



BROOKHAVEN
NATIONAL LABORATORY

NSRL-7 RUN

FINAL REPORT

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BNL/NASA webpage:
<http://www.bnl.gov/medical/NASA/NASA-home%20frame.htm>

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EXECUTIVE SUMMARY

During the fall of 2005, a series of radiobiological and physics experiments were performed using the NASA Space Radiation Laboratory to accelerate heavy ion beams (NSRL-7). These experiments were part of the seventh NSRL scientific run sponsored by NASA's Space Radiation Health Program (SRHP) heavy ion radiobiology research program at BNL.

A total of 41 proposals were reviewed by the BNL' SACR to participate in the NSRL-7 run. Thirty eight proposals participated in the actual run. Twenty four institutions from the United States were represented, totaling 104 users. More than 2000 biological samples were exposed at the NSRL beam line, employing 394 hours of beam time (37.5 hours for in vivo studies, 119.5 hours for in vitro studies and 23.5 hours for physics experiments) delivered in a seven-weeks period. In addition, 76 hours were used for beam development and, 80 hours for set-up and dosimetry. A total of 16 hours of beam time were lost due to accelerator related problems.

During NSRL-7, Booster provided iron (300 and 1000 MeV/nucleon), protons (1 GeV/n), sequential fields of iron and protons (1 GeV/n), oxygen (1000 MeV/nucleon), silicon (300, 375 and 1000 MeV/nucleon) and Titanium (1000 MeV/n) beams for biology and physics experiments. The maximum dose/rates used were as high as 10.8 Gy/min (Si 300 MeV/n). The general spill rate employed was 20 with duration of 300 msec/spill. The spill fluence range was (particles/spill) from 9×10^{10} (max) and 1×10^5 (min). Square beam spots as big as 20 x 20 cm and small as 1 x 1 cm was employed for biology and physics experiments. Tandem-Booster-NSRL complex delivered a sequential field composed by iron and protons with energies of 1 GeV/n with a steady and repeatable switching from protons to iron.

During NSRL-7 additional investigators used the sequential field modality as part of the operational beam manifesto. As part of the dosimetry and beam development program, several items were developed such as: Cl 500 MeV/n, Si 375 MeV/n, Solar Event Simulator, structured beam (beam with 20 Hz. structure) as well as fast-extracted beam. For the first time, two teams performed fractionated exposures using animals (P. Chang) and cells in culture (Minna-Story).

Tandem-Booster set-up started on October 2 with the transport and circulation of H beams at the NSRL complex. Beam was tuned into cave on October 3 and 1000 MeV/n H beams were available for tuning on October 3. NSRL-7 officially ended at 0000pm, November 17, 2005.

NSRL-7 Projects Reviewed by the BNL's Scientific Advisory Committee in Radiobiology (SACR):

Proposal	PI	Sponsor	NSRL-7 Participation
B3	Cucinotta/Wu	NASA	Yes
B7	Rabin	NASA	Yes
B10	Chang	NSBRI	Yes
B52	Gewirtz	NSBRI	Yes
B64	Vazquez	NASA/DOE	Yes
B65	Vazquez	NASA/DOE	Yes
B67	Blakely	NASA	Yes
B73	Sutherland	NASA/DOE	Yes
B75	Ford	NASA/DOE	Yes
B76	Green	NASA/DOE	No
N86	Wang	NASA	Yes
N88	Sutherland	NASA	Yes
N89	Held	NASA	Yes
N91	Rydberg	NASA	Yes
N99	Zhao	NASA	Yes
N102	Hall	NASA	Yes
N103	Barcellos-Hoff	NASA	Yes
N104	Weil/Ullrich	NASA	No
N108	Pecaut	NASA	Yes
N110	Nelson	NASA	Yes
N111	Obenaus	NASA	Yes
N112	Obenaus	NASA	Yes
N113	Pecaut	NASA	Yes
N115	Bacher	NASA	Yes
N120	Redpath	NASA/DOE	No
N124	Li	NASA	Yes
N126	Kennedy	NASA/NSBRI	Yes
N129	Limoli	NASA	Yes
N130	Ware	NASA	Yes
N134	Chen	NASA	Yes
N135	Pluth	NASA	Yes
N136	Britt	NASA	Yes
N139	Krucker-Obenaus	NASA	Yes
N140	Saganti	NASA/CARR	Yes
N141	Krucker-Obenaus	NASA	Yes
N142	Burns	NASA	Yes
N145	O'Banion	NASA	Yes
N146	Wu	NASA	Yes
N148	Chamberland	NASA	Yes
N151	Posner	NASA	Yes
N153	Minna-Story	NASA	Yes

