

Space RAD Health

Newsletter

Vol. 3 No. 1 - March 2003 | Executive Editor: [Dr. Francis Cucinotta](#) | Contributing Editor: [Kay Nute](#)

NASA Announces Opportunities for Space Radiation Research

On March 11, 2003 NASA's [Office of Biological and Physical Research](#) (OBPR) announced new opportunities for NASA Specialized Centers of Research (NSCOR) to perform Ground-based Research in Space Radiation Biology (NRA 03-OBPR-XX). The focus of this new NASA Research Announcement (NRA) in Space Radiation Biology is to solicit research investigations that will support the first use of the NASA Space Research Laboratory (NSRL) at Brookhaven National Laboratory in 2003. An NSCOR differs from a set of independent projects in that suitable mechanisms are defined to engage the contributing projects in a synergistic manner, so that the total output of the NSCOR is greater than the sum of the parts: each project needs to contribute to all other projects, and each project needs to benefit in demonstrable ways from the contributions of all other projects. The team approach is also expected to lead experimental protocols that achieve efficient beam utilization and sharing of experimental resources.

Access to application materials and guidelines for submittal of proposals can be obtained from: http://research.hq.nasa.gov/code_u/nra/current/NRA-03-OBPR-02/index.html. Proposals are due to OBPR by June 2, 2003 with average awards of \$1.5 M with a maximum of \$2.0 M per year. These new grants are anticipated to receive initial funding in fiscal year 2003. There are three NSCORs that are currently being solicited:

- **Cancer Effects Project:** with emphasis on using biological models to estimate cancer risks, especially leukemia from space radiation
- **Cellular and Molecular Biology Project:** with emphasis on understanding the mechanisms of DNA damage processing
- **Neuronal Space Radiation Risks Project:** with emphasis on the risks of CNS effects from space radiation.

Space Radiation Health Investigators' Workshop - 2003

The 14th Annual NASA Space Radiation Health Investigators' Workshop will be hosted by the Space Radiation Health Project of NASA's Johnson Space Center from April 27th (Sunday) through April 30th (Wednesday), 2003. The workshop will be held at [South Shore Harbour Resort and Conference Center](#), League City, Texas.



IMPORTANT DATES TO REMEMBER	
Date(s)	Workshop Events
February 1, 2003	Deadline for Response Form
February 14, 2003	Online Registration Begins
February 21, 2003	Deadline for Abstract Submission
April 1, 2003	Deadline for Hotel Registration at Special Rate
April 21, 2003	Deadline for Submitting Presentation CD-ROM
April 27-30, 2003	Space Radiation Health Investigator's Workshop

The scientific committee for the 14th Annual Workshop is: Dr. Francis A. Cucinotta, *NASA Johnson Space Center*; Prof. John F. Dicello, *Johns Hopkins University*; Dr. Amy Kronenberg, *Lawrence Berkeley National Laboratory*; Dr. Greg D. Nelson, *Loma Linda University Medical Center*; Dr. Walter Schimmerling, *NASA Headquarters*; Dr. Michael D. Story, *University of Texas M. D. Anderson Cancer Center*; Dr. Betsy M. Sutherland, *Brookhaven National Laboratories*; and Dr. Elizabeth L. Travis, *University of Texas M. D. Anderson Cancer Center*. As the scientific committee finalizes the program schedule and other details, more information will be made available via the SRHP Website.

Invited talks to be given at the meeting include presentations on: - DNA Damage Processing, ATM and Radiation Sensitivity, Signal Transduction, Apoptosis, Neuronal Radiobiology, Individual Approaches to Cancer Risks, and

Translational Research. Early morning *Refresher Courses* (served with coffee) will include talks on Running Accelerator Experiments with Protons and Heavy Ions. NASA Astronaut Dr. Shannon Lucid will give a *Special Welcome* and NASA Astronaut Dr. Franklin Chang-Diaz will be the *Banquet Speaker*.

A New NCRP Report on Radiation Safety for NASA Astronauts

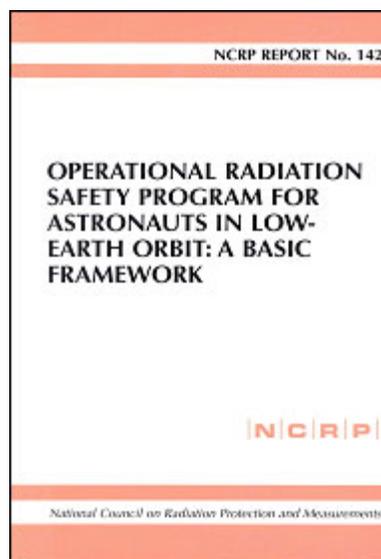
The [National Council on Radiation Protection and Measurements \(NCRP\)](#) released their report on "Operational Radiation Safety Program for Astronauts in Low Earth Orbit: A Basic Framework" (NCRP-Report No.142, 2002). The committee members for the report were Richard J. Vetter (Mayo Clinic), Chair, Ellen S. Baker (NASA-Johnson Space Center), David T. Bartlett (National Radiological Protection Board), Thomas B. Borak (Colorado State University), Susan M. Laghorst (Washington University in St. Louis), Stephen W.S. McKeever (Oklahoma State University), Jack Miller (Lawrence Berkeley National Laboratory), R. Julian Preston (Environmental Protection Agency), and John W. Wilson (NASA-Langley Research Center). Charles B. Meinhold (NCRP) served as an advisor to the Committee.

