PROJECT SUMMARY

Purpose of the research

The Zero G Mass Measurement Device (ZGMMD) will provide the ability to quantify the mass of objects, including live animal specimens, in a zero G environment. There are currently no mass measurement devices available to the ISS that can accurately measure the mass of objects that have a relatively low mass, or may be sensitive to accelerations, such as live animal specimens. The ZGMMD provides the capability to quantify the mass of an object, while limiting the acceleration applied to the specimen being measured. The ZGMMD provides a fundamental capability (measuring mass of an object) that would increase the capabilities of NASA's fundamental space biology program.

A significant amount of ground-based fundamental biology research has occurred that used mass measurements as a fundamental data parameter and to compare zero G results with previously conducted ground experiments; zero G mass measurement capabilities must be provided. Recommendations provided to NASA as part of the National Research Council (NRC) decadal survey include increasing life science research capabilities of the International Space Station (ISS), with an initial focus on rodents as the primary non-human, mammalian model for studies of physiology in space. At the present time, many of the most fundamental and essential laboratory tools upon which experimental procedures depend are lacking. Foremost among them is a means of measuring the mass of research animals and plants, which is required for evaluating their health status, growth, and for calculating dosages that will be used in experimental and/or therapeutic manipulations (including anesthesia and drug doses). Experimental procedures are restricted without an appropriate mass measuring device, one of the most basic instruments in any biology laboratory.

Previous experiments on-orbit have been unable to provide mass data for specimens, or required that the tissue be preserved and returned to the ground for analysis. Making specimen measurements without the significant time delay required for retrieval of samples from on-orbit to weigh on the ground will improve the quality of the data obtained as it avoids the physiological degradation observed in specimens preserved for long periods in less than optimal storage environments.

Brief description of the research carried out

During Phase I work was performed on five technical tasks, including requirements development, development of a specimen interface, development of an actuation device, design and fabrication of a prototype, and preliminary development of the interface architecture. Each of these tasks was completed successfully, resulting in a functional prototype that was used to collect data to characterize system performance.

Research findings or results

During the Phase I, the ZGMMD prototype was used to investigate measurement accuracy and precision and to demonstrate the basic feasibility of using mass acceleration to determine the mass of samples less than 1kg. Prototype testing demonstrated that a range of masses from a few grams to 1kg could be readily determined with acceptable accuracy and precision. It was also used to test specimen mounting and ease of use. Testing identified design and operating parameters that can be implemented during Phase II to further increase accuracy and precision, as well as to improve the specimen and operator interfaces.

Do the results justify Phase II continuation?

The prototype testing demonstrated fully the feasibility of the ZGMMD design and identified a design path to increase accuracy and precision during Phase II, and to enable translation of the design to a protoflight system.