



Brookhaven National Laboratory

SNS

Ring and Transfer Lines Systems

DECEMBER

MONTHLY REPORT

01 December – 31 December 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
December 2001
Ring and Transfer Lines Systems

I. Senior Team Leader Assessment

1. TECHNICAL PROGRESS AND ACCOMPLISHMENTS

- There are 6 completed half-cell assembly of the SNS accumulator ring, out of 32 required. One of them has been successfully Ti-N coated and vacuum leak checked.
- The high power test of the first article ring RF station has reached its full field of more than 10 KV. Additional test is underway for the dynamic tuning and life time reliability.
- BNL has delivered the first scanning wire profile monitor system to LBNL for the MEBT beam line. 5 more units will be delivered in January.
- BNL engineer visited vendor, SDMS, for the progress on the RTBT collimator system. It was on schedule and would produce first collimator tube in February.
- The handoff agreement between BNL and ORNL has been finalized. More detailed testing procedures and the cognizant engineers will generate acceptance criteria. A MOA governing collaboration after handoff will be generated for final approval in January.
- The SNS project office and the ASD visited BNL to discuss plan for finding new STL for the ring system and procedures for transition in couple of months.

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)

<u>BCWS</u>	<u>BCWP</u>	<u>ACWP</u>	<u>SV</u>	<u>%</u>	<u>CV</u>	<u>%</u>
5045.7	5045.7	5039.2	0.00	0.0%	6.5	0.1%

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

Project Impact: None.

Corrective Action: None.

WBS 1.5 Ring and Transfer Lines

<u>BCWS</u>	<u>BCWP</u>	<u>ACWP</u>	<u>SV</u>	<u>%</u>	<u>CV</u>	<u>%</u>
41060.7	41913.9	41180.9	853.2	2.1%	733.0	1.7%

Variance Statement: Cum variances are within thresholds. No analysis required.

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	0	1	3	13	129
FY02	0	0	0	0	27
Due in Next 30 days	0	0	0	0	5
Total Due at present	0	0	3	12	89
Made	0	0	3	11	84
Missed	0	0	0	1	5
Ahead of Schedule	0	0	0	0	0

3.3 PROJECT CRITICAL PATH ANALYSIS

The critical path items for the Ring are the Ring Sextupole magnet, followed by the BCM and wire scanner for the MEBT.

II. Detail R&D Subproject Status

WBS 1.1.3 – Ring System Development

All work covered by R&D funds is essentially complete except for some material commitments.

Variance Analysis (Cumulative to date) (\$K)

BCWS	BCWP	ACWP	SV	%	CV	%
5045.7	5045.7	5039.2	0.00	0.0%	6.5	0.1%

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

Project Impact: None.

Corrective Action: None.

III. Detail Line Item Subproject Status

WBS 1.5.1 – HEBT Systems

Phone conferences continued with Tesla during the month on the HEBT dipole magnet. ORNL completed a round of field measurements and approved the HEBT dipole for fabrication. ORNL is making one revision to the design to add two 1 1/2” lifting holes for the magnet on the top plate. ORNL owns the drawing package so they will make the drawing changes. At this time ORNL/BNL are struggling with the native drawing files. This will be resolved shortly. The HEBT dipole stands have been shipped to ORNL.

Phone conferences continued with Danfysik during the month. Danfysik moved the delivery date for the 12Q45 quadrupole magnet and the 16CD20 corrector to 2/15/02. They have machined the first pole tip profile for the 12

Requisitions for 12cm vacuum components have been generated and will be released after the drawings are checked. The welding fixture for 21cm quadrupole chamber is being designed and the mounting flanges ordered. The traveler for the first article dipole chamber has been completed and sent to ASD. A HEBT collimator review was held resulted in changes to the quadrupole beam pipe length, the movable shielding and foil mechanism downstream the collimator.

Integration of the absorber, scraper, and adjacent quadrupoles is continuing. In addition, the effect of a shortened absorber is being estimated.

