

# Space RAD Health

## Newsletter

Vol. 2 No. 1 - May 2002 | Executive Editor: [Dr. Francis Cucinotta](#) | Contributing Editor: [Kay Nute](#)

### Space Radiation Research Conference - Nara, Japan

The [13th NASA Annual Space Radiation Health Investigators' Workshop](#) was held in conjunction with the [2nd International Workshop on Space Radiation Research](#), in Nara, Japan, from March 11-15, 2002. The scientific committee included Drs. Abe (HYUGO, Japan), Amaldi (TERA, Italy), Belli (ISS, Italy), Cucinotta (NASA-JSC, USA), Dicello (Johns Hopkins Univ., USA), Miller (LBNL, USA), Nakamura (Tohoku Univ., Japan), Ohnishi (Nara Med. Univ., Japan), Reitz (DLR, Germany), Schimmerling (NASA-HQ, USA, Chairman), Sekiguchi (NASDA, Japan), Tsujii (NIRS, Japan), and Yano (RIKEN, Japan).

#### The 2nd International Workshop on Space Radiation Research -- Toward a Permanent Human Presence in Space -- March 11 (Mon) - 15 (Fri), 2002, Nara, Japan

About 200 participants contributed 186 papers representing 500 authors. The meeting was divided into ten Roundtable Discussions that spanned over five days along with poster session events. The format for the Roundtable Discussions consisted of an overview keynote presentation by an invited speaker and several short presentations by a limited number of selected authors. Keynote presentations were made by: Dr. Burns (USA), Dr. Cucinotta (USA), Dr. Durante (Italy), Dr. Hall (USA), Dr. Kiefer (Germany), Dr. Nagaoka (Japan), and Dr. Schimmerling (USA). Dr. Curtis (USA) presented a special lecture in the memory of Dr. Badhwar (USA), whom the radiation community lost during the past year.

Roundtable discussion topics included:

- Space Radiation Related Issues
  - Accelerator Facilities (11 papers)
  - Physical Shielding (22 papers)
  - Dosimetry (20 papers)
  - Environment (17 papers)
- Space Radiation Biology
  - Physiological Effects (25 papers)
  - Cellular Responses (20 papers)
  - Gene Stability (28 papers)
  - Seeds & Plants (7 papers)
- Biological Protection in Radiation Treatments (18 papers)
- Radiation Experiments in Space including on the ISS (18 papers)

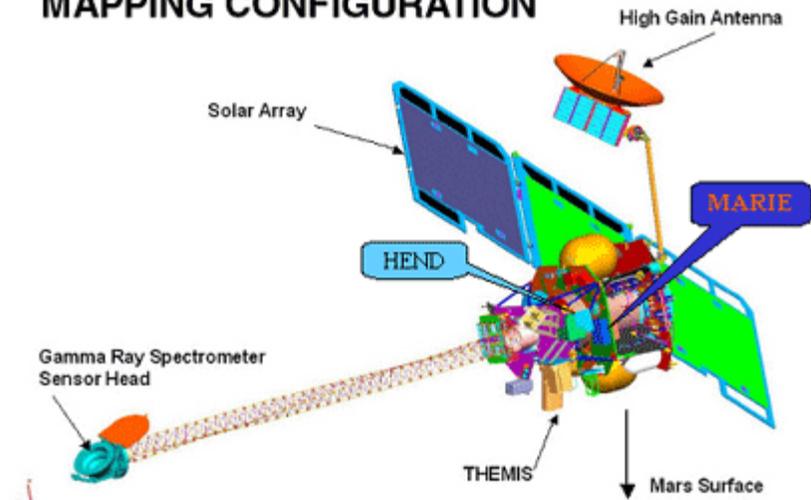
The 3rd International Workshop on Space Radiation will be held in the US at the [Brookhaven National Laboratory](#) in the year 2004. Dr. Derek Lowenstein, Chairman of the [Collider-Accelerator Department at BNL](#), extended his invitation on behalf of the host committee to all of the international radiation research community.