The new report reviews current methods, and makes 20 major recommendations on all areas of operational radiation safety program in LEO including:

- Methods of physical and biological dosimetry
- Approaches to immediate dose management
- Implementation of the ALARA principle
- Organ dose assessments and radiation safety records
- The overall management and structure of the radiation protection program

The panel members on this NCRP report have used knowledge of terrestrial radiation protection programs and considerations of the unique aspects of space travel in their recommendations. Also, these new recommendations include the assessment of guidelines provided in the [NCRP-98 \(1989\)](#) and [NCRP-132 \(2000\)](#) reports. The NCRP Report-132 updated dose limits for fatal cancer risk based on recent research findings, epidemiology data and a new approach to the assessment of doses for deterministic effects, and the NCRP Report-142 is intended as a companion document to this report. Several Appendices provide a detailed review on the space environment, computational methods in space radiation transport, and dosimetry.

The NCRP-142 report identifies the premises for these recommendations and guidelines based on our current knowledge that - the radiation environment external to a spacecraft in LEO consists of electrons, positrons, neutrons, protons, and heavier nuclei (up to $Z = 92$). Sources include: GCR from deep space, SPEs produced by coronal mass ejections or by acceleration in solar flare events; particles trapped in Earth's magnetic field; and scattering from earth's atmosphere (*albedo* neutrons, electrons, and protons). Energies of these particles range from a few electron volts (eV) for trapped electrons and *albedo* neutrons to in excess of 10^{14} MeV for GCR ions. The space radiation environment is modulated by spatial and temporal factors including the 11-year solar cycle and the solar wind, and Earth's magnetic field, which traps some particles and deflects other particles. The particle distributions are sensitive to both inclination and altitude. In LEO, the GCR intensity is modulated by the geomagnetic field lines, such that the high-inclination Space Shuttle flights and the ISS (51.6°) are exposed to higher GCR fluxes than are low-inclination Space Shuttle flights (ex. 28.5°). The NCRP report addresses the unique set of dosimetry needed to monitor this complicated environment.



Commissioning of the NASA Space Research Laboratory (NSRL) at BNL

The Office of Biological and Physical Science Research has announced the official title for the new NASA space radiation facility at the Brookhaven National Laboratory (BNL) as the NASA Space Research Laboratory (NSRL) (formerly known as Booster Application Facility, BAF). This milestone comes during the commissioning phase of the NSRL that includes comprehensive testing of the major components (see Figure 1) and operation of the beam line as well as the testing of general experimental capabilities to perform biology and physics experiments. The first beam extraction tests at the NSRL were accomplished on October 23, 2002 (see Figure 2) and click the image to watch the movie). The major portion of NSRL commissioning will occur during May and June of this year, followed by three weeks of commissioning experiments planned for July 2003. All of this will lead to the long awaited first science experiments at the NSRL during the fall of 2003.

