UNITED NATIONS
Office for Outer Space Affairs

Announcement of Opportunity

United Nations Human Space Technology Initiative (UN-HSTI)

Fellowship Programme for "Drop Tower Experiment Series (DropTES)"

Fourth Cycle

19 October 2016

1. Thematic Area: Human Space Technology Initiative (HSTI) Science Activity

2. Title: Drop Tower Experiment Series (DropTES)

3. Hosting Institution: Center of Applied Space Technology and Microgravity (ZARM), University of Bremen, Germany

4. Supporting Agency: German Aerospace Center (DLR) Space Administration

5. Executing Agency: United Nations Office for Outer Space Affairs (UNOOSA)

6. Duration: May 2017 – March 2018

7. Deadline for Applications: Completed application forms must be submitted to the United Nations Office for Outer Space Affairs (UNOOSA) **by 31 March 2017**. Applicants will be notified of the outcome of the application by 1 May 2017.

8. Number of Drop Tower Experiment Series: One drop tower experiment series consists of four drops or catapult launches to be conducted within one week.

9. Expected Profile of Applicants: Heads of research institutions, university professors with a team of Bachelor, Master and/or PhD students.

10. Language of the Programme: English

11. Brief Programme Description:

The United Nations Office for Outer Space Affairs (UNOOSA) is pleased to announce the Fellowship Programme "Drop Tower Experiment Series" as part of the Human Space Technology Initiative (HSTI) under the United Nations Programme on Space Applications and in close cooperation with the Center of Applied Space Technology and Microgravity (ZARM) and the German Aerospace Center (DLR) Space Administration. The programme is aimed at scientists and researchers who are from Member States of the

United Nations and invites them to conduct their own microgravity experiment series at the Bremen Drop Tower in Germany.

ZARM is a scientific institute at the University of Bremen with a focus on research under space conditions and research questions related to space technology. With a height of 146 meters, the Bremen Drop Tower is the predominant laboratory at ZARM and also the only drop tower of its class in Europe. It has acquired international renown during the last decades for offering experiments under the condition of weightlessness of excellent quality (10^{-6} g_0 - microgravity). Moreover, scientists and engineers from all over the world benefit from the longest microgravity experiment duration on Earth (9.3 seconds with ZARM's world-wide unique catapult system; alternatively 4.7 seconds with the standard drop mode) - available up to three times a day. An experimental investigation in an environment of reduced gravity offers the opportunity to develop new perspectives and technologies for a wide range of research fields like gravity-relevant phenomena in fundamental physics, astrophysics and biology and also applied sciences like fluid dynamics, combustion and material sciences. For further information on the Bremen Drop Tower, please see the attached information brochure.

The DropTES Fellowship Programme is aimed at contributing to the promotion of space education and research in microgravity around the world, particularly for the enhancement of relevant capacity-building activities in developing countries.

12. Programme Outline and Schedule:

UNOOSA offers the selected research team the opportunity to conduct one microgravity experiment series at the Bremen Drop Tower consisting of four drops or catapult launches to be conducted within one week.

Timeline of the Application and Selection Process:

Deadline for Application Submission: **31 March 2017**

Selection of Applicants: **1 May 2017**

Timeline of the Experiment Process:

Preparation of the Drop Tower Experiment: **May – October 2017**

Drop Tower Experiment Series in Bremen: **27 November - 01 December 2017**

On-site Experiment Integration in Bremen: **one week before**

Experiment report submission: **31 March 2018**

13. Requirements for Participants

A) Eligibility Criteria

The DropTES Fellowship Programme is open to research teams from entities that are located in Member States of the United Nations. Each team should consist of up to four Bachelor, Master and/or PhD students who must be endorsed by their academic supervisor.

It is further required that the proposed experiment be an integral part of the students' syllabuses, that is, part of a Bachelor thesis, a Master thesis, a PhD thesis, or another form of research project associated with the applicants' studies at their respective universities.

The final number of team members who will participate in the experiment series on site at the Bremen Drop Tower depends strictly on the requirements of the experiment and is subject to approval by the Selection Board of the DropTES Fellowship Programme. The Board reserves the right to change or limit the team size if considered necessary.

Changes to the composition of the team are NOT allowed once the application has been submitted. If for exceptional reasons changes are absolutely necessary, they will be subject to the approval of the Selection Board. Priority will be given to teams that have not previously participated in an experiment series at the Bremen Drop Tower and/or research projects that have never been conducted at the Bremen Drop Tower.

Each team applying must be supported by one of its academic supervisors, whose role will be to supervise the work of the students. This person must belong to the same entity as at least one of the students and will be expected to endorse the entire application and development process of the team and bear responsibility for the execution of the experiment.

Applicants must be able to show that they have their respective entities' support through a Letter of Endorsement from their entities' directors.

B) Selection Criteria

The Selection Board will consist of team members from UNOOSA, ZARM and DLR. The Board will assess all applications against the following criteria: (i) the scientific and/or technological value of the proposed experiment, (ii) the involvement of the proposed experiment in the students' syllabuses, (iii) the relevance of microgravity in the proposed experiment, and (iv) the relevance of the drop tower utilisation in the proposed experiment. The entire selection process will be performed in a single step.

