



BNL-7 RUN

FINAL REPORT

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EXECUTIVE SUMMARY

During the Winter of 2001, a series of radiobiological and physics experiments were performed using the BNL's Alternating Gradient Synchrotron to accelerate iron ion beams (Experiment 957, BNL-7). These experiments were part of the seventh consecutive run sponsored by NASA's Space Radiation Health Program (SRHP) heavy ion radiobiology research program at BNL.

A total of 24 proposals (from 25 proposals submitted) were approved to participate in the BNL-7 run, 7 of which were renewals, four were continuing projects and fourteen, which were new proposals. From the total number 23 were full proposals and 2 were piggyback experiments. Six proposals declined to participate. Nineteen institutions from the United States (10 states), and 5 from foreign countries (Italy, Japan and England) were represented, totaling 81 users. More than 1600 biological samples were irradiated at the AGS A-3 beam line, employing 89.5 hours of beam time. In addition, 37 hours were used for physics experiments, and a total of 21 hours were necessary for beam characterization, tuning, dosimetry, and calibration. A total of 35.5 hours of beam time were lost (19%) due to accelerator or power supply related problems.

During BNL-7, AGS provided iron beams with an energy of: 1 GeV/nucleon (1.046 GeV/nucleon*, LET: 148 keV/ μm), for biology and physics experiments. The dose/rates used were as low as 10 cGy/min and as high as 15 Gy/min. The spill rate employed was 30 spills/min with a duration of 500-600 msec/spill. The spill fluence was (particles/spill) 1×10^8 (max) and 1.5×10^5 (min). The intensities (particles/ cm^2/sec on target) used during the run were 1×10^8 (max) and 400 (min). A 7.5-cm diameter beam spot was employed as a nominal spot for the majority of the exposures. For larger samples (animals), an elliptical spot was used (up to 9 cm).

Tandem-Booster set-up started on Jan. 4 with the transport and circulation of Fe beams at the AGS complex. Beam was tuned into cave on Jan. 6 and 1.08 GeV/u ^{56}Fe beam was available for tuning on Jan. 8. The next several shifts were spent on tuning into the target area, beam diagnostics and establishing several different combinations of beam intensities and spot shapes and sizes for biology running. Biology studies started early on Jan. 9 (biology, NYU Medical Center, F. Burns) and proceeded with several interruptions through early Jan. 11, after which the machine operations was more stable. After all biology experiments were completed, LBNL (C. Zeitlin) ran 37 hours of fragmentation physics studies with 1.2 GeV/u ^{56}Fe . BNL-7 finished at 2300 PM on Jan. 15

Radiobiological experiments employed cells, tissues, and intact specimens, which required a complex coordination and planning of their respective logistic support. Biological studies used human, mouse, rat and hamster cell lines, human-hamster hybrid cell lines, tumor cell lines and intact specimens (rodents and fish). Physics experiments involved the exposure of solid state detectors and spacecraft materials. The full program was completed in 8 days.

*Actual beam energy on target

BNL-7 Projects Reviewed by the BNL's Scientific Advisory Committee in Radiobiology

| Project | P.I. | Status | SACR Review | BNL-7 Participation |
|----------------|-----------------|---------------|--------------------|--------------------------------|
| B-1 | Miller | Renewal | Approved | Yes |
| B-7 | Rabin | Renewal | Approved | Yes |
| B-10 | P. Chang | New | Approved | No |
| B-12 | Hei | Continuing | Approved | Yes |
| B-18 | Cooper | New | Approved | Yes |
| B-19/20 | Kronenberg | Renewal | Approved | Yes |
| B-25 | Evans | Renewal | Approved | Yes |
| B-29 | Natarajan* | Renewal | Approved | Yes |
| B-30 | Kale | Continuing | Approved | No |
| B-32 | Dicello | Renewal | Approved | Yes |
| B-39 | Burns | Renewal | Approved | Yes |
| B-42 | Barcellos-Hoff | Continuing | Approved | Yes |
| B-43 | Nelson | Continuing | Approved | Yes |
| B-44 | Durante/Belli | New | Approved | Yes |
| B-45 | Setlow | New | Approved | Yes |
| B-46 | Barbanel | New | Not Approved | No |
| B-47 | Nelson | New | Approved | Yes |
| B-48 | Green | New | Approved | Yes |
| B-49 | Cucinota-Kawata | New | Approved | No |
| B-50 | Cucinota-Wu | New | Approved | No |
| B-51 | Murnane | New | Approved | Yes |
| B-52 | Gerwitz | New | Approved | Yes |
| B-53 | Lupton | New | Approved | Yes |
| B-54 | Kennedy | New | Approved | No |
| B-55 | Vazquez | New | Approved | Yes |

