CALIFORNIA SCIENCE & ENGINEERING FAIR
2019 PROJECT SUMMARY

Name(s)

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Project Number

S1704

Project Title

High-Stratospheric Testing of Novel Cosmic Ray Shielding Composites

Abstract

Objectives

Cosmic rays are an unsolved problem in space exploration. While manned Mars missions are possible with current propulsion systems, the threat of cosmic radiation has not been addressed. Without a shielding system in manned spacecraft, astronauts will be exposed to extreme levels of radiation. The goal of the project was to develop a practical shielding system for interplanetary spacecraft to negate risks using both theoretical and experimental data.

Methods

A total of 9 materials were investigated. The project was composed of an computational and experimental phase. The computational phase utilized an ESA supercomputer to run 26 simulations, which tracked the materials shielding ability. The simulation ran inside of an application published by ESA, in which I defined particle characteristics and material geometry and chemical composition. These simulations were used to formulate a hypothesis going into the experimental phase, which will be composed of one or more balloon launches. A GPS tracked detector suite I designed (HADES), will float to 29km of altitude. The operating conditions will expose HADES to cosmic ray primaries. The detectors used are Geiger tubes and the flight computer is distributed across two Arduino boards which I programmed. Ground evaluation was completed, but due to bad weather the launch has been delayed

Results

The results from preliminary computational analysis were used to predict the outcomes of the coming experimental phase. Results from the proton simulations were consistent with the current literature, and Polyethylene (PE) was the most effective, due to its low nuclear charge, leading to less secondary radiation. Composite materials and graphite also performed well against proton flux. Against 10^11eV Oxygen HZEs, Aluminum failed to provide shielding, as secondaries actually increased the experienced dose; Boric Acid and PE performed best. When exposed to 10^14eV Iron HZEs, Ammonium Chloride provided the best shielding, with 80% of the dose shielded, while PEEK* increased the final dose by 182% due to delta rays.

Conclusions

The goal of the project was to test various novel technologies, such as lightweight hydrogen salts, as candidates for cosmic radiation shields. The need for a practical, lightweight shielding system is great with manned deep-space missions planned. A detector suite (HADES) was built and successfully ground tested, while computational simulations were used to form predictions for experimental data. All systems are ready and tested for launch, and HADES will take off as soon as an appropriate launch window is found.

Summary Statement

The goal of the project is to develop a practical shielding technology for manned spacecraft using both computational data and experimental data taken from the upper stratosphere.

Help Received

I asked some questions of a JPL scientist about how scientific balloons work in person after a public lecture.