C) Requirements for Experimentation

MICROGRAVITY; HOW TO ACHIEVE WEIGHTLESSNESS ON EARTH?

Basically, if there is no external gravitational acceleration measurable inside a laboratory system, the physical definition describes it as weightless. In order to achieve a state of weightlessness, objects have to uniformly move in feasible paths without propulsion in the gravity field of the Earth. In the case of a free fall, the inertial force will compensate for the force of gravity. The compensation will be more or less favourable depending on different external influences, for example, in parabolic flights on the residual air drag of the aircraft or in drop tower operations on the residual pressure acting on the pressure-proof experiment capsule inside a vacuum tube. Finally, due to a very low pressure of 10 Pa at the Bremen Drop Tower the quality of weightlessness achieved is one millionth of the Earth's gravity (10^{-6} g_0 - microgravity).

WHAT KIND OF MICROGRAVITY EXPERIMENTS CAN BE CONDUCTED?

A variety of scientific disciplines and topics can benefit from experiments under the condition of high-quality weightlessness at the drop tower facility in Bremen. An experimental investigation in an environment of reduced gravity offers the opportunity to develop new perspectives and technologies for a wide range of research fields:

- Fundamental Physics (such as general relativity: equivalence principle, gravitational waves, space time fluctuation; quantum mechanics: Bose-Einstein condensates, decoherence, interferometry, and cold atoms)
- Astrophysics (such as gravitation dynamics, cosmic dust, astro-particles, planet formation, and plasmas)
- Fluid Dynamics (such as multiphase flow, fluid films, droplets, bubbles, dispersion, interfaces, and colloids)
- Combustion (such as droplet ignition, gaseous flames, laser diagnostics, spray systems, and propellant tests)
- Materials Sciences (such as cooling, heating, heat transfer, crystallization, melting, alloys, foams, granular systems, and porous materials)
- Chemistry (such as sol-gel processes, polymer molecules, chemical interactions, bonds, and patterns)
- Biology (such as interactions of organism, cellular biological diagnostics, organic macro molecules, proteins, and nucleic acid)

HOW TO PREPARE YOUR DROP TOWER EXPERIMENT?

In order to participate in the drop tower operation, a consultation with ZARM engineers is mandatory to realize and accomplish the microgravity experiment successfully. All participants will work in close cooperation with them as part of ZARM's drop tower services that are free of charge. However, compared to standard laboratory setups, the operation with drop or catapult capsules at the Bremen Drop Tower requires certain preconditions:

- While defining a microgravity experiment at the Bremen Drop Tower, scientists must consider the size and mass/weight of their experiment hardware/setup to meet the capsule constraints/dimensions:
    - overall payload height: 953 mm / 1718 mm (short/long drop capsule) and 953 mm (catapult capsule)
    - area of each capsule platform: 0.359 sqm (maximum diameter: 700 mm, fully rounded useable diameter: 600 mm)
    - maximum point load (to the center) of each platform: 50 kg (overall distributed load including platform weight: 100 kg)

- maximum payload mass: 264.4 kg / 221.2 kg (short/long drop capsule) and 161.5 kg (catapult capsule)

- Environmental conditions for microgravity experiments at the Bremen Drop Tower:

  - approximately 1 hPa (1 bar) pressure environment inside the pressure-sealed drop/ catapult experiment capsule

  - temperature inside experiment capsule in general: room temperature depending on thermal power losses in the experiment

  - thermal experiment environment adjustable between -20° C and +60° C on demand (controlled by a liquid circuit thermostat outside the vacuum tube, the liquid circuit is only disconnected approximately 1.5 minutes prior to the launch command)

- Standard equipment of drop tower capsules:

  - The mandatory basic equipment of drop tower capsules includes the Capsule Control System (CCS) and the radio telemetry/telecommand system with a WLAN-unit to remotely control the experiment and to securely save all acquired experimental data via a National Instruments(TM) Real Time System, as well as the Power Distribution Unit (PDU) with six switchable current channels supplied with power by a rechargeable battery pack for the experiment operation during free fall (nominal 24 V/max. 40 A, 25 Ah - continuously buffered by an external power supply (28 V/10 A) in the laboratory and until approximately 1.5 minutes prior to the launch command). The standard equipment also includes an on-board sensor pack monitoring the acceleration, deceleration, pressure and temperature of the drop/catapult experiment capsule during the drop tower operation.

- Special equipment of drop tower capsules:

  - On request, ZARM is able to provide a digital high performance video system (Photron Fastcam MC2(TM) – 2GB) for all microgravity experiments. This high-speed video system is based on light sensitive monochrome or optionally colour CMOS imaging sensors (Model 10K) and its live video output can be transmitted to the ground control prior to and during the free fall. The transmitted data has a bandwidth of standard video, and the high-speed data is directly stored on board at a chosen frame rate of up to 10000 fps.