*Piggyback experiment with B-47 project (Nelson)

BNL-7 PARTICIPANTS

| Exp. | Participants | Affiliation | Title |
|--------------|--|---|---|
| B-1 | C. Zeitlin. J. Miller L. Heilbronn R.P. Sigh W. Holley M. Nyman W. Schimmerling F. Cuccinota M. Cosolino V. Bidoli W. Sanita L. Narici R. Wilkins H. Huff R. Maurer D. Roth D. Stephens J. Kinnison | Lawrence Berkeley National Laboratory, CA " " " " " NASA, HDQ, DC NASA, JSC, TX University of Rome, Thor Vergara, Italy " " " Prairie View A&M University " APL, John Hopkins University, MD " Colorado State University, CO " | Ph.D., Principal Investigator Ph.D., Co-Principal Investigator Ph.D., Co-Worker Ph.D., Co-Worker Ph.D. Student Ph.D. Student |
| B-7 | B. Rabin J. Joseph B. Sukit-Hale J. McEwen S. Szprengiel | University of Maryland, Baltimore County, MD Human Nutrition Research Center on Aging, MA " " | Ph.D., Principal Investigator Ph.D., Co-Principal Investigator Co-Worker Co-Worker Co-Worker |
| B-12 | T. Hei L. Smilenov C. Piao M. Suzuki | Columbia University, NY " " " | Ph.D. Principal Investigator Ph.D., Co-Worker Ph.D., Co-Worker Ph.D., Co-Worker |
| B-18 | P. Cooper* B. Rydberg B. Cooper | Lawrence Berkeley National Laboratory, CA " " | Ph.D., Principal Investigator Ph.D., Co-Principal Investigator Student |
| B-19 B-20 | A. Kronenberg C. Wiese S. Gauny J. Hain | Lawrence Berkeley National Laboratory, CA " " " | Ph.D., Principal Investigator Post-Doctoral Student Senior Research Associate Ph.D., Co-Worker |
| B-25 | H. Evans T. Evans J. Schwartz | Case Western Reserve University, OH " " | Ph.D., Principal Investigator Co-Worker Ph.D., Co-Worker |
| B-29 | M. Natarajan | The University of Texas Health Sci., TX | Ph.D., Principal Investigator |
| B-32 | J. Dicello D. Huso Y. Zhang J. Man D. Simonson R. Arbona A. Chesnut | NSBRI, John Hopkins University, MD " " " " " " | Ph.D., Principal Investigator DVM, Ph.D., Co-Worker MD. Co-Worker DVM Co-Worker MS. Co-Worker MD. Co-Worker MS. Co-Worker |
| B-39 | F. Burns J. Xu | New York University Medical Center, NY " | Ph.D., Principal Investigator Co-Worker |