### Back to Life from Mars, the MARIE

[The Martian Radiation Environment Experiment \(MARIE\)](#), one of the four payloads on the 2001 Mars Odyssey Spacecraft, is currently in Martian orbit collecting radiation environment data. The MARIE instrument was designed and developed by the NASA Johnson Space Center, and more information about MARIE is included in an earlier SRHP newsletter ([Space RAD Health, Vol.1, No.2](#)).

The MARIE instrument was in stand-by mode during the majority of the cruise phase and the early part of the mapping phase. On March 13th 2002, the MARIE instrument was switched back into science mode and started acquiring mapping data as part of the Mars Odyssey suite of instruments. In spite of the fact that MARIE was forced to be in stand-by and safe mode for nearly seven months (from August 12, 2001 through March 12, 2002), the instrument is working as expected and is

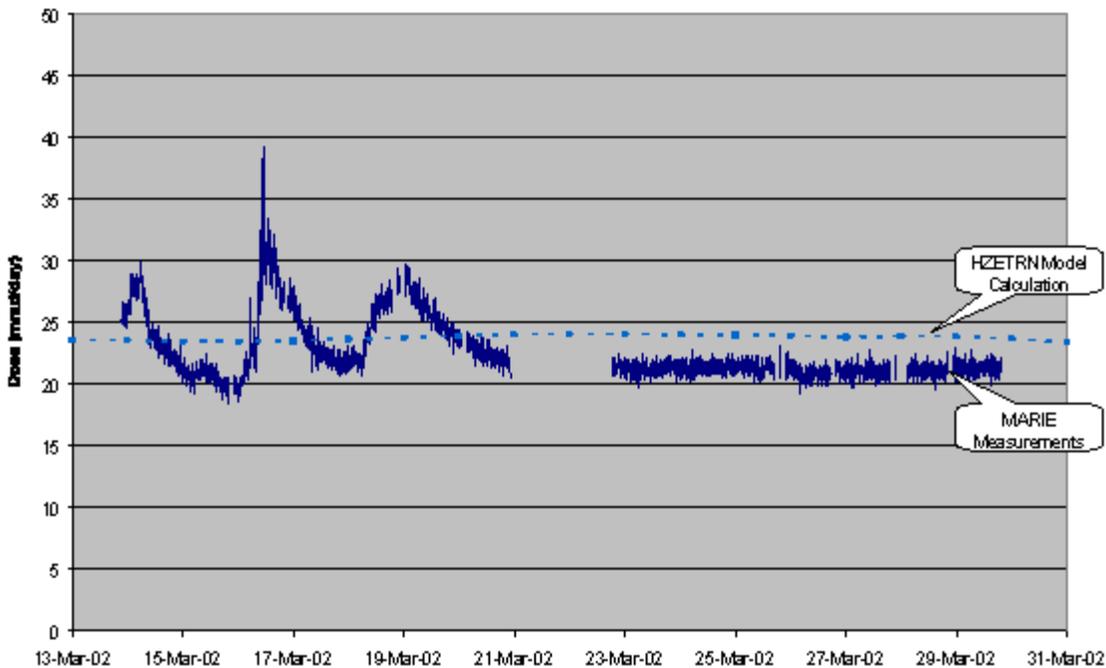
## MAPPING CONFIGURATION



providing first radiation measurements from the Martian orbit.

The figure below presents [preliminary radiation data](#) in Mars orbit measured by the MARIE instrument during March 2002. The comparison, which represents the first data set received from the instrument, shows a dose enhancement in mid-March due to a solar particle event. This is the first SPE data ever recorded by a radiation detector in Mars orbit. The background GCR dose-rate is good in agreement with theories with the current dose-rates near the lowest in the solar cycle. Current Mars radiation data analyses, including model calculations provided in the figure below, are performed at NASA's Johnson Space Center. Further data analysis and preliminary science reports are also available from the [MARIE website](#). More info on the past (1958-1978) NASA Mars explorations can be found on the [NASA-HQ website](#).

