Brookhaven National Laboratory

SNS

Ring and Transfer Lines Systems

A U G U S T

MONTHLY REPORT

01 August – 31 August 2001

Performing Organization: Brookhaven Science Associates
Location: Brookhaven National Laboratory
Upton, New York 11973-5000

Contract Period: October 1998 – June 2006

Brookhaven National Laboratory
SNS MONTHLY PROGRESS REPORT
August 2001
Ring and Transfer Lines Systems

I. Senior Team Leader Assessment

1. TECHNICAL PROGRESS AND ACCOMPLISHMENTS

- The bids for 30Q ring quadrupole have been studied. An award will be reached in September.
- The bids for the median field power supply have been received.
- Teleconference among ORNL, LANL, and BNL diagnostics groups was conducted to clear the collaborative design and manufacturing on the SNS instruments.
- The BNL staff worked on the ASAC presentation and ETC estimates.

2. ISSUES AND ACTIONS

- None.

3. COST AND SCHEDULE STATUS

3.1 VARIANCE ANALYSIS AND PROJECT COST PERFORMANCE REPORTS

WBS 1.1.3 R&D

Variance Analysis (Cumulative to date) ($K)

BCWS	BCWP	ACWP	SV	%	CV	%
5043.9	5043.9	5021.7	0.00	0.0%	22.1	0.4%

Variance Statement: Cum variances are within thresholds. No analysis required. Current period CV of $94.5K (109.1%) is driven by a $18.6K credit to 1.1.3.4 Beam Scrapping and lowered ACWP to -$7.9K.

Project Impact: None.

Corrective Action: None.

WBS 1.5 Ring and Transfer Lines

BCWS	BCWP	ACWP	SV	%	CV	%
36698.4	32643.2	33889.7	(4055.2)	-11.1%	(1246.5)	-3.8%

Variance Statement: Cum schedule variance (SV) of -$4055.2K (-11.1%) is driven by 1.5.2, 1.5.3, 1.5.4, 1.5.5, and 1.5.7.

Project Impact: None.

Corrective Action: None

3.2 MILESTONE STATUS

WBS 1.5 and 1.1.3 have no level 0 milestones. Milestone status is listed below.

Milestones	Level 1	Level 2	Level 3	Level 4	Level 5
Project	1	2	8	13	161
FY01	0	0	0	4	24
Due in Next 30 days	0	0	0	0	3
Total Due at present	0	0	3	11	89
Made	0	0	3	11	82
Missed	0	0	0	1	7
Ahead of Schedule	0	0	0	1	0

3.3 PROJECT CRITICAL PATH ANALYSIS

The critical path for the Ring is the Diagnostic Instrumentation, specifically the BPM and IPM systems. The next area that is critical within the ring are the high field magnets, specifically the chromaticity sextupoles and the 30Q44/Q58 magnets.

II. Detail R&D Subproject Status

WBS 1.1.3 – Ring System Development

Variance Analysis (Cumulative to date) ($K)

BCWS	BCWP	ACWP	SV	%	CV	%
5043.9	5043.9	5021.7	0.00	0.0%	22.1	0.4%

Variance Statement: Cum variances are within thresholds. No analysis required. Current period CV of $94.5K (109.1%) is driven by a $18.6K credit to 1.1.3.4 Beam Scrapping and lowered ACWP to -$7.9K.

Project Impact: None.

Corrective Action: None.

III. Detail Line Item Subproject Status

WBS 1.5.1 – HEBT Systems

Work was completed on the first phase the materials cost and manpower effort estimate required to complete the BNL contribution to the SNS project. Preliminary descriptors defining BNL responsibility and handoff have been written.

Phone conferences continued with Tesla during the month except when they were on vacation. They have not potted the coils yet because of an error in there potting fixture design. They are rebuilt the potting fixture and are preparing to pot the first coil. Tesla has nearly completed machining the core steel for the first article magnet. The stands for the dipole magnets are being fabricated.

Danfysik has not provided a price for the trim coils yet. They have ordered steel and copper for the 12Q45 and 16CD20. They are working on fabrication drawings.