| | | | |
|------|--|--|--|
| B-42 | M. Barcellos-Hoff* R. Henshall S. Pearson | Lawrence Berkeley National Laboratory, CA “ Colorado State University, CO | Ph.D., Principal Investigator Co-Worker Co-Worker |
| B-43 | G. Nelson T. Jones M. Pecaut A. Smith G. Peterson | Loma Linda University, CA “ “ “ “ | Ph.D., Principal Investigator BS., Co-Worker BS, Co-Worker BS, Co-Worker BS, Co-Worker |
| B-44 | M. Durante* M. Belli F. Antonelli G. Simone | University “Federico II”, Napoli, Italy National Institute of Health, Rome, Italy “ “ | Ph.D., Principal Investigator Ph.D., Co-Worker Ph.D., Co-Worker Ph.D., Co-Worker |
| B-45 | R. Setlow J. Jardine A. Shima | Brookhaven National Laboratory, NY “ University of Tokyo, Japan | Ph.D., Principal Investigator BS, Co-Worker Ph.D., Co-Worker |
| B-47 | G. Nelson A. Smith G. Peterson R. Dutta-Roy D. Murray M. Kadhim | Loma Linda University, CA “ “ “ “ MRC, England | Ph.D., Principal Investigator Ph.D., Co-Worker BS, Co-Worker BS, Co-Worker BS, Co-Worker Ph.D., Co-Worker |
| B-48 | L. Green* G. Nelson D. Murray T. Jones | Loma Linda University, CA “ “ “ | Ph.D., Principal Investigator Ph.D., Co-Worker BS, Co-Worker BS, Co-Worker |
| B-51 | J. Murnane* B. Fouladi | University of California, San Francisco, CA “ | Ph.D., Principal Investigator Ph.D., Co-Worker |
| B-52 | J. Gerwitz* B. Sutherland P. Bennett J. Sutherland P. Guida J. Trunk D. Monteleone | NSBRI, University of Pennsylvania Brookhaven National Laboratory, NY “ “ “ “ “ | Ph.D., Principal Investigator Ph.D., Co-Investigator MS., Biology Associate. Ph.D., Co-Worker Ph.D., Co-Worker Co-Worker Co-Worker |
| B-53 | J. Lupton* L. Braby N. Turner S. Taddeo N. Popovic M. Young Hong C. Henderson | NSBRI, Texas A&M University, TX “ “ “ “ “ “ | Ph.D., Principal Investigator Ph.D., Co-Investigator Ph.D., Co-Investigator Co-Worker Co-Worker Co-Worker Co-Worker |
| B-55 | M. Vazquez Gaofeng Fan Luis Estevez Stefanie Otto Kay Conkling Divine Adika | NSBRI, Brookhaven National Laboratory, NY “ “ “ “ “ | MD, Ph.D., Principal Invest. MD, Ph.D., Co-Worker BS, Co-Worker BS, Co-Worker. BS, Co-Worker BS, Co-Worker |

*Not present during the actual run

BNL-7 PARTICIPANTS STATISTICS

| PARTICIPANTS | BNL-7 |
|---|--------------|
| Ph.D., Principal Investigators | 10 |
| M.D., Ph.D., Principal Investigators | 1 |
| Ph.D., Co-Principal Investigators | 3 |
| Ph.D., Co-Investigator | 3 |
| Co-Workers | 11 |
| Ph.D. | 29 |
| MD, Ph.D. | 1 |
| DVM, Ph.D. | 1 |
| M.D. | 2 |
| B.S. | 11 |
| M.S. | 2 |
| DVM | 1 |
| Post-Doctoral Students | 1 |
| Ph.D., Student | 2 |
| MS Biology Associate | 1 |
| Senior Research Associates | 1 |
| Student | 1 |
| Total: | 81 |

BNL-7 PARTICIPANT INSTITUTIONS

NASA related centers/institutes (4)

- **NASA, Headquarters, DC**
- **NASA, Johnson Space Center, TX**
- **NSCORT, LBNL-CSU**
- **National Space Biomedical Research Institute, TX**

National Laboratories/Institutes (3)

- **Brookhaven National Laboratory, NY**
- **Lawrence Berkeley National Laboratory, CA**
- **Human Nutrition Research Center on Aging, MA**

Universities (12)

- **Prairie View A&M University**
- **Colorado State University, CO**
- **APL, John Hopkins University, MD**
- **University of Maryland, Baltimore County, MD**
- **Columbia University, NY**
- **Case Western Reserve University, OH**
- **The University of Texas Health Sciences., TX**
- **New York University Medical Center, NY**
- **Loma Linda University, CA**
- **Texas A&M University, TX**
- **University of California, San Francisco, CA**
- **University of Pennsylvania, PA**

Foreign Institutions (5)

- **University of Rome, Thor Vergara, Italy**
- **University “Federico II”, Napoli, Italy**
- **National Institute of Health, Rome, Italy**
- **University of Tokyo, Japan**
- **MRC, England**

BNL-7 RUN DATES

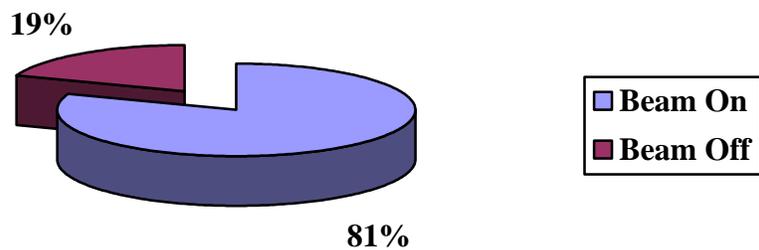
| Run dates | Scheduled | | Actual | |
|----------------------------|-----------|------|--------|------|
| | Date | Time | Date | Time |
| Run start | 01/08 | 0800 | 01/08 | 0800 |
| Run end | 01/14 | 1400 | 01/15 | 2300 |
| Tuned into cave | 01/9 | 0100 | 01/9 | 0100 |
| Beam delivered for Biology | | | | |
| Fe 1 GeV/n | 01/09 | 0100 | 01/09 | 0100 |
| End run | 01/13 | 0600 | 01/14 | 1000 |

