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MICROGRAVITY SCIENCES AND PROCESSES SYMPOSIUM (A2)
Facilities and Operations of Microgravity Experiments (5)

Author: Mr. Valentin Belser
Institute of Space Systems, University of Stuttgart, Germany

Mr. Jakob Breuninger
Institute of Space Systems, University of Stuttgart, Germany
Dr. Rene Laufer
Baylor University, United States
Mr. Kirk Boehm
TU Dresden, Germany
Mr. Michael Dropmann
Institute of Space Systems, University of Stuttgart, Germany
Prof.Dr. Georg Herdrich
Institute of Space Systems, Germany
Mr. Truell Hyde
Baylor University, United States
Prof. Hans-Peter Röser
University of Stuttgart, Germany
Prof. Stefanos Fasoulas
University of Stuttgart, Germany

AERODYNAMIC AND ENGINEERING DESIGN OF A 1.5 SECONDS HIGH QUALITY MICROGRAVITY DROP TOWER FACILITY CURRENTLY UNDER DEVELOPMENT AT BAYLOR UNIVERSITY IN WACO, TEXAS

Abstract

Microgravity experiments are essential for research in space science, biology, fluid mechanics, combustion- and material sciences. One way to conduct microgravity experiments on Earth is available using drop tower facilities. Those combine a high quality of microgravity, adequate payload masses and the advantage of virtually unlimited repeatability under same experiment conditions, at a low cost. In a collaboration between the Institute of Space Systems (IRS) of the University of Stuttgart and Baylor University (BU) in Waco, Texas a new drop tower is currently under development at the Center for Astrophysics, Space Physics and Engineering Research (CASPER) with the design parameters of at least 1.5 seconds drop duration while providing a quality of at least 10^{-5} g. Preceding research has shown that this quality has only been achieved in vacuum drop tower facilities in which the capsule experiences virtually no aerodynamic drag during the drop. Since this design comes at high costs, another common drop tower design concept, which does not require an evacuated drop shaft, was chosen. It features a dual capsule system, in which the experiment capsule is shielded from aerodynamic forces by dropping a drag shield in front of it. As no other dual capsule drop tower has been able to achieve a quality of 10^{-5} g so far, the design was optimized under an aerodynamic perspective in previous work by using computational fluid dynamics (CFD) simulations to optimize the shape and size of the outer capsule and exact dimensions of the overall system. Simulations demonstrated that the required quality of microgravity can be met with the proposed design. Main focus of the paper are the mechanical construction of that design, as well as the development and layout of the surrounding main components, like the drop shaft, deceleration device and

release mechanism. As the drop tower facility is a rather complex system with many interdependencies between all components, several engineering challenges had to be met. For example a common problem at drop towers are initial disturbances caused by the capsule release mechanism, which may decrease the quality of microgravity during the initial phase of the drop. Since this would reduce the actual drop time under high quality, a design has been developed to provide a soft release. Challenges and proposed solutions for all components will be highlighted in this work.