Nsrl07a Schedule and Parameters

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Caution! The following schedule is subject to change. Please note release date above.

NSRL is to begin taking beam on **Monday 12 March 2007**; the run will last through June 2007.

Protons for NSRL will come from Linac and will be set up on BU2. All other ions for NSRL come from Tandem and will be set up on BU3. (At some time during the run we may want to take protons from Tandem for "Solar Particle Simulator" work.)

Setup for the run will begin on **Monday 5 March 2007**.

1 Setup Notes and Tasks

1. Opening the LTB beamstops to allow protons from Linac into Booster will require that two fault studies be done in the region of the EBIS-Booster penetration.

2. If RHIC is running, we will also need to commission PPM between Au^{31+} and carbon and silicon ions.

3. Since BLIP will be running with its own funds during the NSRL run, NSRL will have to pay for any protons it takes from BLIP. Also, since only 5 of the 9 Linac tanks are used to accelerate protons to a kinetic energy 116 MeV for BLIP, protons at 200 MeV, the nominal kinetic energy used for the NSRL setup, would require operation of the remaining 4 tanks. NSRL would have to pay for this. An alternative would be to inject protons into Booster at the lower kinetic energy. This would require some setup and commissioning time before the NSRL run starts.

4. The present plan is to start with 200 MeV protons from Linac and use these to do the fault studies.

5. Upon completion of the fault studies, we will switch to the lower kinetic energy (116 MeV) and setup Booster injection and acceleration to 1000 MeV.

6. Then we switch to carbon (from Tandem) and setup injection and acceleration to 300 MeV per nucleon. If RHIC is running, we will need to setup PPM with Au^{31+} ions; otherwise we will inject carbon ions into Booster at the same magnetic rigidity as iron ions.

7. Finally, we switch to silicon and setup injection and acceleration to 300 MeV per nucleon. If RHIC is running, we will again need to setup PPM with Au^{31+} ions; otherwise we will inject silicon ions into Booster at the same magnetic rigidity as iron ions.

2 Beam order and nominal extraction energy

2.1 Week 1

1. Carbon. 300 and 200 MeV per nucleon. March 12–15 (Mon–Thur).

2. Silicon. 300, 600, and 850 MeV per nucleon. March 16 (Fri).

2.2 Week 2

1. Silicon. 850 MeV per nucleon. March 19 (Mon).

2. Silicon. 850 and 300 MeV per nucleon. March 20 (Tue).

3. Protons. 1000 MeV per nucleon. March 21–23 (Wed–Fri).

2.3 Week 3

1. Protons. 1000 MeV per nucleon. March 26–30 (Mon–Fri).

2.4 Week 4

1. Iron. 1000 MeV per nucleon. April 2–3 (Mon–Tue).
2. No beam to NSRL on Wed 4 April.
3. Iron. 1000 MeV per nucleon. April 5–6 (Thur–Fri).

2.5 Week 5

1. Iron. 1000 MeV per nucleon. April 9–10 (Mon–Tue).
2. No beam to NSRL on Wed 11 April.
3. Titanium. 1000 MeV per nucleon. April 12–13 (Thur–Fri).
4. Iron. 1000 MeV per nucleon. April 14 (Sat).

2.6 Week 6

1. Iron. 1000 MeV per nucleon. April 16 (Mon).
2. Protons. 1000 MeV per nucleon. April 17–18 (Tue–Wed).
3. Iron. 600 and 1000 MeV per nucleon. April 19 (Thur).
4. Iron. 1000 and 600 MeV per nucleon. April 20 (Fri).

2.7 Week 7

1. Protons. 1000 MeV per nucleon. April 23 (Mon).
2. Iron. 1000 MeV per nucleon. April 24 (Tue).
3. Protons. 1000 MeV per nucleon. April 25 (Wed).
4. Iron. 1000 MeV per nucleon. April 26 (Thur).
5. Protons. 1000 MeV per nucleon. April 27 (Fri).

2.8 Week 8

1. Iron. 1000 MeV per nucleon. April 30 (Mon).
2. Iron. 600 MeV per nucleon. May 1 (Tue).
3. No beam to NSRL on Wed 2 May.
4. Iron. 1000 MeV per nucleon. May 3–4 (Thur–Fri).

2.9 Week 9

1. Iron. 1000 MeV per nucleon. May 7–8 (Mon–Tue).
2. No beam to NSRL on Wed 9 May.
3. Iron. 1000 MeV per nucleon. May 10–11 (Thur–Fri).

2.10 Week 10

1. Iron. 1000 MeV per nucleon. May 14–15 (Mon–Tue).
2. No beam to NSRL on Wed 16 May.
3. Iron. 1000 MeV per nucleon. May 17–18 (Thur–Fri).