The 1st dipole chamber was received at RATS building in good condition. A non-disclosure agreement was signed between BNL and EVAC, the manufacturer of SNS quick-disconnect flange assemblies, allowing BNL access to EVAC drawings for QA inspection. Order for 8" pump tees was placed. Drawings for all 12cm quadrupole chambers, except those in doublets and at dumps, were generated. Detailed layouts of space adjacent to collimators and stripper foils were generated.

The revised collimator length and vacuum line components are in the process of being designed.

Variance Analysis (Cumulative to date) ($K)

BCWS	BCWP	ACWP	SV	%	CV	%
3514.4	3240.6	2717.6	(273.7)	-7.8%	523.0	16.1%

Variance Statement: Cum CV $523K (16.1%) is driven by 1.5.1.1 HEBT Magnets and Support; whereas procurement progress was acknowledged.

Project Impact: None.

Corrective Action: None.

WBS 1.5.2 – Injection Systems

Work was completed on the first phase the materials cost and manpower effort estimate required to complete the BNL contribution to the SNS project. Preliminary descriptors defining BNL responsibility and handoff have been generated.

The injection foil mechanism fabrication is continues. Most of the parts have been completed. Injection septum magnet fabrication has been approved and will begin next month.

The fabrication of the first article long injection kicker has begun. Two first article magnets will be assembled and tested: a long horizontal and a long vertical. The first article Ceramic Tubes with end cuffs have been ordered. The ferrite for the 1st article magnets is on order. Design of the short magnet is underway.

Variance Analysis (Cumulative to date) ($K)

BCWS	BCWP	ACWP	SV	%	CV	%
2428.2	1987.6	2387.1	(440.6)	-18.1%	(399.6)	-20.10%

Variance Statement: Cum SV of -$440.6K (-18.1%) is driven by 1.5.2.1 Pulsed Magnets SV -$261K and 1.5.2.5 Stripped Foil Mechanism SV -$122.9K, by late to start procurement. Cum CV of -$399.6K (-20.1%) is driven by WBS 1.5.2.2 Injection Kicker PS whereas actual costs were greater than planned due to the redesign of the PS (programmable).

Project Impact: None.

Corrective Action: None.

WBS 1.5.3 – Magnet Systems

Work was completed on the first phase the materials cost and manpower effort estimate required to complete the BNL contribution to the SNS project. Preliminary descriptors defining BNL responsibility and handoff have been generated.

The all of the cores for the ring dipole magnets were received from Allied Engineering. Coils have been installed in 20 of the cores and this assembly work continues. 1st article measurement of the first 1.3 GeV dipole with the Allied steel and the full end pole pieces is nearly complete.

Measurements of the prototype 21Q40 with and without a 1st article vacuum chamber were completed and analyzed. Improvements were made to the data acquisition program that is used to calibrate the first article test stations for all magnets. Plans were made for measuring coil modifications needed for the 26 cm and 30 cm quadrupoles and for large diameter corrector magnets.

Installation of the measuring coil for production measurements of the ring dipoles was nearly completed. The coil support stand was completed. The coil was mounted on the support stand and surveyed to establish the positions of the sense wires. The coil was then surveyed with respect to a ring dipole.

Phone conferences continued with Tesla during the month after they came back from vacation. Tesla shipped a slice of the pole tip to BNL for inspection. The discontinuities are due to a gap

in the Tesla machining program and will be corrected. Overall the schedule continues to slip on there end with the first magnet scheduled for shipping now by the end of September. Dr. Beggs has been contacted about accelerating the production schedule.

Danfysik completed the first 27CDM30 magnet and shipped it. The quality of the epoxy potting was poor and Danfysik agreed that this will not be a first article magnet. Instead it is being called a preproduction magnet with no charge to BNL. Electrical measurements and a heat run were successfully completed. The magnet is being set up on the magnet measurement stand.

The fabrication of the steel for the 21CS30 and 21CO30 sextupole and octopole corrector magnets is underway at New England Technicoil. They estimate delivery of a first article magnet in October.

