SNS HFIR User Group (SHUG) Executive Committee Minutes
Archived at http://neutrons.ornl.gov/users/shug

Teleconference held March 6, 2012, 1:00pm EST.
Attendees

- Executive Committee: Greg Beaucage (chair), Antonella Longo, Hanno zur Loye, Tyrel McQueen, Dave Belanger, Yan Gao, Fred Heberle, and Cora Lind
- Guests: Robert McGreevy, Mike Simonsen, Laura Edwards, Al Ekkebus

Minutes submitted for review April 1, 2012 by F.A. Heberle.

ACTION ITEMS:

- Email election for chair-elect (Greg).
- Draft a webpage for proposed SHUG blog (Malcolm).
- Provide feedback to Robert McGreevy on proposed overhaul of access mechanisms.

ATTACHMENTS and WEBSITES of interest from the teleconference:

- HFIR/SNS General User Program submission and performance statistics: neutrons.ornl.gov/users/stats.shtml
- NScD beamtime access mechanisms—attached
- NScD user numbers—attached
- NScD user statistics detailed analysis—attached

1. Status updates (Robert McGreevy)

HFIR is currently shutdown for the end-of-cycle 440A refueling outage. The startup for cycle 440B is planned for Monday, March 26. With the exception of a brief shutdown on Friday March 2 due to a tornado threat, SNS is running and performing great. The accelerator reliability is over 95% for the current fiscal year.

2. User Office updates (Laura Edwards)

The proposal call for the 2012B cycle is complete. 602 proposals were received, down from 691 received for the 2012A cycle (although it should be noted we are down an instrument). Furthermore, there were a larger number of single proposals for multiple samples. Overall, the oversubscription rate is 2.5-2.75 of what we would like to accommodate.

3. Discussion: Overhaul of access mechanisms and NScD user numbers (Robert)

At the recent NAB meeting, there was discussion of new beamtime access mechanisms, rather than the current "one proposal—one experiment" basis. New mechanisms under consideration include single proposal—multiple instrument, mail-in (currently being tested on POWGEN), delayed or reserved beamtime, program proposals, and rapid access. A summary of these mechanisms is found in an attachment to this document. Robert has asked the SHUG committee members to consider these proposed mechanisms and provide feedback on the advantages/disadvantages.

As a second item, Robert briefly discussed NScD user numbers, and in particular the unique users metric stressed by DOE. Looking at other user facilities, a typical number of unique users per experiment is 1; the ratios for SNS and HFIR are closer to 2, which is not viable in the long term. In particular, the load on staff scientists is high because so many new people (one-time users) must be trained. New users are of course necessary (they include the next generation of regular users), but a better balance needs to be found. A summary of NScD user numbers is found in attachments to this document.

4. Discussion: Outreach to private sector, industry (Mike Simonson, Yan Gao)

Mike reports that the DOE Office of Science User Facilities is in the early stages of creating a web portal for private users and industry to secure access to beam time. This project is currently in the discussion stage, with participation from representatives of various user facilities. The goal is to create a website focused on instruments (2-4 at a given facility) that are of particular interest to private sector or industrial users.

5. Election of chair for next year

Greg will send an email reminder, and the candidates will write a short bit about themselves. The election will be held by email. Everyone on the committee can vote.

Next telecon date: Tuesday April 3, 2012, at 1:00pm EST

ORNL Neutron Sciences Directorate

Access Mechanisms

Current status

Approximately 100 days per 6 month allocation period are available on instruments at HFIR and SNS that are fully in the user program. A number of days are removed 'off the top' for calibration, technical development etc. Under normal circumstances the goal would be to have 85% of the days available for experiments, though for instruments still in partial commissioning this proportion may be lower.

Currently 75% of the experimental beam time at SNS and HFIR neutron scattering instruments is allocated through the General User Program (GUP) on a 'one proposal – one experiment' basis. 5% is allocated to instrument scientists (IS). The remaining 20% is divided between Instrument Development Teams (IDT), Partner Users (PU) and Program Development (PD). The Fundamental Neutron Physics Beamline, for obvious reasons, is an exception with 100% of time going to the IDT. The 2011 status for the different instruments is given in Table 1.