NSRL-7 PARTICIPANTS

Exp.	Participants	Affiliation	Title
B-3	F. Cucinotta* K. George T. Elliott J. Harper	NASA, Johnson Space Center “ “ RAGU, Medical Research Council	Ph.D., Principal Investigator M.S., Co-Worker Ph.D., Co-Worker Ph.D. Co-Worker
B-7	B. Rabin B. Shukitt-Hale K. Carrahill-Knoll V. Cheng	UMBC, Baltimore, MD HNRCA, USDA-ARS, Boston, MA “ “	Ph.D, Principal Investigator Ph.D., Co-Worker Ph.D., Co-Worker B.S., Co-Worker
B-10	P. Chang J. Bakke A. Puey	SRI International, CA “ “	Ph.D, Principal Investigator B.S., Co-Worker B.S., Co-Worker
B-52	A. Gewirtz B. Sutherland P. Bennett M. Naidu D. Roy S. Tafrov J. Trunk N. Cuomo	University of Pennsylvania, SOM BNL, Upton, NY “ “ “ “ ” “	Ph.D, Principal Investigator Ph.D., Co-Principal Investigator M.S., Co-Worker Ph.D., Co-Worker Ph.D., Co-Worker Ph.D., Co-Worker Ph.D., Co-Worker Ph.D., Co-Worker
B-64 B-65	M. Vazquez P. Guida A. Billups B. Pyatt L. Thompson A. Kim	BNL, Upton, N.Y. “ “ “ “ “	MD, Ph.D., Principal Investigator Ph.D., Co-Worker B.A., Co-Worker M.S., Co-Worker B.S., Co-Worker B.S., Co-Worker
B-67	E. Blakely P. Chang K. Bjornstad C. Rosen	LBNL, Berkeley, CA SRI International, Menlo Park, CA SRI International, Menlo Park, CA SRI International, Menlo Park, CA	Ph.D, Principal Investigator Ph.D., Co-Worker B.S., Co-Worker B.S., Co-Worker
B-73 N-88	B. Sutherland P. Bennett M. Naidu D. Roy M. Hada G. Zhou J. Sutherland S. Tafrov D. Monteleone J. Trunk N. Cuomo	BNL, Biology Dept., Upton, NY “ “ “ “ ” “ “ “ “ “ “	Ph.D, Principal Investigator M.S., Co-Worker Ph.D., Co-Worker Ph.D., Co-Worker Ph.D., Co-Worker Ph.D., Co-Worker Ph.D., Co-Worker Ph.D., Co-Worker B.S., Co-Worker B.S., Co-Worker B.S., Co-Worker
B-75	J. Ford A. Maslowski R. Redd C. Almanza	AMU, College Station, TX “ “ “	Ph.D., Principal Investigator Ph.D., Co-Worker PhD., Co-Worker Ph.D., Co-Worker
N-86	Y. Wang H. Wang X. Wang	Thomas Jefferson University, PA “ “	Ph.D, Principal Investigator Ph.D, Co-Worker Ph.D, Co-Worker
N-89	K. Held H. Yang V. Anzenberg	Massachusetts Gen. Hosp./Harvard M. School Massachusetts General Hospital Massachusetts General Hospital/MIT	Ph.D., Principal Investigator Ph.D., Co-Worker B.S., Co-Worker
N-91	B. Rydberg T. Groesser A. Kumari	LBNL, Berkeley, CA “ “	Ph.D, Principal Investigator M.S., Co-Worker Ph.D., Co-Worker

Exp.	Participants	Affiliation	Title
	J. Garbe S. Costes P. Andarawewa	“ LBNL, Berkeley, CA “	Ph.D., Co-Worker Ph.D., Co-Worker Ph.D., Co-Worker
N-96	G. Nelson * A. Smith T. Jones K. Archambeau M. Pecaut	Loma Linda University “ “ “ “	Ph.D, Principal Investigator B.S, Co- Worker B.S, Co-Worker M.D, Co-Worker Ph.D, Co-Worker
N-99	Y. Zhao C. Piao	Columbia University “	Ph.D, Principal Investigator Ph.D., Co-Worker
N-102	E. Hall* L. Smilenov G. Zhou	Columbia University “ “	Ph.D, Principal Investigator Ph.D., Co-Worker Ph.D., Co-Worker
N-103	M. Barcellos-Hoff* B. Rydberg T. Groesser A. Kumari S. Costes J. Garbe	LBNL, Berkeley, CA “ “ “ “ “	Ph.D, Principal Investigator Ph.D., Co-Worker M.S., Co-Worker Ph.D, Co-Worker Ph.D., Co-Worker Ph.D., Co-Worker
N-108 N-113	M. Pecaut A. Smith T. Jones	Loma Linda University “ “	Ph.D, Principal Investigator B.S., Co-Worker Ph.D, Co-Worker
N-111 N-112	A. Obenaus A. Smith C. Quesada S. Chong S. Shin	Loma Linda University “ “ “ “	Ph.D, Principal Investigator B.S, Co-Worker B.S., Co-Worker B.S, Co-Worker B.S., Co-Worker
N-115	J. Bacher R. Halberg W. Megid	Promega Corporation “ “	Ph.D, Principal Investigator Ph.D, Co-Worker Ph.D, Co-Worker
N-124	C. Li B. Yan Y. Yuan	Duke University Medical Center “ “	Ph.D., Principal Investigator Ph.D., Co-Worker Ph.D., Co-Worker
N-126	A. Kennedy* J. Ware J. Donahue J. Stewart	University of Pennsylvania “ “ “	Ph.D., Principal Investigator Ph.D., Co-Worker Ph.D., Co-Worker M.S., Co-Worker
N-129	C. Limoli E. Giedzinski J. Baure	University of California San Francisco “ “	Ph.D., Principal Investigator Ph.D., Co-Worker Ph.D., Co-Worker
N-130	J. Ware* J. Guan J. Donahue J. Stewart	University of Pennsylvania “ “ “	Ph.D., Principal Investigator Ph.D., Co-Worker Ph.D., Co-Worker M.S., Co-Worker
N-134	D. Chen M. Story J. Shay N. Uematsu L. Ding	University of Texas, Southwestern Medical Center at Dallas “ “ LBNL, Berkeley, CA	Ph.D., Principal Investigator Ph.D., Co-Worker Ph.D., Co-Worker Ph.D., Co-Worker Ph.D., Co-Worker
N-135	J. Pluth G. Dilyte	Lawrence Berkeley National Lab. “	Ph.D., Principal Investigator Ph.D., Co-Worker
N-136	A. Britt	University of CA, Davis	Ph.D., Principal Investigator
N-139	T. Krucker-Obenaus* A. Smith M. Pecaut T. Jones	Scripps Research Institute, CA Loma Linda University Loma Linda University	Ph.D., Principal Investigator B.S., Co-Worker Ph.D., Co-Worker