Variance Analysis (Cumulative to date) (\$K)

BCWS	BCWP	ACWP	SV	%	CV	%
3569.0	3582.3	3497.4	13.3	0.4%	84.9	2.4%

Variance Statement: Cum variances are within thresholds. No analysis required.

Current period cost variance (CV) \$84.9K (50.8%) is BCWP driven by the procurement of HEBT Dipole Chamber Beam; Pipe Assy and Gate Valves.

Project Impact: None.

Corrective Action: None.

WBS 1.5.2 – Injection Systems

The two open C magnets for the foil mechanism area are being revised to modify the field shaping pole tips that run the length of the magnets. The drawings for those two magnets and the first chicane magnets should be complete by the end of January. The fabrication of the injection septum magnet continues – delivery of the parts is scheduled for the end of January. The

redesign of the dump septum magnet continues. A PCR for the spare injection septum magnet and spare coils for the last chicane magnet was submitted and awaits approval by the project office.

The injection foil mechanism still awaits the delivery of the rotary feedthroughs. The base support plate fabrication has been approved.

The fabrication of the first article long injection kicker components is complete. Ferrites have been delivered and they are being inspected. One ferrite size will be returned because it is missing a chamfer. About 1/2 of the ferrite has been received from Ceramic Magnetics. Everson Electric has wound and potted the first article coils; they are doing final inspection and testing prior to shipping. Ceramaseal has revised the delivery date of the ceramic chamber to 2/26/02. The revised short injection kicker design work continues.

Variance Analysis (Cumulative to date) (\$K)

BCWS	BCWP	ACWP	SV	%	CV	%
2905.0	3070.8	3041.3	165.7	5.7%	29.5	0.96%

Variance Statement: Cum variances are within thresholds. No analysis required.

Current period schedule variance (SV) \$165.7K (155.6%) is BCWP driven by the procurement of Ferrite Blocks 1st delivery.

Project Impact: None.

Corrective Action: None.

WBS 1.5.3 – Magnet Systems

The seventh ring dipole (17D120) is on the measuring stand. The sixth magnet had a slightly different integrated field than the previous magnets. At this time there is no correlation to the lot number or dimensions that would indicate a cause. There was some work done on the measurement electronics and that will be reviewed. Worst case – one of the previous magnets will be measured again for results comparison. No measurements were done during the Holiday period.

Phone conferences continued with Tesla during the month on the 21Q40 quadrupole magnet. Fabrication of the next four magnets continues with shipment scheduled for the end of January.

Design of the fixtures that will hold the remaining ring magnets in the magnetic measurement facility continued. BNL Central Shops continued work on the two measuring coil forms needed for the larger aperture magnets.

Detailed design of the 1/2 cell assembly continues. Right and left hand details of the quadrupoles are being designed. The dipole magnet water-cooled bus that runs along the π cells in the arcs is being designed. The water lines for the quadrupole magnets have been defined on the first unit and are being made up. The 1/2 cell-lifting fixture for the ring has been approved for fabrication.

Danfysik continued on the production of the 27CDM30. They have started winding coils and they are preparing to pot the first coil with the new mold. Completion of the first production lot is still scheduled for January.

The first article 21CS30 and 21CO30 sextupole and octopole corrector magnets acceptance testing continues. The testing procedures and inspection documentation provided by the manufacturer were in place at the time of receipt of the product. The 21CS30 was magnetically tested. The testing verified the mechanical measurement that the pole tip location is out of tolerance. The magnet was packed up and shipped back to NE Technicoil for realignment of the pole tips. The calculations for the 21CS30 were repeated to determine if the weight of the magnet could cause the out of alignment condition. The results indicate that this is not the case and they were verified with the 21CO30 measurements. The 21CO30 is being set-up for magnetic measurement. Initial mechanical measurements indicate much better alignment of the pole tips.

A visit to review progress on the 26Q40 contract was made to Stangenes Industries and their subcontract Quest Machining by a joint BNL/ORNL team. The 26Q40 quadrupole steel has been machined but has not been aligned yet. The coils are being wound. Delivery of first article 26Q40 quadrupole is now scheduled for January 31, 2001. Progress seen during the visit indicated that they would meet or beat that delivery date.

