Leibniz Universität Hannover

Press release

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Unique Drop Tower Einstein-Elevator Launched Successfully

Experiments in microgravity conducted over a period of four seconds - 300 times a day: HITec researchers at Leibniz University Hannover realise space conditions on Earth, which will open up new possibilities for scientists across the world.

"Three - two - one - go". The gondola weighing several tons shoots up into the tower structure painted in yellow, blue and red – it then drops to the launch position and stops at the last second: The video of the "Einstein-Elevator" (link: https://www.hitec.uni-hannover.de/en/large-scale-equipment/einstein-elevator/first-flight/) in action not only inspires the involved scientists involved from the fields of quantum physics and production engineering. Academics from around the globe conducting research under microgravity conditions will benefit from the first test runs of the special drive and guiding concept of the "Einstein-Elevator".

"We demonstrated that linear motors used in roller coaster constructions can be controlled very precisely so that they compensate for the air resistance of the gondola, therefore creating free fall conditions for experiments inside our drop tower.", says project manager and engineer Christoph Lotz. Inside the gondola, which acts as the vacuum chamber of the facility and where the experiments will be set up, microgravity experiments can be conducted over a period of four seconds. This is possible because the movement resistance of the gondola is fully compensated by the drive during its flight.

"Unlike conventional drop towers, it is not necessary to evacuate the entire tower for every experiment. This means that we are able to conduct approximately 300 experiments per day.", explains Professor Ludger Overmeyer, head of the Institute of Transport and Automation Technology and one of the two initiators of the "Einstein-Elevator". "This will open up entirely new possibilities for future space missions. For example, we intend to test how additive manufacturing can be used in space travel under microgravity conditions. Ultimately, we aim to understand how matter can be written into nothingness."

His colleague, co-initiator Professor Wolfgang Ertmer from the Institute of Quantum Optics, shares this enthusiasm. He focuses on experiments addressing fundamental questions in physics and measurement accuracy: "As quantum physicists, we are eager to explore new opportunities for testing quantum sensors and new quantum technological applications under space conditions. For example, we could conduct research on quantum gravity, as well as high-resolution measurements of the Earth's gravitational field in Earth observation missions to determine the changes in ground water in ice layers."

Christoph Lotz, who was involved in the project from the start, has been a driving force behind the "Einstein-Elevator" and works in the underground command centre on a daily basis, where he deals with the nuances of this ambitious project. He is enthusiastic about what is still to come: "In the microgravity phase of the experiments, we will soon only have a maximum of one millionth of the Earth's gravitational force, while being able to simulate different acceleration profiles and thus different gravitational conditions - such as those prevailing on the Moon or on Mars."

And what will be in the gondola? "The possibilities are virtually endless", says Alexander Wanner, project partner and managing director of HITec. "After all, microgravity experiments can even be conducted with Bose-Einstein condensates - close to almost absolute zero. As long as an experiment is 'technically encapsulated', researchers will be able to simulate conditions found on the Moon or on Mars and its atmosphere, by using dust".

Researchers around the world will be able to use the "Einstein-Elevator" for their experiments. The facility will be available for regular usage in spring 2020.

Videos, images and additional background information can be found at https://www.hitec.uni-hannover.de/en/large-scale-equipment/einstein-elevator/first-flight/

Facts, figures, background

The planning phase for the research infrastructure Hannover Institute of Technology (HITec) started in 2011. Within the framework of this research centre, which was promoted by the Institute of Quantum Optics and QUEST-LFS (QUEST Leibniz Research School, founded by the Cluster of Excellence QUEST) and focuses on research in the field of quantum physics, the "Einstein-Elevator" - a new type of drop tower - was proposed and built under the coordination of the Institute of Transport and Automation Technology. In spring 2017, the drive system and the 170-ton steel structures for guiding the gondola were installed. Upon completion of the air conditioning system, the guide rails were aligned with high precision (0.1 mm over a distance of 33 m). The drive with a maximum output of 4.8 MW (average energy requirements per flight: 0.41 kWh) was installed along with the energy storage system, the "SuperCaps" (voltage: 1,050 V, max. current: 5,000 A). The gondola (CFRP structure weighing 465 kg) was installed on 22 November 2018. Since then, intensive work has been carried out regarding the interaction of the control systems. The facility has been put into operation step by step. On 28 October 2019 at 15:41:40 (local time), the experiment carrier weighing 1,000 kg finally took off for the first time and spent four seconds under microgravity conditions inside the gondola.

Companies involved in the project:

- Ingenieurbüro Heinz Berlin (http://www.heinz-berlin.de/)
- Eilhauer Maschinenbau GmbH (https://www.eilhauer.de/)

- InTraSys GmbH Innovative Transportsysteme (https://intrasys-gmbh.com/)
- Stercom Power Solutions GmbH (https://stercom.de/de/)
- Hall BV (https://hallspars.com/)

Einstein's thought experiment:
Human beings are unable to perceive whether they are standing in an enclosed room on Earth or in a rocket constantly accelerated with 1 g. Similarly, a free fall experienced inside an elevator feels like floating in space (for example inside the ISS). This applies both to humans or living creatures and to scientific experiments.

Research:
Key research areas at HITec and the involved partner institutions will include additive manufacturing under space conditions, fundamental research in quantum physics, tests on specifically designed quantum sensors, and quantum technology research. In addition, other research fields in physics, as well as materials science, biology, biotechnology, and medicine will benefit from experiments conducted in this facility. To date, these experiments were only possible within the scope of parabolic flights, rocket missions, satellites, the International Space Station (ISS), or in the few existing drop towers worldwide.

Note to editors:

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