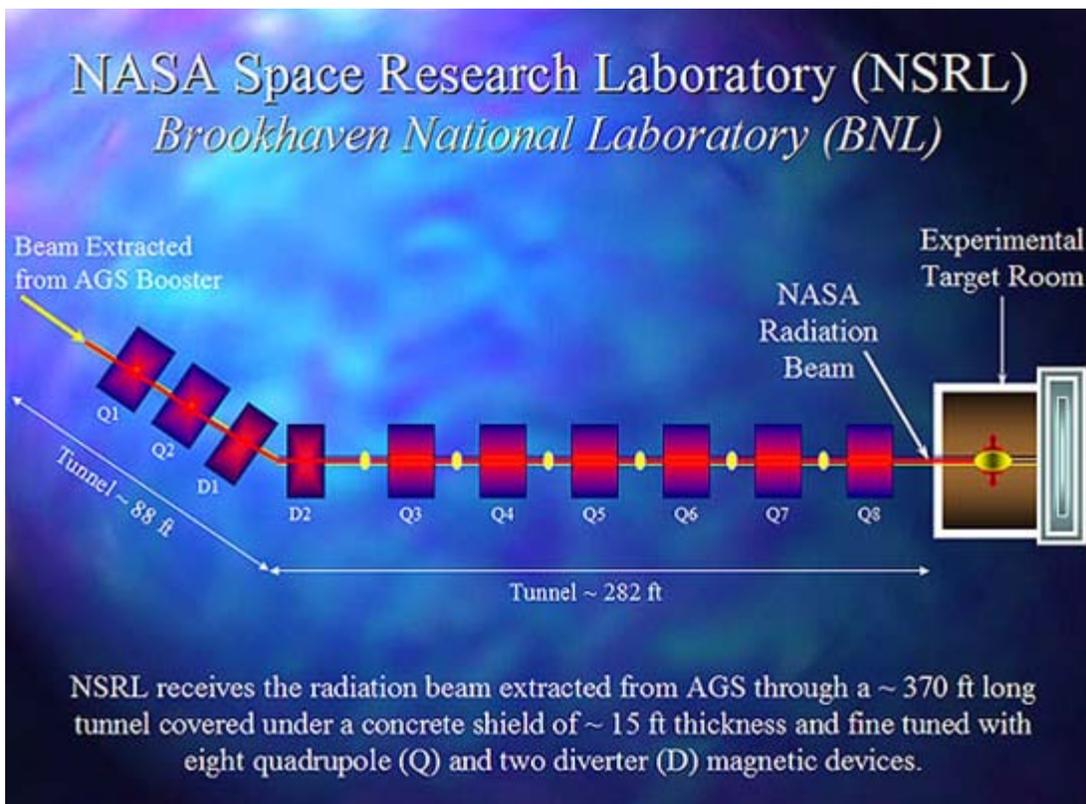
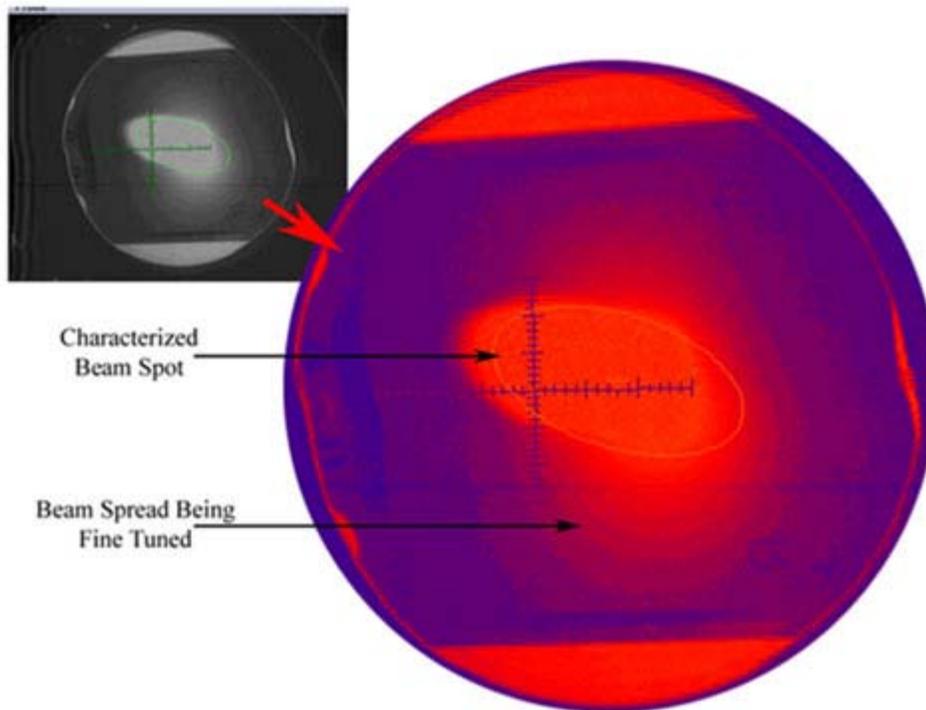


Figure 1. An illustration of the NSRL beam line and target area (not drawn to scale). [Click image for animated version.](#)

In the future, NASA sponsored radiobiology researchers will be able to use the NSRL facilities with charged particle beams to include protons (with energies up to 3 GeV); silicon, titanium, iron (with energies exceeding 1 GeV/u); and gold (with energies up to 0.3 GeV/u); with variable beam spot sizes of 1 - 25 cm.



First Test Beam Profile - NSRL: October 23, 2002

Figure 2. The first beam extraction test at the NSRL target facilities on October 23, 2002. In this figure, the original still image and color enhanced illustration are provided. [Click the image to view a movie of the test beam \(110 MeV/u Au\) at the target.](#)

