Paper ID: 44274
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IAF MICROGRAVITY SCIENCES AND PROCESSES SYMPOSIUM (A2)
Facilities and Operations of Microgravity Experiments (5)

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CONTROL, SENSOR AND DIAGNOSTICS SYSTEMS DESIGN FOR A 1.5 SECONDS HIGH QUALITY MICRO GRAVITY DROP TOWER FACILITY

Abstract

As part of a collaborative project of the Center for Astrophysics and Engineering Research (CASPER) at Baylor University and the Institute for Space Systems (IRS) of the University of Stuttgart, a 1.5 seconds microgravity non-vacuum drop tower is constructed at the Baylor Research and Innovation Collaborative (BRIC) building in Waco, Texas, USA. An efficient and effective engineering solution for a control, sensor and diagnostics system for the Baylor University drop tower is identified and outlined. The system shall deliver precise monitoring and experiment data with wide supervisory control and data acquisition to ensure adequate operational safety, system security and meaningful experimental results. All of this within the important constraints to develop, build and maintain the system at low cost so that the financial framework and funding of the project are not exceeded. Applying the methods of a detailed system engineering approach, broad and detailed system requirements are determined and constraints and subsystems and components requirements resulting from the engineering design of drop tower and capsule system are taken into consideration. An in-depth analysis of the possible operations scenarios leads to detailed design solutions for hardware and software of the overall system. The strategy of a system-oriented “top-down” to “bottom-up” development delivers specific subsystems and assemblies with the components needed for realization.

A fully developed control room with a control and data acquisition software as well as a diagnostics and monitoring software is the interface to the subsystems of the drop tower. In addition to sensors and cameras for comprehensive monitoring of the tower and the drop capsule as well as its experiment payload, the design consists of fail-safe systems to control access to the tower and the deceleration device inside. As required, the design is implemented using mainly commercial of the shelf components with a focus on reliability achieved by redundant hardware and software measures against malfunctions. The subsystems and assemblies are all controlled by low-cost microcomputers as well as microcontroller systems.

Moreover, a feasibility study and analysis of necessary modifications to the design for implementing a similar drop tower facility at the University of Cape Town, South Africa was performed. The objective was to keep changes to the existing engineering design of the drop tower as minimal as possible to reduce cost and project schedule. The assessment suggests an unused elevator shaft in one of the new campus buildings as the most promising site for an UCT Drop Tower.