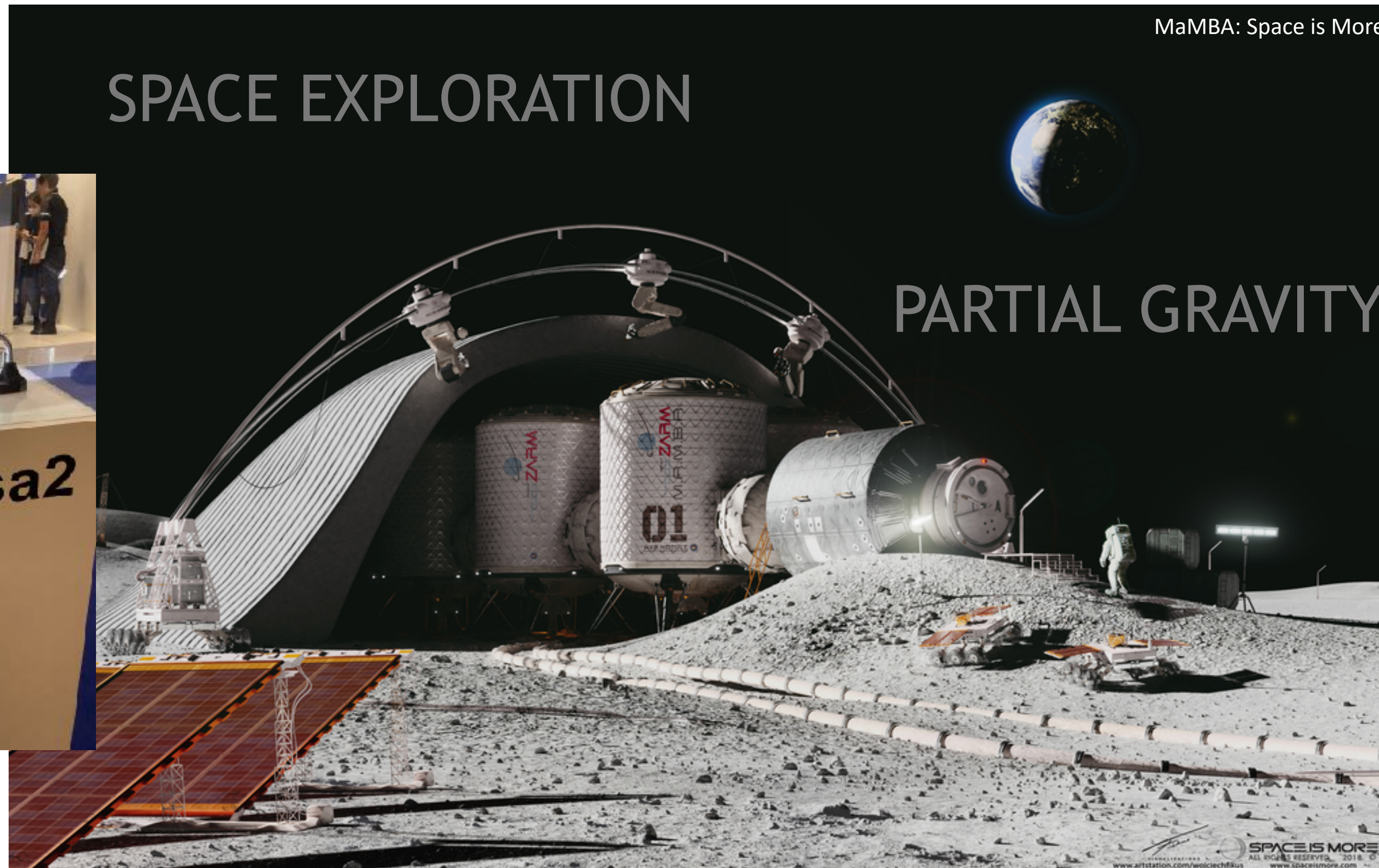
SPACE EXPLORATION

MaMBA: Space is More

PARTIAL GRAVITY



IAC 2022, Paris



INTEGRATION, PREPARATION, AND QUALIFICATION
- SCIENTIFIC EXPERIMENTS / TECHNOLOGY TESTS -



BREMEN DROP TOWER

Bremen Drop Tower

- Stepping Stone into Space -



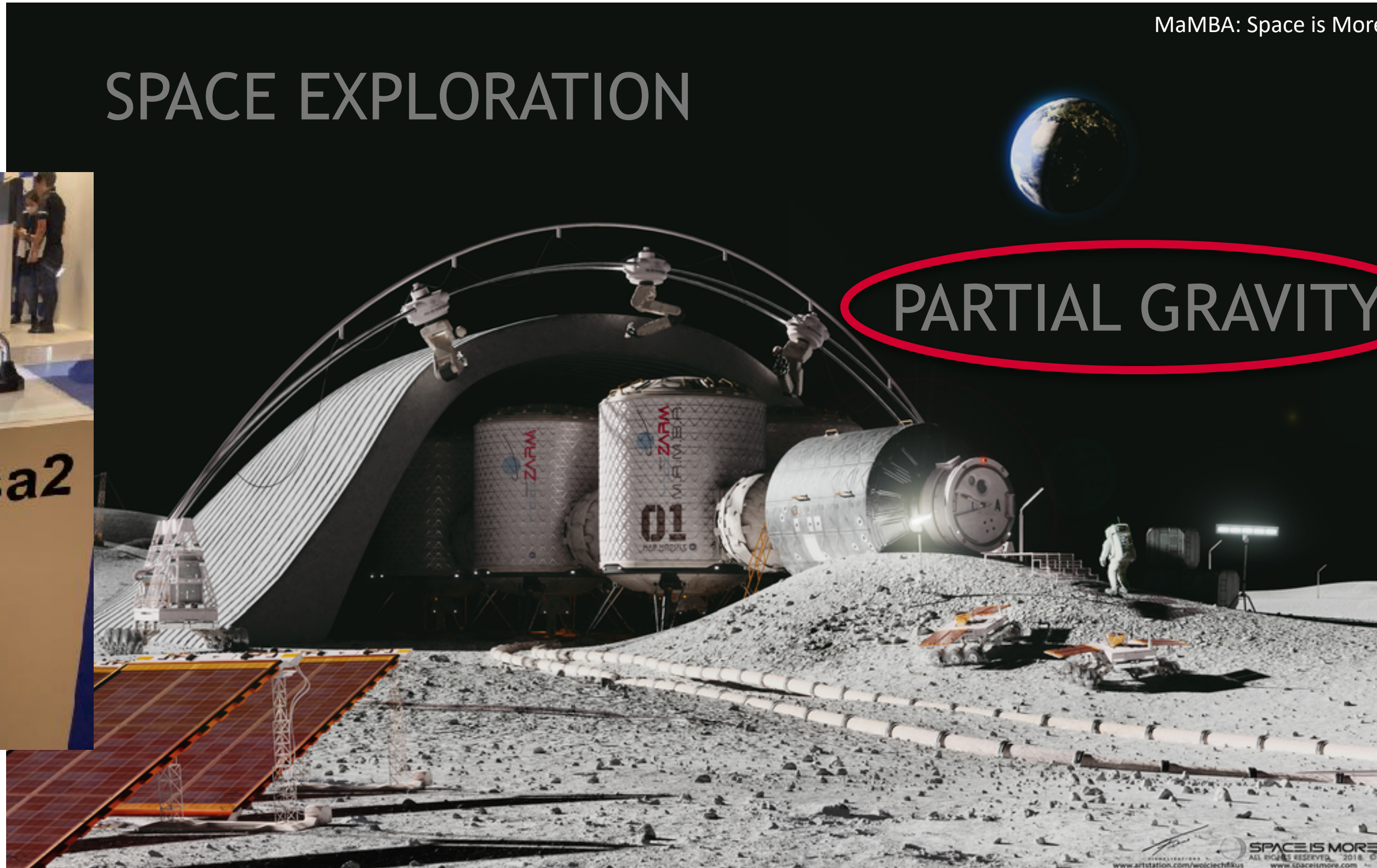
SPACE EXPLORATION