MARIE Measurements vs HZETRN Model Calculations - March 2002

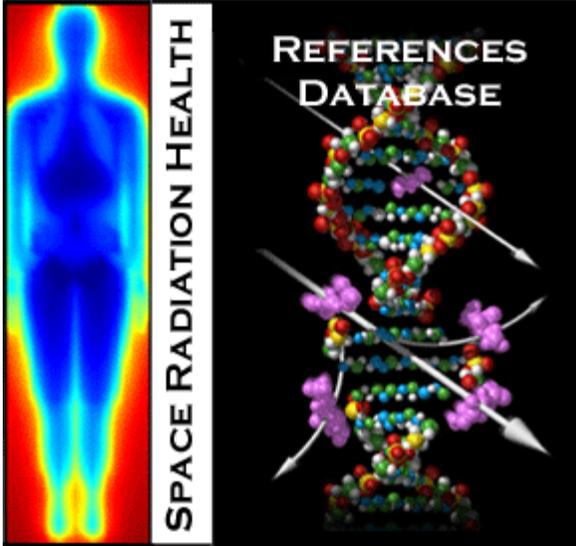


## NASA Study Links Astronaut Cataracts to Space Radiation

The human eye is considered to be the most radiosensitive organ of the human body, and a recent study of cataract incidence among the NASA astronauts highlighted concern for this effect of space radiation. The study is based on three decades of historical data that are part of the Longitudinal Study of Astronaut Health (LSAH). An assessment of the 48 cataract cases in 295 astronauts shows an association between cataracts incidence and space radiation exposure, especially during high-inclination missions, which have a larger dose fraction from high-charge and energy (HZE) ions. The study concluded that astronauts exposed to higher amounts of space radiation have an earlier appearance and higher incidence of cataracts compared to astronauts who received lower doses or have not flown in space. The results of this study appeared in the November 2001 issue of the journal [Radiation Research](#) [*Radiat. Res.* **156**, 460-466 (2001)]. The paper, authored by F. A. Cucinotta, F. K. Manuel, J. Jones, G. Iszard, J. Murray, B. Djojonegoro and M. Wear, is entitled *Space Radiation and Cataracts in Astronauts*.

In December 2001, NASA released a press report on this research contribution recognizing the need for developing new techniques to protect space travelers. More details can also be found from the [NASA News Release # 01-245](#), dated December 17, 2001. Also, an earlier SRHP Newsletter ([Vol.1, No.1](#)) contains more information on current and ongoing NASA supported research pertaining to radiation damage to the human lens.

## SRHP's Reference Database on DNA Damage



The Space Radiation Health Project (SRHP) is committed in developing scientific databases that can provide access to radiobiological data for the SRHP sponsored research investigators and to the NASA program offices as needed. We are pleased to announce the collection of the literature citations containing more than 1000 peer-reviewed publications on DNA damage and repair mechanism as well as the current BEIR VII committee review citations for their upcoming report. The collection may be searched by author, title, and collection.

NASA and Lawrence Berkeley National Laboratory published a study in 1997 entitled *Modeling Human Risk: Cell and Molecular Biology in Context*. Excerpts from this study on the [Cellular and Tissue Response to Radiation Damage](#) are available. The United Nations Scientific Committee on the Effects of Atomic Radiation UNSCEAR 2000 Report included several scientific annexes. Excerpts from the UNSCEAR annex on [DNA Repair and Mutagenesis](#) are also available. The future challenge for space travel is to understand how DNA damage and repair are controlled following HZE radiation.

## An Update on BAF: A NASA Facility for Space Radiation Research



**BROOKHAVEN**  
NATIONAL LABORATORY

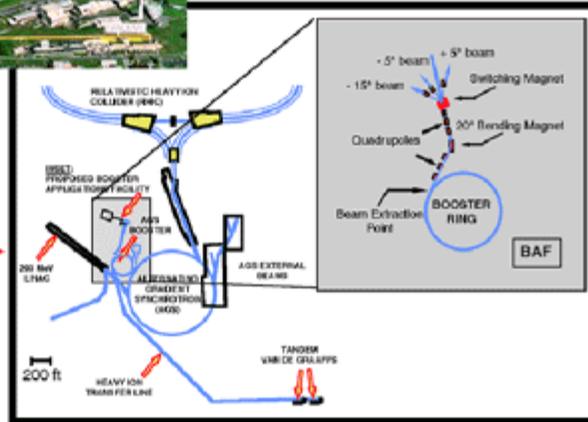
*Years in the making and only a few more months to reality . . .*