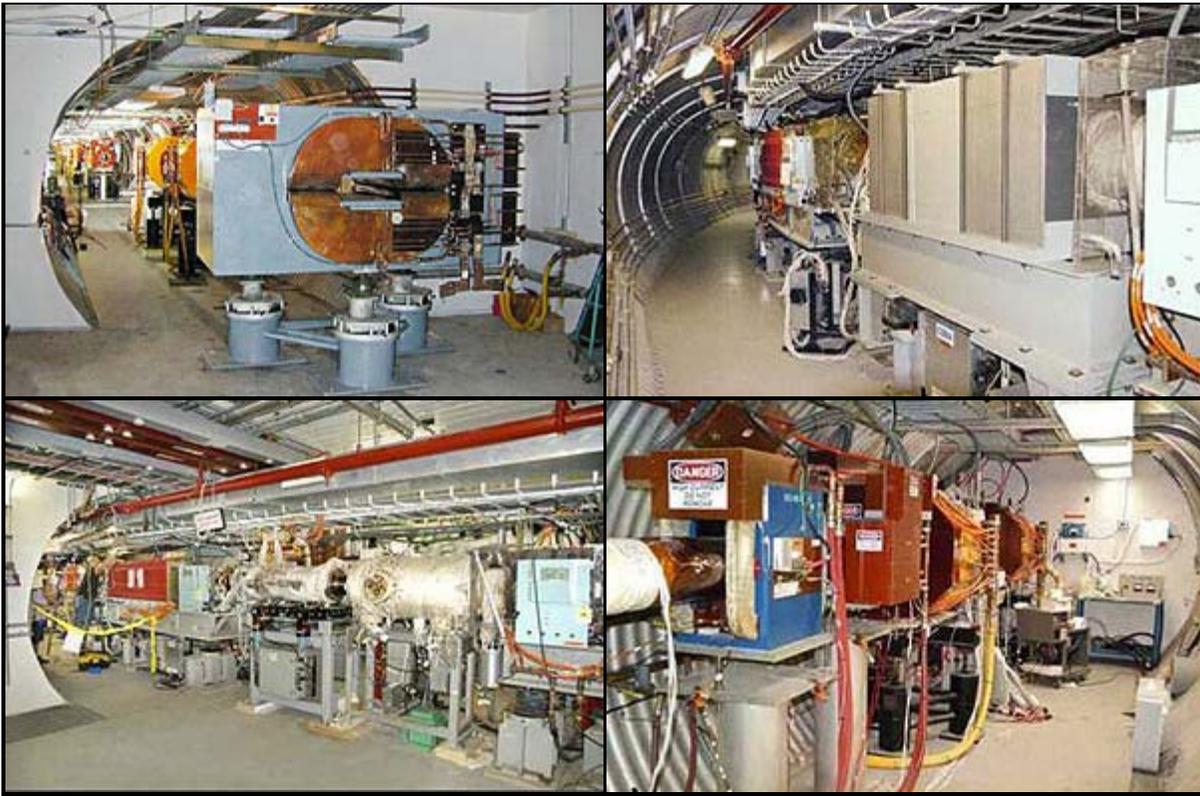


Figure 3. Selected views of a magnet and associated electronics are shown. In all about eight sets of such quadrupole (Q) magnets and two diverter (D) magnet systems steer the beam to the target room and with the required characteristics.

NASA Supported Space Radiation Research Experiments: BNL-9

NASA supported space radiation research experiments were conducted at the Brookhaven National Laboratory (BNL) from November 7th through 14th, 2002 utilizing the beam line from the [AGS \(Alternating Gradient Synchrotron\)](#) Booster. These experiments are 9th in series of NASA sponsored research at BNL (BNL-9). For the first time, a high-energy iron beam with 5 GeV/u, an energy five-fold higher than that was used in prior NASA experimental runs, was delivered by the AGS for heavy ion radiobiology and shielding research investigations. The 5 GeV/u beam is more typical of energies of the galactic cosmic rays that pass through the International Space Station (ISS) since the Earth's magnetic field shields the ISS from galactic cosmic rays with energies below about 1 GeV/u. More than 30 research experiments were conducted during the nine days of experiments for these BNL-9 [NASA supported research investigations](#).

The majority of the experiments concentrated on the radiation effects on human cell lines including respiratory, thyroid, lens, and lymphoid cells, studying a variety of biological endpoints including genomic instability, chromosomal aberrations, modulation of gene expression, and CNS damage. Also, shielding studies pertinent to the long-term space travel applications and the physics of heavy ion transport were made. In all three different radiation beams were provided to the investigators: 5 GeV/u Fe, 1 GeV/u Fe, and 0.6 GeV/u Si. In Figure 4, a complete listing of all the BNL-9 experiments along with the investigator names is provided. Also, a time-line of the BNL-9 experiments in the order of occurrence are provided along with the usage of the beam time for each experiment (Figure 5).

S. No.	PI (Last Name)	BNL-9 Experiment Title
1	Azzam	Effects of Low Fluences of High Energy Ions in Normal Human Cells
2	Barcellos-Hoff	Tissue and Cell Stress
3	Blakely	Heavy Ion Effects Differentiating Human Lens Cells
4	Burns	Tumor Induction by High LET Radiation
5	Burns	Selective Inhibition of ⁵⁶ Fe Carcinogenesis
6	Chang	Charge Particle Radiation Induced Genetic Damage
7	Chatterjee	Chromosomal Damage
8	Chen	Radiation Induced Genomic Instability
9	Cucinotta	Heavy Ion Induced Chromosome Damage
10	Durante	Influence of Shielding on Space Radiation
11	Ford	Low Dose Response of Respiratory Cells in Intact Tissue
12	Gewirtz	Effect of Deep Space Radiation on Human Hematopoietic Stem Cells
13	Gonda	3D Tissue Equivalents
14	Green	Response of Thyroid Tissue
15	Hall	Genetic Control of Radiation Sensitivity
16	Kennedy	Screening of Agents for Protection of Radiation Induced Oxidative Stress
17	Koniarek	Microlesions in Membranes
18	Kronenberg	Mutagenesis & Genomic Stability in Human Lymphoid cells
19	Lupton	Nutritional Countermeasures to Radiation Exposure
20	Morrell	Diamond Ultraviolet Sensors
21	Murnane	Telomere Repair and Chromosome Instability
22	Narici	Effects of Transient Heavy Ion Radiation on the Electrophysiology
23	Nelson	Radiation Induced Gene Expression
24	Nelson	Mutation and Chromosome Aberration in Nematode C Elegans
25	Obenaus	Differential Cognitive, Behavioral, and Biological Effects of Proton and ⁵⁶ Fe Irradiation
26	Rabin	Effect of Exposure to Heavy Particles
27	Setlow	Germ Cell Mutagenesis
28	Sutherland	Effect of Deep Space Radiation on Human Hematopoietic Stem Cells
29	Sutherland	DNA Damage Clusters
30	Vazquez	CNS and Countermeasure
31	Vazquez	Risk Assessment and Chemoprevention of HZE-Induced CNS Damage
32	Worgul	Genetic Control of Radiation Sensitivity
33	Wu	Heavy Ion Induced Chromosome Damage
34	Zeitlin	Heavy Ion Transport in Matter