MaMBA: Space is More

PARTIAL GRAVITY



IAC 2022, Paris

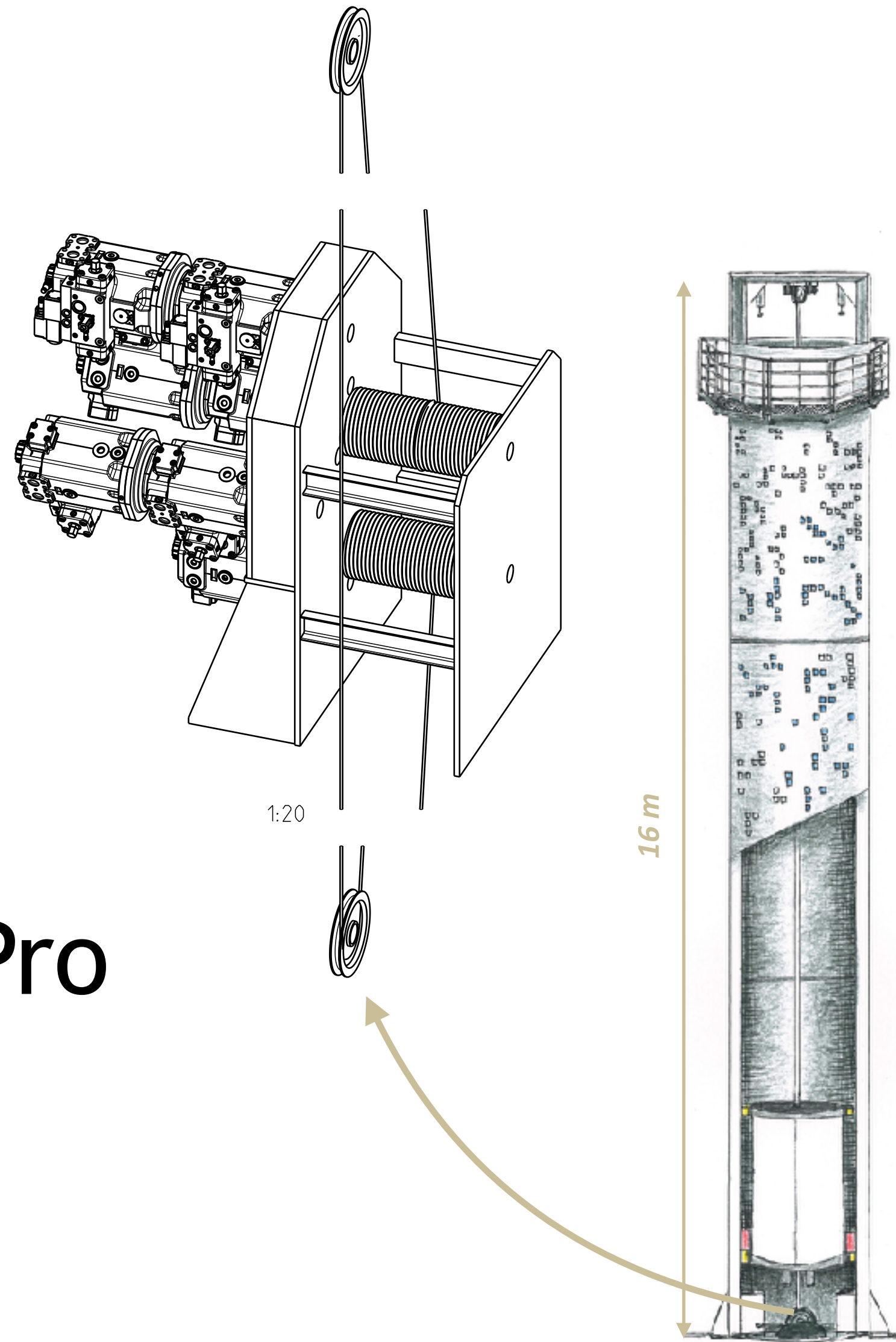


BREMEN DROP TOWER

INTEGRATION, PREPARATION, AND QUALIFICATION
- SCIENTIFIC EXPERIMENTS / TECHNOLOGY TESTS -

Content

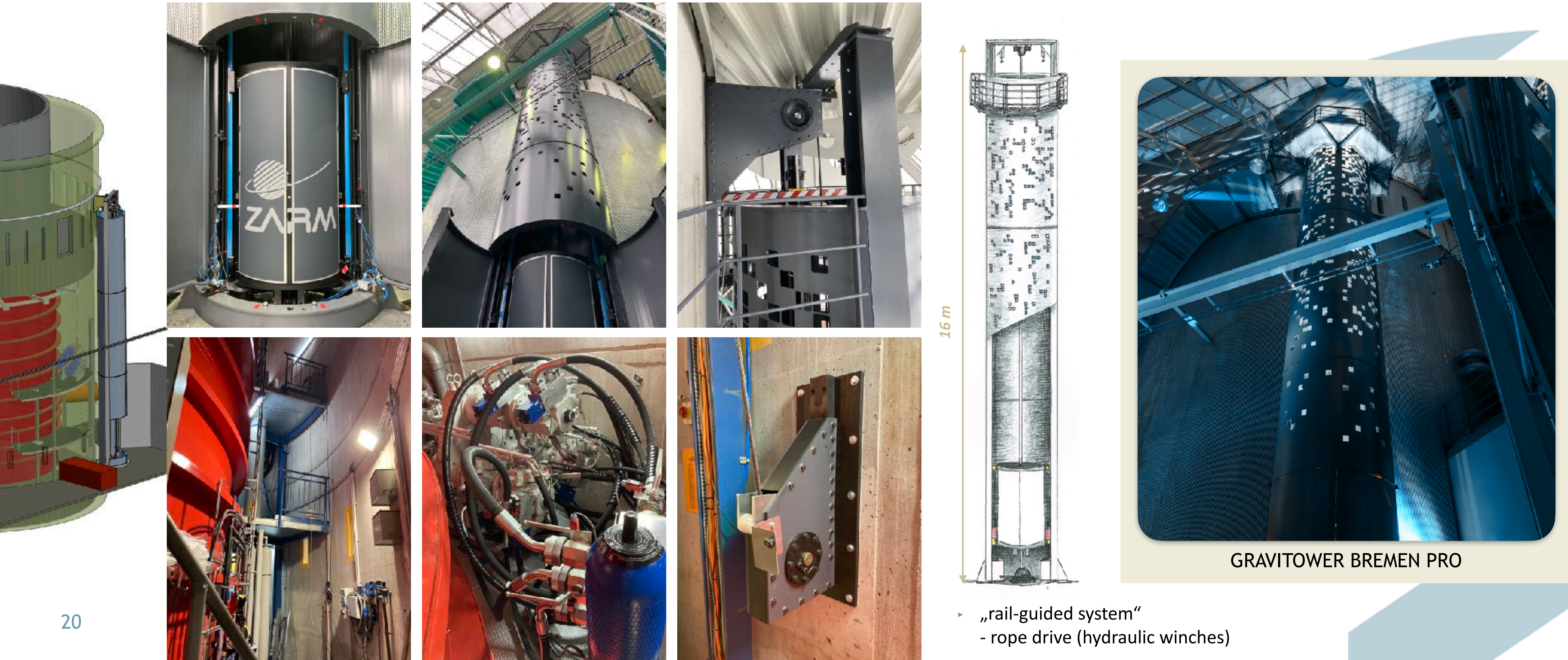
- ▶ About ZARM
- ▶ Bremen Drop Tower
- ▶ **GraviTower Bremen Pro**
- ▶ Take Home Messages



