UN FELLOWSHIP PROGRAM - DROPTES
@ THE BREMEN DROP TOWER

DropTES Webinar: 8th Round Announcement of Opportunity
Feb. 11, 2021 - Bremen, Germany

Dr. Thorben Könemann
ZARM Drop Tower Operation and Service Company
WWW.ZARM.UNI-BREMEN.DE
ZARM’s Organization Structure

ZARM - Center of Applied Space Technology and Microgravity

c/o Universität Bremen
Am Fallturm 2, 28359 Bremen, Germany
www.zarm.uni-bremen.de

ZARM - University of Bremen
Research Institute - Faculty 04
Production Engineering
- Prof. Dr. Marc Avila (Executive Director)
- Prof. Dr. Marc Avila (Director Fluid Dynamics)
- Prof. Dr. Claus Lämmerzahl (Director Space Science)
- Prof. Dr. Claus Braxmaier (Director Space Technology)

ZARM FAB mbH
ZARM Drop Tower Operation and Service Company
- Prof. Dr. Marc Avila
- Peter von Kampen (Executive Board)
- Christian Eigenbrod
- Dr.-Ing. Thorben Könemann
- Ulrich Kaczmarczik (Scientific / Technical Management)

ZARM Technik AG
Supplier of Attitude Control Equipment for Satellites
- Holger W. Oelze (Chief Executive Officer)
- Peter von Kampen (Chief Financial Officer)
- Marco R. Fuchs (Chairman of Supervisory Board)

- Research / Teaching
- Technical Support
- Space Hardware

founded in 1985
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- Research / Teaching
- Technical Support
- Space Hardware
Convenient Combination of ZARM’s Test Labs

- Aerospace Qualification and Test Services under one roof
  - VIBRATION TEST LAB - LONG STROKE SHAKER (35.6 kN)
  - THERMAL VACUUM LAB - LARGE-/MEDIUM-/SMALL-SIZED TVCs + TCC

know-how, reliability, flexibility, customer-focused solutions
ZARM TEST CENTER - we.know.how.

- Convenient Combination of ZARM’s Test Labs
  - Aerospace Qualification and Test Services under one roof
    - 30g CENTRIFUGE - EUROPE’s LARGEST HYPER-GRAVITY FACILITY

- ELECTRICAL TEST SERVICES
  (in cooperation with Aircraft Elektro/Elektronik System GmbH)

- VARIETY OF TEST STANDARDS:
  RTCA DO-160, MIL-STD-810, ...

- ZARM Test Center - Team
Content

- Bremen Drop Tower
- Experiment Examples
- DropTES - Program
- GraviTower Bremen Pro
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 m$^3$ 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 m$^3$ 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

Experimenter’s Integration Area / Payload Services

Standard Capsule Versions:
- payload masses -
  - catapult
  - short
  - long

- 165 kg -
- 265 kg -
- 225 kg -

ZARM
Bremen Drop Tower

**FACTS AND FIGURES**
- start of operation: September 1990
- number of drops / catapult launches: over 9000 performed
- number of drop tower projects: over 230 assisted
- framework contractor of

**RESEARCH AREAS OF DROP TOWER EXPERIMENTS**
- fundamental research
- technology development (mission preparations)
  - Combustion
  - Fundamental Physics
  - Fluid Dynamics
  - Astrophysics (Planet Formation)
  - Materials Sciences
  - Biology
  - Hardware Tests
  - Student Programs
  - Chemistry
Bremen Drop Tower

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Experiment Examples

PROJECTS @ BREMEN DROP TOWER

ASTROPHYSICS
The question of the origin of life in our universe is closely connected to the formation of planets. At the drop tower scientists investigate the fundamental growth of young planets from dust particles. more...

BIOLOGY
How does a biological organism respond to an environment of weightlessness? - Biology experiments performed i.a. with freely falling roots at the drop tower give adequate answers. more...

CHEMISTRY
Life on Earth originates from amino acids? - Drop tower tests for the Miller-Urey experiment in space. more...

Experiment Examples

www.zarm.uni-bremen.de

Projects @ Bremen Drop Tower

Astrophysics
The question of how connected to the scientists neck from dust particles.

Biology
How does a bio weightlessness? - falling roots at 1g

Chemistry
Life on Earth-ori for the Miller-Urr

Combustion
An efficient combustion with the lowest possible emissivity is essential for future engine developments. Combustion research at the drop tower provides new measurement and diagnostic tools in order to support numerical simulations. more...

DropTES
Your opportunity to conduct your own scientific experiment in microgravity conditions as part of your Bachelor’s, Master’s and/or PhD thesis by participating in a Drop Tower Experiment Series (DropTES) at the Bremen Drop Tower organized by the United Nations Office for Outer Space Affairs. more...