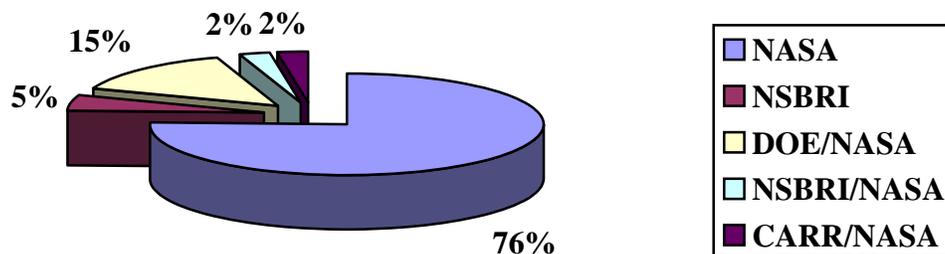
Exp.	Participants	Affiliation	Title
		Loma Linda University	Ph.D., Co-Worker
N-140	P. Saganti B. Gersey R. Wilkins C. Zeitlin	NASA – CARR, Prairie View A&M Univ. “ “ LBNL, Berkeley, CA	Ph.D., Principal Investigator Ph.D., Co-Principal Investigator Ph.D., Co-Principal Investigator Ph.D., Co-Principal Investigator
N-141	T. Krucker-Obenaus* A. Smith M. Pecaut T. Jones	Scripps Research Institute, CA Loma Linda University Loma Linda University Loma Linda University	Ph.D., Principal Investigator B.S., Co-Worker Ph.D., Co-Worker Ph.D., Co-Worker
N-145	K. O’Banion J. Williams S. Hurley L. Trojanczyk	University of Rochester Medical Center “ “ “	Ph.D., Principal Investigator Ph.D., Co-Worker Ph.D., Co-Worker Ph.D., Co-Worker
N-146	H. Wu* J. Meador	NASA, Johnson Space Center USRA/JSC	Ph.D., Principal Investigator Ph.D., Co-Worker
N-148	D. Chamberland H. Levine S. Durrance M. Vazquez	NASA, Kennedy Space Center, FL NASA, Kennedy Space Center, FL Florida Space Res. Institute, (Partner of NASA) BNL, NY	Ph.D., Principal Investigator Ph.D., Co-Worker Ph.D., Co-Worker MD.,Ph.D., Co-Worker
N-151	A. Posner D. Hassler M. Maple	Southwest Research Institute “ “	Ph.D., Principal Investigator Ph.D., Co-Worker Ph.D., Co-Worker
N-153	J. Minna - M. Story D. Chen J. Shay S. Sheridan O. Delgado A. Rioj L. Ding N. Uematus D. Dejsuphong	University of Texas, Southwestern Medical Center “ “ “ “ “ Lawrence Berkeley National Lab “ “	Ph.D., Principal Investigator Ph.D., Co-Worker Ph.D., Co-Worker Ph.D., Co-Worker Ph.D., Co-Worker Ph.D., Co-Worker Ph.D., Co-Worker Ph.D., Co-Worker Ph.D., Co-Worker

*Not Present During Actual Run

NSRL-7 PARTICIPANTS STATISTICS

PARTICIPANTS	NSRL-7
Ph.D., Principal Investigators	21
M.D., Ph.D., Principal Investigators	1
Ph.D., Co-Principal Investigators	3
Co-Workers	
Ph.D.	56
M.D.	1
M.S.	5
B.S.	16
B.A.	1
Total:	104

RESEARCH PROJECT SPONSORS:



PARTICIPANT INSTITUTIONS

NASA related centers/institutes (5)

- NASA, Johnson Space Center, TX
- NASA, Kennedy Space Center, FL
- Florida Space Research Institute
- USRA, Johnson Space Center
- RAGU Medical Research Council

National Laboratories/Institutes (3)

- Brookhaven National Laboratory, NY
- Lawrence Berkeley National Laboratory, CA
- HNRCA, USDA-ARS, MA

