Paper ID: 88254
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IAF MICROGRAVITY SCIENCES AND PROCESSES SYMPOSIUM (A2)
Facilities and Operations of Microgravity Experiments (5)

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ADVANCES IN THE REALIZATION OF PARTIAL GRAVITY: ENHANCING THE CAPABILITIES OF THE GRAVITOWER BREMEN PRO

Abstract

In recent years, the demand for research opportunities under reduced gravity conditions has increased, driven by the planed exploration activities on Moon and Mars. While microgravity experiments have been conducted extensively aboard spacecraft and specialized platforms, the availability of platforms offering partial gravity environments is limited.

The GraviTower Bremen Pro (GTB Pro) represents a significant advancement in this regard, offering a versatile platform for conducting experiments under microgravity and partial gravity conditions. Utilizing a rail-guided rope drive system, the GTB Pro is capable of performing over 100 short-term microgravity experiments per day. Central to its capabilities is the Release-Caging-Mechanism (RCM), a novel technology containing of air-bearings developed by ZARM, enabling precise and fast decoupling of experiment payloads in all six degrees of freedom within the tower. In addition to microgravity, partial-gravity levels were also demonstrated within the Gravi-Tower this year, showing significant potential for quality improvement.

This paper provides an overview of the ongoing development aimed at enhancing the capabilities of the GTB Pro, particularly in refining the quality of partial gravity. The presented research project focuses on developing an active, closed-loop force control system as an extension of the existing RCM, referred to as RCMmm. This advancement enables precise control of gravitational levels ranging from 0 g to 1 g for payloads up to 500 kg, eliminating the need for mechanical coupling of experiments in the vertical-translational direction under partial gravity. As a result, significantly lower residual accelerations under partial gravity are anticipated.

To demonstrate and validate the feasibility of an active decoupling mechanism for the GraviTower Pro, a technology prototype was developed. The prototype has been tested under quasi-real operational conditions, providing valuable insights into its performance and reliability. The paper outlines the conclusions derived from these technological tests, together with predictions of the achievable quality of partial gravity.