Future mechanisms

We propose to start a significant overhaul of access mechanisms for HFIR and SNS beamtime. In general the approach is to increase flexibility to make the process better fit the requirements of the users and the science, rather than vice-versa.

<u>General User Program.</u>

GUP will remain at least 75% of the available beamtime.

- In order to introduce the required program flexibility not all GUP time will be allocated to specific experiments immediately following the SRC meeting. Up to 20% will be allocated to 'stand by' experiments, but these will only be confirmed when it is certain that time is available. It is also important to ensure that scheduled experiments are completed and lead to publishable results; squeezing more experiments into the same time is not necessarily more productive. Note that this will not mean a reduction in the overall time available to the GUP.
- Mail-in access. This has already been launched for POWGEN. It will be restricted to specific types of 'standard' experiments. Extension to other instruments, e.g. power diffraction (HB-2A, NOMAD), small angle scattering (EQ-SANS, GP-SANS, Bio-SANS) and chemical spectroscopy (VISION) could be considered later.
- Multi-instrument proposals. Use of several complementary instruments in a single project is increasingly common. IPTS will be modified to enable single proposals that encompass more than one instrument. Currently this has to be

done via multiple proposals, which hinders coherent consideration of the science case relative to the resources requested.

- 'Delayed' or 'reserved' beamtime. In specific circumstances users should be able to ask for beamtime to be scheduled in future allocation periods, not just in the current period. For example, a protein crystallography study might require more than 6 months of time and effort in crystal growth and deuteration. It is reasonable that users should be certain of access to beamtime before they undertake such work. Conversely, a review committee should be able to reserve beamtime in the upcoming cycle to enable an experiment provided that a suitable quality sample had been produced.
- Rapid access. At other facilities this is often known as "Director's discretion" beamtime. Typical uses might be for either 'hot topics' or as a mechanism for attracting new users. The procedures for applications/approvals via this route will be made more widely known and transparent.
- Program proposals. The 'one proposal – one experiment' system, coupled with the relatively small number of neutron scattering instruments in the US, discourages researchers from committing thesis students to projects that require beamtime for a series of experiments. This can be overcome by allowing program proposals. However, a suitable balance (which might vary between instruments) must be kept between programs and single proposals. We would envisage that much of the advantage would actually be for programs on higher throughput instruments, e.g. 2-3 days of SANS or powder diffraction time every 6 months for 3 years. Programs would still be subject to 6 monthly review.

		GUP	PD	IDT	PU	IS
BL-1a	MUSANS					
BL-1b	NOMAD	75%	20%			5%
BL-2	BASIS	75%	10%		10%	5%
BL-3	SNAP	75%	20%			5%
BL-4a	MAGICS	75%	20%			5%
BL-4b	Liq Ref	75%	20%			5%
BL-5	CNCS	75%		20%		5%
BL-6	EQ-SANS	75%	20%			5%
BL-7	VULCAN	75%	10%		10%	5%
BL-9	CORELLI					
BL-10	VENUS					
BL-11a	POWGEN	75%	10%		10%	5%
BL-11b	MANDI					
BL-12	TOPAZ	75%	20%			5%
BL-13	FNPB			100%		
BL-14b	HYSPEC	75%		20%		5%
BL-15	NSE	75%			25%	
BL-16b	VISION	75%		20%		5%
BL-17	SEQUOIA	75%		10%	10%	5%
BL-18	ARCS	75%		20%		5%
CG-1d	Imaging	38%	10%			3%
CG-2	GP-SANS	75%	20%			5%
CG-3	Bio-SANS	75%	20%			5%
CG-4d	IMAGINE					
CG-4c	CTAX	75%		20%		5%
HB-1	Pol TAS	75%	20%			5%
HB-1a	Fixed Ei TAS	75%		20%		5%
HB-2a	Powder	75%	20%			5%
HB-2b	Res Stress					
HB-2c	WAND	75%		20%		5%
HB-3	TAS	75%	20%			5%
HB-3a	4 Circle	75%	20%			5%