The contract for the first article 26Q40 magnet was award to Stangenes. Stangenes and their machine shop subcontractor, Quest, were visited during the month. The drawings were reviewed and Quest had machined a sample pole tip profile. As a result two ECN's were generated to change the location of the trim windings on the magnet coil and to define the pole tip profile geometrically.

The bids for the 30Q44/30Q56 were received. There is a delay in reviewing the bids and awarding the contract because all of the bids were not complete. The drawings for the 41CD30 are 95% complete and will be sent for checking in September. The detailed design of the 21S26 high field sextupole has begun.

Variance Analysis (Cumulative to date) ($K)

BCWS	BCWP	ACWP	SV	%	CV	%
5440.4	4538.0	6782.0	(902.4)	-16.6%	(2244.0)	-49.4%

Variance Statement: Magnet System has a cum SV of -$902.4K (-16.6%) and is driven by 1.5.3.1 High Field Magnets, 30Q44/Q58 Magnet Assy & Test and 1.5.3.2 Low Field Magnets, 41CD30 Corrector Procurement, whereas BCWS is greater than BCWP, Magnet Systems has a cum CV of -$2244K (-49.4%) and is driven by 1.5.3.1 High Field Magnets whereas ACWP for purchased material is greater than BCWS. FY01 BCWS does not reflect FY00 authorized material purchases received and paid for in FY01. Current period SV -$362.4K (-69.7%) & CV -$522K (-330.6%) are driven by 1.5.3.1 High Field Magnet 30Q44/58 Mag Assy & Test of 1st Article and 1.5.3.2 Low Field Magnet 41CD30 Correctors Procurement.

Project Impact: None.

Corrective Action: None.

WBS 1.5.4 – Power Supply Systems

Work continues on the medium power supply purchase order.

Variance Analysis (Cumulative to date) ($K)

BCWS	BCWP	ACWP	SV	%	CV	%
1777.0	982.2	549.0	(794.8)	-44.7%	433.2	44.1%

Variance Statement: Power Supply Systems with cum period SV -$794.8K (-44.7%) and a cum period CV $433.2K (44.1%) are driven by WBS 1.5.4.1 Ring Quadrupole PS Procure and 1.5.4.2 Ring Low Field PS, respectively. Current period SV -$420.1K (-91.8%) is driven by 1.5.4.1 Quadrupole PS & 1.5.4.2 Low Field PS whereas vendor procure under performed. Current period CV $21.6K (57.4%) is driven by 1.5.4.2 Low Field PS Type A.

Project Impact: None.

Corrective Action: None.

WBS 1.5.5 – Ring Vacuum System

The magnet measurement group has tested the dipole and quadrupole chambers for their effect on magnetic field and found to be negligible. The welding fixture for halfcell chambers has been set up at Bldg. 820 and is being aligned by Survey Group. The 2nd dipole chamber arrived and is being measured by Survey Group. All the pump screens were received in house.

The 1st article ion pumps were received and are being evaluated. The diode pump has passed base pressure and outgassing tests. The measured pumping speed is approximately 20% less than that of the specification. The specification, SOW, system schematic and wiring diagrams for turbomolecular pump cart were revised and forwarded to PO for review and comment. The RFQ for ion pump controllers was released to two potential vendors with the bids due at mid September.

Work on setting up halfcell chamber production coating continues with installation of support stand and bellows restraint. The Ti cathode has been bent to dipole chamber contour. The coating thickness along the length of the ceramic tube was measured with 4-probe meter and found to be very thin in the middle. More tests with conductive masks are being prepared to improve the thickness uniformity. Method of fabricating a gold cathode is being explored. The impedance measurement of the coated ceramic tube was inconclusive due to noise at low frequency.

A lot of effort was dedicated to complete the Estimate-To-Complete (ETC) for vacuum systems.

Variance Analysis (Cumulative to date) ($K)

BCWS	BCWP	ACWP	SV	%	CV	%
2430.2	1984.6	2467.6	(445.6)	-18.3%	(483.0)	-24.3%

Variance Statement: Vacuum Systems has a cum SV of -$445.6K (-18.3%) and CV of -$483K (-24.3%) are driven by 1.5.5.1 Evac CFX Flange, & 1.5.5.3 Ring Gate Valves. Current period SV -$228.7K (-72.8%) and CV -$22.7K (-26.5%) are impacted by the same issues and WBS activities as the cum variances.

