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THE GRAVITOWER – LUNAR GRAVITY CONDITIONS ON A GROUND-BASED PARTIAL-GRAVITY PLATFORM

Abstract

Drop Towers are the ideal platform for microgravity experiments on short time scales which demand high accessibility and flexibility. The request for increased repetition rates without losing microgravity quality leads to novel drop tower concepts. In particular guided platforms offer the additional advantage to provide partial gravity. Experiments and technology developments conducted under Lunar and Martian gravity conditions are becoming more important for human exploration, e.g. to our next destination – the Moon.

Since the beginning of the year 2022, the GraviTower Bremen Pro represents ZARM's new next-generation drop tower system, which makes use of a rail-guided rope drive being able to perform 20 experiments per hour. Its technology is based on a commercial hydraulic winch system with more than 4000 hp of engine power that moves a rail-guided drag shield in a 16 m high tower, upwards and downwards. With its novel and sophisticated Release-Caging-Mechanism (RCM), the actively driven GraviTower located in the integration hall of the Bremen Drop Tower is capable of controlling heavy payloads of up to 500 kg in a very smooth and precise manner. The RCM developed and patented by ZARM also enables a fast and reliable decoupling as well as re-coupling of the experiment capsule inside the drag shield.

In this contribution, we will give an overview of ongoing development projects on the GraviTower. The first project is dedicated to the next version of the RCM aiming for precise partial gravity capabilities. First demonstrations of lunar gravity levels were performed with the current RCM design, demanding that the experiment stay connected to the drive. The resulting high vibration levels will be reduced with the novel RCMmm concept (RCM Moon / Mars), based on an active force control system. Since the RCMmm will ensure a decoupling in the vertical-translational direction, low residual acceleration levels are expected for partial gravity. The second project concentrates on the automation of the facility and precise time-synchronization. In particular the implementation of machine learning (ML) algorithms for optimization purposes benefits from the high repetition rate of the GraviTower.

With these novel aspects, the GraviTower facility becomes the ideal testbed for partial gravity experiments, while the high repetition rates can be exploited for future big scientific data handling. Thus,

the easy excess and cost-efficient GraviTower platform will pave the way into space for a broad field of research.