BREMEN DROP TOWER

GraviTower Bremen Pro

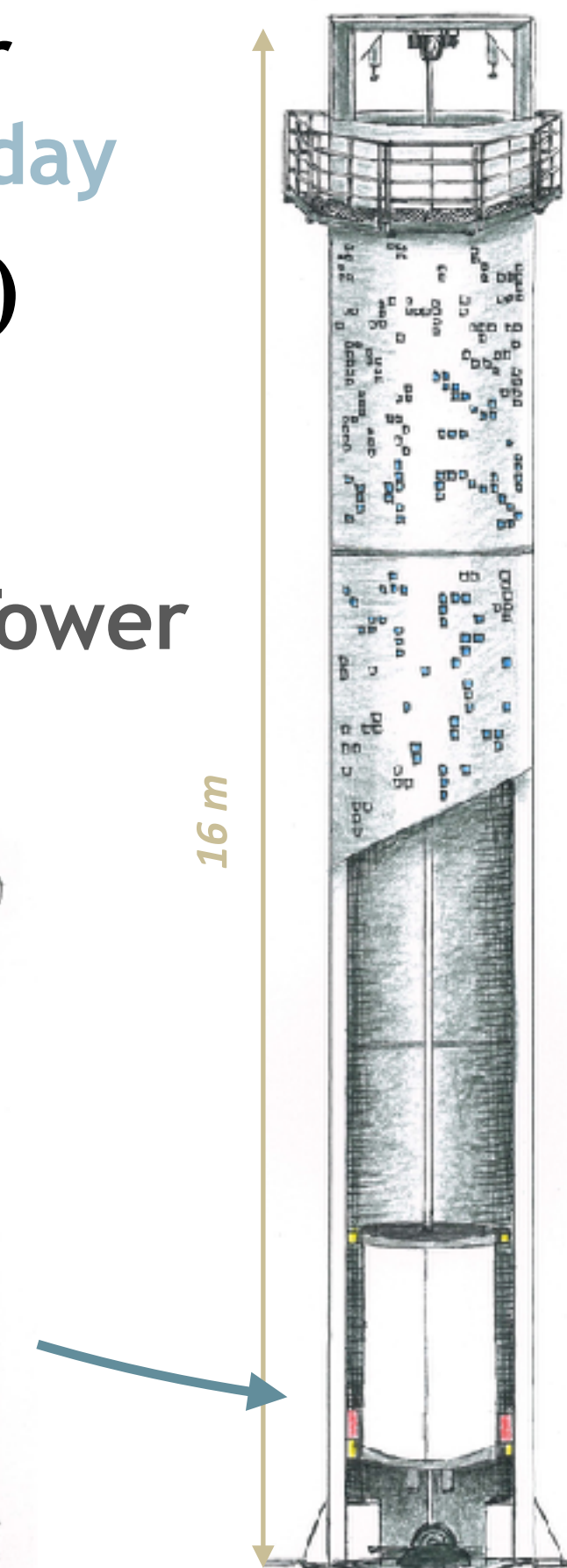
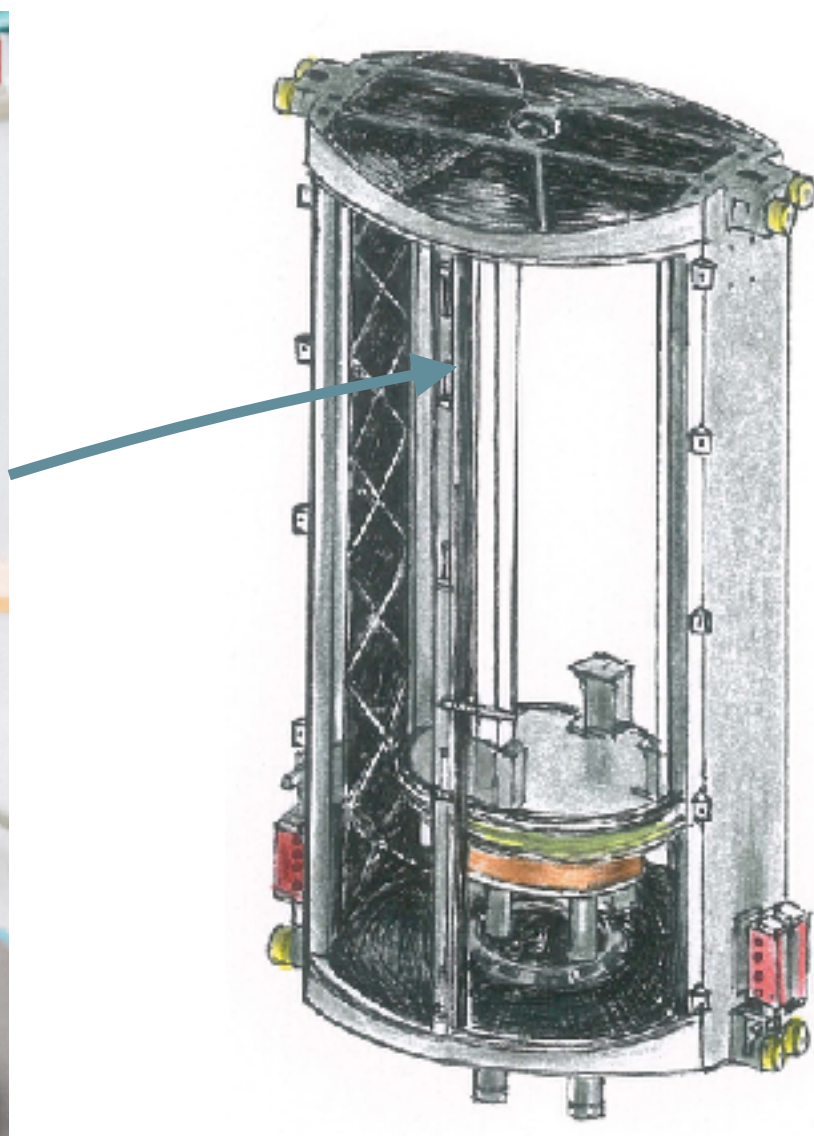
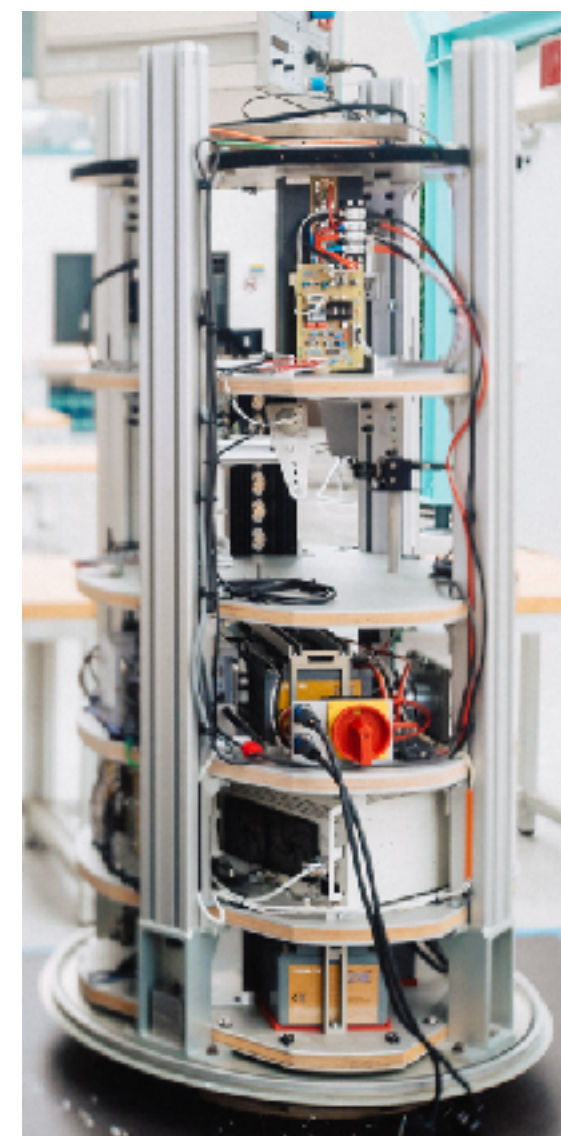
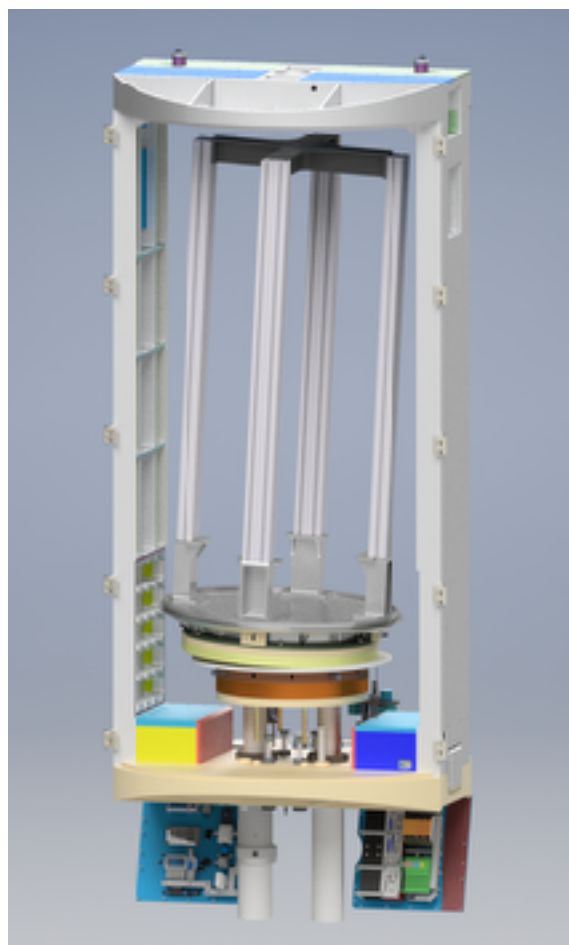
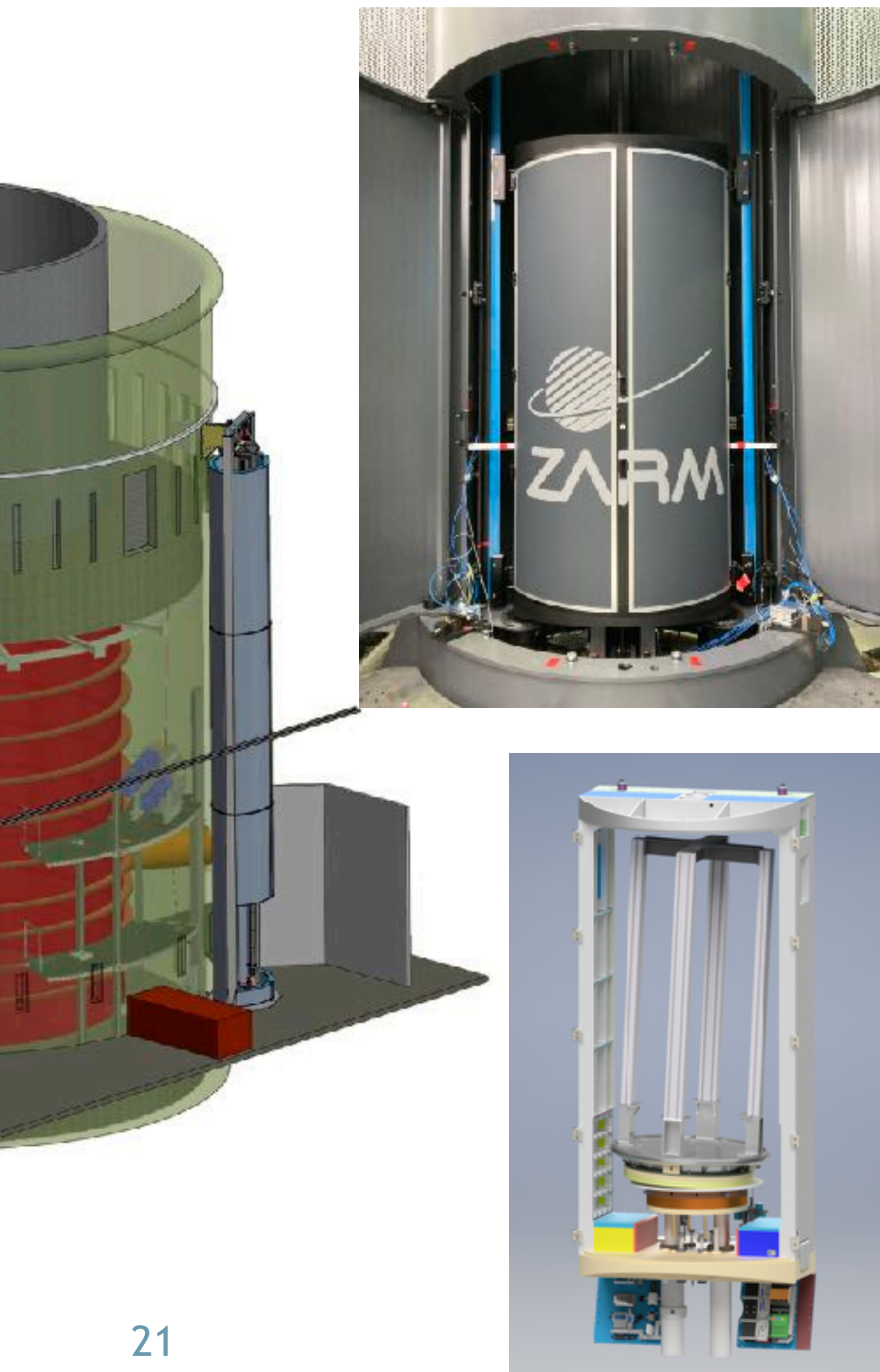
- Next-Generation Drop Tower System -