Project Impact: None.

Corrective Action: None.

WBS 1.5.6 – RF System

Finished the estimate to completion. Continued work on high and low level RF systems.

Accelerator physics: continued stability analysis and prepared for ASAC.

Variance Analysis (Cumulative to date) ($K)

BCWS	BCWP	ACWP	SV	%	CV	%
4319.3	4019.1	3781.1	(300.1)	-6.9%	238.1	5.9%

Variance Statement: Variances are within thresholds. No analysis required.

Project Impact: None.

Corrective Action:

WBS 1.5.7 – Ring Diagnostics

PUE machining for all SNS BPMs has been released to the shops. Flange material for all BPMs was sent out for annealing. Remaining material for all BPMs has been delivered to shops. NC programming is in progress. Quantities of Ring BPMs have been increased to provide PUEs for spare vacuum chambers.

Unexpected ringing has been observed in RHIC IPMs. Efforts to understand and remedy this are in progress. Magnet design is in progress.

Prototype single channel BLM AFE board has been designed, produced and stuffed. Initial testing is in progress. Preliminary results are good. Different packaging models of the OPA627 were evaluated to determine which is best for input guarding issues. Four additional BLMs were installed in the RHIC Ring near the RF cavities to evaluate X-Ray sensitivity.

Testing of BCM prototype AFE and digitizer continues. Comparison of protected amplifier circuits is in progress.

Preliminary evaluation of MEBT carbon wire scanner actuator position and repeatability was completed. Drawings for the five final actuators have been released to the shops.

Purchased parts for the MEBT Laser Wire are in house. Machined parts are in the shops. Laser wire for Linac tunnel installation at 200 MeV is nearing completion. Optics alignment is complete, with a 2 inch scanning travel with no loss of laser intensity in both X and Y. Stepping motor wiring is complete and ready for controls testing. During a tunnel access cables for the stepping motors, controls and signals were pulled and connectorized. New final optics have been worked out to give a long narrow line focus parallel to the ion beam. This is to lower the power density on the beam stop, as well as increasing ionization efficiency and improving profile resolution. Preparations are underway for a presentation to ASAC.

Variance Analysis (Cumulative to date) ($K)

BCWS	BCWP	ACWP	SV	%	CV	%
4483.0	3989.6	3741.3	(493.4)	-11.0%	248.3	6.2%

Variance Statement: Ring System Diagnostics Instrumentation has a cum SV of -$493.4 (-11.0%) and is driven by 1.5.7.6 Wire Scanner, SV -$250.4K; Current period SV $305.1K (97.7%) and CV $476.4K (77.2%) is driven by 1.5.7.1 Beam Position Monitor and 1.5.7.6 Wire Scanner.

Project Impact: None.

Corrective Action: None.

WBS 1.5.8 – Collimation and Shielding

The scraper system of the primary collimator is being designed.

Modifications tot he prototype shield are still being carried out.

Variance Analysis (Cumulative to date) ($K)

BCWS	BCWP	ACWP	SV	%	CV	%
1050.0	1002.8	1115.1	(47.1)	-4.5%	(112.3)	-11.2%

Variance Statement: Collimation and Shielding has a cum CV of -$112.3K (-11.2%) and is driven by 1.5.8.2 Moveable Shielding CV -$106.8K. Current period CV $11.9K (18.6%) is driven by Ring Collimator and Shielding.

Project Impact: None.

Corrective Action: None.

WBS 1.5.9 – Extraction System

Work is underway for updating the materials cost and manpower effort required to complete the BNL contribution to the SNS project. A preliminary descriptor defining BNL responsibility and handoff is being generated.

The assembly of the prototype extraction kicker is was completed. The magnet was assembled in stages so impedance measurements can be made with various configurations of the ferrite, bus bar, and figure eight shorting assembly. The impedance measurements continue.

Effort continues on revising the layout of the extraction region and the RTBT line to take into account the roll of the lambertson magnet. A redesign that eliminates a need for the vertical dipole correction from a dipole corrector magnet continues.