Table 1. 2011 distribution of beamtime

NScD user numbers

Total user numbers for a facility are determined by the numbers of experiments carried out – after all, that is the reason that users come to the facility. The number of experiments is determined by the number of days the facility operates, the number of instruments and the average length of an experiment. An experiment, depending on the type of instrument, might have 2-4 users. Neutron scattering experiments typically range from 1-6 days.

Unique user numbers are a fraction of total user numbers, depending on how many experiments per year particular users carry out. An 'occasional' user might carry out only one experiment in a year, but an 'established' user group might carry out 10 (often using a range of instruments). A healthy user community will contain a mix of occasional and established users. Occasional users (unless they happen to be established users of other facilities) will tend to be inexperienced and will not typically be carrying out the more challenging or speculative experiments. They place a significantly higher support burden on the facility, particularly on the instrument scientists.

Statistics for HFIR and SNS are given in the spreadsheet NScD user statistics detailed analysis.xslx. The ratio of unique user numbers to experiments for European neutron facilities[1] tend to be slightly less than one for those facilities with large external user programs, and lower for those with a higher proportion of in house research. None of them has a ratio higher than one. The ratios for SNS and HFIR are both well above 1. This is not a healthy situation for developing a user community. If most users are effectively only carrying out one experiment per year then they are never going to develop a research program with a significant requirement for neutron scattering and they are not going to have a 'stake' in the success of that facility. The US does not have the network of smaller facilities that Europe has (or at least had) and which 'feed' experienced users to the premier facilities. While a higher ratio of unique users would naturally be expected in the first few years of operation of a new facility, to aim to maintain (or even increase) this ratio as the facility expands and matures will not be sustainable and will not lead to high quality science.

The situation is somewhat different for synchrotrons. Firstly, there is a much higher number of instruments distributed across the different facilities in the US, so it is perfectly possible for a group to have a viable research program that uses only a small amount of time at a number of facilities. Secondly, X-ray/photon use is not

[1] Over a three year period (2008-2010) ISIS had 2143 unique users running 1539 experiments on 26 instruments with an average 3.6 days per experiment, i.e. a size of business very similar to NScD. Annual figures are not available, but on average there is a turnover of about 1/3 of the users per year (understandable given the average length of a PhD or postdoc). This gives 0.83 unique users per experiment on an annual basis. The ratio on the same basis is 0.77 for ILL and 0.96 for FRM-II.

confined to large facilities (as it is for neutrons) so a group can undertake a lot of relevant research at their home institution and then only move to the central facility when the specific need requires.

To emphasise the 'thin spread' of SNS experiments across research groups we show in Figure 1 an analysis of the number of experiments participated in per institution (excluding ORNL) for FY11. UT Knoxville predictably participates in the largest number of experiments. Julich and McMaster University are major users since they are partner organisations with contractually guaranteed access to beamtime. Other major user institutions are the Carnegie Institute Washington and SUNY Stony Brook (who are heavily involved in technical development of the high pressure beamline SNAP), NIST, Indiana University, Georgia Tech., MIT, ANL and BNL. However, 56% of institutions only participate in a single experiment per year, 75% in two or less (and note that there may be more than one research group per institution).