Budker Institute of Nuclear Physics (BNIP) continues to suggest changes on the 30Q44/30Q56 magnet design. BNIP had sent 32 e-mails in three weeks and 29 replies were returned. They have not provided a detailed schedule yet – this is the first deliverable required by the purchase order. They have also not provided a sample pole tip yet – the second deliverable required by the purchase order. A large effort was expended in getting a purchase order in place with SGS Vostok, Ltd. to provide inspection and surveillance services on the BNIP procurement. The ongoing effort on this procurement indicates that it will be high maintenance procurement from a Quality Assurance standpoint. Coordinating the initial visits by SGS took a bit of time but the reports and pictures that were sent by SGS personnel gave BNL & SNS personnel the necessary information especially with respect to the steel. The steel for these magnets will come from an existing lot of steel purchased by BNIP more than a year ago. Concerns noted in the report and in an e-mail to Budker are a Quality Assurance Plan for the procurement especially on the travelers that will be used in processing and how and who will perform the ultrasonic inspection. We also await documentation on the annealing of the steel. These concerns have been relayed to Budker and will be reviewed during follow-on visits by SGS.

The bid package for the 41CDM30 was sent out – bids are due on 1/04/02.

The detailed design of the 21S26 high field sextupole continues though time was lost because the designer was temporary reassigned. The design of the 36CDM30 corrector is continues.

PCR's were submitted for spare magnets and to update costs as a result of actual contract prices. They await approval by the Project Office.

Variance Analysis (Cumulative to date) (\$K)

BCWS	BCWP	ACWP	SV	%	CV	%
7898.6	7853.3	7836.1	(45.3)	-0.6%	17.2	0.2%

Variance Statement: Variances are within thresholds. No analysis required

Project Impact: None.

Corrective Action: None.

WBS 1.5.4 – Power Supply Systems

Medium Range Supplies: The design review for the first six models of power supplies has been set for February 12 & 13, and the second six models of power supplies for March 26 & 27. These dates are not only consistent with the production scheduling of the medium range power supplies, but are good monitor points for the progress of the new circuitry for the injection kicker first article.

Injection Kicker First Article: Computer simulations and discussions between the vendor and BNL have given us confidence with the vendor's solution of using a regenerative circuit, capacitor bank, and auxiliary power supply to improve low voltage performance. Progress will be monitored at the vendors facility during the time of the medium range power supply reviews.

Main Dipole Power Supply: The first of two design reviews with ORNL was held on December 13. This presented the mechanics of the RFP, and how the vendors will be requested to support the installation and commissioning of the main dipole power supply. The second design review will be held in January, shortly after specification is completed.

Low Field Corrector Power Supplies: A vendor representative visited BNL on December 2. Based on those discussions, design changes were made, most notably changing the input line power from single phase 120 VAC to three phase 208 VAC. The prototype was modified at the vendor's facility, and operated at full power, 1500 Watts, successfully. First article testing at the vendor's facility is set for February 27 through 29.

Variance Analysis (Cumulative to date) (\$K)

BCWS	BCWP	ACWP	SV	%	CV	%
839.3	840.3	847.7	1.0	0.1%	(7.4)	-0.9%

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

Project Impact: None.

Corrective Action: None.

WBS 1.5.5 – Ring Vacuum System

Seven dipole chambers were received from vendor SDMS this month. Two more type A halfcell (HC) chambers were welded and leak checked, bringing the total completed HC chambers to six. Pump down and outgassing measurements of the HC chamber continue. The design of the injection straight section doublet chambers has been completed and the drawings are under checking. The design of the RF straight section doublet chambers has started. Some Conflat shipping flanges for HC chambers have arrived

Uniform TiN coating was obtained on the 1st HC chamber after modification to the nitrogen distribution line, gas flow and installation of additional Residual Gas Analyzer (RGA). Titanium coating of the ceramic chambers with 2-wire and 4-wire anode shields were carried out, better results were obtained with 4-wire shield.. The 1.5” copper tubing and wire mesh for the development of ceramic chamber coating have arrived.