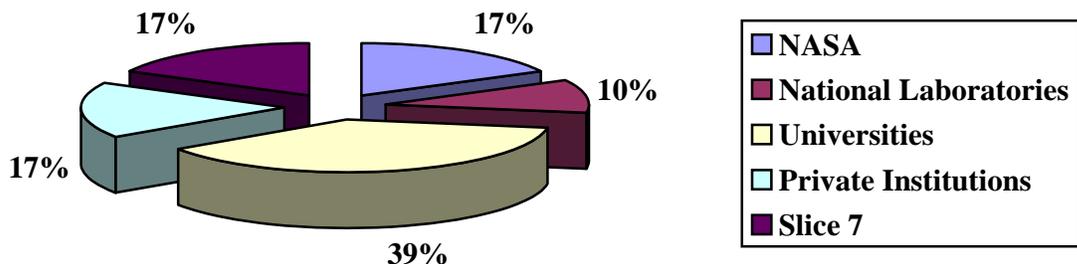
Universities (11)

- Loma Linda University, CA
- University of Pennsylvania, PA
- Thomas Jefferson University, PA
- Columbia University, NY
- New York University, Medical Center, NY
- University of California, San Francisco, CA
- University of Maryland, Baltimore County, MD
- University of Rochester, Medical Center
- University of Texas, Southwestern Medical Center at Dallas
- Texas A&M University, TX
- Duke University, NC

Private Institutions (5)

- Massachusetts General Hospital/Harvard Medical School, MA
- Massachusetts General Hospital/MIT, MA
- Scripps Research Institute, CA
- Promega Corporation, WI
- SRI International, CA

INSTITUTIONS STATISTICS:

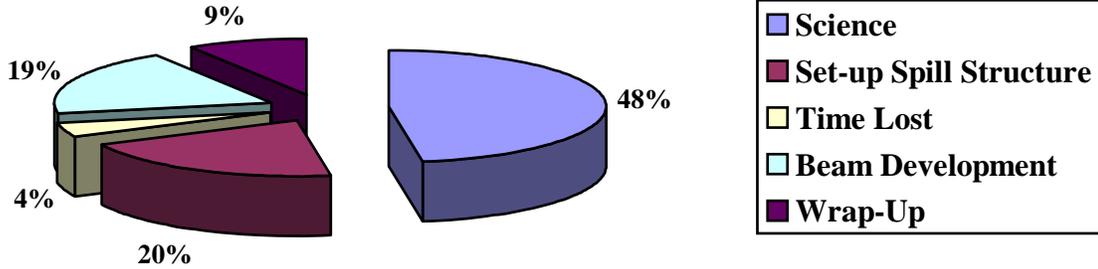


RUN TIME DESCRIPTION (hours)

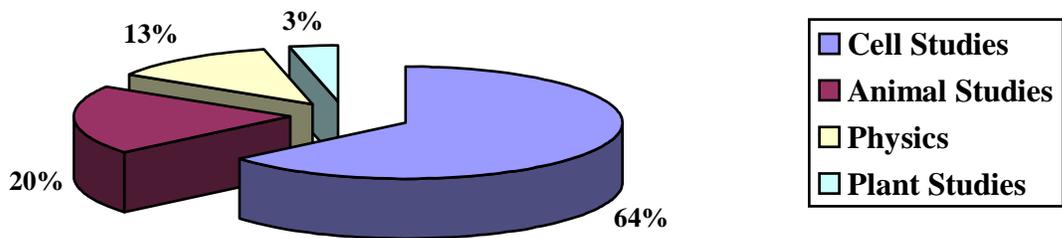
NSRL-7	ION SPECIES AND ENERGIES (MeV/n)										
	H 1000	Ti 1000	Fe 600	Fe 1000	Fe-H 1000	O 1000	Si 1000	Si 375	Si 300	Cl 500	Totals
Set-Up-Spill S.	16	9	8	29	6	4	3	3	2	0	80
Wrap-Up	6	5	6	7	3	2	2	2	2	0	35
Non-Science Sub-Total: 115											
B. Develop.	11.5	22	2.5	15	0	3	0	7	7	8	76
Time lost	1	1	0.5	4	5	4	0.5	0	0		16
Biology											
• In Vitro	15.5	15.5	3	58	23.5	2.5	1.5	0	0	0	119.5
• In Vivo	8	0	13.5	11.5	0	0	3	1.5	0	0	37.5
• Others	0	0	0	6.5	0	0	0	0	0	0	6.5
Physics	2.5	0	5.5	3	0	4.5	0	0	8	0	23.5
Science Sub Total: 187											
Totals	60.5	52.5	39	134	37.5	20	10	13.5	19	8	394