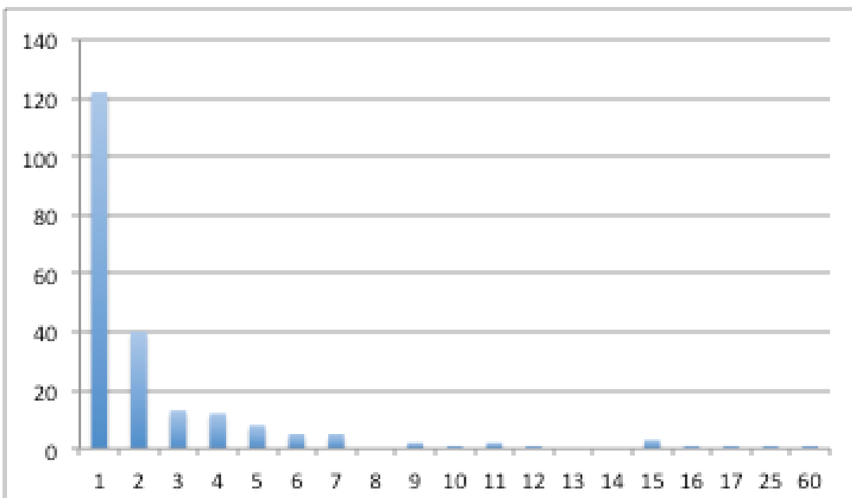

Figure 1. Number of user experiments per institution for FY11, excluding ORNL. 122 institutions (56%) participated in only a single experiment; one institution (UT Knoxville) participated in 60.

It might be argued that experiments should be shorter at high flux facilities like SNS and HFIR and so user numbers should be higher. This is generally only true if the high flux is used to carry out standardized high throughput experiments (e.g. protein crystallography) – otherwise higher flux is typically used to carry out more complex experiments. Except for high throughput, the average experiment length did not change significantly between second and third generation synchrotrons despite a factor of 10^5 increase in flux. In well documented cases for neutron instruments where the count rate has been increased by more than an order of magnitude (e.g. HRPD at ISIS) the average experiment time has not decreased by more than a third. In addition, decreasing average experiment time below 2-3 days for 'normal' experiments would require a significant increase in support staff.

A detailed analysis of NScD user statistics is given in the worksheet NScD user statistics detailed analysis.xslx. Figures for the first quarter of FY12 are similar to those for FY11, as would be expected. The 'steady state' projection for 2015 is that, in a healthy and sustainable state, SNS should support of order 800 experiments per year with 2000-2500 external user visits, with 900 unique users (including about 10% NScD staff). The corresponding figures for HFIR are 350 experiments with 1000-1400 user visits and 350 unique users. The SNS unique user number comparable to the current number, while the HFIR number is a decrease, but this reflects the maturing of the user community. Note that this does not mean that the user community is static; in this context the turnover of unique users per year is more important, not the number.

BL	Name	2007							2008							2009							2010						
		Experiments	Days	Days/expt	Users	Users/expt	Unique users	Unique users/expt	Experiments	Days	Days/expt	Users	Users/expt	Unique users	Unique users/expt	Experiments	Days	Days/expt	Users	Users/expt	Unique users	Unique users/expt	Experiments	Days	Days/expt	Users	Users/expt	Unique users	Unique users/expt
BL-1a	MUSANS																						0			0		0	
BL-1b	NOMAD																						0			0		0	
BL-2	BASIS																						36			105		64	1.8
BL-3	SNAP																						15			49		35	2.3
BL-4a	MAGICS																						28			63		31	1.1
BL-4b	Liq Ref																						28			111		61	2.2
BL-5	CNCS																						27			54		26	1
BL-6	EQ-SANS																						6			19		16	2.7
BL-7	VULCAN																						4			37		30	7.5
BL-9	CORELLI																						0			0		0	
BL-10	VENUS																						0			0		0	
BL-11a	POWGEN																						33			90		29	0.9
BL-11b	MANDI																						0			0		0	
BL-12	TOPAZ																						0			0		0	
BL-13	FNPB																						1			9		8	8
BL-14b	HYSPEC																						0			0		0	
BL-15	NSE																						2			7		0	0
BL-16b	VISION																						0			0		0	
BL-17	SEQUOIA																						36			157		74	2.1
BL-18	ARCS																						29			95		56	1.9
		9					**24**	**2.7**	**61**					**165**	**2.7**	**109**					**307**	**2.8**	**244**			**787**		**422**	**1.7**

