BROOKHAVEN
NATIONAL LABORATORY

NSRL-06C RUN

September - October 2006

FINAL REPORT

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http://www.bnl.gov/medical/NASA

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EXECUTIVE SUMMARY

During September and October 2006, a series of radiobiological and physics experiments were performed using the proton and heavy ion beams available at the NASA Space Radiation Laboratory (NSRL). These experiments were part of the ninth NSRL scientific run (NSRL-06C) sponsored by NASA's Space Radiation Health Program (SRHP) heavy ion radiobiology research program at BNL.

A total of thirty seven (37) proposals were approved for participation in the NSRL-06C run. One hundred and nineteen (119) users from thirty (30) institutions were represented, all from the United States. Approximately 2900 biological samples were exposed at the NSRL beam line, employing 195:02 hours of beam time (38:33 hours for in vivo studies, 134:10 hours for in vitro studies, and 22:19 hours for physics experiments) delivered in a six week period. In addition, 31:51 hours were used for dosimetry and beam development. Machine set-up took a total of 60:00 hours, and 14:30 hours for wrap-up of the beam. Accelerator problems accounted for 29:40 hours lost. This gave a total NSRL usage time of 331:03 hours.

During NSRL-06C, Booster provided iron (300, 600 and 1000 MeV/nucleon), protons (200, 1000 and 2500 MeV/n), sequential fields of iron and protons (1000 MeV/n), and chlorine (600 and 1000 MeV/n) beams for biology and physics experiments. The maximum dose/rates used for biology experiments were as high as 5 Gy/min (Fe 1000 MeV/n). The general spill rate employed was ~16 spills per minute with durations of ~300 msec/spill. The spill fluence range (particles/spill) from a maximum of 1.5×10^{11} to a minimum of 2×10^{2} was employed for experiments. Square beam spots as big as 20 x 20 cm^2 and as small as 1 x 1 cm^2 were employed for biology and physics experiments. The Tandem-Booster-NSRL complex delivered a sequential field composed of iron and protons with energies of 1 GeV/n with a steady and repeatable switching from protons to iron.

Tandem-Booster set-up started on September 5 with the transport and circulation of Cl beams at the NSRL complex. Beam was tuned into the target cave on September 11 and 1000 MeV/n Cl beams were available for tuning at 7:00 AM 11 September 2006. NSRL-06C officially ended at 10:16 AM 20 October 2006.

PROJECTS REVIEWED BY THE BNL SCIENTIFIC ADVISORY COMMITTEE IN RADIOBIOLOGY (SACR)

Proposal	PI	Sponsor	NSRL-06C Participation
B-7	RABIN	NASA	Yes
B-52	GEWIRTZ/SUTHERLAND*	NSBRI	Yes
B-73	SUTHERLAND	DOE/NASA	Yes
N-64	VAZQUEZ	NSBRI	Yes
N-65	VAZQUEZ	NSBRI	Yes
N-88	SUTHERLAND	NASA	Yes
N-89	HELD	NASA	Yes
N-90	BAILEY	NASA	Yes
N-97	KRONENBERG	NASA	Yes
N-99	ZHAO	NASA	Yes
N-102	HALL*	NASA	Yes
N-103	BARCELLOSHOFF*	NASA	Yes
N-108	PECAUT*/OBENAUS*	NASA	Yes
N-116	BENTON*	NASA	Yes
N-129	LIMOLI	NASA	Yes
N-134	CHEN*	NASA	Yes
N-142	BURNS	NASA	Yes
N-145	O'BANION	NASA	Yes
N-146	WU*	NASA	Yes
N-153	MINNA*/STORY	DOE/NASA	Yes
***Not Present During Actual Run**			

PROJECTS REVIEWED BY THE BNL SCIENTIFIC ADVISORY COMMITTEE IN RADIOBIOLOGY (SACR)

Proposal	PI	Sponsor	NSRL-06C Participation
N-155	RABER	NASA	Yes
N-157	SCHIESTL*	NASA	Yes
N-159	HALL*	NASA	Yes
N-160	SPENCE	NASA	Yes
N-163	WIESE	NASA	Yes
N-164	YU	NASA	Yes
N-166	KENNEDY	NSBRI	Yes
N-167	BURMA	NASA	Yes
N-170	WANG	DOE/NASA	Yes
N-171	DYNLACHT	NASA	Yes
N-172	BERKOWITZ	NASA	Yes
N-173	GEARD*	NASA	Yes
N-175	FIKE*	DOE NASA-NSCOR	Yes
N-176	CUCINOTTA*	DOE/NASA	Yes
N-177	MORGAN*	NASA	Yes
N-178	YU	NASA	Yes
N-184	MILLER	NASA	Yes