  - If required, all microgravity experiments can be connected to a thermal liquid heating and cooling circuit. This liquid circuit (glycol/water-mixture) is linked to a thermostat outside of the drop tower vacuum tube. Through closed loop regulation, the temperature can be adjusted between -20° C and +60° C. The liquid circuit will be disconnected approximately 1.5 minutes prior to the launch command.

  - In addition, ZARM offers the option of a non-standard power supply. This external power supply provides an adjustable DC voltage with up to 100 A and will be disconnected from the experiment capsule lid plate approx. 1.5 min prior to the launch command.

- The release of gases during the experiment (such as from cryogenic devices or combustion exhaust) is regulated/served by a vent line. Its connectors are located on top of the capsule's lid plate (alternative use of the connectors of the heating and cooling circuit up to approximately 1.5 minutes prior to the launch command). The gases can be either released outside of the drop tower vacuum tube or directly into the ambient vacuum. To avoid thruster effects during the free fall, the vent line must be closed prior to the launch of the capsule and the gases must be stored in on-board containers.

- For experiments which request data from accelerations between 1 g_0 and 0 g_0 ZARM recommends the application of a specially designed on-board microgravity centrifuge. Basically, this centrifuge consists of a rotating platform equipped with a number of slip-ring transducers for the supply of electrical power and signal transmission between the rotating platform and the capsule. The on-board microgravity centrifuge is not applicable for catapult operation.

- Experiment components inside drop tower capsules:

  - All experiment components inside drop tower capsules must be able to withstand maximum decelerations of 50 g during the short-term capsule impact with a duration of about 200 ms and maximum accelerations of 30 g only in the case of a catapult launch with a duration of about 300 ms. Drop tower operation experience has shown that there is a wide range of commercial hardware capable of used in drop tower applications.

It is mandatory to refer to the ZARM Drop Tower User Manual downloadable at "http://www.zarm.uni-bremen.de/drop-tower/downloads.html".

D) Schedule of the DropTES Fellowship Programme

April - May 2017: Selection of the winning research team by the Selection Board
Suggestion of a cooperation partner from the European space science community as a mentor for the selected research team if desired

May - October 2017: Experiment preparation in close cooperation with ZARM experts and the scientific mentor if selected:
- submission of the first experiment progress report at the beginning of June
- critical design review (CDR) soon afterwards
- submission of the final experiment progress report at the beginning of September
- experiment transfer in October or November (depending on customs issues) to the Bremen Drop Tower

November 2017: Experiment Series:
- one week of experiment integration at the Bremen Drop Tower prior to the series week
- one week drop tower experiment series from 27 November to 01 December 2017

December 2017 - March 2018:
Experiment Report:
- submission of the final experiment report to the Selection Board

- submission of ZARM's feedback report to the Selection Board
- publications in journals, proceedings, and others - if possible
- presentations at conferences, workshops, and others - if possible
- part of Bachelor, Master and/or PhD thesis - if possible

14. Financial Support

The selected research team will be offered financial support exclusively for travel purposes. This may include the provision of most economical economy class round-trip air tickets between the participants' international airport of departure and Bremen. En-route expenses or any changes made to the air tickets must be the responsibility of the participants.

In this context it has to be noted that UNOOSA will not bear the expenses for the preparation, transport and shipping as well as insurance of the experiment. Funding to cover these costs must be obtained separately, through private means or through national or international institutions. Applicants and their respective entities are therefore strongly encouraged to find additional sources of sponsorship.

The drops or catapult launches are sponsored by DLR Space Administration. Technical Support provided by ZARM is included in those drops or catapult launches and therefore free of charge.

For the stay of the research team in Bremen, ZARM will provide free of charge its on-site apartment which has two separate cabins, a bathroom and a common kitchen. The ZARM apartment can accommodate up to four people.

15. Application to the Programme:

The fully completed application, properly endorsed by the applicant's entity, should be emailed to hsti-droptes@unoosa.org both in PDF format (.pdf) containing the signature page, and in MS WORD (.doc), **no later than 31 March 2017.**

The applicants should also send the fully completed original application form by postal mail to the following address:

Office for Outer Space Affairs
United Nations Office at Vienna
Vienna International Centre
P.O. BOX 500
A-1400 Vienna, AUSTRIA
Phone: (+43-1) 26060- 8716
Fax: (+43-1)-26060-5830
E-mail: hsti-droptes@unoosa.org

UNOOSA will then proceed to evaluate each submission. At UNOOSA's sole discretion, additional information may be requested from applicants, if necessary, to assist in the evaluation of an application. Selected applicants will then be notified with the results of the selection process. All awards are final and made at the sole discretion of UNOOSA, not subject to challenge or review, and are contingent on the successful applicant's agreement to UNOOSA's terms and conditions of the donation agreement.

16. Additional Information:

The latest information on the HSTI DropTES Fellowship Programme will be made available on the website of UNOOSA at
http://www.unoosa.org/oosa/en/ourwork/psa/hsti/capacity-building/droptes.html
For further information regarding the Fellowship Programme and applications, please contact hsti-droptes@unoosa.org