Two first article ion pump controllers (IPC) were accepted after passing incoming inspection. The production lot order has been awarded to Varian Vacuum Products. The IPCs are set up at vacuum control test bed for software development. The bids for gauges and gauge controllers are being evaluated and the low bidder contacted for revised pricing before releasing the 1st article order. The turbopump cart (TMP) RFQ was released in early Dec. to five potential vendors. The bid due date was extended to 2nd week of January.

The IPC vendor was visited to review their production plan as well as assessing their manufacturing capacity for upcoming turbopump station RFQ.

Variance Analysis (Cumulative to date) (\$K)

BCWS	BCWP	ACWP	SV	%	CV	%
3054.9	3165.1	3009.6	110.1	3.6%	155.5	4.9%

Variance Statement: Cum variances are within thresholds. No analysis required.

Current period schedule variance (SV) \$110.1K (79.7%) and CV \$155.5K (62.6%) is BCWP driven by the procurement of Ring Ion Pump PS final delivery.

Project Impact: None.

Corrective Action: None.

WBS 1.5.6 – RF System

- For low level RF, the problem of through put and delay in the system are under detailed study. Specifications of available DSPs are being used to find suitable candidates.
- For high level RF, test of dynamic tuning continued.
- Initial specifications for the TiN kicker coating were made.

Variance Analysis (Cumulative to date) (\$K)

BCWS	BCWP	ACWP	SV	%	CV	%
4502.1	5128.4	4711.8	626.4	13.9%	416.6	8.1%

Variance Statement: Cum schedule variance (SV) of \$626.4K (13.9%) is driven by 1.5.6.1 and early delivery of material for RF Cavities and Amplifier. Current period variances are the result of early material deliveries as well.

Project Impact: None.

Corrective Action: None.

WBS 1.5.7 – Ring Diagnostics

We are in production on Ring and HEBT 21cm BPM PUEs. All parts have been received from the shops. PUEs are being assemble in lots of 8 and shipped out for brazing, then undergoing final assembly and electrical and leak checks before delivery to the Vacuum Group. Redesign and rework necessary to accommodate the added vacuum firing/cleaning was completed. Fabrication of assembly tools for the 26cm, 30cm, and 36cm BPMs was completed. Work is proceeding on the Ring analog front end electronics design.

Work continues on the 'Optical IPM' prototype. Photomultipliers, optical path couplers, and phosphor screens have been ordered. Drawings were prepared for the electrode support structures.

Conceptual sketches have been made of several approaches to cylindrical ion chamber for a new BLM design to improve the response time by an order of magnitude. Manufacturers have been approached to determine manufacturability. Cabling is under review. The interface logic design to the MPS is underway. We are working with the control group on interface issues.

A prototype BCM circuit board was completed for delivery to LBNL. Computer chassis modifications are in process to accommodate input and output connectors. Software has been developed to analyze data and provide DC restoration and droop compensation. Software is being revised to improve computation speed. LANL PCI mother cards have been received with 64K FIFOs capable of storing in excess of 1ms of data (sampled at 40MHz). Working with LANL PCI mother card to acquire multi channel data using LANL drivers. A second generation PC board layout revision is underway. A prototype carbon scanner has been delivered to LBNL for mechanical fit investigations. Five additional scanners are under construction for delivery to LANL in January 2002.

The laser wire scanner for the 200MeV “proof of principal” experiment in the BNL Linac experiment beam line was on line, waiting for sufficient beam to make measurements. The 100uA beam used for polarized proton RHIC experiments is marginal, but we are refining our acquisition system in the hope of being able to make measurements before normal intensity unpolarized beam becomes available. Such measurements would correspond to measurements beyond 3 sigma in the halo of the SNS beam. A 50mJ laser was installed in the BLIP line for radiation resistance measurements, and that experiment is underway.

Variance Analysis (Cumulative to date) (\$K)

BCWS	BCWP	ACWP	SV	%	CV	%
4586.5	4605.5	4656.6	19.0	0.4%	(51.1)	-1.1%

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

Project Impact: None.