DESCRIPTIVE STATISTICS

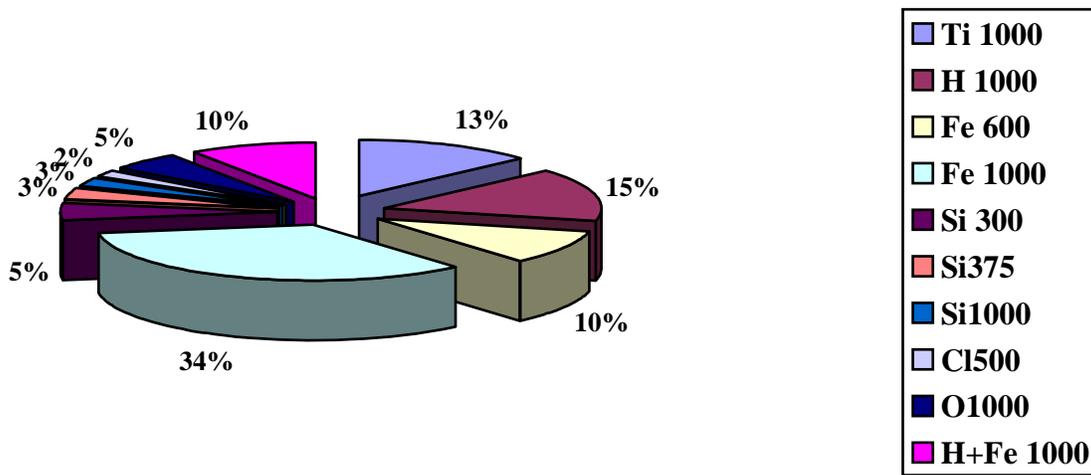
Total NSRL-7 Stats:



Science Studies Stats:



NSRL-7 Ion Species and Energy (MeV/n) Distribution



NSRL-7 BEAM CHARACTERISTICS

Ion	Fe		H	Ti	Si			O	Cl
Planned Energy (MeV/n)	600	1000	1000	1000	1000	400	300	1000	500
Fluence (particles/cm ² /sec)									
Maximum on target	2.6e6	7.5e6	2.1e8	2.6e6	1.6e7	1.6e7	1.6e7	2.1e5	5.8e6
Minimum on target	200	200	200	200	200	200	200	200	200
Spill Period (sec)	3	3	3	3	3	3	3	3	3
Spill rate (spills/min)	20	20	20	20	20	20	20	20	20
Spill length (msec)	300	300	300	300	300	300	300	300	300
Particles/spill	1.2e9	2.6e9	9.0e10	6.0e8	3.5e9	3.5e9	3.5e9	3.0e9	2.0e9
Maximum	1.0e5	1.0e5	1.0e5	1.0e5	1.0e5	1.0e5	1.0e5	1.0e5	1.0e5
Minimum									
Beam Cut Off Accuracy	0.5%	0.5%	0.5%	0.5%	0.5%	0.5%	0.5%	0.5%	0.5%
Actual Energy (MeV/n)									
Extracted	600	1000	1000	1000	1000	400	325	1000	520
On Target	585.1	967.7	1000*	976.4	973.6	375	300	1000*	501.0
Actual LET on Target (keV/μm)	175.2	151.4	0.222*	108.2	43.6	61.6	69.3	14.2*	79.56
Max. Dose Rate (Gy/min)/ Beam Size (cm x cm)									
20 x 20	5.0	10.0	.40	2.5	6.5	9.6	10.8	3.0	3.5
Total Dose (Gy)	50	50	50	50	50	50	50	50	50
Maximum	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Minimum									

Dosimetry and Beam Developments

During this run we developed some new beam techniques, among which are structured beam (beam with 20 Hz. structure) and fast-extracted beam, that is, extraction of the full contents of the Booster in one revolution, resulting in a ~800 ns pulse, at the full intensity we get in a normal slow extracted beam. We also made good progress on the Solar Event Simulator, resulting in our ability to change energies almost on the fly.

In dosimetry, we continue to learn more uses for the Digital Beam Imager (DBI). We have made use of the DBI to fine tune the Binary Filter to give us a stopping beam at a desired depth. We also have added the infrastructure for 6 stepper motors to facilitate automation in the future. Two of these motors will be used for a remotely-movable EGG counter holder, which will shorten setup time in many situations. The motors will be controlled by a computer program, currently under development.

The Pixel Ion Chamber with Gain was fully used to image the beam during low fluence work, and we are fully convinced that it renders the dosimetry hodoscope unneeded.

RUN DATES

	Scheduled		Actual	
	Date	Time	Date	Time
H 1000 MeV/n				
R 1 Start	10/03	0700	10/03	0700
End	10/10	1600	10/10	1500

	Date	Time	Date	Time
Ti 1000 MeV/n				
R 1 Start	10/10	1600	10/11	0700
End	10/17	1700	10/17	1900

	Date	Time	Date	Time
Fe 600 MeV/n				
R 1 Start	10/19	0700	10/19	0700
End	10/21	2200	10/21	2130

	Date	Time	Date	Time
Fe 1000 MeV/n				
R 1 Start	10/24	0700	10/24	0700
End	11/10	1800	11/10	1700

	Date	Time	Date	Time
Fe + H 1000 MeV/n				
R 1 Start	11/11	0700	11/11	0700
End	11/15	1900	11/15	2200

	Date	Time	Date	Time
O 1000 MeV/n				
R 1 Start	11/16	0700	11/16	0700
End	11/16	2300	11/16	2200