Figure 4. NASA supported radiation experiments conducted during November 7-15, 2002 (BNL-9).

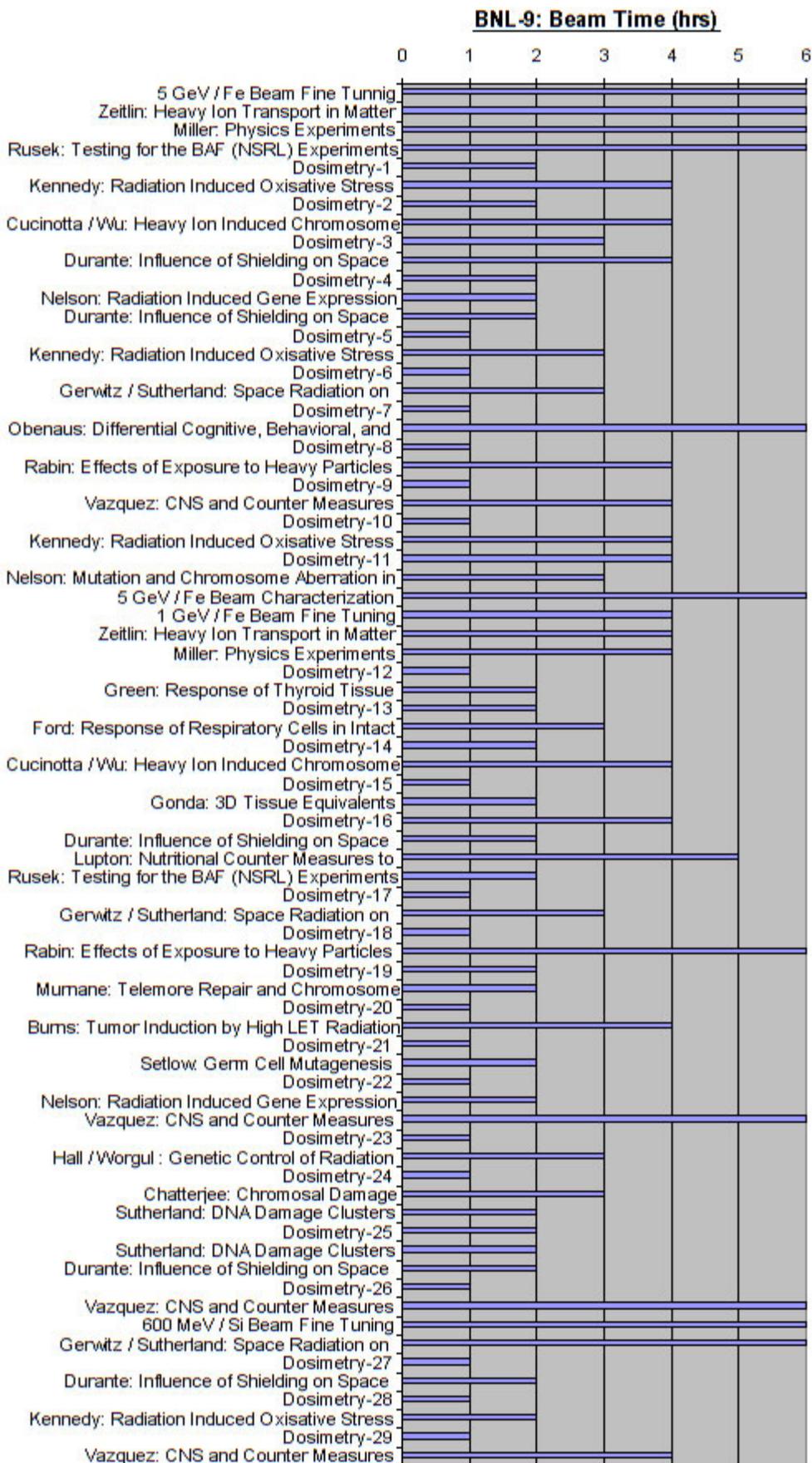
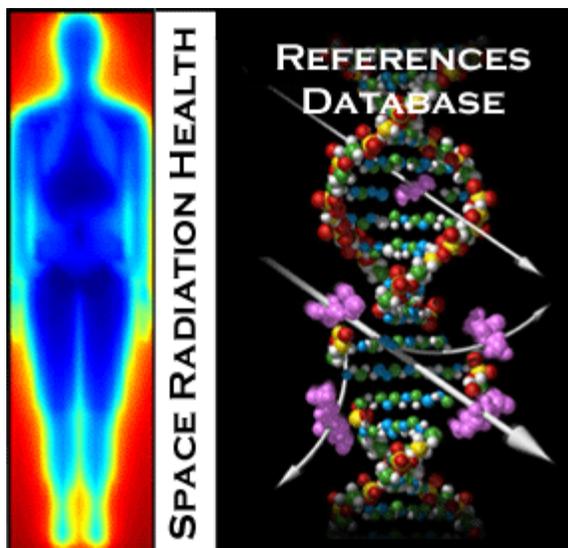