**Past:** The [National Aeronautical and Space Administration \(NASA\)](#) and the [Department of Energy \(DOE\)](#) have identified the need for developing a national research facility to simulate the space radiation environment and conduct research investigations to assess its effects on human beings. Simulation of space radiation effects demands the capability to produce protons and electrons at low energies (few MeV per nucleon) as well as heavy ions at higher energies (several GeV per nucleon). In response to a July 1992 Memorandum of Understanding (MoU) between NASA and the DOE and a subsequent agreement between NASA and [Brookhaven National Laboratory \(BNL\)](#), plans were made for the construction of a high energy, heavy ion irradiation facility at the BNL site. This facility, named the [Booster Application](#)



## Brookhaven National Laboratory

**Booster Applications Facility (BAF - NASA)**



[Facility \(BAF\)](#), will use a beam line diverted from the existing [Alternating Gradient Synchrotron \(AGS Booster\)](#). The construction of the BAF began in 1998.

**Present:** The AGS Booster is a circular accelerator with a circumference (~ 660 feet) slightly less than one quarter of the size of the AGS ring. The AGS Booster receives either a proton beam from the [LINAC \(Linear Accelerator\)](#) or heavy ions from the [Tandem Van de Graaff](#) generator and pre-accelerates particles prior to injection into the AGS. The primary function of the AGS Booster has been to accelerate protons and heavy ions prior to injection into the main AGS ring. With the new BAF construction, the capabilities of the AGS Booster are greatly expanded for space radiation research. The construction of the BAF includes a new beam tunnel branching from the AGS Booster, a target room and beam stop, and a number of associated support facilities. For BAF applications the beam from the AGS Booster is extracted via a tangential tunnel (88 feet) and diverted (~ 20 degrees) to the BAF target room facilities through a long beam line tunnel (282 feet). The following group of pictures illustrates the construction progress which had been made as of February 2002. A thick earth and concrete shielding (~ 15 feet) was added over the tunnel, target room and beam stop.



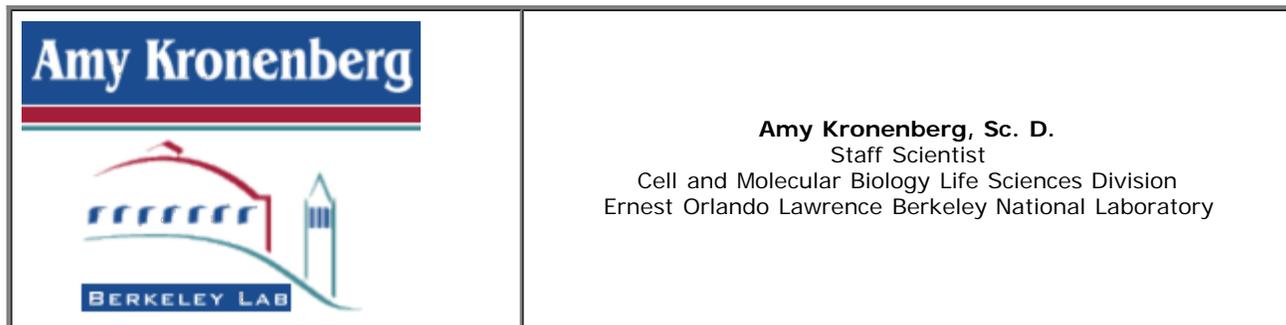
**Future:** The commissioning phase for the BAF will begin in October 2002, and the first experiments are being scheduled for July 2003. A broad range of particle species and energies will be available to simulate the space radiation environment in order to achieve the objectives of NASA's radiobiology research.