GraviTower Bremen Pro

- Next-Generation Drop Tower System -

- ▶ over 80 experiments per hour
 - almost 1000 experiments a day
- ▶ 2.5 s in microgravity ($< 10^{-4} g$)
 - **partial-g: e.g. Moon / Mars**
- ▶ standard capsule
 - synergy with Bremen Drop Tower

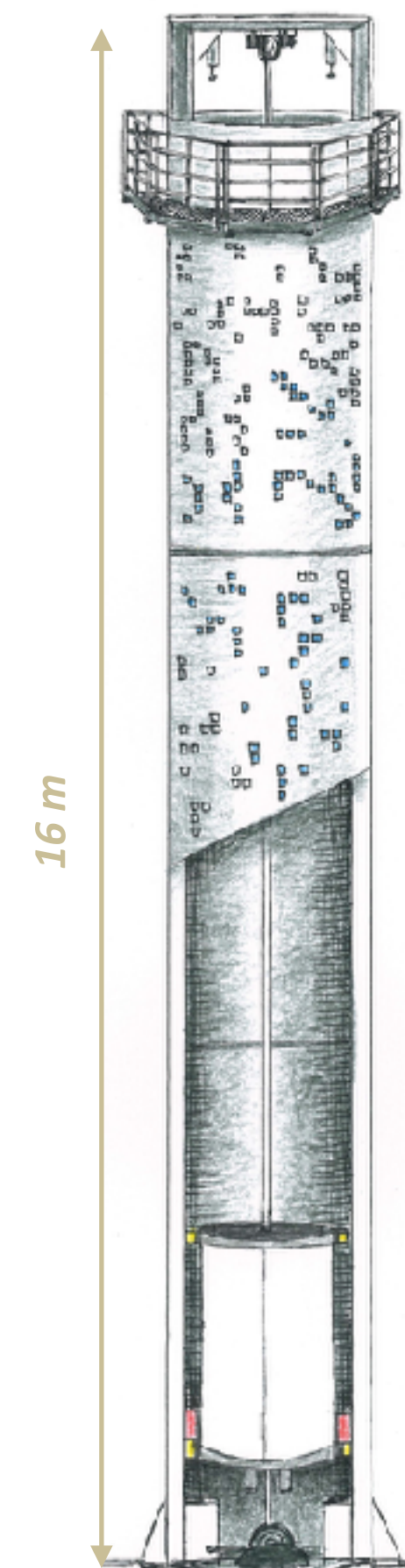
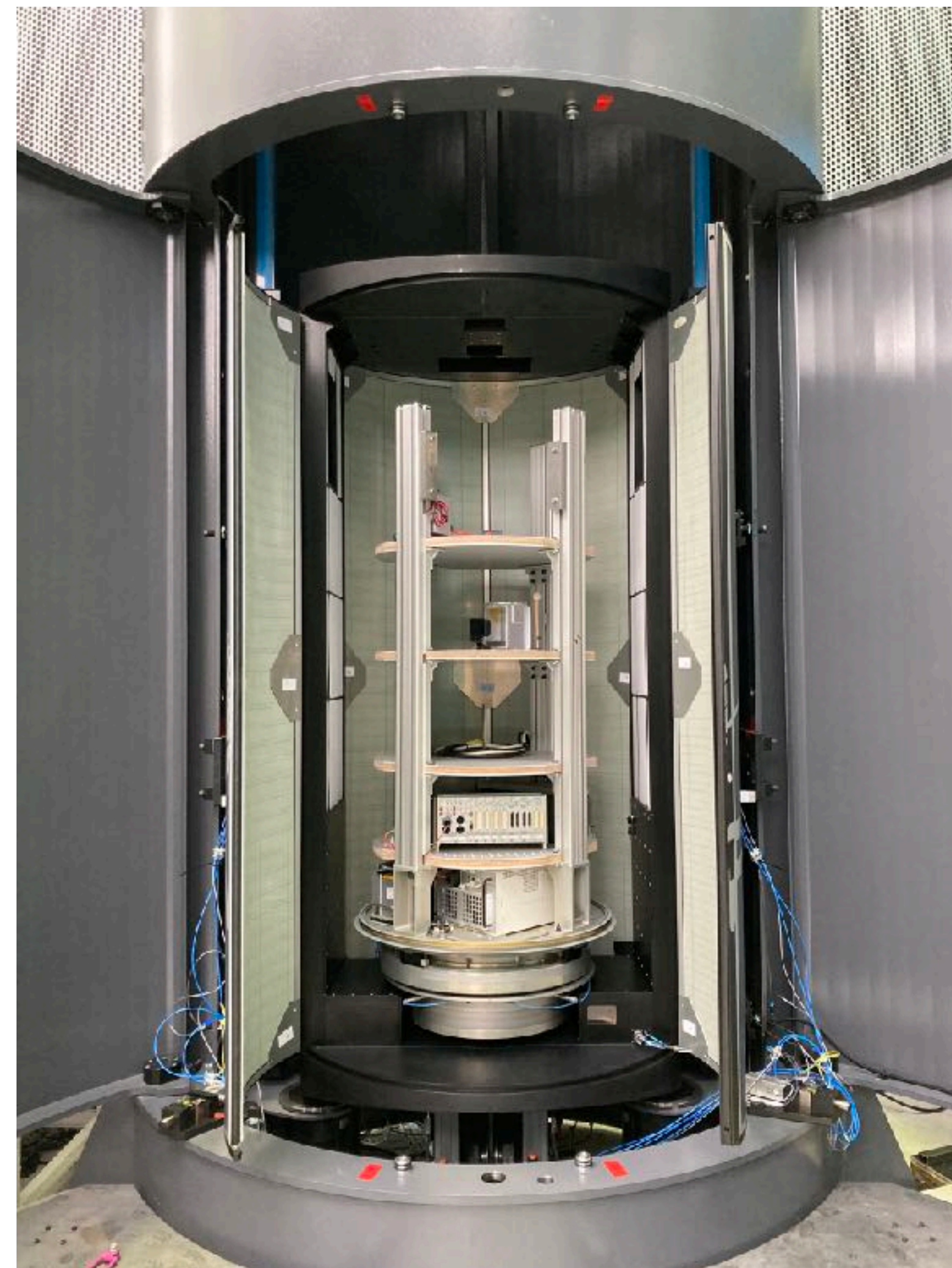
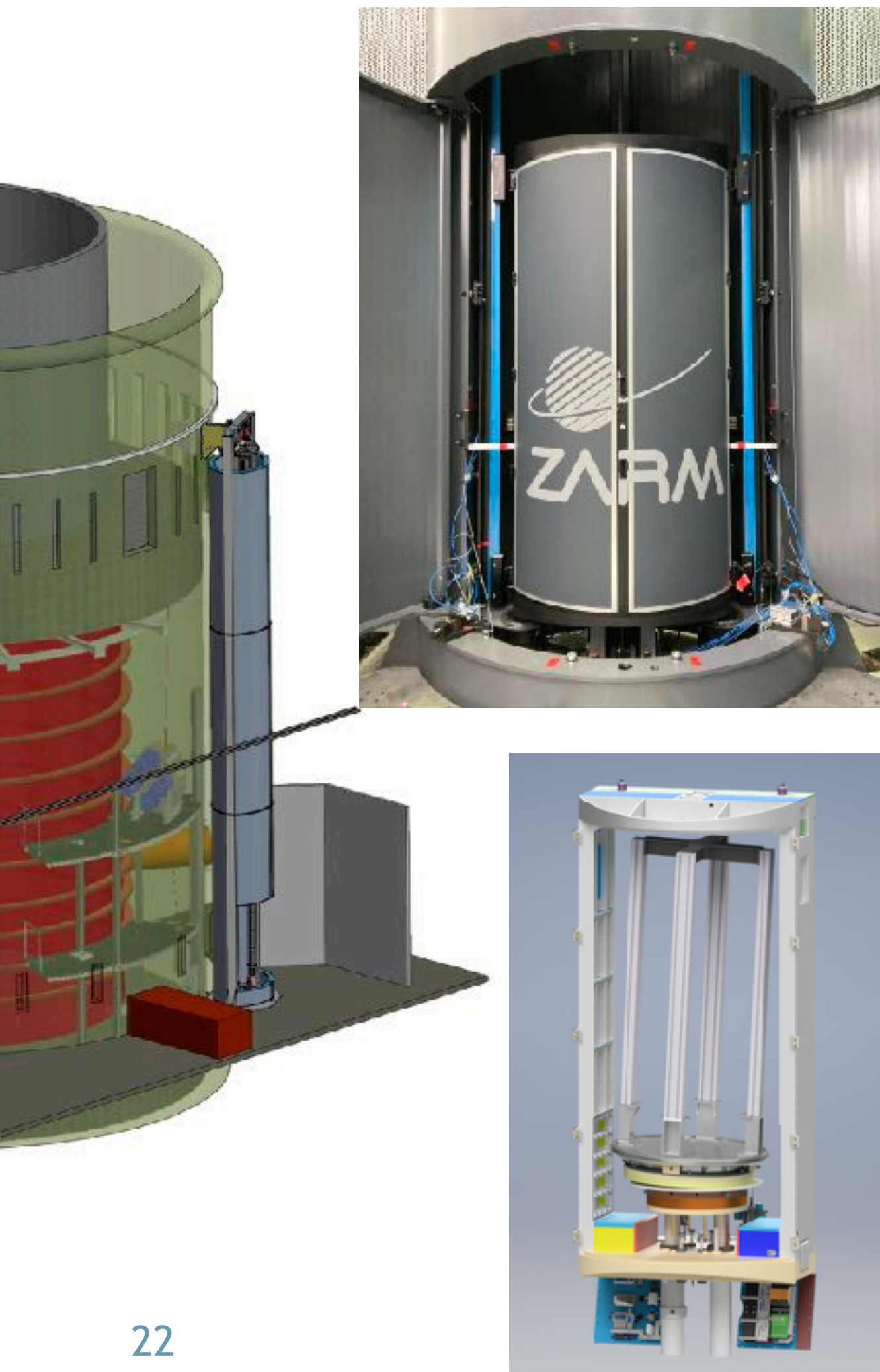