BEAM TIME DESCRIPTION (hours)

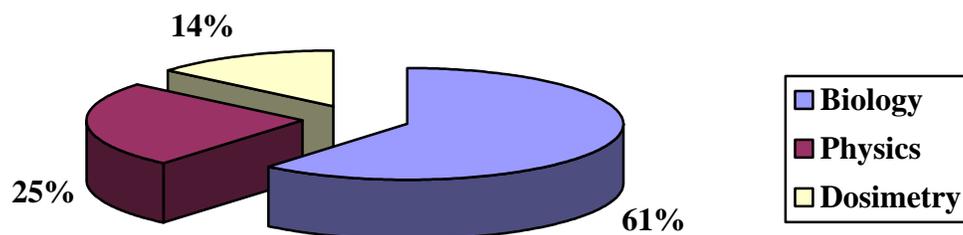
| | | |
|--|---------------------------------|---------------------|
| Total Clock Time | (from 01/08 0800 to 01/15 2300) | 183 |
| Total Beam-on Time | | 147.5 (81%) |
| Total Beam-off time | | 35.5 (19%) |
| | Total: | 183.0 (100%) |
| Beam Time for Biology | 89.5 (61%) | |
| Beam Time for Physics | 37 (25%) | |
| Beam time for dosimetry, calibration, tuning, etc. | 21 (14%) | |
| Totals | 165 | |

DESCRIPTIVE STATISTICS

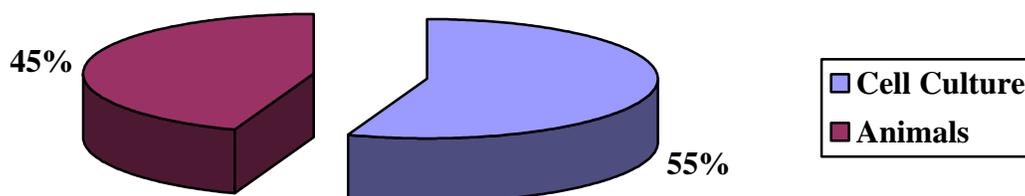
- **AGS Fe 1 GeV/n Beam Availability**



- **Distribution of Beam Time Usage:**



- **Distribution of Beam Time for Biology:**



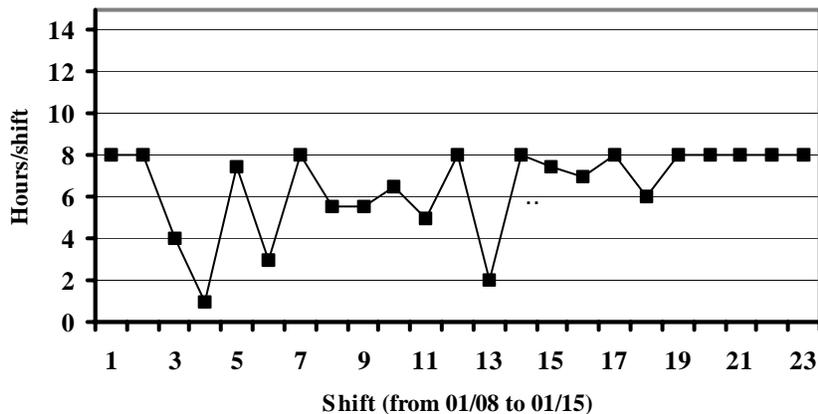
IRON BEAM CHARACTERISTICS

| | $^{56}\text{Fe}^{26}$ |
|--|-----------------------------|
| | 1000 MeV/n |
| Fluence (particles/cm²/sec) | |
| Maximum on target | 1 x 10⁸ |
| Minimum on target | 400 |
| Spill rate (spills/min) | 18 |
| Spill length (msec) | 500-600 |
| Particles/spill | |
| Maximum | 1 x 10⁸ |
| Minimum | 1.5 x 10⁵ |
| Beam spot diameter (cm) | 5* - 7.5 - 9 |
| Beam cut off length. | <1% |
| Actual Energy (MeV/n) | |
| Extracted | 1078 |
| On Target | 1046 |
| Actual LET on Target (keV/μm) | 148 |
| Dose/rate recorded (cGy/min) | |
| Maximum | 1000 |
| Minimum | 30 |
| Minimum dose exposure (cGy) | 1 |
| No of hours for beam characterization, tuning and dosimetry | 21 |