***Not Present During Actual Run**

PARTICIPANTS (PRINCIPAL INVESTIGATORS ARE HIGHLIGHTED)

Exp.	Participants	Affiliation	Title
B-7	**RABIN**	University of Maryland	Ph.D, Principal Investigator
	SHUKITTHALE	U.S. Department of Agriculture	Guest Scientist
	CHENG	University of Maryland	Guest Jr. Research Associate
	CARRIHILL	University of Maryland	Guest Research Associate
B-52	**GEWIRTZ/SUTHERLAND***	BNL, Biology Dept. /University. of Pennsylvania	Ph.D, Principal Investigator
	BENNETT	BNL, Biology Dept., Upton, NY	M.S., Co-Worker
	ROY	BNL, Biology Dept., Upton, NY	PhD., Co-Worker
	NAIDU	BNL, Biology Dept., Upton, NY	PhD., Co-Worker
	SUTHERLAND	BNL, Biology Dept., Upton, NY	PhD., Co-Worker
	MONTELEONE	BNL, Biology Dept., Upton, NY	B.S., Co-Worker
	TRUNK	BNL, Biology Dept., Upton, NY	PhD., Co-Worker
B-73	**SUTHERLAND**	BNL, Biology Dept., Upton, NY	Ph.D, Principal Investigator
N-64	**VAZQUEZ**	BNL, Medical Dept., Upton, NY	MD, PhD., Principal Invest.
	GUIDA	BNL, Medical Dept., Upton, NY	Ph.D., Co-Worker
	BILLUPS	BNL, Medical Dept., Upton, NY	B.A., Co-Worker
	PYATT	BNL, Medical Dept., Upton, NY	M.S., Co-Worker
	THOMPSON	BNL, Medical Dept., Upton, NY	B.S., Co-Worker
	KIM	BNL, Medical Dept., Upton, NY	B.S., Co-Worker
N-65	**VAZQUEZ**	BNL, Medical Dept., Upton, NY	MD, PhD., Principal Invest.
N-88	**SUTHERLAND**	BNL, Biology Dept., Upton, NY	Ph.D, Principal Investigator
N-89	**HELD**	Massachusetts General Hospital	Ph.D, Principal Investigator
	PURSCHKE	Massachusetts General Hospital	Guest Research Associate
	SPANTCHAK	Massachusetts General Hospital	Guest Scientific Associate

Exp.	Participants	Affiliation	Title
N-90	**BAILEY**	Colorado State University	Ph.D, Principal Investigator
N-97	**KRONENBERG**	Lawrence Berkeley National Laboratory	Ph.D, Principal Investigator
	SUDO	Lawrence Berkeley National Laboratory	Guest Research Associate
	GAUNY	Lawrence Berkeley National Laboratory	Guest Scientific Associate
	DAN	Oregon Health & Science University	Guest Scientific Associate
	TURKER	Oregon Health & Science University	Guest Scientist
N-99	**ZHAO**	Columbia University	Ph.D, Principal Investigator
N-102	**HALL***	Columbia University	Ph.D, Principal Investigator
N-103	**BARCELLOS-HOFF***	Lawrence Berkeley National Laboratory	Ph.D, Principal Investigator
	GROESSER	Lawrence Berkeley National Laboratory	Guest Research Associate
	RYDBERG	Lawrence Berkeley National Laboratory	Guest Scientist
	ANDARAWEWA	Lawrence Berkeley National Laboratory	Guest Research Associate
	COSTES	Lawrence Berkeley National Laboratory	Guest Scientist
	KRONENBERG	Lawrence Berkeley National Laboratory	Guest Scientist
N-108	**PECAUT*/OBENAUS***	Loma Linda University	Ph.D, Principal Investigator
	SMITH	Loma Linda University	Guest Scientist
	LLOYD	Loma Linda University	Guest Scientific Associate
	JONES	NASA - Loma Linda University Medical School	Guest Scientific Associate
N-116	**BENTON***	Eril Research, Inc.	Ph.D, Principal Investigator
	SAWAKUCHI	Oklahoma State University	Guest Research Assistant
N-129	**LIMOLI**	University of California @ San Francisco	Ph.D, Principal Investigator
	IZADI	University of California @ Irvine	Guest Scientific Associate
	GIEDZINSKI	University of California @ San Francisco	Guest Scientific Associate
N-134	**CHEN***	University of Texas Southwestern	Ph.D, Principal Investigator
	STORY	University of Texas Southwestern	Guest Scientist