Variance Analysis (Cumulative to date) ($K)

BCWS	BCWP	ACWP	SV	%	CV	%
988.4	699.8	774.7	(288.6)	-29.2%	(74.8)	-10.7%

Variance Statement: Extraction System with a cum SV of -$288.6K (-29.2%) is driven by WBS 1.5.9.2.2 Charging Power Supply Procure. Cum CV of -$74.8K (10.7%) is also driven by 1.5.9.2 Extraction Kicker Power Supply. Current period SV -$45K (-58.2%) is driven by 1.5.9.2.2 Charging Power Supply. Current period CV is driven by 1.5.9.2 Extraction Kicker Power Supply.

Project Impact: None

Corrective Action: None.

WBS 1.5.10 – RTBT System

Work is underway for updating the materials cost and manpower effort required to complete the BNL contribution to the SNS project. A preliminary descriptor defining BNL responsibility and handoff is being generated.

Fabrication of the fixtures for winding the solid radiation resistant bus (for the 41CD30 correctors) continues. The ETC for the RTBT used a 30Q58 quadrupole in place of the first 36Q80 quadrupole at the end of the line. 3D computer field analysis is being done on the 36Q40 magnet to determine the best design of the radiation resistant coils. Saddle coils with are being considered for use. Because the radiation resistant coil material comes in fixed lengths and spicing the coils is not an option coil material for the quadrupole will not be ordered until the coil shape is defined.

The beam window analysis and design for the Linac and Extraction Dumps continued. A video-conference with ORNL to review has not been scheduled because of scheduling conflicts with many of the participants. It will be rescheduled.

The design of RTBT vacuum system continues with effort focused at extraction region.

Negotiations with the winning vendor to construct the first article are still being carried out. The inner shield box and cooling system is being designed.

Variance Analysis (Cumulative to date) ($K)

BCWS	BCWP	ACWP	SV	%	CV	%
1597.0	1545.5	1160.7	(51.5)	-3.2%	384.8	24.9%

Variance Statement: RTBT System has a cum CV of $384.8K (24.9%) and is driven by 1.5.10.5 RTBT Collimator & Shielding whereas labor is under performing the plan. Current period SV of -$45.6K (-34.4%) is driven by 1.5.10.5 RTBT End of Line. Current period CV of $34.8K (39.9%) is driven by 1.5.10.1 RTBT Magnet & Support whereas labor is under performing the plan.

Project Impact: None.

Corrective Action: None.

WBS 1.5.12 – Technical Support

Kicker Measurements:

- Kicker impedance measurements with and without YY loop were completed and measurement inside vacuum chamber continued.

Space Charge Study:

- Group studying several important issues related to space-charge limit in a Ring
  1. Coherent resonance crossing.
  2. Beam loss models for various working points. Space-charge experiments at LANL PSR.

Code Developments:

- Benchmarking of the scattering algorithms in ORBIT against K2. Correction of coupling globally and locally for the baseline lattice.

End-to-End Simulation:

- One set of ideal distribution tracking completed from RFQ to the target.

Variance Analysis (Cumulative to date) ($K)

BCWS	BCWP	ACWP	SV	%	CV	%
8641.4	8641.4	8412.8	0.0	0.0%	228.6	2.6%

Variance Statement: Variances are within thresholds. No analysis required.

Project Impact: None.

Corrective Action: None.

WBS 1.9.1 – R&D

WBS 1.9.2.2 – Global Timing

The V124s timing slave module was submitted to drafting to correct several layout errors in preparation for the production run. All layout errors except one have been corrected and reviewed. The final layout will be reviewed in September and a new prototype will be built and tested prior to the production run. Changes suggested at the final design review have been incorporated into the module design. These changes did not require artwork changes. We will go out for bids on the production run sometime in late September or early October.

After the new prototype is completed we will decide if a small quantity of pre-production modules need to be built to satisfy early needs.

V123s

There has been very little activity on this since the engineer is on an extended vacation until the end of September. At that time, the final PCB changes will be made for the two production modules that are to be delivered.

A prototype eventlink master and RTDL master remain set up in the SNS controls lab for driver development.