BNL-7 RUN STATISTICS AND INCIDENTS

| Date | Shift | Beam On | Beam Off | Remarks |
|----------|-------|---------|----------|--|
| 01/08/01 | 2 | 8 | 0 | 1 GeV Iron run start, beam tuned into the cave |
| | 3 | 8 | 0 | Beam tuning for biology. |
| 01/09/01 | 1 | 4 | 4 | Biology run start. Power supply trip off. |
| | 2 | 1 | 7 | Power supply off. Magnet problems. |
| | 3 | 7.5 | 0.5 | RF problems |
| 01/10/01 | 1 | 3 | 5 | Controller for the Booster RF failed |
| | 2 | 8 | 0 | No incidents |
| | 3 | 5.5 | 2.5 | RF problems |
| 01/11/01 | 1 | 5.5 | 2.5 | RF problems |
| | 2 | 6.5 | 1.5 | TTB beamstop failure |
| | 3 | 5 | 3 | Magnets problems |
| 01/12/01 | 1 | 8 | 0 | No incidents. |
| | 2 | 2 | 6 | TTB beamstop failure |
| | 3 | 8 | 0 | No incidents. |
| 01/13/01 | 1 | 7.5 | 0.5 | Beam drift, magnets problems (AQ7&8) |
| | 2 | 7 | 1 | Beam drift, magnets problems (AD4-9) |
| | 3 | 8 | 0 | No incidents. |
| 01/14/01 | 1 | 6 | 2 | Magnets problems. |
| | 2 | 8 | 0 | Biology run end. Physics run starts. |
| | 3 | 8 | 0 | No incidents. |
| 01/15/01 | 1 | 8 | 0 | No incidents. |
| | 2 | 8 | 0 | No incidents. |
| | 3 | 8 | 0 | No incidents. BNL-7 end. |

Beam availability



BNL-7 EXPERIMENTERS AND RUN STATISTICS

| Exp. ID | Principal Investigator | Ion & Energy | Beam Time Approved | Beam Time Used | Dose Range (cGy) | Dose/Rate (cGy/min) | Number of Samples |
|---------------|------------------------|--------------|--------------------|-----------------|------------------|---------------------|-------------------|
| B-1 | Zeitlin | Fe, 1 GeV/n | 32 | 37 | NA | NA | NA |
| B-7 | Rabin | Fe, 1 GeV/n | 9.5 | 10 | 100-150 | 50-150 | 100 |
| B-12 | Hei | Fe, 1 GeV/n | 4 | 2 | 20-400 | 100 | 75 |
| B-18 | Cooper | Fe, 1 GeV/n | 6 | 6 | 60-600 | 200 | 50 |
| B-19-20 | Kronenberg | Fe, 1 GeV/n | 12 | 10 | 31 - 189 | 50-100 | NA |
| B-25 | Evans | Fe, 1 GeV/n | 6 | 3 | 10-400 | 20-100 | 32 |
| B-29 | Natarajan | Fe, 1 GeV/n | 0 | 1 | NA | NA | NA |
| B-32 | Dicello | Fe, 1 GeV/n | 10 | 10 | 1 - 100 | 1-100 | 200 |
| B-39 | Burns | Fe, 1 GeV/n | 9 | 14 | 300 | 150 | 72 |
| B-42 | Barcellos-Hoff | Fe, 1 GeV/n | 5 | 4 | 50-200 | 100 | 50 |
| B-43 | Nelson | Fe, 1 GeV/n | 2.5 | 4.5 | 10 - 200 | 100 - 200 | 120 |
| B-44 | Durante | Fe, 1 GeV/n | 6 | 5 | 1000-40000 | 1500 | 200 |
| B-45 | Setlow | Fe, 1 GeV/n | 2 | 2 | 30-100 | 50-100 | 200 |
| B-47 | Nelson | Fe, 1 GeV/n | 4 | 4.5 | 50-300 | 50-200 | 255 |
| B-48 | Green | Fe, 1 GeV/n | 0.7 | 1 | 10-300 | 50-200 | 30 |
| B-51 | Murnane | Fe, 1 GeV/n | 3 | 2 | 400 | 200 | 50 |
| B-52 | Gerwitz | Fe, 1 GeV/n | 2 | 2.5 | NA | NA | NA |
| B-53 | Lupton | Fe, 1 GeV/n | 1.5 | 2 | 100 | 100 | 20 |
| B-55 | Vazquez | Fe, 1 GeV/n | 6 | 6 | 10-200 | 30-150 | 200 |
| Totals | | | 122.7 hr | 126.5 hr | 10-40000 | 5 to 200 | 1654+ |