Figure 5. A time-line of the BNL-9 experiments listed with the PI names and the experimental title along with the number of hours of radiation beam utilization.

Other Items of Space Radiation Research Interest

- The SRHP References Database is now updated with an additional 500 research publications pertinent to the low dose radiation studies. Also, over 100 research publications citations are added into the SRHP Database in the area of track structure. This brings the total of the citations available through SRHP Database to nearly 2000.
- NASA Johnson Space Center released a new technical publication, [NASA/TP-2003-210792: Physics of the Isotopic Dependence of Galactic Cosmic Ray Fluence Behind Shielding](#). In this publication, the authors present the enhanced model capabilities provided by a new complete GCR isotopic flux model of 170 isotopes for more accurate assessments of the space radiation environment, which will increase the predictable capabilities for the International Space Station (ISS) and deep space missions such as travel to the Moon or Mars. This publication is also available upon request from SRHP.



SRHP Featured Investigator: Lorna M. Green, Ph. D.



Lorna M. Green, Ph. D.
Associate Professor of Medicine
Loma Linda University School of Medicine
Loma Linda, CA 92354

Dr. Lorna Green is a good friend of Space Radiation Health Project and has recently been selected as one of the SRHP Principal Investigators. Dr. Green has been associated with the [Loma Linda University's](#) Radiobiology Program since 1997. Concurrent positions held by Dr. Green include: Research Molecular Immunologist at the J. L. Pettis Memorial Veterans Administration Medical Center in Loma Linda (1991-present); and Associate Professor in the departments of Medicine, Rheumatology (1997-present); Biochemistry & Microbiology (1996-present), and Physiology (1996-present) at the Loma Linda University. Dr. Green's Postdoctoral training included a Research Fellowship in Anatomy & Molecular Cytology at the JL Pettis VAMC and Loma Linda University (1989-1991); and Immunology & Tumor Biology at the University of California, Riverside (1987-1989). Dr. Green received her B.S. degree in Biochemistry from the University of California, Riverside (1981), M.S. degree in Biochemistry from the University of California, Riverside (1982), and Ph.D. from the University of California in Cell and Molecular Biology (1987).

Dr. Green has a variety of research interests that center on normal tissue responses to injury. She investigates the role of tissue integrity and cellular context to radiation and inflammatory induced damage and currently uses a rat thyroid model that she has developed. Dr. Green began her research career as a tumor immunologist focused on cytokine-mediated signal transduction and programmed cell death in Dr. Carl Ware's laboratory. Her belief that the integrated status of the tumor target cells dictated their sensitivity or resistance to cytotoxic agents that was confirmed in studies of gap junction mediated cell-to-cell communication and tumor insensitivity. To further this interest in tissue context and cytokine-mediated destruction she pursued a fellowship in a laboratory focused on gap junctions (Dr. William H. Fletcher), JL Pettis VAMC. Dr. Green was awarded a VA-Merit Review Grant and her own laboratory at the VAMC to study the role of tissue integrity and gap junction-mediated protection against tissue destruction at sites of inflammation. During this time Dr. Green and her laboratory developed a rat thyroid experimental model, and characterized a mouse model of autoimmune thyroiditis to use as tools to study inflammatory processes and the state of tissue integration. Those studies demonstrated that at sites of autoimmune reactivity the inflammatory process promoted tissue disruption, not frank tissue destruction that had been the accepted dogma. Dr. Green's studies provided evidence that reduction of contact-dependent intercellular communication and loss of cellular organization in the target tissue coincided with reduced function and promoted

subsequent fibrosis and eventual replacement of the glandular epithelium. At the conclusion of those studies, Dr. Green joined the NASA sponsored laboratories headed by Dr. James M. Slater and Dr. Gregory A. Nelson to apply her expertise in normal tissue models to ionizing radiation responses and mechanisms of tissue damage.