Exp.	Participants	Affiliation	Title
N-134	DING	University of Texas Southwestern	Guest Scientist
	AROUMOUGAME	University of Texas Southwestern	Guest Scientist
	UEMATSU	University of Texas Medical Branch	Guest Jr. Research Associate
N-142	**BURNS**	New York University School of Medicine	Ph.D, Principal Investigator
	WU	New York University School of Medicine	Guest Scientist
N-145	**O'BANION**	University of Rochester	Guest Scientist
	WILLIAMS	University of Rochester	Guest Scientist
	TROJANCZYK	University of Rochester	Guest Scientific Associate
	HURLEY	University of Rochester	Guest Scientist
N-146	**WU***	NASA - Johnson Space Center	Ph.D, Principal Investigator
	HADA	Universities Space Research Association	Guest Scientist
	MEADOR	Columbia University	Guest Research Associate
N-153	**MINNA*/STORY**	University of Texas Southwestern	Ph.D, Principal Investigator
	PEYTON	University of Texas Southwestern	Guest Scientist
	ROIG	University of Texas Southwestern	Guest Jr. Research Associate
	PEYTON	University of Texas Southwestern	Guest Scientist
	DELGADO	University of Texas Southwestern	Guest Jr. Research Associate
	BURMA	University of Texas Medical Branch	Guest Scientist
	D. MINNA	University of Texas Southwestern	Guest Scientific Associate
	PARK	University of Texas Southwestern	Guest Research Associate
N-155	**RABER**	Oregon Health & Science University	Ph.D, Principal Investigator
	SMITH	Loma Linda University	Guest Scientist
	POAGE	Oregon Health & Science University	Guest Scientific Associate
N-157	**SCHIESTL***	University of California @ Los Angeles	Ph.D, Principal Investigator
	HAFER	University of California @ Los Angeles	Guest Jr. Research Associate

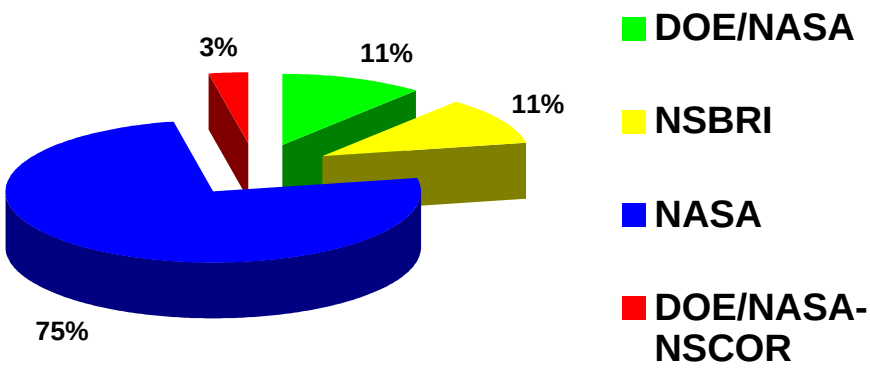
Exp.	Participants	Affiliation	Title
N-157	YAMAMOTO	University of California @ Los Angeles	Guest Jr. Research Associate
	KELLY	University of California @ Los Angeles	Guest Jr. Research Associate
	RELIENE	University of California @ Los Angeles	Guest Scientist
N-159	**HALL***	Columbia University	Ph.D, Principal Investigator
	KLEIMAN	Columbia University	Guest Scientist
	DAVID	Columbia University	Guest Scientific Associate
N-160	**SPENCE**	Boston University	Ph.D, Principal Investigator
	KASPER	Massachusetts Institute of Technology	Guest Scientist
	FOSTER	Massachusetts Institute of Technology	Guest Scientific Associate
	CASE	Boston University	Guest Research Assistant
	GOLIGHTLY	Air Force Research Laboratory	Guest Scientific Associate
N-163	**WIESE**	Lawrence Berkeley National Laboratory	Ph.D, Principal Investigator
N-164	**YU**	University of Texas Medical Branch	Ph.D, Principal Investigator
N-166	**KENNEDY**	University of Pennsylvania	Ph.D, Principal Investigator
	WARE	University of Pennsylvania	Guest Scientist
	DAVIS	University of Pennsylvania	Guest Scientist
	DONAHUE	University of Pennsylvania	Guest Scientific Associate
N-167	**BURMA**	University of Texas Medical Branch	Ph.D, Principal Investigator
	MUKHERJEE	University of Texas Southwestern	Guest Scientist
N-170	**WANG**	Lawrence Berkeley National Laboratory	Ph.D, Principal Investigator
	RYDBERG	Lawrence Berkeley National Laboratory	Guest Scientist
	KURPINSKI	University of California @ Berkeley	Guest Jr. Research Associate
N-171	**DYNLACHT**	Indiana University @ Indianapolis	Ph.D, Principal Investigator
	CAPERELL-GRANT	Indiana University @ Indianapolis	Guest Scientific Associate
	MENDONCA	Indiana University @ Indianapolis	Guest Scientist