Drop Your Thesis!
Your opportunity to conduct your own scientific experiment in microgravity conditions as part of your Bachelor’s, Master’s and/or PhD thesis by participating in the Drop Your Thesis! Program at the Bremen Drop Tower organized by the ESA Education Office. more...
Experiment Examples

FLUID DYNAMICS

How can a spacecraft tank supply gas-free propellant without the supporting effect of weightlessness? Only one of many questions that fluid dynamics experiments at the drop tower are expected to resolve... more...

FUNDAMENTAL PHYSICS

Is Einstein right? - Microgravity experiments allow accurate investigations of relativistic effects and quantum-physical phenomena. For instance, at the Bremen Drop Tower the world-wide first Bose-Einstein Condensate (BEC) in weightlessness could be realized - an ensemble of coldest atoms, which can be used for high-precision measurements... more...

MATERIALS SCIENCES

Material and technology tests are important for fail-safe space-based operations. Thus, prototyping of hardware under appropriate environmental conditions is required. Furthermore, weightlessness provides an ideal basis to fundamentally investigate material properties and behaviors... more...

DROP YOUR THESIS!

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Experiment Examples

WWW.ZARM.UNI-BREMEN.DE

ULTRACOLD MACROSCOPIC QUANTUM SYSTEMS IN WEIGHTLESSNESS (QUANTUS) - BOSE-EINSTEIN CONDENSATES IN WEIGHTLESSNESS

research area: fundamental physics

experiment title:
Ultracold macroscopic quantum systems in weightlessness (QUANTUS) - Bose-Einstein Condensates in weightlessness

experiment acronym:
QUANTUS I / QUANTUS II

funding agency: DLR

grant number:

performing organization:
Institut für Quantenoptik (IQO), Leibniz Universität Hannover /
ZARM, Universität Bremen /
DLR - Institut für Raumfahrttechnik, Bremen /
Institut für Laserphysik, Universität Hamburg /
Institut für Physik, AG Optische Metrologie
Experiment Examples

WWW.ZARM.UNI-BREMEN.DE

Experimental Examples

ULTRACOLD MACROSCOPIC QUANTUM WEIGHTLESSNESS (QUANTUS) - BOSI CONDENSATES IN WEIGHTLESSNESS

EXPERIMENT OBJECTIVE

abstract

Physics based on laser cooled atomic ensembles and quantum degenerate gases, such as Bose-Einstein Condensates (BEC), became a fast growing field of research with the first realization of a Bose-Einstein Condensate with a dilute gas of atoms in 1995. Many quantum-mechanical phenomena like matter waves, interferences, superfluidity, solitons or Bloch oscillations are research subjects in various laboratories worldwide. In the field of quantum sensors, condensates can serve as an ideal coherent atomic source. These quantum sensors have promising applications ranging from geodesy over metrology up to fundamental questions as tests of the equivalence principle. Inertial sensors can be realized with free falling pipes, whereas the sensitivity increases with the quadratic time of flight. An increase of the sensitivity in this way gives the need of environments with low vibrations and of minimizing the energy or unmodeled temperatures. Microgravity offers the advantage of unsampled regimes of coldest temperatures, macroscopic dimensions of matter waves and longest free evolution of the condensate on the time scale of seconds.

Within the QUANTUS-IT project an experiment for the implementation of a Bose-Einstein Condensate in microgravity was developed and constructed followed by the realization of the first BEC in weightlessness. The drop tower in Bremen was chosen to be the most ideal platform, since there is a relatively easy access to the experiment, excellent micro-gravitational conditions, 4.74 seconds of freefall and a repetition rate of up to three drops per day. The restrictions on the usable space, the availability of power of the battery, the maximum weight and the exigency of a remote controlled system are basic conditions, that make this approach a prototype of a mobile BEC experiment implementable in ballistic rockets or space missions like the ISS.

The realization of the first BEC in microgravity on November 13th, 2007 was followed by the first free evolution of a condensate in the time domain of 1 second. This experiment could open new roads for applications especially in the field of atom interferometry. The interplay of a high sensitive optical systems and quantum optics onthrone based and a compact, robust and remote controlled experiment on the other hand was shown.

Within the QUANTUS-IT experiment a further step forward in technology development and science with cold atoms was made. The initial QUANTUS experiment and its successors are still on-going projects with very promising scientific results and future applications on earth and in space.