	Date	Time	Date	Time
Si 1000 MeV/n				
R 1 Start	11/17	0700	11/17	0700
End	11/17	2300	11/17	1930

	Date	Time	Date	Time
Si 375 MeV/n				
R 1 Start			11/18	0700
End			11/18	1030

	Date	Time	Date	Time
Si 300 MeV/n				
R 1 Start	11/18	0700	11/18	0700
End	11/18	2300	11/18	0000

NSRL-7 EXPERIMENTERS AND RUN STATISTICS

Exp. ID	Principal Investigator	Ion & Energy	Beam Time Approved (hours)	Beam Time Used (hours)	Dose Range (cGy)	Dose/Rate (cGy/min)	Number of Samples
B3	Cucinotta/Wu	Ti, 1GeV/n	4	3.5	10-200	0.2-0.5	46
B7	Rabin	Si, 0.3GeV/n	4	1.5	25-200	25-50	45
		Si, 1GeV/n	5.5	3.0	25-200	50-100	30
B10	Chang	P, 1 GeV/n	24	8.0	10-300	20-30	~200
B52	Gerwitz	P+Fe, 1GeV/n	8.6	7.0	NA	NA	NA
N64	Vazquez	Fe, 1GeV/n	3	1	100-200	50-100	20
		P, 1GeV/n	7.2	0			
N65	Vazquez	Fe, 1GeV/n	4	2.0	50-200	50-100	62
		P, 1GeV/n	2	1.5	100-300	100	30
		P+Fe, 1GeV/n	3.5	2.5	15-100	30-50	69
B67	Blakely	Ti, 1GeV/n	10	7	50-400	100	294
B73	Sutherland	Fe, 1GeV/n	1	1.0	NA	NA	NA
		P, 1GeV/n	3	3.0			
B75	Ford	Fe, 1 GeV/n	4	4	1, 10, 100	100-500	47
N86	Wang	Fe, 1 GeV/n	6	4	5-100	2.5	48
N88	Sutherland	Fe, 1 GeV/n	3	2.5	NA	NA	NA
		P, 1GeV/n	3	2.5			
		P+Fe, 1GeV/n	6.8	7.5			
		Ti, 1GeV/n	10.7	3.0			
N89	Held	Fe, 1GeV/n	7	5.75	500cGy- 2x10 ³ particles/cm ² 10	50cGy-1000 particles/ spill 20	64 entries
		P, 1GeV/n	6.2	3.0			34 entries
		Ti, 1GeV/n	6	4.0			56 entries
		P+Fe, 1GeV/n	4.25	4.0			46 entries
							*3-12 samples/entry
N91	Rydberg	Fe, 1GeV/n	3	3	5-100	50-100	62
		Fe, 0.6GeV/n	3	3	5-100	50-100	52
		P, 1GeV/n	3	0.0			
N99	Zhao	Fe, 0.6GeV/n	2	0.5			
N102	Hall	Fe, 1GeV/n	3	1.5	10-300		32
N103	Barcellos-Hoff	Fe, 1GeV/n	14.5	7.5	10-500	20-100	111
N108	Pecaut	Fe, 0.6GeV/n	4	1.0			
N110	Nelson	Fe, 0.6GeV/n	3.7	3	500-5000	174-208	7
N111	Obenaus	Fe, 0.6 GeV/n	5	1.5	0-400	200-250	24
N112 N139 (108) & N141 (113)	Obenaus Krucker	Fe. 0.6 GeV/n	11	4.0	0-400	187-250	233
			3.0	3.0			*incl. 4 entries for Chang
N113	Pecaut	Fe, 0.6GeV/n	3	1.0			
N115	Bacher	Fe, 1GeV/n	2.5	1.5	50-300	50	75
N124	Li	Fe, 1GeV/n	2.5	1.72	50-500	500	166
N126	Kennedy	Fe, 1GeV/n	9.5	5.5	10-600	20-200	288
		P, 1GeV/n	3.5	2.0	10-800	20-40	104
N129	Limoli	Fe, 1GeV/n	3.5	3.5	50-500	200	100
N130	Ware	Fe, 1GeV/n	1.5	1.5	200	200	60
		P, 1GeV/n	3.5	2.75	200	20	60

Exp. ID	Principal Investigator	Ion & Energy	Beam Time Approved (hours)	Beam Time Used (hours)	Dose Range (cGy)	Dose/Rate (cGy/min)	Number of Samples
N134	Chen	Fe, 1GeV/n	2	2	50-150	100	26
		O, 1GeV/n	2	1	100	100	2
N-135	Pluth	Fe, 1GeV/n	8	7.5	5-200	10-200	228
N136	Britt	Fe, 1GeV/n	2.5	2.0	2,500-20,000		122
N140	Saganti	Fe, 1GeV/n	3	3.0	NA	NA	NA
		P, 1GeV/n	3	2.5			
		Si, 0.3GeV/n	3	3.5			
N145	O'Banion	Fe, 1 GeV/n	4.5	4	600	100	144
N146	Wu	Fe, 1GeV/n	3	0.0	10-200	100	15
		P, 1GeV/n	3	2.5	50-400	50	15
		O, 1GeV/n	3	1.5	10-200	50	6
N148	Chamberland	Fe, 1GeV/n	1	1	50-100	50	44
N151	Posner	Fe, 0.6GeV/n	4	5.5	NA	NA	NA
		P, 1GeV/n	6	0.0			
		O, 1GeV/n	4	4.5			
		Si, 0.3GeV/n	4	4.5			
N153	Minna-Story	Fe, 1GeV/n	19	12	5-150	20-100	450
		Si, 1GeV/n	3	1.5	100-300	100	89
Totals			299	187.2	1-20,000	2-500	2000+