Exp.	Participants	Affiliation	Title
N-172	**BERKOWITZ**	Johns Hopkins University	Ph.D, Principal Investigator
	SOUCY	Johns Hopkins University	Guest Research Assistant
N-173	**GEARD***	Columbia University	Ph.D, Principal Investigator
	HU	COLUMBIA NEVIS LAB	Guest Research Associate
	ZHAO	Columbia University	Guest Scientist
	GRABHAM	Columbia University	Guest Scientist
N-175	**FIKE***	University of California San Francisco	Ph.D, Principal Investigator
	KENNEDY	University of Pennsylvania	Guest Scientist
	JONES	NASA - Loma Linda University Medical School	Guest Scientific Associate
	LLOYD	Loma Linda University	Guest Scientific Associate
N-176	**CUCINOTTA***	NASA - Johnson Space Center	Ph.D, Principal Investigator
	HUFF	Universities Space Research Association	Guest Scientist
	GEORGE	Wyle Laboratories @ Houston	Guest Scientific Associate
	ELLIOTT	Wyle Laboratories @ Houston	Guest Scientific Associate
	HARPER	Medical Research Council	Guest Research Associate
N-177	**MORGAN ***	University of Maryland	Ph.D, Principal Investigator
	GOETZ	University of Maryland	Guest Scientific Associate
	BAULCH	University of Maryland	Guest Scientist
	DZIEGIELEWSKI	University of Maryland	Guest Research Associate
N-178	**YU**	University of Texas Medical Branch	Ph.D, Principal Investigator
	GAO	University of Texas Medical Branch	Guest Scientific Associate
N-184	**MILLER**	Lawrence Berkeley National Laboratory	Ph.D, Principal Investigator
	ZEITLIN	Lawrence Berkeley National Laboratory	Guest Scientist
	HEILBRONN	Lawrence Berkeley National Laboratory	Guest Scientist

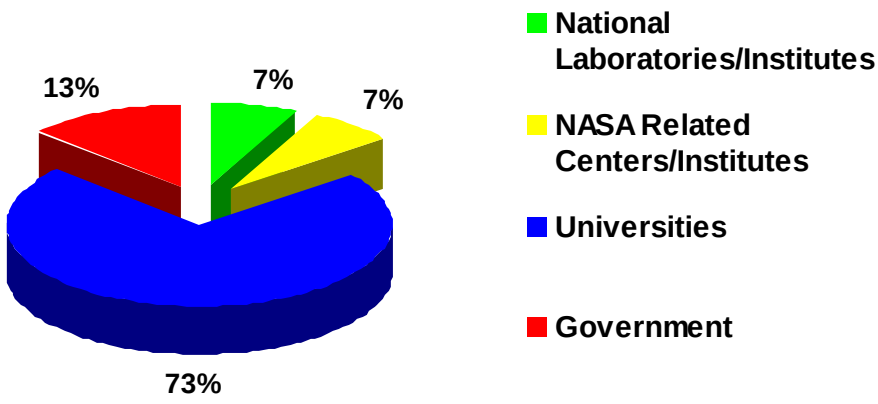
PARTICIPANT INSTITUTIONS

Universities (21)		**National Laboratories/Institutions (2)**
Boston University		Brookhaven National Laboratory
Colorado State University		Lawrence Berkeley National Laboratory
Columbia University, Nevis Laboratories		
Columbia University		
Indiana University @ Indianapolis		
Johns Hopkins University		
Loma Linda University		**NASA Related Centers/institutions (2)**
Massachusetts Institute of Technology		NASA - Johnson Space Center
New York University School of Medicine		NASA - Loma Linda University Medical School
Oklahoma State University		
Oregon Health & Science University		
Universities Space Research Association		
University of California @ Berkeley		**Private Institutions(1)**
University of California @ Irvine		Massachusetts General Hospital
University of California @ Los Angeles		
University of California @ San Francisco		**Government (4)**
University of Maryland		Wyle Laboratories @ Houston
University of Pennsylvania		Air Force Research Laboratory
University of Rochester		U.S. Department of Agriculture
University of Texas Medical Branch		Medical Research Council
University of Texas Southwestern		