WBS 1.9.2.2 –Timing Software

Event Timing System:

We are working on the event system software (beta release for event master is nearly complete). We received a prototype V124s slave module for software development.

RTDL System:

The beta version of RTDL master software was released. The software is available on the WEB and is CVS checked into the ORNL CVS repository. We are waiting for the Utility module to do RTDL integration testing.

WBS 1.9.5.1 -Ring Controls Integration

Installation and testing of CapFast for Linux has been completed on BNL Linux host.

The VME address mapping issue (reported in my Jun3, 2001 Status Report) has been resolved.

A Linux version of CapFast was installed last month. It will be used for the power supply application.

SNS WEB page at BNL.

A new WEB page for the BNL SNS project was designed. The new Page has two frames. The left frame is the index of contents , the right frame is an SNS overview with an image of HEBT, Ring and RTBT with hotspots on it. It is being tested and will be installed soon. New items are being added to the Web and include SNS Lattice data, parameter lists, PAC01 conference papers, links to other useful sites.

WBS 1.9.5.2 - Power Supply Controls

PSI:

Apogee delivered 22 PSI boards. We are in the process of setting up in the lab at least a dozen units so we can test the PSC boards with a full complement of PSI's attached. We still

have a bug in the PSC related to the detection of timeout errors. Delivery of a few PSC boards is expected in the first part of September.

Ethernet Digitizer & Function Generator:

Engineering looked at the function generator output to determine the cause of noise observed on the output. By putting a filter on the output bandwidth there was significant reduction in the noise. Only a few kHz bandwidth is needed and the output filter tested was 100KHz. It was decided that the function generator met the system requirements with the filter. We are still looking for a Japanese translator to help in translating the comments in the source code we received from Yokogawa.

Power Supply Application:

A method has been implemented to automate the generation of IOC database and operator screen components from configuration tables. This will facilitate building instances of the application for different groups of power supplies. The method uses optional EPICS make system features that fetch configuration information from Perl scripts. These scripts can be customized to get the information from simple tables or from other sources such as a centralized configuration database.

An instance of the application has been built using the group of power supplies from the SNS HEBT. It will be used to test the first fully configured power supply controls IOC as soon as the hardware components are available. A sample configuration report giving the IOC name, location and the list of client power supplies has been generated.
The current version of the application has been tested in the Linux development environment. Further development and testing will be carried out under Linux.

WBS 1.9.5.3 – Diagnostics

Vacations and work on the ETC slowed our progress on the BLM ICD. The controls group is assisting the diagnostics group by setting up a PC with motor control hardware and software for Laser wire testing.

WBS 1.9.5.4 - Vacuum

We completed the ETC for the Vacuum system last month. We are waiting for the selection of the vendors to supply the vacuum controllers and gauges before continuing with the Vacuum software.

WBS 1.9.5.5 - Application Software

SNS Application Toolkit.

Provided intensive consultations for the SNS application team about the UAL 2.0 structure and applications.

Evaluated several UML (Unified Modeling Language) modeling tools (Describe http://www.embarcadero.com, Poseidon http://www.gentleware.com/ etc.) and the UML report generated by Chris Allen from the UAL 2.0 Java classes.

Implemented several SNS sample Java applications illustrating the usage of the UAL 2.0

Application Toolkit. Implemented several Jython (Java Python http://www.jython.org) scripts illustrating the rapid development environment of SNS applications.

WBS 1.9.5.6 – RF

Except for the ETC here was no work done on the RF this month. The RF group has requested an Epics development system for training purposed and is expected to start working with the controls group soon.