As an active faculty member of Loma Linda University Dr. Green has a modest teaching load, but a constant flow of Graduate Students and Medical Residents that she mentors. Dr. Green has developed a number of methods and has a broad and varied scientific background. At the NASA sponsored laboratories in Loma Linda she supervises the laser scanning cytometer and confocal microscopy fluorescent imaging facility and has developed many protocols to utilize these instruments. Dr. Green's abilities and willingness to help others has lead to a variety of scientific collaborations, with the most pertinent:

- **MRC, UK:** Dr. Munira Kadhim, Radiation-Induced Genomic Instability & Bystander Effects
- **Gray-Lab, UK:** Drs. Kevin Prise & Melvin Folknard, Microbeam Studies, Bystander Effects
- **BNL, UK:** Dr. Marcelo Vazquez, Radiation-Induced Neuronal Cell Damage
- **AFRRI, MD:** Dr. Alexandria Miller, Depleted Uranium, Communication Status and Cell Transformation
- **Slone-Kettering, NY:** Dr. Adriana Haimovitz-Friedman, Aortic Endothelium, Communication Status
- **LLU, CA:** Dr. Gregory Nelson, Radiation-Induced Alteration of Gene Expression; Dr. Daila Gridley, Radiation-Induced Tumor Tissue Infiltration & Various Techniques; Drs. Vivian Mao & John Archambeau, Radiation-Induced DNA Damage in Quiescent Vascular Endothelium, & Various Techniques; Dr. Larry Sandberg, Skin, Mechanisms of Tissue Regeneration and Small Peptide Signaling; Dr. Keith Colburn, Autoimmunity, Inflammation and Signal Transduction; Dr. Wolff Kirsch, Iron-Regulatory Protein-2's Role in the Development and Progression of Alzheimer's Disease [Dr. Green, Co-PI, NIH award 2002 (\$6,700,000)]; Dr. Christopher Jobe, Arthroscopy, Tissue Quality; Dr. Larry Longo (LLU, CA), Common Carotid and Mid-Cerebral Arterial Development.

This year, Dr. Green was awarded a grant from the Department of Energy in conjunction with NASA -Program notice 02-15 to study how low dose gamma irradiation potentiates secondary exposure to gamma rays or protons in thyroid tissue analogs, and an additional award from NASA (OBPR-06) to study the response of thyroid tissue analogs to space-like radiation fields. These studies utilize thyroid tissue analogs (produced during growth in low-shear bioreactors) that develop into realistic three-dimensional replicas of the thyroid gland. Use of this model provides the opportunity to investigate how normal tissue responds to ionizing radiation at multiple levels, including: cell-cell exchanges (bystander), signal transduction, functional changes and modulation of gene expression. Dr. Green says that she is excited by the opportunity to investigate how the organizational status of the target cells influences their response to low dose, low dose rates and various radiation qualities, and is looking forward to the challenges ahead.

One of the current NASA sponsored research investigation that is being managed by the Space Radiation Health Project is a study entitled "[Response of Thyroid Functional Tissue Units to Space-Like Radiation Fields](#)". This study is based on the understanding that the thyroid like most epithelial-based glandular tissues are a common site of tumor development and sensitive to ionizing radiation induced carcinogenic changes.

Selected Research Publications

- Green LM, Z Patel, DK. Murray, SS Rightnar, CG. Burell, DS. Gridley & GA. Nelson, Cytoskeletal and functional changes in bioreactor assembled thyroid tissue organoids exposed to gamma radiation. *J Radiat. Res.* (in press) (2002).
- Kadhim MA, Green LM, Gridley DS, Murray DK, Tran DT, Pocock D, Macdonald D, Andres M, Moyers MF, Goodhead DT & Nelson GA. In Vitro Studies on Space Radiation Induced Delayed Genetic Responses: Shielding Effects. *Radiat. Measurements* (in press) (2002).
- Gridley DS, Pecaut MJ, Green LM, Miller GM and Nelson GA, Hypergravity-induced immuno-modulation in a rodent model: Lymphocytes and lymphoid organs. *J Gravitational Physiol.* (in press) (2002).
- Green LM, Tran DT, Murray DK, Rightnar SS, Todd S, and Nelson GA. Response of thyroid follicular cells to gamma irradiation compared to proton irradiation: II. The Role of Connexin32. *Radiat. Res.* 158:475-485 (2002).
- DW Kim, ML Andres, GM Miller, J Cao, LM Green, Ann LB Seynhaeve, TLM Ten hagen & DS Gridley. Immunohistochemical analysis of immune cell infiltration of a human colon tumor xenograph after treatment with STEALH liposome-encapsulated tumor necrosis factor-alpha and radiation. *International J of Oncology* 21:973-979 (2002).
- Green LM, Murray DK, Tran DT, Bant AM, Kazarians G, Moyers MF and Nelson GA. Response of thyroid follicular cells to gamma versus proton irradiation: I. Initial characterization of DNA damage, micronuclei formation, apoptosis, survival and cell cycle phase redistribution. *Radiat. Res.* 155:32-42. (2001).
- Green LM, Murray DK, Tran DT, Nelson GA, Shah MM and Luben RA. A Spontaneously Arising Mutation in Connexin32 with Repeated Passage of FRTL-5 Cells Coincides with Increased Growth Rate and Reduced Thyroxin Release. *J. Mol Endocrinol* 27: 145-163 (2001).
- Mao X W, Green LM and Gridley DS. Evaluation of Polysaccharopeptide (PSP) Effects Against C6 Glioma in Combination with Radiation. *Oncology* 61:243-253 (2001).
- Nelson GA, Green LM, Gridley DS, Archambeau JO, Slater JM. Research activities at the Loma Linda University and Proton Treatment facility - an overview. *Phys Med* 17:30-33, (2001).
- Green LM, Lazarus JP, Song X, Stagg RB, LaBue M, and Hilliker S. Elevated protein kinase C in autoimmune diseased thyroid prevents assembly of connexin43 gap junctions and reduces intercellular communication. *Thyroid* 7(6):913-921. (1997).
- Green LM, LaBue M, Lazarus JP and Jennings JC. Reduced cell-cell communication in experimentally induced thyroid disease. *Endocrinology* 137:2023-2032. (1996).
- Green LM, LaBue M, Lazarus JP and Colburn KK. Characterization of autoimmune thyroiditis in MRL-lpr/lpr mice. *LUPUS* 4:187-196. (1995).