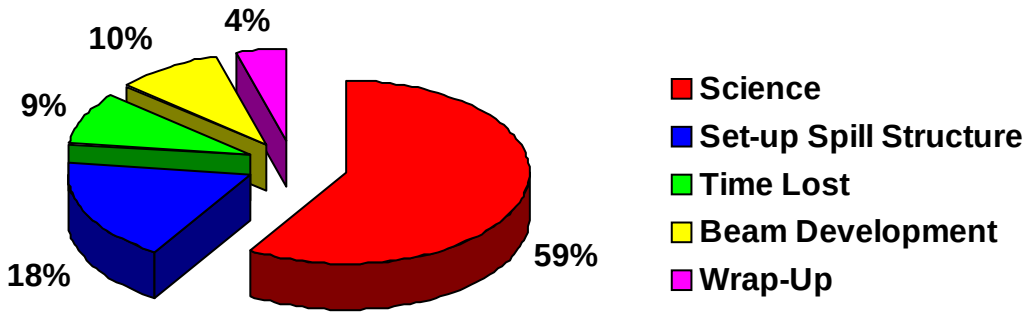
RESEARCH PROJECT SPONSORS



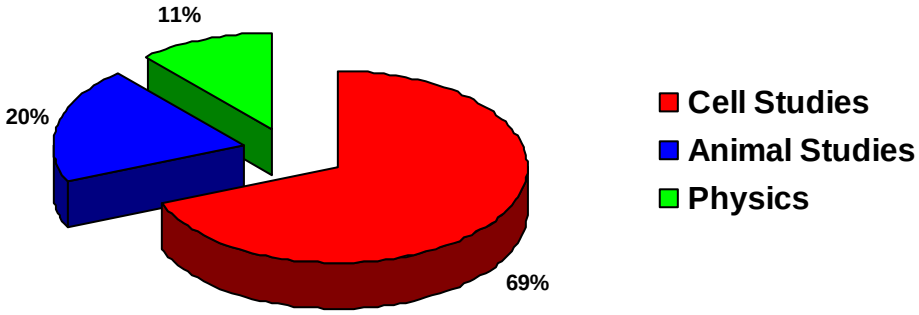
INSTITUTION STATISTICS



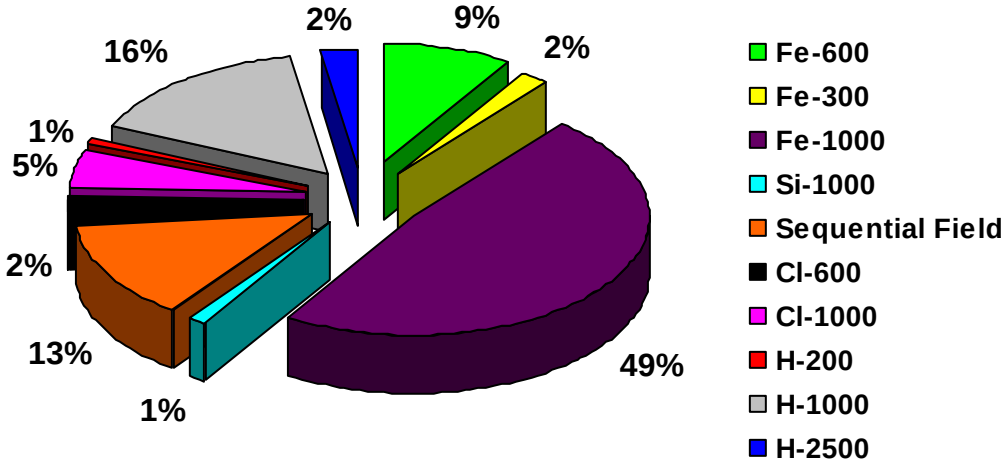
TOTAL RUN-TIME STATISTICS



SCIENCE STUDIES STATISTICS



ION SPECIES AND ENERGY (MeV/n) DISTRIBUTION



RUN TIME DESCRIPTION (HOURS)

NSRL-06C	ION SPECIES AND ENERGIES (MeV/nucleon)										Totals
Ion Species	Si	Fe			Fe-H	Cl		H			
Energy/nucleon	1000	300	600	1000	1000	600	1000	200	1000	2500	
Machine Set-Up	2:00	2:00	6:00	30:00	6:00	0:00	2:00	0:00	10:00	2:00	60:00
Wrap-Up	0:30	0:00	1:00	8:30	1:30	0:00	0:00	0:30	2:30	0:00	14:30
Non-Science Sub-Total: 74:30											
Development	0:00	2:32	3:12	22:53	0:00	0:00	0:00	0:00	3:14	0:00	31:51
Biology											
In Vitro	1:00	1:45	9:05	53:33	29:42	0:00	3:00	2:15	28:55	4:55	134:10
In Vivo	0:00	0:00	9:18	22:24	0:00	0:00	0:00	0:00	6:51	0:00	38:33
Others	0:00	0:00	0:00	0:00	0:00	0:00	0:00	0:00	0:00	0:00	0:00
Physics	0:00	0:00	0:00	5:49	0:00	6:50	9:40	0:00	0:00	0:00	22:19
Science Sub Total: 195:02											
Time lost	0:15	0:00	0:55	15:55	7:25	0:00	2:30	0:00	1:40	1:00	29:40
Totals	3:45	6:17	29:30	159:04	44:37	6:50	17:10	2:45	53:10	7:55	331:03

