Design of the Embry-Riddle High Altitude Science Engineering Rig

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Extended Abstract

ERHASER or Embry-Riddle High Altitude Science and Engineering Rig consisted of a modular test rig which was mounted in the payload bay of a NASA WB-57F 'Long Wing' aircraft and hosted two experiments, whose goals and expected outcomes are sequentially listed in this abstract. The purpose of the first experiment was to study the position of the aircraft using an Automatic Dependent Surveillance-Broadcast system (ADS-B) for subsonic or supersonic flights through triangulation from communication nodes. The goal of the second experiment was to test the effects of radiation using the Timepix on in-vitro T-Cells in a cytokine solution, as well as cells with medicinal plants and extracts. Given the cytokines' ability to alter the cellular processes and the role of supercritical extracts as potential epigenetic modulators, we hypothesize that our study will provide some insights on potential radiation-induced cellular changes in T-cells. Furthermore, by using supercritical extracts the team investigated their efficacy in reversing the epigenetic changes potentially induced by exposure to radiation. The second experiment also included the development of an Environment Control Life Support System NanoLab which can be used to host and sustain the cells at the required temperature. The payload consisted of two steel boxes –designed to secure the experiments in the cargo bay of the aircraft. The NanoLabs were 3D printed structures made from ABS premium and secured inside the containment boxes for stability during the four hours of flight. Each containment box had different experiments which were secured inside. Containment Box 1 consisted of one 6U NanoLab and a 2U box. Containment Box 2 hosted another 6U NanoLab. The cells and instruments contained within these 3D printed structures had to be kept at a certain temperature for them to function. To maintain a constant temperature in each section of the 6U NanoLab, the thermocouples were mounted in each section and their data was sent to an Arduino Uno that controlled each individual heater. The ADS-B mounted inside the containment box and connected to the aircraft was the SkyGuardTWX Vision-Pro Plus Kit, placed inside a 2U 3D-printed box. The biological component of the radiation experiment consisted of a 6U NanoLab divided into two science blocks, 4U each, and two avionics blocks, 2U each. The two science blocks were separated into two smaller units of 2U blocks that were used to maximize the data science collection. This design allowed 4 experiment areas in total for the 6U NanoLab. The avionics blocks held all the needed avionics for the experiments, except for the EDL-4S and the EL-21CFR-TP-LCD. Both experiments yielded strong results which now are being used for research to enhance the knowledge of students in various disciplines. The ADS-B provided positive results during the ascent and descent phase of the flight although there was a cut-off in the transmission over 50,000 feet due to the instrument being a commercial product and locked above a certain altitude due to regulations. The data is expected to be integrated into the SSFS (Suborbital Space Flight Simulator) after the ADS-B returns are concurred with the data provided by the NASA's Aircraft Operations Division group and the pilot's Garmin. The flight path of the WB-57F was obtained from FlightAware to map the proposed ADS-B ground-based transceivers along the Gulf of Mexico where future spaceports will be operating. A high trend in atmospheric radiation was observed during flight. This trend perfectly matched our hypothesized trend following the data. A clear trend line in which the strength and frequency of particle strikes raises and lowers at a time coincided with the WB-57's ascent and descent phases. Instances of a spike in the dosage were also registered during the flight with the maximum being 48 μGy/hr. The average dose rate per minute was calculated as 2.877 μGy. The T-cells and cytokines have an incubation period of 6 to 8 weeks during which the medium is tested for growth and activation of the immune cells. The cells require continuous observation over the incubation period and scheduled logs are made over the course of the mediums. It was noticed that 10 of the 32 cell mediums exhibited a change in color which can be attributed to extreme temperature shock. This exhibited the high survivability of T-cells in the Nanolab developed when subjected to extreme temperatures and atmospheric pressures.