- Green LM, Lazarus JP, LaBue M and Shah MM. Deficient cell cell communication in a spontaneous murine model of autoimmune thyroiditis. *Endocrinology* 136(8): 3611-3618. (1995).
- Dorshkind K, Green LM, Godwin AJ and Fletcher WH. Gap junction formation and cell cell communication between bone marrow stromal cells. *BLOOD* 82(1): 38 45. (1993).
- Godwin AJ, Green LM, Walsh MP, McDonald JR, Walsh DA, and Fletcher WH. In situ regulation of cell cell communication by cAMP dependent and Ca⁺⁺-sensitive, phospholipid dependent protein kinases. *Mol & Cell Biochem.* 127/128:293-307. (1993).
- Coffman FD, Green LM, Godwin A. and Ware CF. Cytotoxicity mediated by TNF: Surface receptors, gap junctions and DNA topoisomerase II in lethal event variants of the ME 180 cervical carcinoma line. *J. Cell Biochem.* 39: 95 105. (1989).
- Coffman FD, Haviland DL, Green LM and Ware CF, Cytotoxicity by TNF is linked with the cell cycle but does not require DNA synthesis. *Growth Factors*, 1:357 364. (1989).
- Coffman FD, Green LM and Ware CF. The relationship of receptor occupancy to the kinetics of cell death mediated by TNF. *Lymphokine Res.* 7: 371 383. (1988).
- Ware CF, Green LM, Reade JL, Devlin PE, Liang C and Devlin JJ. Antigenic characterization of cytotoxic lymphokines produced by cloned human T cell lines. *Membrane Mediated Cytotoxicity* 45: 389 400. (1987).
- Green LM, Stern ML, Reade JL, Ware CF, Devlin PE, Liang CM and Devlin JJ. Cytotoxic lymphokines produced by cloned human cytotoxic T lymphocytes. II. A novel CTL produced cytotoxin that is antigenically distinct from tumor necrosis factor or lymphotoxin. *J. Immunol.* 137:3488 3493. (1986).
- Ware CF, Green LM, Reade JL, Stern ML and Berger AE. Human T cell Hybridomas producing cytotoxic lymphokines: Induction of LT release and killer cell activity by anti CD3 monoclonal antibody or lectins and phorbol ester. *Lymphokine Res* 5:313 324. (1986).
- Green LM, Stern ML, Haviland DL, Mills BJ and Ware CF. Lymphokines produced by cloned human cytotoxic T lymphocytes. I. Cytotoxins produced by antigen specific and natural killer like CTL are dissimilar to classical lymphotoxins. *J. Immunol.* 135:4034 4043. (1985).
- Green LM, Reade JL and CF Ware. Rapid calorimetric assay for cell viability: Application to the quantitation of cytotoxic and growth inhibitory lymphokines. *J. Immunol. Methods* 70:257 268. (1984).

Selected Book Chapters

- DS Gridley, LM Green, and GA. Nelson. Cancer - Radiation-Induced Damage. In: *Therapeutic Applications of Superoxide Dismutase and its Mimetics*, Daniella, Salvemini ed., Landers Bioscience-Riley (Book in progress).
- Green LM, LaBue M, Lazarus JP, Stagg RB, Shah M.M and Fletcher WH. Differential expression of connexin32 and connexin26 in liver from autoimmune diseased MRL-lpr/lpr mice. Council of Scientific Information Immunity & Infectious Diseases 14:1-9. (1995).
- Ware CF, Coffman FD, Green LM and Fletcher WH. Hierarchy of molecular mechanisms controlling the sensitivity of tumor cells to cytolysis by LT and TNF. In: *Tumor Necrosis Factor/Cachetin, Lymphotoxins, and Related Cytotoxins*, B. Bonavida, H. Kirchner and L. Olds, eds. S. Karger, A.G. Basel, pp. 26 31. (1988).
- Ware CF and Green LM. The cytotoxic lymphokines elaborated by effector T cells. *Lymphokines* 14: 307 334. (1987).