Corrective Action: None.

WBS 1.5.8 – Collimation and Shielding

- The final scraper drawings are in checking. Following this step the first unit will be manufactured.
- Drawings of the modified shield are being prepared. A modified bearing system for the moveable arms is being investigated.

Variance Analysis (Cumulative to date) (\$K)

BCWS	BCWP	ACWP	SV	%	CV	%
1264.6	1235.3	1260.5	(29.3)	-2.3%	(25.2)	-2.0%

Variance Statement: Cum variances are within thresholds. No analysis required.

Current period schedule variance (SV) -\$29.3K (-83.6%) and CV -\$25.2K (-438.1%) are performance driven by 1.5.8.1, Collimation and Shielding; whereas design and assy are late to schedule.

Project Impact: None.

Corrective Action: None.

WBS 1.5.9 – Extraction System

Full power testing in vacuum chamber of the extraction kicker prototype continued. This time modifications were made to the bus bar and the ferrite core blocks were rearranged. There is still minimal heat generation in the ferrite. The accuracy of the measuring equipment was tested and verified by different means. In response to a request from the ORNL Physics group, a PO for a complete set of low mu ferrite blocks for the prototype assembly was placed. This will be used to see if this material will reduce the magnet's impedance. A PCR for this R&D testing was submitted to the project office and turned down. The effort will be charged to SNS physics accounts.

The PFN Assembly work is moving along. A perforated shield was designed and will be added to the resistor pack. Within a week or two the tank will be filled with silicon oil.

Extraction Kicker First Article: A design review for the extraction kicker was held on December 7. The extraction kicker has been tested at 10 KV in air, producing a 700 Amp pulse with a 200 nSec rise time. Testing at full power in the silicon fluid will be done late January and early February. Planning continues to produce these units in the quantities needed for the machine (14).

Spares: Spare levels have been established for the PSI/PSCs, the low field correctors, and the medium range power supplies. PCRs are being generated to make funds available.

Variance Analysis (Cumulative to date) (\$K)

BCWS	BCWP	ACWP	SV	%	CV	%
1122.7	1115.3	1127.0	(7.4)	-0.7%	(11.7)	-1.0%

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

Project Impact: None

Corrective Action: None.

WBS 1.5.10 – RTBT System

The designer continues on the layout and design has begun of the 36Q80 magnet core. A PCR is being generated for using radiation resistant mineral insulated coil material. The manufacturer has provided a sample of the material. A requisition for the insulators and enough conductor for one magnet is being prepared. Design will resume next month on the transfer line work when the designer returns from another assignment.

Detail layout of RTBT vacuum system is still on hold waiting for available designer.

The manufacture process for the first article is on schedule. The welding of the tube was successful and the next phase of the assembly is being carried out. A bi-weekly phone-conference is held with the vendor to discuss the progress of the manufacturing process. The final drawings of the inner collimator box are current in checking.

Variance Analysis (Cumulative to date) (\$K)

BCWS	BCWP	ACWP	SV	%	CV	%
1861.4	1861.1	1755.0	(0.3)	0.0%	106.1	5.7%

Variance Statement: Cum variances are within thresholds. No analysis required.

Current period cost variance (CV) \$106.1K (65.3%) is BCWP driven by RTBT Beam Pipe Procure and Ion Pump PS Final Deli.

Project Impact: None.

Corrective Action: None.

WBS 1.5.12 – Technical Support

This report reflects the new baseline from the ETC effort.

- Two group members travel to Russia to complete the collimator experiments.
- Reviewed the design of 36CDM30 ring dipole skew corrector.
- Establishing the SNS ring dipoles PI point and communication of all the relevant values to the survey group
- Analyzing of space-charge effects of PSR experiment data.
- Comparison of model and measurement of the SNS ring dipole. The quad harmonic is suppressed when integrated on a curved path.

- Study continued on space charge limit in the presence of imperfection resonates and effect of high-order resonances on half-integer resonance crossing study started on space-charge influence on transverse beam stability and on a new method to estimate the dynamic aperture based on the stability of high-order periodic orbits.
- Studies of the electron-proton instability continued.