- ▶ „rail-guided system“
 - rope drive (hydraulic winches)



GraviTower Bremen Pro

- Next-Generation Drop Tower System -



- ▶ „rail-guided system“
- rope drive (hydraulic winches)

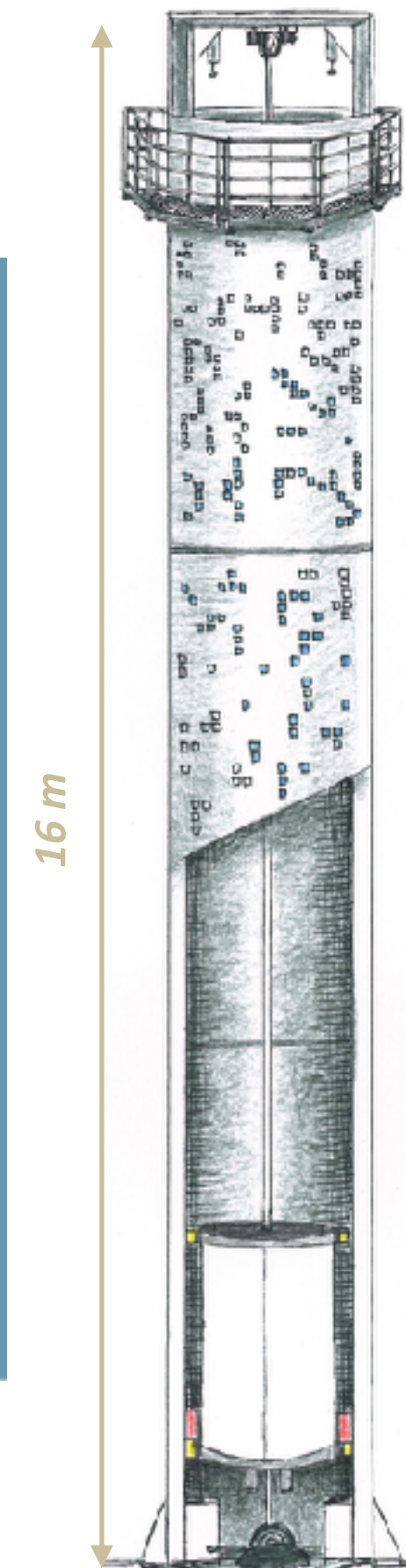
GraviTower Bremen Pro

- Next-Generation Drop Tower System -

- ▶ **User-Friendly Software Interface**
operation by the experimenters



- ▶ **Artificial Intelligence (AI) Capabilities**
interacting with the experimental setup



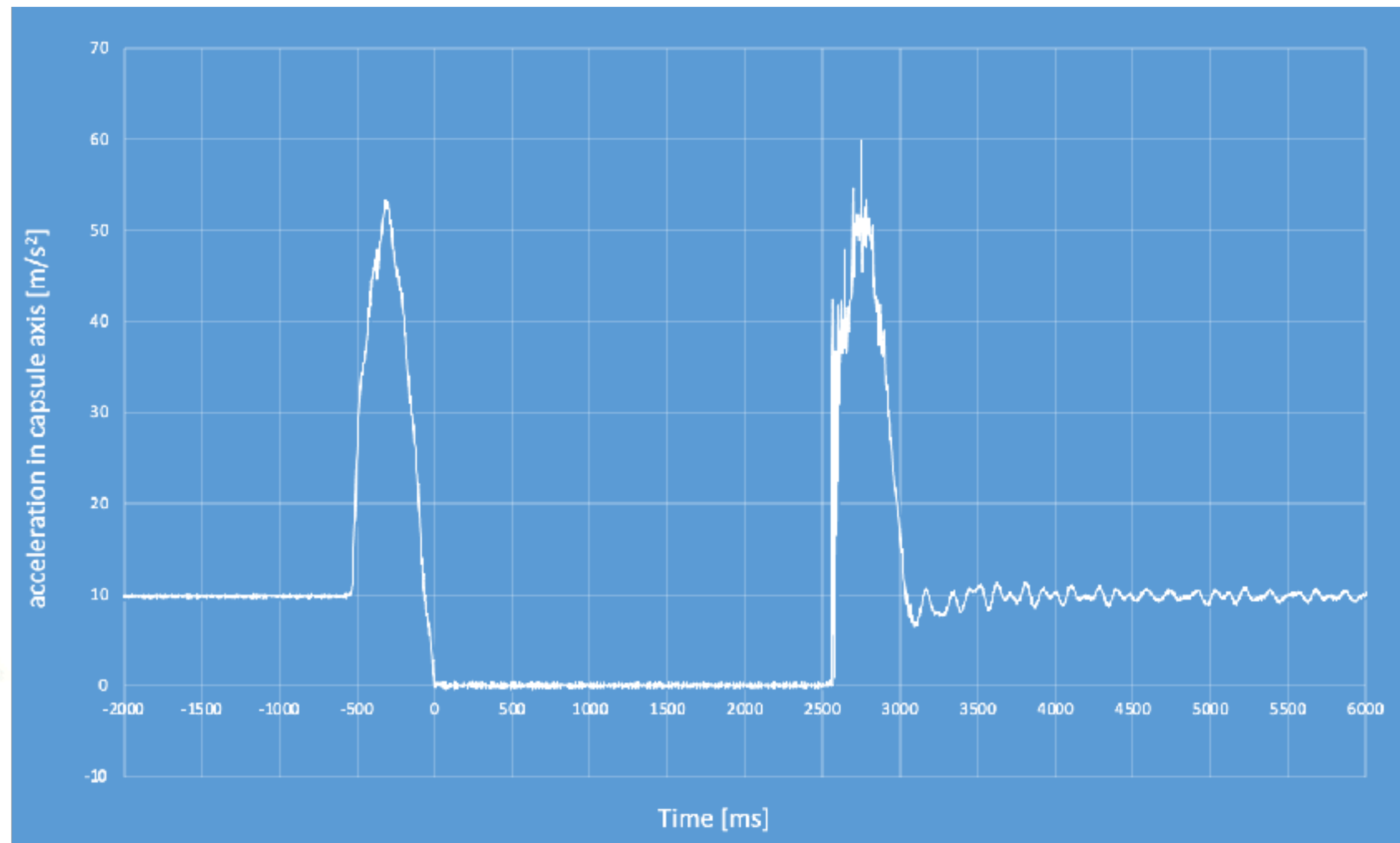
GRAVITOWER BREMEN PRO

- ▶ „rail-guided system“
- rope drive (hydraulic winches)

