NASA Space Radiation Laboratory at Brookhaven

Discovering Space Travelers' Exposure Risks

Purpose
To use beams of heavy ions provided by the Booster accelerator at Brookhaven to study the effects of simulated space radiation on biological and physical systems, with the goal of developing methods and materials to reduce the risk to human beings on prolonged space missions of the effects of ionizing radiation

Sponsor
National Aeronautics and Space Administration (NASA)

Project cost
$34 million over 4 years

Operating costs
$5 million per year

Features
- *beams of heavy ions extracted from the Booster accelerator with masses and energies similar to the cosmic rays encountered in space:*
  - *1-billion electron volt (GeV)/ nucleon iron-56*
  - *0.3-GeV/nucleon gold-97*
  - *0.6-GeV/nucleon silicon-28*
- *a new 100-meter transport tunnel and beam line to deliver the beam to a 400-square-foot shielded target hall for NASA -funded space-effects experiments*
- *a target hall connected to 4,560-square-foot support building, which includes five laboratories for biological, medical and materials experiments; specimen rooms; dosimetry room; and control rooms*
- *long-term user support provided by Brookhaven's Biology and Medical Departments*

Facility-users
NASA, four national laboratories and institutes in the U.S. and Europe, 15 universities in the U.S., Europe and Japan

Web address
server.c-ad.bnl.gov/esfd/nsrl/index.html

Inside the target room of the NSRL are four ion chambers used for beam imaging (black-framed objects) or dosimetry (blue-framed objects).

Because astronauts are spending more time in space, the National Aeronautics and Space Administration (NASA) is working with Brookhaven National Laboratory and others here on Earth to learn about the possible risks to human beings exposed to space radiation. To study the radiobiological effects using beams that simulate the cosmic rays found in space, a new, $34-million NASA Space Radiation Laboratory (NSRL) has been established at Brookhaven Lab.

A view of the front of the NASA Space Radiation Laboratory at Brookhaven Lab

Jointly managed during the four-year construction by the U.S. Department of Energy's Office of Science and NASA's Johnson Space Center, the new facility employs beams of heavy ions extracted from Brookhaven's Booster accelerator, the best in America for radiobiology studies. NSRL also features its own beam line dedicated to radiobiology research, as well as state-of-the-art specimen-preparation areas.

When the NSRL became operational during summer 2003, over 75 experimenters from some 20 institutions from the U.S. and abroad took part in what was the tenth running of heavy-ion beams at Brookhaven solely for radiobiology research. With the NSRL on line, instead of running only once or twice a year, radiobiology and physics experiments are conducted three to four times per year, for three to four weeks per run.

Space radiation

Since astronauts are spending more time in space, they are receiving more exposure to ionizing radiation, a stream of particles that, when passing through a body, has enough energy to cause the atoms and molecules within that substance to become an ion.

By directly or indirectly ionizing and thus damaging the components of living cells, including genetic material called DNA, ionizing radiation may cause changes in cells' ability to carry out repair and reproduction. This may lead to mutations, which, in turn, may result in tumors, cancer, genetic defects in offspring, or death.

Although the spacecraft itself somewhat reduces radiation exposure, it does not completely shield astronauts from galactic cosmic rays, which are highly energetic heavy ions, or from solar particles, which primarily are energetic protons. By one NASA estimate, for each year that astronauts spend in deep space, about one-third of their DNA will be hit directly by heavy ions.

New NASA facility

From 1995 until 2002, Brookhaven Lab researchers and their colleagues used beams of heavy ions for radiobiology research at another Brookhaven accelerator. To simulate the less-than-1-GeV energy spectrum of galactic cosmic rays and solar radiation better, NASA and Brookhaven have worked together since 1997 to build the NSRL based at the Booster accelerator.

Within the NSRL target room, Brookhaven researchers and other NASA-sponsored scientists irradiate a variety of biological specimens, tissues, and cells, as well as DNA in solution. Other experimenters use industrial materials as samples, studying their suitability for space suits and spacecraft shielding.

In increasing knowledge of the effects of cosmic radiation, NSRL studies may expand the understanding of the link between ionizing radiation and aging or neuro-degeneration, as well as cancer. In aiming to limit the damage to healthy tissue by ionization, NSRL research may also lead to improvements in cancer radiation treatments.

Brookhaven National Laboratory is managed for the U.S. Department of Energy by Brookhaven Science Associates, a company founded by Stony Brook University and Battelle.

September 2003