Space-VEST

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Goal of the Project:

The ***goal*** of our investigation is the development of a 3D printed vest that optimizes crew safety during EVA. Our focus is on keeping crew radiation exposure as low as reasonably achievable (ALARA) during extended duration space missions adding layers of protection for those crew members during exploration beyond low earth orbit (LEO). We also aim to retrofit our design to the existing cooling system of currently operational spacesuits to optimize thermoregulation and add radiation protection to the vulnerable organs. Our goal will be achieved by addressing the following specific ***objectives***:

Objective 1: Radiation protection. We will use Thermoplastic Polyurethane in combination with radio-protective polymers produced by our partners at Georgia Tech to achieve radioprotective properties in our design. We will test our prototype using Space-Permissible Exposure Limits (SPEL) as identified by NASA.

Objective 2: Thermoregulation. Tubing connected to the liquid cooling garment will be incorporated in the prototype for dual purpose: a) using radiation protection properties of water, b) as a cooling system to avoid the overheating of astronauts.

Objective 3: Layered approach. Our prototype will be retrofitted to the existing spacesuit to simplify integration and compliance.

Below: 3D Printed Prototype design on cooling garment.

Right Prototype design and cooling garment attached to cooling system.

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References:

[1] NASA Space Flight Human-System Standard Volume 1, Revision A: Crew Health

Methods:

We are working to test and develop possible prototypes for space operations:

1) Human spacesuits, (starting with head and torso)

2)Equipment/Life support systems (ECLSS) to protect other equipment for crew surface operations.

Our testing includes consideration of the best possible fitting for comfort, lightweight, and adaptation to many contours. Starting with the most radiation vulnerable organs and matching NASA's highest priorities, we aim to create a form-fitting prototype to protect Central Nervous System (CNS) and cardiovascular (CVS) large vessels. Our team identify best medical protocols and safety procedures to reduce radiation damage, minimize common injuries.

Project Implementation:

Our team will apply an integrated multidisciplinary approach to the objectives described as a crucial part of the preparation for increased human space missions beyond LEO. Our approach will test comprehensive technical and scientific methods to perform systematic radiation mitigation.

Project Impact:

We will gain further understanding of needed protection for operations in extreme environments and learn how to create effective safety equipment. We will accelerate scientific knowledge and experience in radiation mitigation relevant to current NASA goals. Accomplishing these goals will provide the existing spacesuit with additional layers of protection that will enhance and help extend space exploration missions.

Future Work:

In addition to the SpaceVEST design for radiation protection to the CVS and chest area, we aim to continue our work with production of the SpaceRADCAP. SpaceRADCAP will provide radiation protection to the head, protecting the vital CNS from damage during space exploration. Our design considerations include comfort, communications, and accommodation for all existing wearable devices.

We are working with materials approved to work in rich oxygen environments (including 100% oxygen) and following procedures used in Hyperbaric Medicine. In collaboration with CLASS and Exolith Lab we will also be testing prototypes and operational procedures with regolith simulants.

Above: Cooling system for the head incorporated into our SpaceRADCAP design