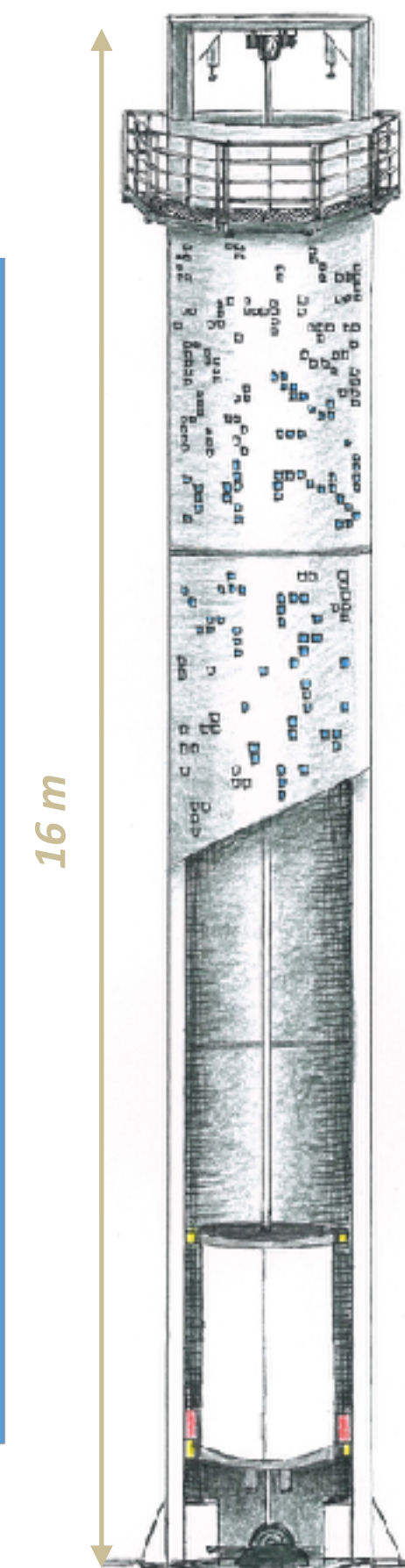
GraviTower Bremen Pro

- Next-Generation Drop Tower System -

- Acceleration / Deceleration Plot
adjustments of all kinematic parameters



up to 5 g (period is automatically calculated)



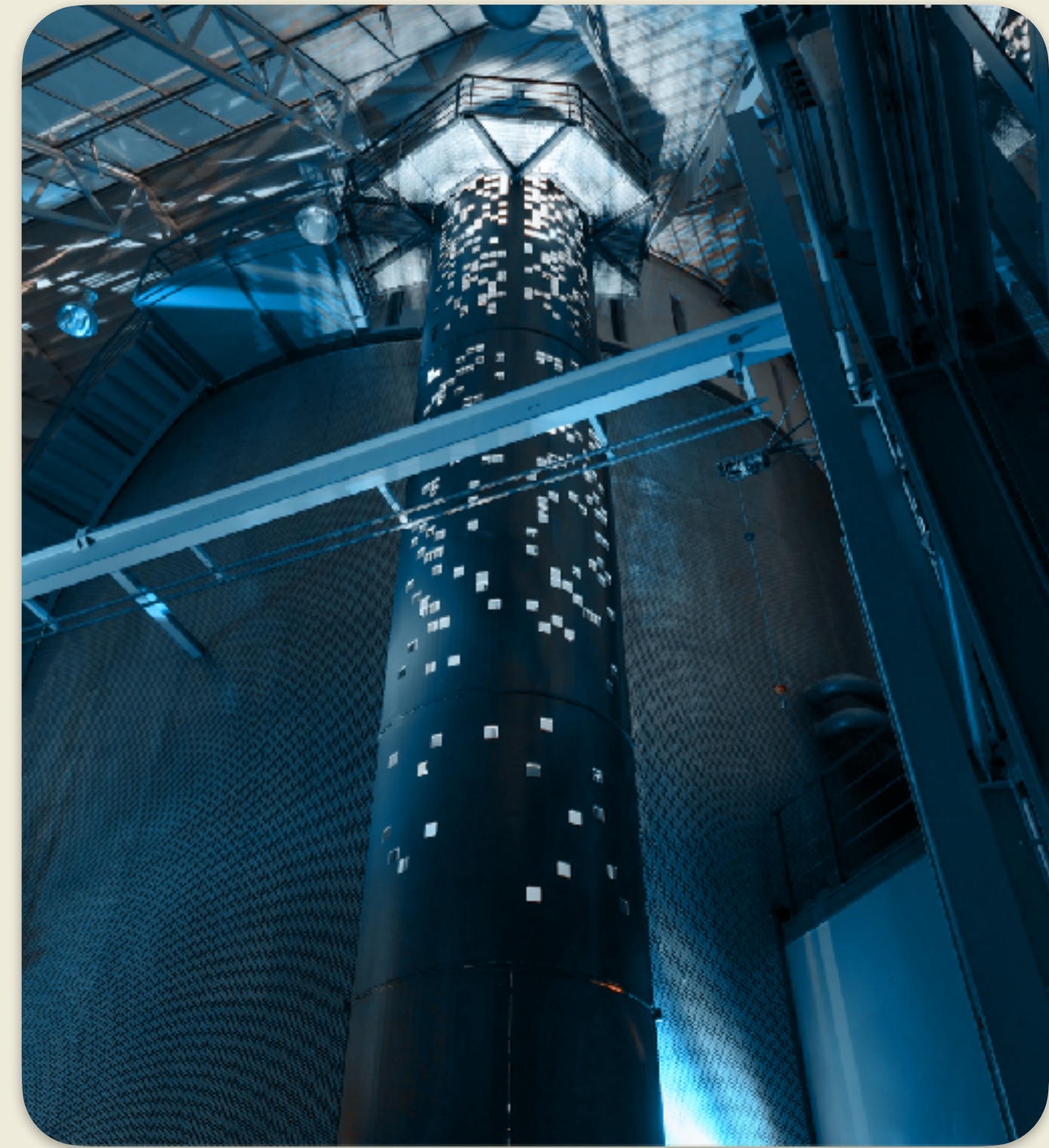
GRAVITOWER BREMEN PRO

- „rail-guided system“
- rope drive (hydraulic winches)

GraviTower Bremen Pro - Next-Generation Drop Tower System -



ZENTRUM FÜR
ANGEWANDTE RAUMFAHRTTECHNOLOGIE
UND MIKROGRAVITATION



GRAVITOWER BREMEN PRO

Content

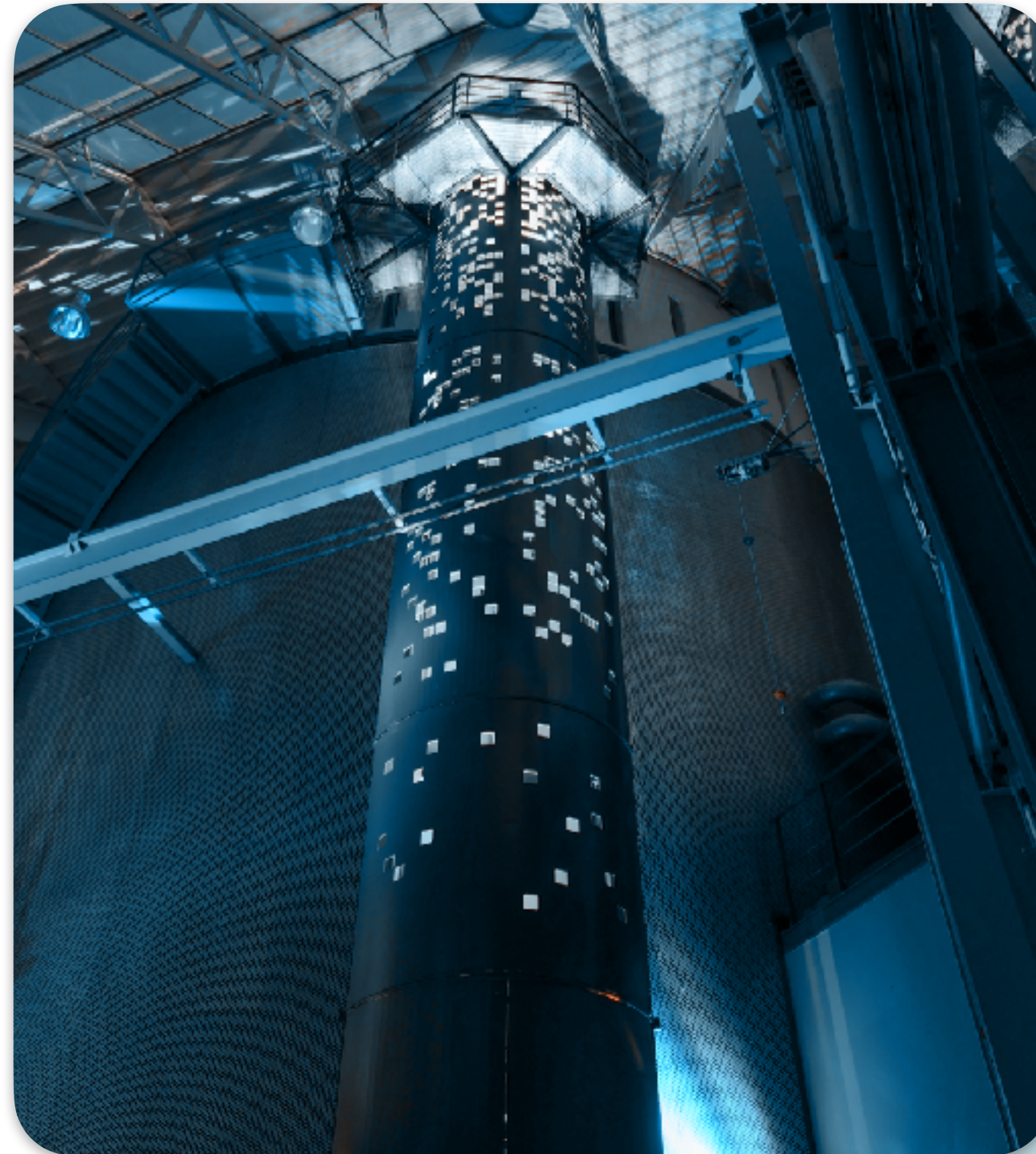
- ▶ About ZARM
- ▶ Bremen Drop Tower
- ▶ GraviTower Bremen Pro
- ▶ **Take Home Messages**