BL	Name	2007							2008							2009							2010						
		Experiments	Days	Days/expt	Users	Users/expt	Unique users	Unique users/expt	Experiments	Days	Days/expt	Users	Users/expt	Unique users	Unique users/expt	Experiments	Days	Days/expt	Users	Users/expt	Unique users	Unique users/expt	Experiments	Days	Days/expt	Users	Users/expt	Unique users	Unique users/expt
BDL-1	Bio-deuteration lab																						0			0		0	
CG-1a																							0			0		0	
CG-1b	Alignment Station																						0			0		0	
CG-1c																							0			0		0	
CG-1d	Imaging																						0			0		0	
CG-2	GP-SANS																						62			206		106	
CG-3	Bio-SANS																						50			131		80	
CG-4d	IMAGINE																						0			0		0	
CG-4c	CTAX																						0			0		0	
HB-1	Pol TAS																						26			76		27	
HB-1a	Fixed Ei TAS																						28			109		21	
HB-2a	Powder																						49			145		71	
HB-2b	Res Stress																						15			40		20	
HB-2c	WAND																						4			27		17	
HB-3	TAS																						23			84		26	
HB-3a	4 Circle																						14			44		7	
		46					**72**	**1.6**	**215**					**258**	**1.2**	**221**					**358**	**1.6**	**271**			**862**		**375**	

BL	Name	2011								2012 (projection)								2015 (projection)							
		Experiments	Days	Availability	Days/expt	Users	Users/expt	Unique users	Unique users/expt	Experiments	Days	Availability	Days/expt	Users	Users/expt	Unique users	Unique users/expt	Experiments	Days	Availability	Days/expt	Users	Users/expt	Unique users	Unique users/expt
BL-1a	MUSANS	0	0			0		0		0	0			0	0	0		25	177	85%	7.0	89	3.5	25	1.0
BL-1b	NOMAD	10	30	16%	3.0	81	8.1	36	3.6	49	76	40%	1.6	159	3.3	93	1.9	59	177	85%	3.0	207	3.5	59	1.0
BL-2	BASIS	40	174	93%	4.4	126	3.2	65	1.6	39	161	86%	4.1	100	2.6	61	1.6	40	177	85%	4.4	141	3.5	40	1.0
BL-3	SNAP	29	128	68%	4.4	133	4.6	60	2.1	29	134	72%	4.6	63.5	2.2	51	1.8	40	177	85%	4.4	141	3.5	40	1.0
BL-4a	MAGICS	39	146	78%	3.7	99	2.5	52	1.3	39	134	72%	3.4	105	2.7	61	1.6	59	177	85%	3.0	207	3.5	59	1.0
BL-4b	Liq Ref	38	137	73%	3.6	165	4.3	87	2.3	44	110	59%	2.5	142	3.2	110	2.5	59	177	85%	3.0	207	3.5	59	1.0
BL-5	CNCS	36	160	85%	4.4	98	2.7	58	1.6	32	149	79%	4.7	85.5	2.7	59	1.8	40	177	85%	4.4	141	3.5	40	1.0
BL-6	EQ-SANS	44	92	49%	2.1	170	3.9	90	2.0	49	137	73%	2.8	129	2.7	93	1.9	84	177	85%	2.1	295	3.5	84	1.0
BL-7	VULCAN	40	110	59%	2.8	187	4.7	100	2.5	37	125	66%	3.4	183	5	139	3.8	59	177	85%	3.0	207	3.5	59	1.0
BL-9	CORELLI	0	0			0		0		0	0			0	0	0		30	177	85%	6.0	103	3.5	30	1.0
BL-10	VENUS	0	0			0		0		0	0			0	0	0		0	0	0%	0.0	0	3.5	0	0.0
BL-11a	POWGEN	73	153	82%	2.1	232	3.2	138	1.9	73	154	82%	2.1	188	2.6	115	1.6	84	177	85%	2.1	295	3.5	84	1.0
BL-11b	MANDI	0	0			0		0		0	0			0	0	0		12	177	85%	15.0	41	3.5	12	1.0
BL-12	TOPAZ	15	59	31%	3.9	36	2.4	20	1.3	1	4	2%	4.0	2.5	2.5	4	4.0	44	177	85%	4.0	155	3.5	44	1.0
BL-13	FNPB	1				32		32		1	0		0.0	17	17	42	42.0	1	177	85%	177.0	40	40	40	40.0
BL-14b	HYSPEC	0	0			0		0	0.0	0	0			0	0	0		35	177	85%	5.0	124	3.5	35	1.0
BL-15	NSE	12	84	45%	7.0	33	2.8	17	1.4	7.3	86	46%	11.7	14.7	2	15	2.0	25	177	85%	7.0	89	3.5	25	1.0
BL-16b	VISION	0	0			0		0		0	0			0	0	0		39	177	85%	4.5	138	3.5	39	1.0
BL-17	SEQUOIA	40	170	91%	4.3	138	3.5	69	1.7	39	132	70%	3.4	103	2.6	103	2.6	41	177	85%	4.3	144	3.5	41	1.0
BL-18	ARCS	41	184	98%	4.5	125	3.0	66	1.6	32	149	79%	4.7	97.7	3.1	98	3.1	39	177	85%	4.5	138	3.5	39	1.0
		458	**1627**		**3.6**	**1623**	**3.5**	**890**	**1.9**	**471**	**1550**		**3.3**	**1640**	**3.5**	**1042**	**2.1**	**818**	**3365**		**3.9**	**2899**	**3.5**	**857**	**1.0**