### Anticipated Beam Characteristics from the Booster Application Facility

<b>Protons</b>	0.07 - 3.07 GeV/nucleon
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<b>Si<sup>28</sup></b>	0.09 - 1.23 GeV/nucleon
<b>Fe<sup>56</sup></b>	0.10 - 1.10 GeV/nucleon
<b>Cu<sup>63</sup></b>	0.10 - 1.04 GeV/nucleon
<b>Au<sup>197</sup></b>	0.04 - 0.30 GeV/nucleon
<b>Beam Size</b>	1 - 25 cm

## SRHP Featured Investigator: Amy Kronenberg, Sc. D.



Dr. Kronenberg has been with the [Lawrence Berkeley National Laboratory \(LBNL\)](#) as a Staff Scientist since 1988 upon completion of her doctoral program (Sc. D.) in cancer biology at the [Harvard School of Public Health, Harvard University](#), Boston, MA. Dr. Kronenberg also served as a Research Assistant Professor of Biophysics with the University of California, Berkeley, CA. Dr. Kronenberg continues to hold several responsible positions including:

- Adjunct Professor of Biophysics, Department of Radiological Health Sciences, Colorado State University, Ft. Collins, CO (since 1991)
- Council Member, [National Council on Radiation Protection & Measurements](#), Bethesda, MD (1993-2005)
- Member, [Life Sciences Advisory Subcommittee](#), NASA, Washington, DC (since 1993)
- Group Leader, Radiation Biology and Environmental Toxicology section, Department of Cell and Molecular Biology, Life Sciences Division, Lawrence Berkeley National Lab, Berkeley, CA (since 1999)
- Councilor-at-Large, [Radiation Research Society](#) (since 1999)
- External Advisory Committee Member, [National Space Biomedical Research Institute](#), Houston, TX (since 2000)
- Vice-Chair, Commission F (Life Sciences), Intl. Committee on Space Research, COSPAR (2000-2004)
- Associate Editor of the [Radiation Research, an International Journal](#) (2001-2005)

For more than two decades, Dr. Kronenberg pursued the development of radiobiological studies to analyze the radiation effects on human cells. These studies have contributed significantly to our current understanding of radiation induced cell mutations. Dr. Kronenberg's research focuses on the mechanisms of mutagenesis and genomic instability following exposure to different types of ionizing radiations, with a particular interest on the biochemical mechanisms that help regulate risk as a function of genotype. Dr. Kronenberg began her investigations with charged particle radiation studies of importance for space flight while completing her doctoral studies. Her work has shown that different loci within the same human cell type can have very different responses to the same charged particle beam, and it is not easy to extrapolate from one locus to another. Recent studies indicated that recombination-mediated mutations occur at autosomal loci but not at X-linked loci including some very large deletions that involve the autosomal locus (Cancer Research, 2001). Most mutations that are associated with the development of human tumors occur at autosomal loci. Related studies in collaboration with the [NASA Specialized Center of Research and Training for Radiation Health](#) (NSCORT, a joint effort between Lawrence Berkeley National Laboratory and Colorado State University) indicated that [charged particle radiation can lead to whole chromosome loss](#), another mechanism of mutagenesis observed in human tumors (Radiation Research, 2000). Dr. Kronenberg's current research investigates the importance of the genotype of the cell at risk on the mutagenic response of human cells, with a particular emphasis on the proteins involved in the regulation of programmed cell death and homologous recombination (Cancer Research, 2002; Nucleic Acids Research, 2002).

Dr. Kronenberg notes on her research, "*We are studying the incidence of genomic instability in human cells exposed to low doses of radiation, as measured by the delayed appearance of non-clonal chromosome aberrations and elevated mutation rates. An important aspect of our ongoing research is the assessment of impact on human cells from the unusual types of radiation exposures in the outer space. We use different charged particles to understand how the physical pattern of energy deposition affects the frequencies and types of mutations produced. These studies are useful to NASA as they help to quantify the risks of human exposure during long term space-flight.*"

Also, Dr. Kronenberg has been serving as a Principal Investigator on several NASA funded research investigations. Currently, she serves as the Principal Investigator for the study of [Mutagenesis in Human Cells with Accelerated H and Fe Ions](#). The goal of this study is to determine the impact of genes that regulate apoptosis in modulating the risk of mutation induction in human cells exposed to space radiation.

## Publications: Selected Original Reports (since 1989):

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