IV. Earned Value Reports and Charts

U.S. DEPARTMENT OF ENERGY
COST PERFORMANCE REPORT - WORK BREAKDOWN STRUCTURE (FORMAT 1)

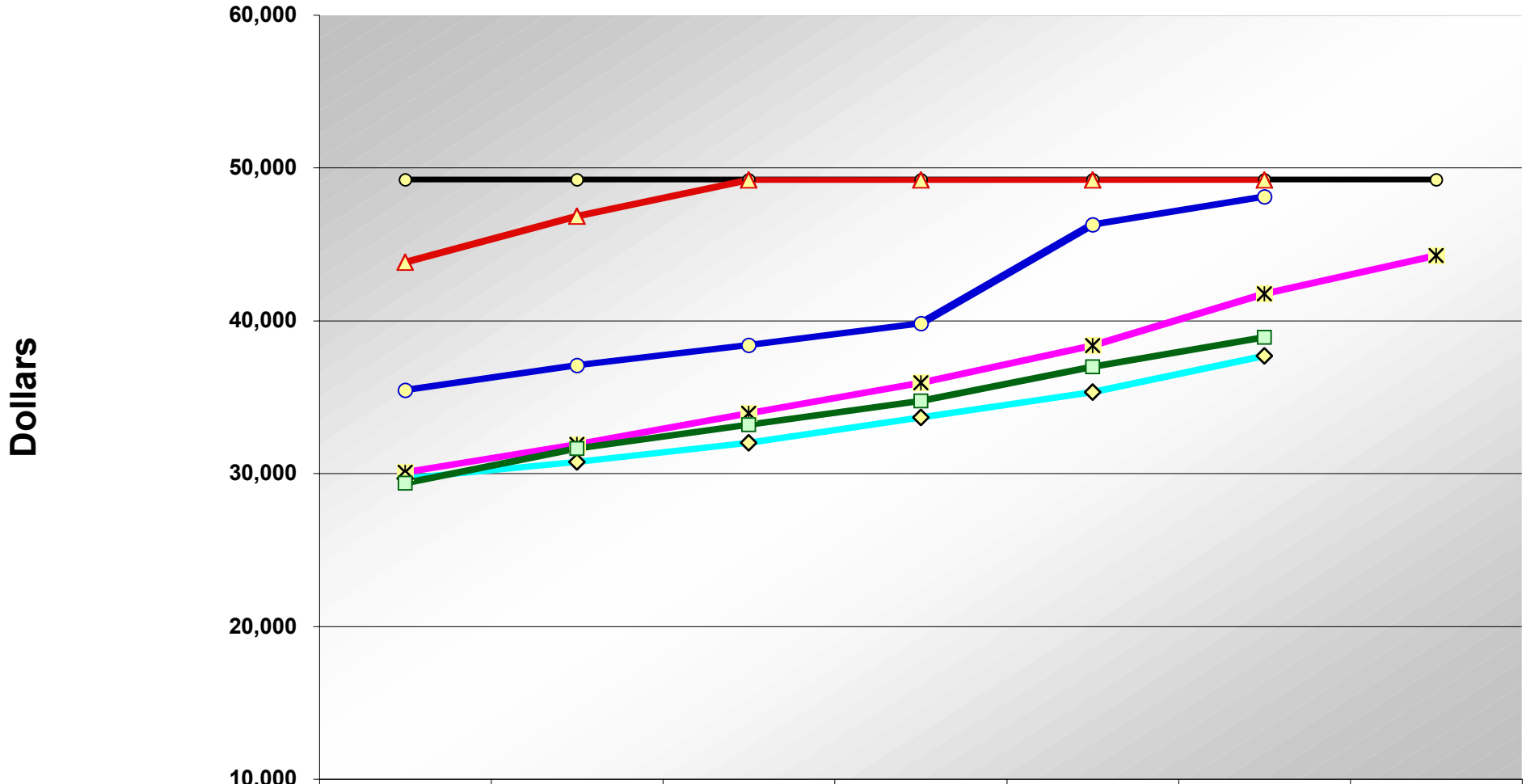
PROJECT TITLE: SPALLATION NEUTRON SOURCE	**REPORTING PERIOD:** 1-Aug-01 thru 31-Aug-01	**PROJECT NUMBER:** 99-E-334
		START DATE: October 1998
PARTICIPANT NAME AND ADDRESS: Brookhaven National Laboratory Brookhaven, NY	**BCWS PLAN DATE:** October 1999	**COMPLETION DATE:** November 2006