BEAM CHARACTERISTICS

Ion	Fe			H	Sequential Field	Cl	Cl	Si
Energy (MeV/n)								
Planned	300	600	1000	1000	1000	1000	600	1000
Extracted	300	600	1000	1000	1000	1000	600	1000
On Target	300*	594.7	967.8	1000*	968/1000*	1000*	600*	978.4
Fluence (particles/cm^2/sec)								
Maximum on target	3.0E+06	2.6E+06	7.5E+06	2.1E+08	1.6E+07	3.0E+03	3.0E+03	2.1E+05
Minimum on target	0.6E+06	200	200	200	200	300	300	200
Spill Period (sec)	3.8	3.8	3.8	3.8	3.8	3.8	3.8	3.8
Spill rate (spills/min)	15	15	15	15	15	15	15	15
Spill length (msec)	~300	~300	~300	~300	~300	~300	~300	~300
Particles/spill								
Maximum	1.5E+09	1.20E+09	2.60E+09	9.00E+10	2.6E9/9.0E10	1000	1000	3.00E+09
Minimum	0.3E+09	1.00E+05	1.00E+05	2.00E+02	1.00E+05	1000	1000	1.00E+05
Beam Cut Off Accuracy	0.5%	0.5%	0.5%	0.5%	0.5%	0.5%	0.5%	0.5%
Actual LET on Target (keV/µm)	238.9	183.8	151.4	0.222*	151.4/0.222	64.3	74.2	43.8
Max. Dose Rate								
(Gy/min)/Beam Size								
20 cm x 20 cm	5.0	3.5	4.0	0.7	5.0	1.0	Negligible	2.5
Total Dose (Gy)								
Maximum	20	10	10	10	30	3	Negligible	20
Minimum	0.5	0 .02	0.05	0.01	0.1	0.01	Negligible	0.01

* No Bragg results are available for H or Cl beam running.

DOSIMETRY AND BEAM DEVELOPMENTS

Target Handling:

We designed and constructed a system designed to irradiate a single eye of rats, three at a time, while minimizing exposure to any other part of the animals. The device was used by a user who was the motivation for this development. The system has enough flexibility to be used for many other single-organ type exposures users may wish to carry out in the future. We also tested the exposure incubator on the beam line, with cells and beam for full functionality.

Energy Switching:

Our experience from NSRL-06A and NSRL-06B gave us confidence that changing beam energy was a simple matter of loading a different file with magnet settings. This was accomplished by the experts in less than 4 minutes during the said run. The responsibility for energy switching for this run was handed over to routine operators. Final beam tuning for the new energy proved to be too difficult for the operators during the first part of the run, so we need to continue working with the experts in order to improve the energy switching program. This was accomplished toward the latter part of the run, during which we were able to switch energies on demand in a matter of a few minutes per change. This can now be done either by looking up archives, if the desired energy has been used and archived before, or by using the "dead reckoning" program which scales the entire accelerator/beam-line system, to accomplish the desired energy change.

Medical:

NSRL 06C marked the first time that biological samples were irradiated over a prolonged time period at NSRL. Two sections were removed from the outside of a standard cell culture incubator, and the resulting holes covered by kapton material. With the incubator mounted on the rails of the beamline, this modification allowed the beam to pass into and then out of the incubator. Human neuronal progenitor cells were placed inside and exposed to either 1 Gy of 1 GeV/n Fe ions delivered acutely (over 3 minutes), or to the same dose delivered over a period of 1 hour.

48 hours post-irradiation, the cells were then assayed for two fundamental radiation-induced cytotoxic parameters, apoptosis and necrosis. In summary, no difference was found in the levels of either apoptosis or necrosis between the acute and prolonged exposures. The prolonged exposure more closely resembles the conditions that astronauts will encounter in space. As such, this initial result indicates that perhaps astronauts will not benefit from the extended time frame under which they will be exposed to radiation during space travel. It also demonstrates that such prolonged exposure conditions can be achieved at NSRL, so that additional studies in this area can be performed.