BNL-7 PARTICIPANTS, EXPERIMENTAL SAMPLES AND ENDPOINTS

| Exp. | Participants | Samples | Endpoints |
|--------------|---|---|---|
| B-1 | Heavy Ion Fragmentation and Transport in Matter C. Zeitlin (PI) | Solid state detectors | Heavy ion fragmentation CR39 calibration |
| B-7 | Effects of Exposure to Heavy Ions. B. Rabin (PI) | Sprague-Dawley Rats | Neurological and neurochemical changes |
| B-12 | Cytogenetic and Neoplastic Transforming Effects of Heavy Ions in Mammalian Cells. T. Hei (PI) | Human bronquial epithelial cells (BEP2D) and breast cells (MCF-10F) | Neoplastic transformation, Differential gene expression, mutation spectra by PCR |
| B-18 | DNA Repair and Early Dev. of Chromosomal Changes. Cytog. Studies. P. Cooper (PI) | HeLa cells, human fibroblast, XP-G cell line | Frequency of non-rejoined/misrejoined PCC |
| B-19 B-20 | Mutagenesis and Genomic Instability in Human Lymphoid cells A. Kronenberg (PI) | Human lymphoid cells (TK6) and WTK-bclX _L | Apoptosis induction, mutat collection, cell killing and mutation, DSB rejoining/fidelity |
| B-25 | Induction of Genomic Instability in Human Lymphoblast H. Evans (PI) | LY-S1 and LY-SR1 murine lymphoblast, human colon cancer cells | Protective effects of WR1065 against cytotoxicity and mutagenic effect. Detection by GFP |
| B-29 | NF-KB Mediated Radio-Responsive Gene Transcription after Heavy Ion Radiation Exposure. M. Natarajan (PI) | Human macrophage cells (Mono Mac 6) | Gene expression |
| B-32 | Tumor Formation in Rat Mammary Glands J. Dicello (PI) | Sprague-Dawley Rats, Rat and lymphocytes, Min Mouse | Tumor induction and Tamoxifen protective effects and chromosomal aberrations |
| B-39 | Tumor Induction by High-LET Radiation. F. Burns (PI) | Sprague-Dawley Rats | Skin tumor induction and modulation by dietary retinyl acetate. |
| B-42 | Particle Irradiation of Human Mammary Epithelial Cells M. Barcellos-Hoff (PI) | Human mammary epithelial cells (HMT 3522) | Microenvironment changes, TGF- β and bFGF levels, immunocitochem., apoptosis and neoplastic potential |
| B-43 | Preliminary Assessment of Immune System and behavioral Responses to Accelerated Iron Ion Exposure in the C57B1/6 Mouse. G. Nelson (PI) | Mouse (C57B1/6) | Neurological and immunological alterations |
| B-44 | Influence of the Shielding on the Space rad. Biological Effectiveness. M. Durante (PI) | AG1522 human diploid foreskin fibroblasts | DNA damage and repair. Shielding effects. |
| B-45 | Germ Cell Mutagenesis in Medaka Fish Following Exposure to HZE particle radiation R. Setlow (PI) | Male Medaka fish | Mutation induction |
| B-47 | Genomic Instability in Mouse Hematopoietic Cells in Resp. to Accelerated Iron Ion Exposure. G. Nelson (PI) | C57B1/6 and CBA/Ca mice | Transmissible delayed expression chrom damage. Genomic instability, apoptosis and oxidative stress. |

| | | | |
|------|---|-----------------------------|--|
| B-48 | Radiobiology of thyroid follicular cells. L. Green (PI) | Thyroid cells | Gene expression alterations |
| B-51 | Particle-Ind. Telomere Loss in Human cells. J. Murnane (PI) | SC308H cells | Survival, mutation frequency, chromosomal changes and telomere status. |
| B-52 | Effect of Deep Space Radiation on Human Hematopoietic Stem Cells. A. Gerwitz (PI) | TF-1 cells | DNA damage (DSB and clustered damages) |
| B-53 | Nutritional Countermeasures to Radiation Exposure. J. Lupton (PI) | Sprague-Dawley rats | Gene expression, tumor incidence. |
| B-55 | Risk Assessment and Chemoprevention of HZE-Induced CNS Damage M. Vazquez (PI) | NT2 human neural stem cells | Survival, apoptosis and gene expression. |