Variance Analysis (Cumulative to date) (\$K)

BCWS	BCWP	ACWP	SV	%	CV	%
9455.7	9455.7	9437.0	0.0	0.0%	18.7	0.2%

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

V124s

The QA visit in early in December went well. A purchase order for ten modules was placed in mid December. Estimated delivery is late February

One V124s has been sent to LBL for field evaluation.

V123s

No activity.

Eventlink Monitor

No Activity.

The Utility module is making good progress. The RTDL and Event links are working, RTDL frames can be read and event link interrupts are working. The external interrupts also work. Environment readbacks have not been looked at in detail yet.

A True Time GPS receiver with the network time server option and IRIG B VME module have been received. It is being set up in the SNS controls lab for software development.

I have begun marking up the prints for the SNS 16 channel eventlink fanout. I expect to get this into drafting during the month of January.

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:

The driver software for the Event Timing Beam Trigger module(V124s) was completed. Integration testing of the Event and RTDL timing system was started. All the timing master driver code was placed in the CVS repository at ORNL. Preparation was started for a timing system software design review scheduled in January. The true-time GPS system was received. An outside antenna is needed and one is being installed outside the timing system lab.

WBS 1.9.5.1 -Ring Controls Integration

Most of the issues related to the licensing of Vxworks software have been resolved with Wind River.

WBS 1.9.5.2 - Power Supply Controls

PSI:

Several PSI units were updated and shipped to ORNL this month. A PSI and PSC setup for testing using a serial port was shipped to K. Rust and ORNL to setup a power supply testing station. Labview software to test the hardware was delivered with the hardware.

PSC:

Several times while running long term tests of the PSC it was noted that the VME CPU was reset. It occurred at irregular hours, often in the evening while other crates in the same room or adjacent rooms had no problem. Changing hardware had no affect so a UPS was ordered and installed. This appears to have fixed the problem. It's assumed that heaters or air conditioners turning on and off are producing transients that are detected by the power fail detect circuit and causing a reset. This is only noted on one of the many power outlets.

Power Supply Application:

Linux Development Environment:

A problem that prevented the EPICS make from generating mbbiDirect records from CapFast schematics was fixed. The solution required updating the original EPICS edb.def file with a newer version that includes mbbiDirect record support.

WBS 1.9.5.3 –Diagnostics

BLM:

Testing of the 16-bit VMIC board started. A Vxworks driver was installed. Some initial results will be presented to the diagnostics group shortly to see if the board is likely to meet their requirements.

The ICS 24-bit ADC board arrived. A vxworks driver is being written to test the board.

Laser Wire:

The equipment is installed in the Linac but time is needed during Linac operations to test the equipment.

BCM:

To support the diagnostic group we are investigating the Active X Channel Access Server which is needed for the BCM prototype.

WBS 1.9.5.4 - Vacuum

The vacuum controllers will use a RS485 interface. The development of drivers for RS485 IP controllers was started. The vacuum group has placed an order for pumps and gauges. It's expected that units will be available and setup in the lab in January or February. When that is done software development of drivers can start.

WBS 1.9.5.5 - Application Software

SNS Application Toolkit:

An Orbit Difference Display application based on the UAL 2.0 environment, Java Channel Access (JCA), and Ptolemy 2D plot was implemented. See Figure 1 below.

SNS Ring Simulation Environment:

Updated the WEB documentation for the Perl Application Programming Interface of the UAL 1.0 user shell. Reference: <http://www.ual.bnl.gov/v1/codes.htm> (ALE::UI)

Updated the WEB documentation for C++ Application Programming Interface of the ZLIB library. Reference: <http://www.ual.bnl.gov/ref/v1/doc/codes/zlib/index.html> (C++ API)

Updated the documentation for the C++ Application Programming Interface of the ZLIB library Reference: <http://www.ual.bnl.gov/ref/v1/doc/codes/zlib/index.html> (C++ API)

The Beam, Survey, and Optics modules of the PAC library were ported to the gcc 3.0 compiler.