Neutron Dosimetry:

For the first time this run, we began a program to study neutron dosimetry at NSRL. We borrowed a thermal neutron counter and used it to study correlations between thermal neutron rates at a variety of locations new the target room and the ionization chamber based dosimetry.

New Beams:

Chlorine beams of 1000 MeV/n and 600 MeV/n were developed for the first time. They were used for both biology and physics experiments.

RUN DATES

Ion Beam	Energy	Scheduled start	Scheduled End	Actual Start	Actual End
Cl-35	1000	9/11/06 5:00 AM	9/11/06 11:00 PM	9/11/06 3:00 PM	9/12/06 8:10 AM
Cl-35	600	9/11/06 11:00 PM	9/12/06 1:00 PM	9/12/06 8:10 AM	9/12/06 3:00 PM
H-1	1000	9/12/06 1:00 PM	9/15/06 7:00 PM	9/12/06 3:00 AM	9/15/06 5:30 PM
Sequential Field	1000	9/18/06 7:00 AM	9/21/06 7:00 PM	9/18/06 7:00 AM	9/22/06 1:20 AM
H-1	2500	9/22/06 7:00 AM	9/22/06 7:00 PM	9/22/06 7:00 AM	9/22/06 2:45 PM
Sequential Field	200	----	----	9/22/06 2:45 PM	9/22/06 5:30 PM
Fe-56	1000	9/25/06 7:00 AM	9/25/06 7:00 PM	9/25/06 7:00 AM	9/25/06 7:03 PM
Fe-56	300	----	----	9/25/06 11:40 AM	9/25/06 2:12 PM
Fe-56	1000	----	----	9/25/06 2:12 PM	9/25/06 7:03 PM
Fe-56	300	9/26/06 7:00 AM	9/26/06 10:00 AM	9/26/06 7:00 AM	9/26/06 9:55 AM
Sequential Field	300	9/26/06 10:00 AM	9/26/06 11:00 AM	9/26/06 9:55 AM	9/26/06 11:02 AM
Fe-56	1000	9/26/06 11:00 AM	9/26/06 2:00 PM	9/26/06 11:02 AM	9/26/06 12:40 PM
Sequential Field	600	9/26/06 2:00 PM	9/26/06 7:00 PM	9/26/06 12:40 PM	9/26/06 7:00 PM
Fe-56	1000	9/27/06 7:00 AM	9/28/06 4:00 PM	9/27/06 7:00 AM	9/27/06 12:49 PM
Fe-56	600	9/29/06 7:00 AM	9/29/06 11:00 AM	9/29/06 7:00 AM	9/29/06 10:22 AM
Fe-56	1000	9/29/06 11:00 AM	10/05/06 6:00 PM	9/29/06 7:00 AM	10/06/06 8:45 AM
Fe-56	600	10/06/06 7:00 AM	10/06/06 1:00 PM	10/06/06 8:45 AM	10/06/06 12:43 PM
Fe-56	1000	10/06/06 1:00 PM	10/13/06 12:00 PM	10/06/06 8:45 AM	10/13/06 10:34 AM
Fe-56	600	10/13/06 12:00 PM	10/13/06 1:00 PM	10/13/06 10:34 AM	10/13/06 11:54 AM
Fe-56	1000	10/13/06 1:00 PM	10/16/06 3:00 PM	10/13/06 11:54 AM	10/16/06 1:25 PM
Fe-56	600	10/16/06 3:00 PM	10/17/06 1:00 PM	10/16/06 1:25 PM	10/17/06 12:59 PM
Fe-56	1000	10/17/06 1:00 PM	10/17/06 8:00 PM	10/17/06 12:59 PM	10/17/06 5:00 PM
Fe-56	600	10/18/06 7:00 AM	10/18/06 12:00 PM	10/18/06 7:00 AM	10/18/06 11:45 AM
Fe-56	1000	10/18/06 12:00 PM	10/19/06 6:00 PM	10/18/06 11:45 AM	10/19/06 4:41 AM
Si-28	1000	10/20/06 7:00 AM	10/20/06 6:00 PM	10/20/06 7:00 AM	10/20/06 10:45 AM