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NSRL-7 PARTICIPANTS, EXPERIMENTAL SAMPLES AND ENDPOINTS

Exp.	Participants	Samples	Endpoints
B-3	Heavy Ion Induced Chromosome Damage and Biomedical Countermeasures F. Cucinotta (PI)	Human Lymphocytes, Human Fibroblasts, and Chinese Hamster cells	Chromosome damage, structure effects on DNA double strand break induction and repair.
B-7	Effects of Exposure to Heavy Particles B. Rabin (PI)	Sprague Dawley Rats	Behavioral paradigms and neurochemistry
B-52	Effect of Deep Space radiation on Human Hematopoietic Stem Cells. A. Gewirtz (PI)	Human bone marrow cells	DNA complex damages, DNA replication and apoptosis, gene expression
B-64	CNS Damage and Countermeasures M. Vazquez (PI)	C57Bl/6 Mice	Behavioral alterations: locomotor activity
B-65	Risk Assessment and chemoprevention of HZE-induced CNS damage M. Vazquez (PI)	NT2 and hNT human cell line	Apoptosis, toxicity, DNA damage, cell Cycle, geneexpression
B-67	Lens Epithelium and Proton-Induced Cataractogenesis. E. Blakely (PI)	Human lens epithelial cells	RNA or protein analyses
B-73	DNA damage clusters in low level radiation responses of human cells. B. Sutherland (PI)	T7 DNA, Human monocytes Supercoiled DNA	DNA damage cluster induction and repair at the molecular and cellular levels
N-88	Complex Space Radiation-induced DNA damage Clusters in Human Cell Transformation: Mechanisms, relationships and Mitigation. B. Sutherland (PI)	Human normal fibroblasts	DNA damage cluster and transformation
N-89	Induction of Bystander Effects by High LET Radiation in Cells K. Held (PI)	Human keratinocytes and fibroblasts	Micronuclei formation, expression of p21 and foci formation of γ H2AX
N-91	Repair of HZE-induced DNA Double Strand Breaks and PCC Breaks. B. Rydberg (PI)	HeLa cells, CHO cells and xrs6 cells	DSB determination, PCC and bystander effects
N-96	Gene Expression in the Nematode <i>C. elegans</i> following Irradiation with Charged Particles G. Nelson (PI)	Nematode <i>C. elegans</i>	Gene expression. Microarrays.
N-99	Transformation of hTERT-immortalized human bronchial epithelial Cells by High Energy Heavy Ions. Y. Zhao (PI)	hTERT-immortalized human bronchial epithelial Cells and MEF cells	Cell survival and transformation
N-103	Mechanism of HZE Damage and Repair in Human Epithelial Cells. M. Barcellos-Hoff (PI)	HMEC 184	Survival assays, Gene expression, Immunostaining

Exp.	Participants	Samples	Endpoints
N-104	Radiation Leukemogenesis M. Weil/R. Ullrich (PI's)	CBA/CaJ strain mice	Determination of RBE for the induction of AML using slope constants
N-108	Progressive Alterations of Central Nervous System Structure and Function Are caused by Charged Particle Radiation. M. Pecaut (PI)	APP23 Transgenic Mice	Neuronal excitability, membrane and synaptic properties, local circuit interactions, synaptic plasticity, using electrophysiology techniques
N-111	Non-Invasive Assessment of Neuropathology Following CNS Radiation Exposure. A. Obenaus (PI)	Sprague-Dawley Rats	MRI and spectroscopy to assess altered tissue characteristics, image analysis, general histology, immunohistochemistry, phagocytic cell quantification, SWI processing
N-112	Charged Particle Alterations of the Functional Output of the Brain as a Function of Dose, Time, and LET A. Obenaus (PI)	C57BL/6	EEG Recordings, In Vitro brain slice preparation, Extracellular recordings and Long Term Potentiation, Quantitative estimates of venous CBV
N-113	The Effects of Charged Particle Radiation on the CNS Response to an Immunological Stressor. M. Pecaut (PI)	C57BL/6	Histological Analysis of the hippocampus
N-115	A Novel Biodosimetry Method for Monitoring Radiation Induced Mutations. J. Bacher (PI)	Mice, HCT116, HEC-59 and MEF cells from MHL1 and MSH2 deficient mice	Multiplex Assays, Mutational Load Profiles
N-124	HZE Particle Induced Genetic Instability/Oncogenic Transformation C. Li (PI)	4T1 cell line BigBlue rat2 cells	Survival, genetic instability, transformation.
N-129	Effects of Heavy Ions on Neural Precursor Cells C. Limoli (PI)	Mice Primary precursor cell culture. Mice	ROS production. Apoptosis
N-130	Screening single antioxidant agents as protectors against space-radiation-induced malignant transformation J. Ware (PI)	HTori-3 cells	Cytotoxicity and malignant transformation
N-134	DNA damage responses induced by HZE particles in human cells. D. Chen (PI)	Human skin fibroblasts (HSF42)	Cytotoxicity, DNA damage (H2AX), gene expression, bystander effect.
N-135	Protein Phosphorylation Profiles After HZE Exposure J. Pluth (PI)	Fibroblast and lymphocytes	BrdU incorporation FACS based survival assay and colony formation assays
N-136	IR-induced damage responses and repair requirements in Arabidopsis A. Britt (PI)	Arabidopsis	Growth-responses and formation of H2AX foci, somatic loss of heterozygosity
N-139	The effects of charged particle radiation on neurodeg. disease progression. T. Krucker (PI)	APP23 transgenic mice	Vascular alterations and histopathology
N-140	Heavy Ion Particle Impact on Simulated Martian Regolith P. Saganti (PI)	Martian regolith targets with simulated Martian	Neutron production flux measurements