RELATED PUBLICATIONS


People at ZARM: What is it like to work at a space research instit...
Experiment Examples

- Bremen Drop Tower - Stepping Stones into Space
  - breadboards for sounding rockets
  - integration, preparation, and qualification:
    1. testing the suborbital / orbital setup
    2. probing experiment parameters
    3. obtaining first results in microgravity
  - bottom-up approach
  - breadboards for space missions
Experiment Examples

- Bremen Drop Tower - Stepping Stones into Space
  - Drop Tower
  - TEXUS / MAXUS
  - MAPHEUS
- Experiments / Tests - Technology Readiness Level (TRL)
- New Shepard
Bremen Drop Tower

RESEARCH AREAS OF DROP TOWER EXPERIMENTS

- fundamental research
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  - Student Programs
  - Chemistry

FACTS AND FIGURES

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DLR

eesa

ZARM
Bremen Drop Tower

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DROP YOUR THESIS!

REXUS / BEXUS

Kiruna, Sweden
Bremen Drop Tower

- DROP TOWER EXPERIMENT SERIES -

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DROP YOUR THESIS!

REXUS / BEXUS

Kiruna, Sweden
Content

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DropTES - Drop Tower Experiment Series

- General Program Information

  - UNOOSA - Access to Space for All Initiative

  - Annual Science Activity at the Bremen Drop Tower

  - First Cycle was initiated by UNOOSA, DLR, and ZARM in 2014
    - Executing Agency: United Nations Office for Outer Space Affairs (UNOOSA)
    - Supporting Agency: German Aerospace Center (DLR) Space Management
    - Hosting Institution: Center of Applied Space Technology and Microgravity (ZARM)
DropTES - Drop Tower Experiment Series

General Program Information

- open to student research teams from entities that are Member States of the United Nations
- research teams should consist of up to four Bachelor, Master and/or PhD students who must be endorsed by an academic supervisor
- allows to realize a real space / microgravity research project
- shall be an integral part of the student’s syllabus, e.g. as Bachelor, Master and/or PhD theses
- follows space project guidelines (proposal, reports, reviews)
- each drop tower experiment series consists of five drops or catapult launches which have to be conducted within one week
- travel, accommodation, and drop tower utilization are sponsored
- program language: English / program duration: usually 1 year / experiment series at the Bremen Drop Tower: June / July
# DropTES - Drop Tower Experiment Series

## DropTES - Schedule

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## Selection Process:
- proposal evaluation by selection board (UNOOSA, DLR, and ZARM)
- one research team per DropTES cycle will be selected each year

## Experiment Preparation (Home Laboratory):
- assisted by ZARM (consulting, drawings, manufacturing of hardware)

## Experiment Series (Bremen Drop Tower):
- experiment integration (drop tower capsule) - first week
- experiment drops or catapult launches - second week

---

**Fiber-Coupled Passively Cooled cw Diode Lasers**

### Features:
- High optical output power of 45 W cw
- Fiber core diameter: 400 μm / 600 μm (NA 0.22)
- Long lifetime > 20,000 h, high reliability
- Passively cooling with integrated TECs

### Applications:
- Pumping of solid-state lasers and fiber lasers
- Material processing in industry
- Medical applications

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**JOLD-45-CPXF-1L**

Design 15415624 / 15415124

**Final Report**

20 June 2022 - 01 July 2022
DropTES - Drop Tower Experiment Series

- DropTES - Schedule

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<td>Announcement of Opportunity</td>
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<td>Experiment Preparation</td>
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- Experiment Series (Accommodation):
  - academic supervisor - in a hotel next to the drop tower
  - up to four students - in ZARM’s apartment at the facility on side

- two separate rooms with two beds each

20 June 2022 - 01 July 2022
Content

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Next-Gen Microgravity Facility

GraviTower Bremen Pro

FACTS ABOUT THE GTB PRO
• over 100 experiments per day
• 2.5 s in microgravity (first development stage)
  - dedicated tower: 8 s microgravity (GTB)
  - partial gravity: Moon / Mars (objective)
• „rail-guided system“
  - with only 4 g acceleration / deceleration
  - without limiting factor - vacuum
    (capsule-in-capsule system)
  - based on an active rope drive
    (commercial hydraulic winches)
• standard catapult / short capsule
  - synergy with Bremen Drop Tower
Next-Gen Microgravity Facility

GraviTower Bremen Pro

**STATUS OF THE GTB PRO**
- *first test assembling / run (hydraulic winches) in May, 2019*
- *final assembly (integration hall) - first half of 2020*
- *initial operation (slider with test masses) since July, 2020*
Next-Gen Microgravity Facility

GraviTower Bremen Pro

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- first test assembling / run (hydraulic winches) in May, 2019
- final assembly (integration hall) - first half of 2020
- initial operation (slider with test masses) since July, 2020

- full commissioning: mid-2021

also available for DropTES
THANK YOU VERY MUCH FOR YOUR ATTENTION

ACKNOWLEDGEMENTS

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CENTE OF APPLIED SPACE TECHNOLOGY AND MICROGRAVITY