List of personnel that participated in the planning, organization and execution of BNL-7 run

BNL Management:

- Laboratory Director: **John Marburger**
- Deputy Director for Science & Technology: **Peter Paul**
- Associate Director for High Energy and Nuclear Physics: **Tom Kirk**
- Associate Laboratory Director for Life Sciences: **Nora Volkow**

NASA Management:

- Headquarters: **Walter Schimmerling**
- JSC: **Frank Cucinotta**

Scientific Advisory Committee:

- **Betsy Sutherland** (Chair), BNL
- **Louis Pena**, BNL
- **Richard Setlow**, BNL
- **Joel Bedford**, CSU
- **Les Braby**, PNL
- **Charles Geard**, Columbia University

Collider Accelerator Department-AGS

- Chairman: **Derek Lowenstein**
- Deputy Chairman: **W.T. Weng**
- Associate Chair of Operations: **A.J. McNerney**
- Experimental Planning and Support Head: **Philip Pile**
- Associate Chair for ES&H/Q.A: **E. Lessard**
- ES&H/Q.A : **Peter Cirnigliaro**,
- Accelerator Division Head: **Thomas Roser**
- Chief Electrical Engineer: **J. Sandberg**
- Chief Mechanical Engineer: **J. Tuozzolo**
- Accelerator Physicist lead by: **Leif Aherns**
- Tandem Group leader: **Peter Thieberger**
- Physics Support: **Yusef Makadisi**
- CAD Components and instrumentation support: **David Gassner**
- AGS Radiation Safety Committee: **Ken Reece**
- C-A Dept Training Manager: **John Maraviglia**
- AGS Control Section lead by: **Don Barton**
- Liaison Engineering Group lead by: **Al Pendzick, David Williams**
- Liaison physicist: **Don Lazarus**

- RHIC&AGS Users Center: **Susan White-DePace, Angela Melocoton**
- Mechanical Service Technicians led by: **Fred Kobasiuk**
- Survey Group led by: **Frank Karl**
- Beam Service Technicians led by: **Paul Valli**
- Electronic Service Technicians led by: **Bill Anderson**
- AGS Instrumentation Group led by: **Pete Stillman**
- AGS Main Control Room and Operations led by: **Pete Ingrassia**
- Health Physics Group led by: **Chuck Schaefer**
- AGS Electricians led by **Bill Softye**
- AGS Riggers led by: **Nick Cipolla**
- Carpenter and Welder Support Service and Technical Support led by: **Roger Hubbard**

Medical Department:

- Dept. Chair: **L. Chang**
- Medical Liaison: **Marcelo E. Vazquez**
- Building manager: **W. Gunther**
- Administration: **B. Coughlin-Byrne, and Donna Russo**
- Animal Care Facilities: **Maryann Kershaw, Kerry Bonti, Chris Risland.**
- Tissue Culture Facility manager: **Michael Makar**
- Technical support: **Divine Adika, Katherine Conkling, Bae Pyatt**
- Training Coordinator: **Ann Emrick**
- **RCD**
 - **Kay Conkling**
 - **Dennis Ryan**
 - **Deana Buckallew**
 - **Jim Williams**
 - **Bob Colichio**

Safeguards & Security

- Sam Velazquez,
- Ted Heuer

Plant Engineering:

- BLAF Custodian, **P. Abrams**
- Plumbers: **B. McCafferty**
- Painters/Carpenters: **B. Laakmann**
- Electricians: **T. Baldwin**

Biology Department:

- Chairman: **Carl Anderson**
- **Betsy Sutherland**

- Administration: **Bonnie McGahern**
- Cesium Source Manager: **Richard Satkoulis**

Safety & Environmental Protection Division:

- Manager: **William Fortunato**
- **Dean Atchison**

Lawrence Berkeley National Laboratory:

- **Jack Miller**
- **Lawrence Heilbronn**
- **M. Nyman**
- **R. P. Singh**
- **W. Holley**