BL	Name	2011								2012 (projection)								2015 (projection)								
		Experiments	Days	Availability	Days/expt	Users	Users/expt	Unique users	Unique users/expt	Experiments	Days	Availability	Days/expt	Users	Users/expt	Unique users	Unique users/expt	Experiments	Days	Availability	Days/expt	Users	Users/expt	Unique users	Unique users/expt	
BDL-1	Bio-deuteration lab	1	7	4%	7.0		0																			
CG-1a		4	19	12%	4.8	48	12.0	14	3.5																	
CG-1b	Alignment Station	0	0	0%																						
CG-1c		0	0	0%																						
CG-1d	Imaging	20	67	41%	3.4	115	5.8	41	2.1	27	51	37%	1.9	93	3.4	54	2	20	68	42%	3.4	79	3.9	20	1.0	
CG-2	GP-SANS	65	146	90%	2.2	222	3.4	121	1.9	45	60	43%	1.3	102	2.3	93	2.07	61	138	85%	2.2	240	3.9	61	1.0	
CG-3	Bio-SANS	52	132	81%	2.5	191	3.7	86	1.7	45	96	69%	2.1	159	3.5	96	2.13	54	138	85%	2.5	212	3.9	54	1.0	
CG-4d	IMAGINE	0	0							0	0			0				12	138	85%	12.0	45	3.9	12	1.0	
CG-4c	CTAX	11	55	34%	5.0	35	3.2	7	0.6	24	129	93%	5.4	63	2.6	39	1.63	28	138	85%	5.0	108	3.9	28	1.0	
HB-1	Pol TAS	28	129	79%	4.6	86	3.1	31	1.1	27	84	60%	3.1	66	2.4	39	1.44	30	138	85%	4.6	117	3.9	30	1.0	
HB-1a	Fixed Ei TAS	34	151	93%	4.4	139	4.1	42	1.2	36	108	78%	3.0	84	2.3	36	1	31	138	85%	4.4	121	3.9	31	1.0	
HB-2a	Powder	49	150	92%	3.1	128	2.6	44	0.9	42	105	75%	2.5	96	2.3	54	1.29	45	138	85%	3.1	176	3.9	45	1.0	
HB-2b	Res Stress	8	44	27%	5.5	72	9.0	15	1.9	3	23	0	8	10	3	6	2	0	0	0%	0.0	0	0	0	0.0	
HB-2c	WAND	10	57	35%	5.7	25	2.5	10	1.0	12	90	65%	7.5	36	3	18	1.5	12	68	42%	5.7	47	3.9	12	1.0	
HB-3	TAS	25	146	90%	5.8	97	3.9	43	1.7	21	138	99%	6.6	36	1.7	24	1.14	24	138	85%	5.8	92	3.9	24	1.0	
HB-3a	4 Circle	25	116	71%	4.6	142	5.7	23	0.9	24	96	69%	4.0	48	2	18	0.75	30	138	85%	4.6	116	3.9	30	1.0	
		332	**1219**		**3.7**	**1300**	**3.9**	**477**	**1.4**	**312**	**1026**		**3.3**	**793**	**2.5**	**489**	**1.57**	**347**	**1380**		**4.0**	**1353**	**3.9**	**347**	**1.0**	

