



## **NASA STTR 2006 Phase I Solicitation**

### **T1.02 Space Radiation Dosimetry and Countermeasures**

**Lead Center: ARC**

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As NASA embarks on its Exploration agenda the study of the Cosmic, Solar, Lunar, and Van Allen Belt space radiation environments will continue to guide new biologically related innovation and mitigation needs at NASA. Understanding Space Radiation induced effects on biological organisms is a vital component for future manned spaceflight mission success. Development of support technologies to protect astronaut crew health will be essential for successful long-term mission operations. Our current understanding of the space radiation environment interaction with humans, space rated materials, and technological systems is limited. Specifically, information on radiation events with high atomic number, high energy particles (HZE particles), and energetic protons is lacking compared to our understanding of gamma and x-rays. NASA has established a space radiation laboratory at Brookhaven National Labs capable of generating HZE particles and protons. NASA also supports a facility at Loma Linda University Medical Center capable of generating energetic protons to enable research studies and technology development. NASA is seeking innovative technologies in the areas described below.

#### **Advanced Space Radiation Dosimeters**

NASA seeks the development of a small, low power suite of dosimeters to measure the biologically significant range of space radiation on board manned spacecraft, planetary habitats, or on astronaut extravehicular activity (EVA) suits. The devices must be able to measure the absorbed dose/linear energy transfer (LET) based dose equivalent from electrons, photons (X-rays and gamma rays), protons, heavy ions (HZE) and secondary neutrons. Both real-time dose/dose equivalent rate and cumulative dose/dose equivalent over selected time intervals, e.g. a day or a mission, are required, along with an alarm system based on fluence rate, dose rate, or cumulative dose (e.g. during Solar Particle Events). The suite of dosimeters should provide time resolved LET data or a suitable surrogate (e.g. lineal energy ( $y$ ) as measured by a gas filled microdosimeter) and have embedded linear energy transfer-based quality factor algorithms for determining dose equivalent. The devices should be sensitive down to 0.05 milliGray/0.1 mSv and should be able to measure a maximum dose of 1 Gy/3 Sv. The LET of charged particles of interest ranges from 0.2 keV/ $\mu\text{m}$  to 1000 keV/ $\mu\text{m}$ . The National Council on Radiation Protection and Measurements Report 142 includes a detailed description of the radiation field to be assessed for radiation protection of astronauts. NASA acknowledges the difficulty in measuring secondary neutrons from interactions of protons and heavy ions with spacecraft structures and has particular interest in this area. If possible, the response of candidate dosimeters to protons, heavy ions, and neutrons should be characterized. For absorbed dose calibrations, the devices should be calibrated to National Institute of Standards and Technology (NIST) traceable absorbed dose standards. Prototype hardware or technology developed must be capable of being converted to robust and reliable space flight hardware in the future. This means that all hardware and software must be capable of being fully documented in the future, and that interface software must be compatible with current operating

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systems.

### **High Throughput Genomic Analysis Techniques**

Following low dose irradiation of cells by protons and heavy ions, damage is localized to only a very few cells. The ability to separate cells with or without genetic changes in an automated manner is of interest. Current technologies are inefficient in identifying smaller-scale genetic changes (less than a million base-pairs (Mbp)) under these conditions. Technologies of interest are:

- Technologies to rapidly score small-scale genetic changes ( 1 Mbp) genetic changes to chromosomes following low dose irradiation;
- Imaging techniques to rapidly identify with high accuracy undamaged cells from a cell population irradiated at low doses.

### **High Throughput Countermeasure Evaluation Techniques**

NASA seeks the development of high throughput techniques for the evaluation of countermeasures that can be used by astronauts to ameliorate the effects of ionizing radiation in space, including Solar Particle Events, secondary radiation particle events, and continuous low dose radiation exposure. Techniques to evaluate currently available pharmaceuticals to counteract radiation effects are of interest.