EXPERIMENTERS AND RUN STATISTICS

Proposal Number	Principal Investigator	Ion	Energy	Beam Time Approved	Beam Time Used	Dose Range	Dose Rate	Number of Samples
B-7	Rabin, Bernard	Protons	1000	8:00:00	5:00:35	35-200	30	96
B-7	Rabin, Bernard	Iron	1000	12:00:00	1:22:03	35-200	30	35
B-52	Gewirtz, Alan	Sequential Field	1000	12:00:00	12:00:00	10-20	10-20	50
N-64	Vazquez, Marcelo	Protons	1000	5:30:00	2:05:00	300-600	100	12
N-65	Vazquez, Marcelo	Iron	1000	2:48:00	1:18:00	50-200	100	25
N-65	Vazquez, Marcelo	Sequential Field	1000	2:30:00	2:05:00	50-150	50	14
N-88	Sutherland, Betsy	Sequential Field	200		2:15:00	10-100	10-100	20
N-88	Sutherland, Betsy	Sequential Field	300		1:06:37	0-500	100-500	5
N-88	Sutherland, Betsy	Sequential Field	600		6:19:51	50-3000	100-500	14
N-88	Sutherland, Betsy	Sequential Field	1000	13:00:00	16:20:19	0.001-3000	0.0001-500	40
N-89	Held, Kathy	Protons	1000	6:12:00	8:32:07		20	20
N-89	Held, Kathy	Sequential Field	1000	6:36:00	7:00:00	1-10	10-20	250
N-89	Held, Kathy	Iron	1000	7:00:00	4:51:26	0.0001-200	0.0001-200	350
N-90	Bailey, Susan	Iron	1000	2:00:00	1:01:34	100-200	100	72
N-97	Kronenberg, Amy	Iron	1000	9:00:00	2:07:31	50-200	50	42
N-99	Zhao, Yongliang	Iron	1000	1:30:00	0:30:27	10-60	20-50	12
N-103	Barcellos-Hoff	Iron	1000	9:00:00	9:44:18	25-100	20-100	105
N-108	Obenaus, Andre	Iron	600	3:00:00	2:45:20	50-400	200	115
N-129	Limoli, Charlie	Iron	600	2:30:00	2:44:49	1-500	5-100	44
N-129	Limoli, Charlie	Iron	1000	6:00:00	4:20:36	1-500	0-200	149
N-134	Chen, David	Iron	1000	3:00:00	2:44:27	100	100	74
N-134	Chen, David	Silicon	1000	1:30:00	1:00:00	100-300	50-100	3

Proposal Number	Principal Investigator	Ion	Energy	Beam Time Approved	Beam Time Used	Dose Range	Dose Rate	Number of Samples
N-142	Burns, Fredric	Iron	1000	6:00:00	2:29:25	150-300	100	28
N-145	O'Banion, Kerry	Iron	1000	7:00:00	5:06:31	100-600	100	38
N-146	Wu, Honglu	Sequential Field	1000	4:00:00	2:10:19	75-200	50-100	20
N-146	Wu, Honglu	Protons	2500	1:30:00	1:25:00	25-400	30	12
N-153	Minna/Story	Protons	1000	3:00:00	6:05:43	50-300	20-25	138
N-153	Minna/Story	Iron	1000	19:00:00	13:18:05	25-200	100	230
N-153	Minna/Story	Iron	300	0:30:00	0:38:46	100	100	9
N-155	Raber, Jacob	Iron	600	4:00:00	2:34:36	300	200	112
N-157	Schiestl, Robert	Iron	1000	3:30:00	3:03:18	10-50	30-100	108
N-159	Hall/Kleiman	Iron	1000	5:30:00	4:41:48	20-300	20-100	30
N-160	Spence, Harlan	Iron	1000	2:00:00	5:48:34	0.1	0.00001	1
N-163	Wiese, Claudia	Iron	1000	8:00:00	4:08:53	32-126	50	117
N-164	Yu, Yongjia	Iron	1000	3:00:00	3:09:21	100-300	200	32
N-166	Kennedy, Ann	Protons	1000	1:30:00	1:50:40	80-300	20	25
N-167	Burma, Sandeep	Chlorine	1000	2:00:00	3:00:00		100	30
N-170	Wang, Daojing	Iron	1000	6:00:00	3:48:31	10-100	10-100	81
N-171	Dynlacht, Joseph	Iron	600	7:30:00	3:57:51	100	100	100
N-172	Berkowitz, Dan	Iron	1000	3:30:00	2:38:13	100	100	40
N-173	Geard, Charles	Protons	1000	3:00:00	2:19:25	20-160	30	48
N-176	Cucinotta, Francis	Protons	2500	3:30:00	3:30:00	20-300	40	16
N-176	Cucinotta, Francis	Iron	1000	3:30:00	2:23:35	12-100	10-100	64
N-177	Morgan, William	Iron	1000	3:00:00	3:08:21	5-50	10	103
N-184	Miller, Jack	Chlorine	1000	18:00:00	9:40:00	0.1	0.00001	1
N-184	Miller, Jack	Chlorine	600	6:00:00	6:50:00	0.1	0.00001	1