3 Injection and Extraction Parameters

Table 1: Proton Parameters at Booster Injection

Parameter	Tandem Protons	Linac Protons	Linac Protons	Unit
Protons Nucleons	1 1	1 1	1 1	
mc^2	0.938271998	0.938271998	0.938271998	GeV
Archive Date	29 Jun 06		26 April 05 4 April 06	
11DH1 NMR Probe	3971.15	Linac	Linac	Gauss
hf	566.033	667.521	843.100	kHz
h	2	1	1	
$T = 1/f$	3.53336	1	1.18609892	μs
Kinetic Energy W	17.5008	116	201.237574	MeV
$B\rho$	0.6073	1.603659833	2.156918716	Tm
$B\rho/\rho$	437.990	1156.5744	1555.5899	Gauss
Booster Hall Probe	418.2	–	453.3	Gauss
Booster Gauss Clock	14.3	–	1101.7	Gauss
Injection Field H	432.5	1150.9	1555.0	Gauss
Inflector Setpoint V_S	67.367	Linac	Linac	kV
Inflector Predicted V_I	67.448	Linac	Linac	kV

Table 2: Carbon and Silicon Parameters at Au^{32+} Injection Rigidity

Parameter	C^{5+}	Si^{9+}	Unit
Protons Nucleons	6 12	14 28	
mc^2	11.1753731615	26.0557405772	GeV
Archive Date	24 Nov 03	19 March 04	
11DH1 NMR Probe	5580	5580	Gauss
hf	507.1300	392.54457	kHz
h	3	3	
$T = 1/f$	5.91564	7.6424	μs
Kinetic Energy W	73.0440	101.6387	MeV
$B\rho$	0.8538	0.8538	Tm
$B\rho/\rho$	615.7685	615.7685	Gauss
Booster Hall Probe	–	–	Gauss
Booster Gauss Clock	–	–	Gauss
Injection Field H	610.5	610.5	Gauss
Inflector Setpoint V_S	–	–	kV
Inflector Predicted V_I	56.638	43.841	kV

Table 3: Carbon and Silicon Parameters at Au^{31+} Injection Rigidity

Parameter	C^{5+}	Si^{9+}	Unit
Protons Nucleons	6 12	14 28	
mc^2	11.1753731615	26.0557405772	GeV
Archive Date			
11DH1 NMR Probe	5760	5760	Gauss
hf	523.2685	405.1054	kHz
h	3	3	
$T = 1/f$	5.7332	7.4055	μs
Kinetic Energy W	77.8164	108.2886	MeV
$B\rho$	0.8813444	0.8813444	Tm
$B\rho/\rho$	635.6338	635.6338	Gauss
Booster Hall Probe	–	–	Gauss
Booster Gauss Clock	–	–	Gauss
Injection Field H	630.3	630.3	Gauss
Inflector Setpoint V_S	–	–	kV
Inflector Predicted V_I	60.326	46.703	kV

Table 4: Carbon and Silicon Parameters at Fe^{20+} Injection Rigidity

Parameter	C^{5+}	Si^{13+}	Unit
Protons Nucleons	6 12	14 28	
mc^2	11.1753731615	26.05369658	GeV
Archive Date	2 May 05 7 March 06	17 Nov 05 7 April 06	
11DH1 NMR Probe	4364.1	4364.1	Gauss
hf	397.121	442.455	kHz
h	3	3	
$T = 1/f$	7.55438	6.78035	μs
Kinetic Energy W	44.6215	129.3224	MeV
$B\rho$	0.6669	0.6669	Tm
$B\rho/\rho$	480.974	480.974	Gauss
Booster Hall Probe	–	–	Gauss
Booster Gauss Clock	–	–	Gauss
Injection Field H	476.9	476.9	Gauss
Inflector Setpoint V_S	–	38.588	kV
Inflector Predicted V_I	34.643	38.598	kV

Table 5: Titanium and Iron Parameters at Booster Injection

Parameter	Ti^{18+}	Fe^{20+}	Unit
Protons Nucleons	22 48	26 56	
mc^2	44.6540277	52.0928437	GeV
Archive Date	16 Jun 06	29 Jun 06	
11DH1 NMR Probe	4364.1	4364.1	Gauss
hf	358.0563	341.131	kHz
h	3	3	
$T = 1/f$	8.3786	8.79427	μs
Kinetic Energy W	144.7817	153.2415	MeV
$B\rho$	0.6669	0.6669	Tm
$B\rho/\rho$	480.974	480.974	Gauss
Booster Hall Probe	–	453.4	Gauss
Booster Gauss Clock	–	23.5	Gauss
Injection Field H	476.9	476.9	Gauss
Inflector Setpoint V_S	–	29.605	kV
Inflector Predicted V_I	31.235	29.759	kV

Table 6: Proton Parameters at Booster Extraction

Parameter	Proton	Proton	Unit
mc^2	0.938271998	0.938271998	GeV
Archive Date	29 Jun 06	22 Jun 06	
hf	2.6001199	2.8586962	MHz
h	2	2	
$T = 1/f$	0.769195	0.699620	μs
Kinetic E per Nucleon	1000	2500	MeV
$B\rho$	5.65737292	11.03354195	Tm
$B\rho/\rho$	4080.15	7957.49	Gauss
Magnetic Field Setpoint	4159.68 4159	8112.60 8086.7085	Gauss
MM Current Setpoint	1710	3333.6537	Amps