WORK BREAKDOWN STRUCTURE	CURRENT PERIOD					CUMULATIVE TO DATE					AT COMPLETION		
	Budgeted Cost		Actual Cost	Variance		Budgeted Cost		Actual Cost	Variance				
	Work Scheduled	Work Performed	of Work Performed	Schedule	Cost	Work Scheduled	Work Performed	of Work Performed	Schedule	Cost	Budgeted	Revised Estimate	Variance
1.1.3 Rings System Development	86.6	86.6	(7.9)	0.0	94.5	5,043.9	5,043.9	5,021.7	0.0	22.1	5,115		
1.5 Ring & Transfer Line System	3,208.8	2,263.7	1,928.0	(945.1)	335.7	36,698.4	32,643.2	33,889.7	(4,055.2)	(1,246.5)	123,312		
1.5.1 HEBT (High Energy Beam Transport) Systems	354.4	360.3	308.0	6.0	52.3	3,514.4	3,240.6	2,717.6	(273.7)	523.0	10,639		
1.5.2 Injection Systems	321.1	38.1	123.9	(283.0)	(85.8)	2,428.2	1,987.6	2,387.1	(440.6)	(399.6)	9,233		
1.5.3 Magnet Systems	520.4	157.91	679.9	(362.4)	(522.0)	5,440.4	4,538.0	6,782.0	(902.4)	(2,244.0)	16,357		
1.5.4 Power Supply System	457.7	37.6	16.0	(420.1)	21.6	1,777.0	982.2	549.0	(794.8)	433.2	5,779		
1.5.5 Vacuum System	314.3	85.6	108.3	(228.7)	(22.7)	2,430.2	1,984.6	2,467.6	(445.6)	(483.0)	11,404		
1.5.6 RF System	295.1	435.6	179.6	140.4	256.0	4,319.3	4,019.1	3,781.1	(300.1)	238.1	13,049		
1.5.7 Ring Systems Diagnostic Instrumentation	312.4	617.5	141.0	305.1	476.4	4,483.0	3,989.6	3,741.3	(493.4)	248.3	16,102		
1.5.8 Collimation and Shielding	62.0	64.0	52.2	2.0	11.9	1,050.0	1,002.8	1,115.1	(47.1)	(112.3)	2,740		
1.5.9 Extraction System	77.3	32.3	46.0	(45.0)	(13.7)	988.4	699.8	774.7	(288.6)	(74.8)	5,965		
1.5.10 RTBT (Ring to Target Beam Transport) System	132.8	87.2	52.4	(45.6)	34.8	1,597.0	1,545.5	1,160.7	(51.5)	384.8	8,099		
1.5.11 Cable	13.8	0.0	0.0	(13.8)	0.0	29.3	11.9	0.8	(17.4)	11.2	2,817		
1.5.12 Technical Support	347.5	347.5	220.7	0.0	126.9	8,641.4	8,641.4	8,412.8	0.0	228.6	21,127		
WBS SUBTOTAL	3,295.4	2,350.3	1,920.1	(945.1)	430.2	41,742.3	37,687.1	38,911.4	(4,055.2)	(1,224.4)	128,428		
UNDISTRIBUTED BUDGET													
SUBTOTAL	3,295.4		1,920.1			41,742.3		38,911.4			128,428		
MANAGEMENT RESERVE													
TOTAL	3,295.4		1,920.1			41,742.3		38,911.4			128,428		

RECONCILIATION TO CONTRACT BUDGET BASE

DOLLARS EXPRESSED IN: THOUSANDS	SIGNATURE OF PARTICIPANT'S PROJECT DIRECTOR: Bill Weng	DATE: September 27,2001

1.5 & 1.1.3 Performance Measurement Chart



	Mar	Apr	May	Jun	Jul	Aug	Sep
Cum Planned BA	49,225	49,225	49,225	49,225	49,225	49,225	49,225
Cum Authorized BA	43,813	46,840	49,201	49,201	49,201	49,201	
Cum Actual BA	35,448	37,075	38,414	39,832	46,275	48,106	
Cum BCWS	30,058	31,894	33,931	35,946	38,373	41,742	44,275
Cum BCWP	29,666	30,764	32,013	33,661	35,337	37,687	
Cum ACWP	29,359	31,615	33,196	34,736	36,991	38,911	

Months