Exp.	Participants	Samples	Endpoints
N-145	HZE Radiation Effects on Neuroinflammation K. O'Banion (PI)	C57Bl/6 mice.	Changes in cytokine profiles in brain areas and histopathology.
N-146	Cytogenetic study of heavy ion-induced chromosomal damage in human cells H. Wu (PI)	Human lymphocytes.	Chromosomal aberrations. FISH
N-148	Reporter mouse lines to evaluate the cellular and molecular effects of charge particles exposures on adult neural stem and progenitor cells D. Chamberlain (PI)	C57Bl/6	Brain Damage
N-151	MSL/RAD Technology Demonstration Model Characterization A. Posner (PI)	Solid state detectors	Hardware and software calibration
N-153	Lung Cancer Pathogenesis and HZE Particle Exposure Minna-Story (PI)	Human Bronquial Epthelial cells	Gene expression, DNA damage

List of personnel that participated in the planning, organization and execution of NSRL-5 run

BNL Management:

- Laboratory Director: **Praveen Chaudhari**
- Associate Director for High Energy and Nuclear Physics: **Samuel Aronson**
- Associate Laboratory Director for Life Sciences: **Gene Jack Wang**

NASA Management:

- JSC: **Frank Cucinotta, Frank Sulzman, Barbara Corbin**

Scientific Advisory Committee:

- **Betsy Sutherland** (Chair), BNL
- **Richard Setlow**, BNL
- **Kathy Held**, MIT
- **Les Braby**, PNL
- **Charles Geard**, Columbia University
- **John Gatley**, BNL

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 ESHQ: **Ed Lessard**
- ESHQ Division Head: **Ray Karol**
- ESH Coordinator: **Asher Etkin**
- Facility Support Representative: **Chuck Schaefer / Henry Kahnhauser**
- Environmental Coordinator: **Joel Scott**
- Training and Procedures Manager : **John Maraviglia**
- Main Control Room: **Peter Ingrassia**
- Work Control Manager: **Peter Cirnigliaro**
- BNL Laser Safety Officer: **Chris Weilandics**
- Experimental Safety Review Committee: **Yousef Makdisi (Chair)**
- Radiation Safety Committee: **Dana Beavis (Chair)**
- Accelerator Safety Review Committee: **Woody Glenn (Chair)**
- ALARA Committee: **Chuck Schaefer (Chair)**
- Associate Chair for ES&H/Q.A: **E. Lessard**
- 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: **David Phillips**
- Liaison physicist: **Adam Rusek**
- 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**
- **AGS MCR Operation Coordinators:**
 - Jim Jamilkowski**
 - Sanjee Abeytunge**
 - Jennifer Kozak**
 - Brian van Kuik,**
 - Travis Shrey**
- AGS Electricians led by **Bill Softye**
- AGS Riggers led by: **Nick Cipolla**
- Carpenter and Welder Support Service and Technical Support led by: **Roger Hubbard**

Dosimetry:

- **Adam Rusek**
- **I-Hung Chiang**
- **Kin Yip**
- **Peter Oddo**
- **Bart Frak**

Medical Department:

NASA LTSF TEAM:

- **Medical Liaisons: Marcelo E. Vazquez, Peter Guida**
- **Technical support: Bea Pyatt, Adele Billups, Laura Thompson, Angela Kim**
- **Secretarial support: Fran Capasso**

- Dept. Chair: **Gene Jack Wang**
- Building Manager: **Chris Harris**
- Administration: **Denise White and Donna Russo**
- Animal Care Facilities: **Maryann Kershaw, Kerry Bonti, Patricia Leone**
- Training Coordinator: **Ann Emrick**
- **RCD**
 - Kay Conkling
 - Dennis Ryan
 - Deana Buckallew
 - Jim Williams
 - Bob Colichio

Plant Engineering:

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

Biology Department:

- Chairman: **Carl Anderson**
- Biology Liason: **Betsy Sutherland**
- Technical Support: **Mamta Naidu, Debasish Roy, Stefan Tafrov**
- Cesium Source Manager: **Richard Satkulis**