WBS 1.9.5.6 – RF

There have been discussions with the RF group on the software requirements and schedule for the Low Level RF. The ICD's for the HLRF will be available soon. Low level RF hardware will not be ready until March.

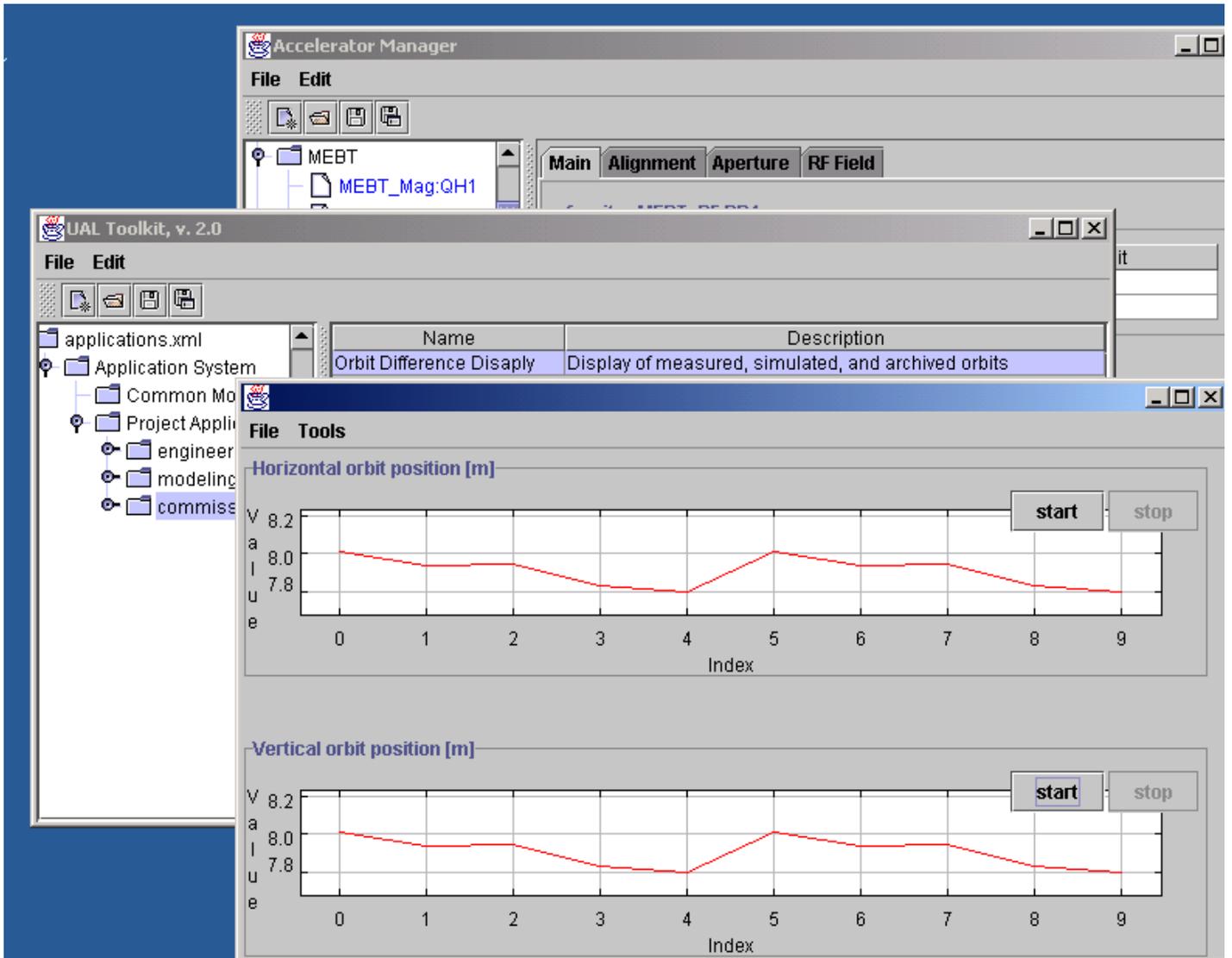


Figure 1 – Orbit Display Program

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-Dec-01 thru 31-Dec-01						PROJECT NUMBER: 99-E-334						
PARTICIPANT NAME AND ADDRESS: Brookhaven National Laboratory Brookhaven, NY			BCWS PLAN DATE: October 1999						START DATE: October 1998						
									COMPLETION DATE: November 2006						
WORK BREAKDOWN STRUCTURE	CURRENT PERIOD						CUMULATIVE TO DATE						AT COMPLETION		
	Budgeted Cost		Actual Cost of Work Performed	Variance		Budgeted Cost		Actual Cost of Work Performed	Variance		Budgeted	Revised Estimate	Variance		
	Work Scheduled	Work Performed		Schedule	Cost	Work Scheduled	Work Performed		Schedule	Cost					
1.1.3 Rings System Development	7.0	7.0	0.5	0.0	6.5	5,045.7	5,045.7	5,039.2	0.0	6.5	5,115				
1.5 Ring & Transfer Line System	1,631.6	2,484.8	1,751.8	853.2	733.0	41,060.7	41,913.9	41,180.9	853.2	733.0	112,731				
1.5.1 HEBT (High Energy Beam Transport) Systems	153.8	167.1	82.2	13.3	84.9	3,569.0	3,582.3	3,497.4	13.3	84.9	10,174				
1.5.2 Injection Systems	106.5	272.2	242.8	165.7	29.5	2,905.0	3,070.8	3,041.3	165.7	29.5	8,994				
1.5.3 Magnet Systems	286.6	241.25	224.1	(45.3)	17.2	7,898.6	7,853.3	7,836.1	(45.3)	17.2	16,712				