BREMEN DROP TOWER

BREMEN DROP TOWER / GRAVITOWER BREMEN PRO

► Stepping Stones into Space - Microgravity / Partial-gravity for Research, Technology Tests, and Mission Preparations



Summary

- *up to 9.3 seconds in weightlessness*
- *high-quality microgravity*
- *up to 1000 experiments per day*
- *partial-gravity option*
- *identical payload capsules*
- *high payload capacities*

BREMEN DROP TOWER / GRAVITOWER BREMEN PRO

► Stepping Stones into Space - Microgravity / Partial-gravity for Research, Technology Tests, and Mission Preparations

Experiment Capsules

- *payload mass: < 165 kg ... 265 kg (dep. on capsule type)*
- *payload height: < 953 / 1718 mm (dep. on capsule type)*
- *payload width: < 600 mm (between capsule stringers)*
- *700 mm for capsule platform / point load < 50 kg (deceleration)*
- *capsule pressure: 1 bar (pressure-tight) / vent line: vacuum or gases*
- *CCS (Capsule Control System):*
 - *exp. control + triggering + data acquisition (acceleration, temp., etc.)*
 - *power supply (batteries): 24 V DC (charging: 27.6 V DC) / max. 1500 W*
- *provision of equipment:*
 - *new camera system: Phantom Miro 321, 1480 fps @ full HD, 240 GB*
 - *heating and cooling circuit, non-standard power supply, etc.*



➡ *Technical Support*

BREMEN

Stepping

Experiment Ca

- payload mas
- payload heig
- payload width
- 700 mm for ca
- capsule pressur
- CCS (Capsule Co
- exp. control + ti
- power supply (b
- provision of equip
- new camera syste
- heating and coolin

University of Bremen

DE | EN

CAREER | CONTACT | LOGIN | SEARCH |

ABOUT US | RESEARCH | STUDIES | DROP TOWER | TEST CENTER | PRESS | VISIT | OUTREACH | EVENTS

GENERAL INFORMATION | EXPERIMENT SUPPORT | PROJECTS | TEAM

REALIZING MICROGRAVITY EXPERIMENTS

The ZARM Drop Tower Operations and Service Company will support you in all phases of experiment preparation and make sure that you will receive the relevant data of your microgravity research project as soon as possible.

The Experimenter's Handbook:

[Bremen Drop Tower - Payload User's Guide](http://www.zarm.uni-bremen.de) → www.zarm.uni-bremen.de

YOU ARE PLANNING AN EXPERIMENT IN THE BREMEN DROP TOWER!
WHAT ARE THE REQUIREMENTS?
WHAT ARE THE FIRST STEPS?