BL	Name	2012 Q1							
		Experiments	Days	Availability	Days/expt	Users	Users/expt	Unique users	Unique users/expt
BL-1a	MUSANS	0	0						
BL-1b	NOMAD	20	31	40%	1.6	65	3.3	38	1.9
BL-2	BASIS	16	66	86%	4.1	41	2.6	25	1.6
BL-3	SNAP	12	55	72%	4.6	26	2.2	21	1.8
BL-4a	MAGICS	16	55	72%	3.4	43	2.7	25	1.6
BL-4b	Liq Ref	18	45	59%	2.5	58	3.2	45	2.5
BL-5	CNCS	13	61	79%	4.7	35	2.7	24	1.8
BL-6	EQ-SANS	20	56	73%	2.8	53	2.7	38	1.9
BL-7	VULCAN	15	51	66%	3.4	75	5.0	57	3.8
BL-9	CORELLI	0	0	0%				0	
BL-10	VENUS	0	0	0%				0	
BL-11a	POWGEN	30	63	82%	2.1	77	2.6	47	1.6
BL-11b	MANDI	0	0	0%				0	
BL-12	TOPAZ	2	4	5%	2.0	5	2.5	5	2.5
BL-13	FNPB	1		0%		17	17.0	17	
BL-14b	HYSPEC	0		0%				0	
BL-15	NSE	3	35	46%	11.7	6	2.0	6	2.0
BL-16b	VISION	0	0	0%					
BL-17	SEQUOIA	16	54	70%	3.4	42	2.6	42	2.6
BL-18	ARCS	13	61	79%	4.7	40	3.1	40	3.1
		195	**637**		**3.3**	**583**		**430**	**2.1**

BL	Name	2012 Q1							
		Experiments	Days	Availability	Days/expt	Users	Users/expt	Unique users	Unique users/expt
BDL-1	Bio-deuteration lab								
CG-1a									
CG-1b	Alignment Station								
CG-1c									
CG-1d	Imaging	9	17	37%	1.9	31	3.4	18	2.0
CG-2	GP-SANS	15	20	43%	1.3	34	2.3	31	2.1
CG-3	Bio-SANS	15	32	69%	2.1	53	3.5	32	2.1
CG-4d	IMAGINE	0	0			0			
CG-4c	CTAX	8	43	93%	5.4	21	2.6	13	1.6
HB-1	Pol TAS	9	28	60%	3.1	22	2.4	13	1.4
HB-1a	Fixed Ei TAS	12	36	78%	3.0	28	2.3	12	1.0
HB-2a	Powder	14	35	75%	2.5	32	2.3	18	1.3
HB-2b	Res Stress	3	23	50%	7.7	10	3.3	6	2.0
HB-2c	WAND	4	30	65%	7.5	12	3.0	6	1.5
HB-3	TAS	7	46	99%	6.6	12	1.7	8	1.1
HB-3a	4 Circle	8	32	69%	4.0	16	2.0	6	0.8
		104	**342**		**3.3**	**271**	**2.6**	**163**	**1.6**