1.5.4 Power Supply System	12.6	13.6	20.9	1.0	(7.4)	839.3	840.3	847.7	1.0	(7.4)	3,434				
1.5.5 Vacuum System	138.2	248.3	92.8	110.1	155.5	3,054.9	3,165.1	3,009.6	110.1	155.5	9,759				
1.5.6 RF System	184.7	811.0	394.5	626.4	416.6	4,502.1	5,128.4	4,711.8	626.4	416.6	12,132				
1.5.7 Ring Systems Diagnostic Instrumentation	212.7	231.7	282.9	19.0	(51.1)	4,586.5	4,605.5	4,656.6	19.0	(51.1)	14,410				
1.5.8 Collimation and Shielding	35.0	5.7	30.9	(29.3)	(25.2)	1,264.6	1,235.3	1,260.5	(29.3)	(25.2)	3,429				
1.5.9 Extraction System	56.2	48.8	60.5	(7.4)	(11.7)	1,122.7	1,115.3	1,127.0	(7.4)	(11.7)	6,169				
1.5.10 RTBT (Ring to Target Beam Transport) System	162.7	162.4	56.3	(0.3)	106.1	1,861.4	1,861.1	1,755.0	(0.3)	106.1	7,182				
1.5.11 Cable	0.0	0.0	0.0	0.0	0.0	0.7	0.7	0.7	0.0	0.0	0.7				
1.5.12 Technical Support	282.7	282.7	264.0	0.0	18.7	9,455.7	9,455.7	9,437.0	0.0	18.7	20,337				
WBS SUBTOTAL	1,638.6	2,491.8	1,752.3	853.2	739.5	46,106.4	46,959.6	46,220.1	853.2	739.5	117,846				
UNDISTRIBUTED BUDGET															
SUBTOTAL	1,638.6		1,752.3			46,106.4		46,220.1			117,846				
MANAGEMENT RESERVE															
TOTAL	1,638.6		1,752.3			46,106.4		46,220.1			117,846				
RECONCILIATION TO CONTRACT BUDGET BASE															
DOLLARS EXPRESSED IN:			SIGNATURE OF PARTICIPANT'S PROJECT DIRECTOR:									DATE:			
THOUSANDS			Bill Weng									January 24, 2002			

1.1.3 Efficiency Indices & Trends