EN PRO

Preparations

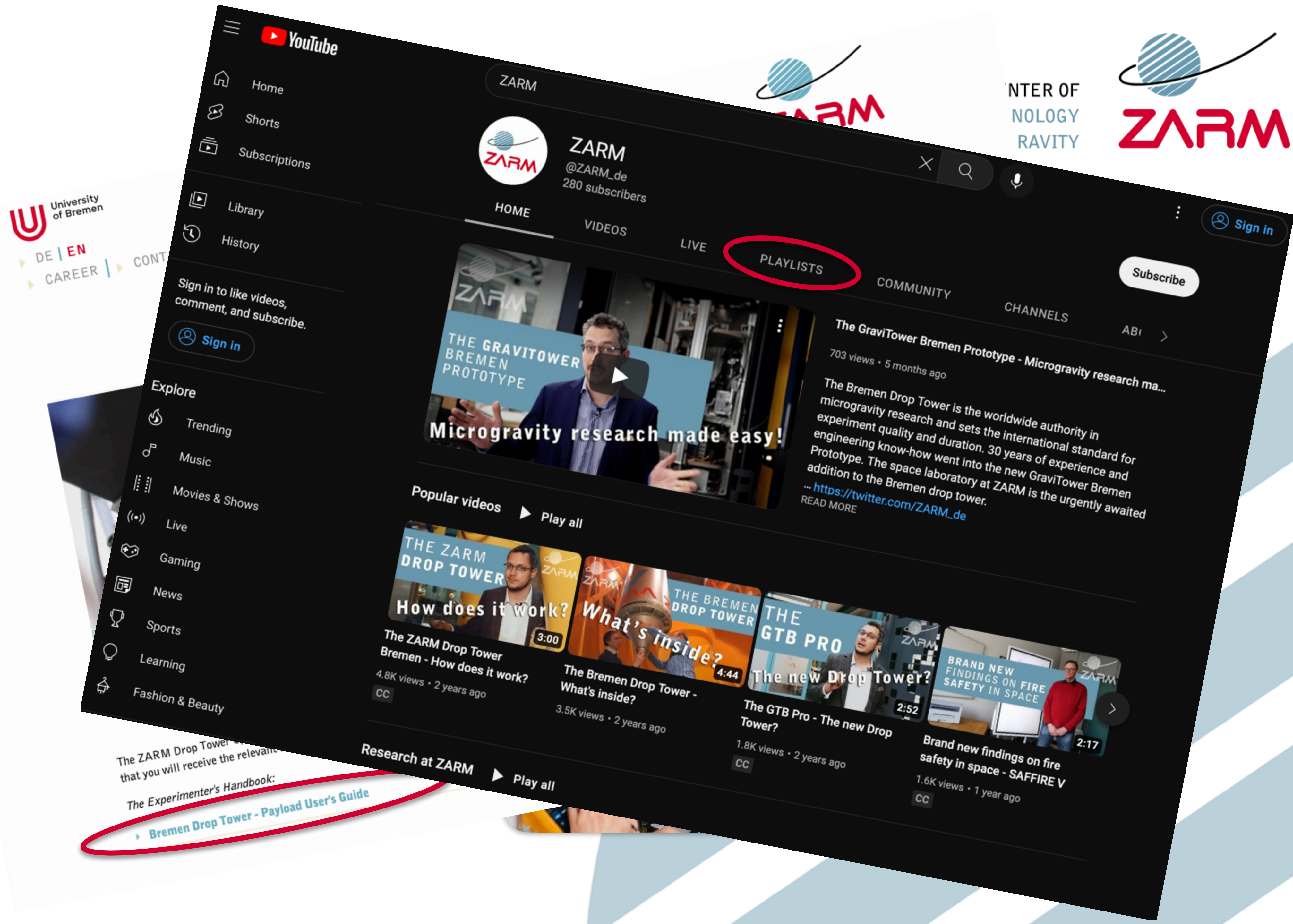
ical Support

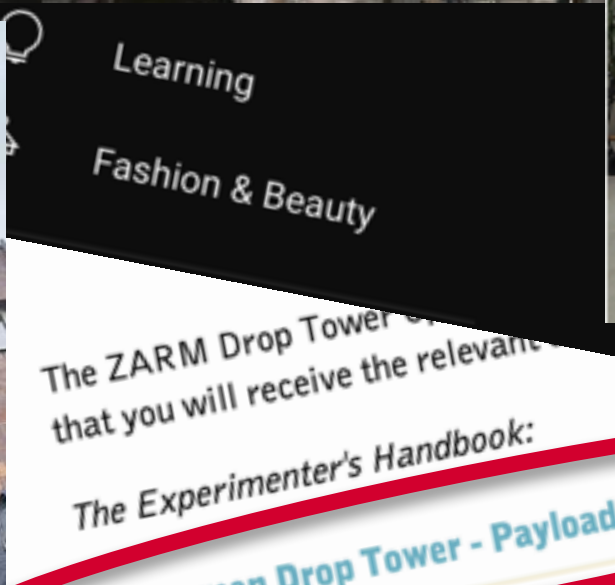
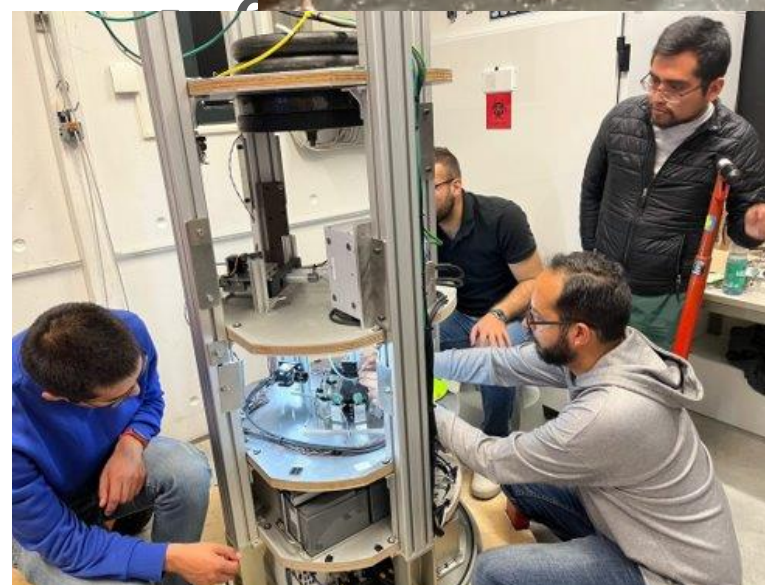
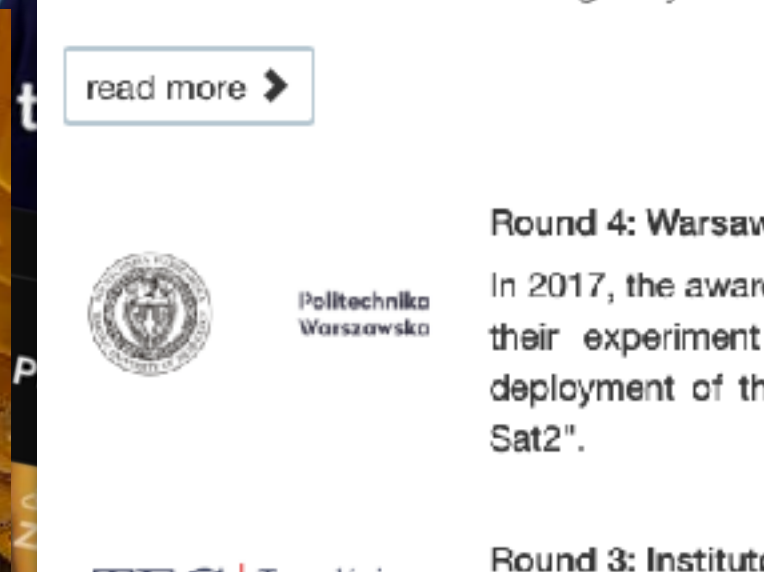
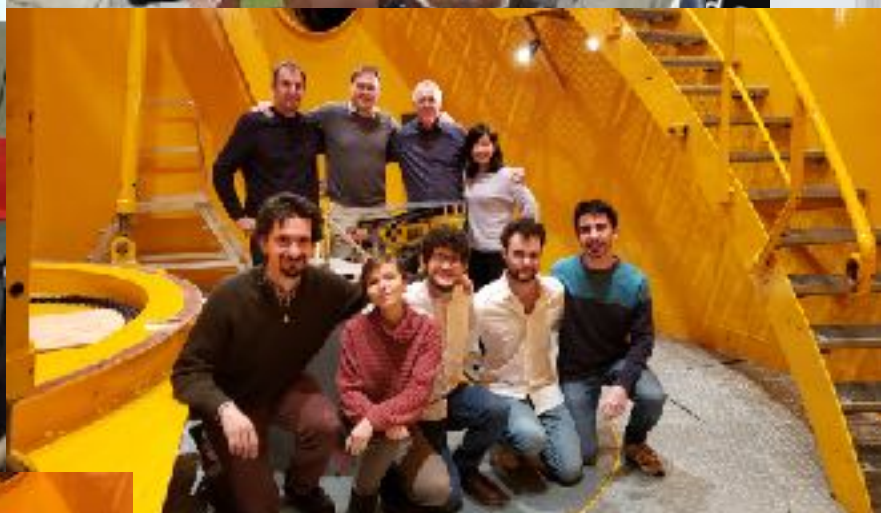
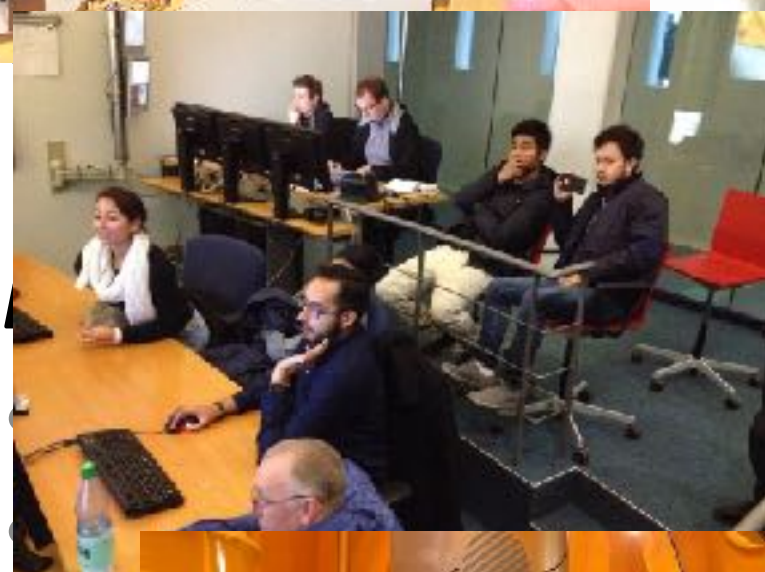
BREMEN

► Stepping

Experiment Ca

- payload mass
- payload height
- payload width
- 700 mm for ca
- capsule pressure
- CCS (Capsule Co.
 - exp. control + ti
 - power supply (b
- provision of equip.
 - new camera syste
 - heating and coolin





Learning
Fashion & Beauty
The ZARM Drop Tower
that you will receive the relevant
The Experimenter's Handbook:
Bremen Drop Tower - Payload User's Guide



UNIVERSIDAD
CATÓLICA
BOLIVIANA

read more >



POLITECNICO
DI MILANO

read more >



UNIVERSITATEA DIN
BUCUREȘTI

read more >



Politechnika
Warszawska



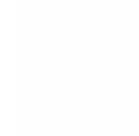
TEC | Tecnológico
de Costa Rica
UNIVERSIDAD DE
COSTA RICA

read more >



UNIVERSIDAD
CATÓLICA
BOLIVIANA

read more >



GJU
الجامعة الأردنية
German Jordanian University

Round 7: Universidad Católica Boliviana "San Pablo" team

In 2020, the award went to Universidad Católica Boliviana "San Pablo" team. The objective is to determine the 3D printing feasibility, measure intra-structure remaining liquid resin after light exposure, and compare manufacturing time, amount of used material while processing in 2 different approaches.

Round 6: Politecnico de Milano "Polimi" team

In 2019, the award went to Politecnico de Milano "Polimi" team. The objective of their experiment is to analyze the lateral sloshing of a ferrofluid solution in low gravity with the aim of measuring its oscillation frequency while subjected to different magnetic field intensities.

Round 5: University of Bucharest and Politehnica University of Bucharest

In 2018, the award went to the University of Bucharest and Politehnica University of Bucharest. The objective of their experiment is to expose medicine droplets containing aqueous chlorpromazine (CPZ) solution to both laser radiation and microgravity conditions.

Round 4: Warsaw University of Technology

In 2017, the award went to the Warsaw University of Technology. The objective of their experiment is to verify, in vacuum and microgravity conditions, the deployment of the deorbit sail system on their two-unit CubeSat called "PW-Sat2".

Round 3: Instituto Tecnológico de Costa Rica and Universidad de Costa Rica

In 2016, the award went to Instituto Tecnológico de Costa Rica and Universidad de Costa Rica. The objective is to expand the technical knowledge and information on the behaviour of a reduced-scale robotic arm manipulator such as dynamics, motion, and control under microgravity conditions.

Round 2: Universidad Católica Boliviana "San Pablo" team

In 2015, the award went to Universidad Católica Boliviana. The objective of their experiment is to examine and evaluate the property of an alloy of Nickel and Titanium "Nitinol" under the microgravity environment.

Round 1: German Jordanian University

In 2014, the award went to German Jordanian University, Jordan. The objective of their experiment is to investigate the stability of tether dynamics for satellites with electromagnetic tether systems using a Tilger, a mass damper.



Thank you very much for your Attention



Follow us

 @ZARM_de

 ZARM

 zarm.uni-bremen.de/

Acknowledgements



Gefördert durch:
 Bundesministerium
für Wirtschaft
und Energie
aufgrund eines Beschlusses
des Deutschen Bundestages



UNITED NATIONS
Office for Outer Space Affairs