Table 7: Proton Parameters at Booster Extraction

Parameter	Proton	Proton	Unit
mc^2	0.938271998	0.938271998	GeV
Archive Date	–	–	
hf	1.6823335	2.2521094	MHz
h	2	2	
$T = 1/f$	1.188825	0.888056	μs
Kinetic E per Nucleon	200	500	MeV
$B\rho$	2.14963569	3.63611180	Tm
$B\rho/\rho$	1550.337	2622.398	Gauss
Magnetic Field Setpoint	1580.557 –	2673.52 –	Gauss
MM Current Setpoint	–	–	Amps

Table 8: Carbon Parameters at Booster Extraction

Parameter	C^{5+}	C^{5+}	C^{5+}	Unit
mc^2	11.1753731615	11.1753731615	11.1753731615	GeV
Archive Date				
hf	3.9047732	2.9157586	2.5305320	MHz
h	3	3	3	
$T = 1/f$	0.768290	1.028892	1.185521	μs
Kinetic E per Nucleon	1000	300	200	MeV
$B\rho$	13.5446567747	6.44815501250	5.14172758052	Tm
$B\rho/\rho$	9768.53	4650.47	3708.26	Gauss
Magnetic Field Setpoint	9958.59	4740.76	3780.19	Gauss
MM Current Setpoint	–	–	–	Amps

Table 9: Silicon (Si^{9+}) Parameters at Booster Extraction

Parameter	Si^{9+}	Si^{9+}	Si^{9+}	Unit
mc^2	26.0557405772	26.0557405772	26.0557405772	GeV
Archive Date				
hf	3.8000637	2.9164920	3.5387939	MHz
h	3	3	3	
$T = 1/f$	0.789460	1.028633	0.847746	μs
Kinetic E per Nucleon	850	300	600	MeV
$B\rho$	15.7535704263	8.35594018283	12.6106426962	Tm
$B\rho/\rho$	11361.62	6026.38	9094.91	Gauss
Magnetic Field Setpoint	11582.7	6143.49	9271.84	Gauss
MM Current Setpoint	–	–	–	Amps

Table 10: Silicon (Si^{13+}) Parameters at Booster Extraction

Parameter	Si^{13+}	Si^{13+}	Unit
mc^2	26.05369658	26.05369658	GeV
Archive Date	17 Nov 05 7 Apr 06	17 Nov 05 7 Apr 06	
hf	3.9052942	2.9165665	MHz
h	3	3	
$T = 1/f$	0.768188	1.028607	μs
Kinetic E per Nucleon	1000	300	MeV
$B\rho$	12.152097912	5.784686256	Tm
$B\rho/\rho$	8764.21	4171.97	Gauss
Magnetic Field Setpoint	8911	4252	Gauss
MM Current Setpoint	3680	1748	Amps

Table 11: Titanium Parameters at Booster Extraction

Parameter	Ti^{18+}	Ti^{18+}	Unit
mc^2	44.6540277	44.6540277	GeV
Archive Date		11 Oct 05 16 Jun 06	
hf	3.9054238	3.912198	MHz
h	3	3	
$T = 1/f$	0.768162	0.766832	μs
Kinetic E per Nucleon	1000	1011.1732	MeV
$B\rho$	15.0444189475	15.15774913	Tm
$B\rho/\rho$	10850.18	10931.91	Gauss
Magnetic Field Setpoint	–	11100	Gauss
MM Current Setpoint	–	4663	Amps

Table 12: Iron Parameters at Booster Extraction

Parameter	Fe^{20+}	Fe^{20+}	Fe^{20+}	Unit
mc^2	52.0928437	52.0928437	52.0928437	GeV
Archive Date	29 Jun 06	29 Jun 06	–	
hf	3.9054651	3.5390849	2.9168317	MHz
h	3	3	3	
$T = 1/f$	0.768154	0.847677	1.028513	μs
Kinetic E per Nucleon	1000	600	300	MeV
$B\rho$	15.79629259	11.34804355	7.519187947	Tm
$B\rho/\rho$	11392.43	8184.31	5422.91	Gauss
Magnetic Field Setpoint	11614.50 11600	8343.84 8471	5528.62 –	Gauss
MM Current Setpoint	4934	3495	–	Amps

Table 13: Longitudinal Emittance and Bucket Area in Booster at Injection. Emit is the emittance of the beam in one bucket assuming $\Delta p/p = \pm 0.00025$. A_S is the stationary bucket area at the indicated gap voltage. The units are eV-s. Note that if the gap voltage is 30 kV and $dB/dt = 80$ G/ms, then the stable phase is 48.25 degrees and the bucket area is αA_S where $\alpha = 0.135$.

Ion	Emit	A_S 0.5 kV	A_S 30 kV
H^+	0.031	0.174	1.35
C^{5+}	0.148	0.719	5.57
Si^{9+}	0.267	1.47	11.4
Si^{13+}	0.292	1.764	13.7
Ti^{18+}	0.404	2.71	21.0
Fe^{20+}	0.449	3.085	23.9