

A Novel Layered System to Prevent High-Energy, Ionizing Radioactive Photon Transmissions and Control Particle Behavior with the Utilization of Monte Carlo Transport Modeling via SPENVIS-based Modular Implementation

Noon, Daniel (School: Brophy College Preparatory)

Today, nuclear weapons and reactor plants are becoming more common. However, current methods of radiation shielding are not viable due to high cost and ineffective means of weakening photon momentum, which not only poses danger on Earth, but also halts further deep-space exploration. Therefore, inexpensive, efficient shields resistant to the behavior of radiation from exposing to human life become necessary. In this study, 280 computational experiments were conducted in the Space Environment Information System (SPENVIS) utilizing Multi-Layered Shielding Simulation (MULASSIS) and Geant4 Radiation Analysis for Space (GRAS) on multiple shielding models. These six models tested against nuclear, artificially-generated, ionizing incident particles under single and multi-ray analyses with four angular photon distributions in comparison to SHIELDDOSE, a current standard for cosmic radiation shielding created by the European Space Agency (ESA). Each design considers stainless steel, lead, bismuth, and lithium-hydride as materials, along with varying thicknesses, conformations, and photon-specific classifications via enhanced algorithms modified from current formulas used in radiation shield production. These models blocked over 99% of particles exposed, are over 14,000% cheaper, and are 7 times thinner than either SHIELDDOSE or other emerging shielding methods such as with the use of metal foams. In contrast, ESA's SHIELDDOSE increased the neutron energy dose by over 700% through their system, and insufficiently reduced harmful gamma ray penetration. Thus, the potential of enhanced energy from nuclear plants, greater space travel, and a safer approach to utilizing/preventing exposure to atomic particles can become more available, saving millions of lives in impending danger.

Awards Won:

Arizona State University: Arizona State University Intel ISEF Scholarship