MONTHLY REPORT

April 1-30, 2009

Performing Organization:	Brookhaven Science Associates
Location:	Brookhaven National Laboratory Upton, New York 11973-5000
Contract Period of Performance:	FY2005 – FY2010

Brookhaven National Laboratory
EBIS MONTHLY PROGRESS REPORT
April 2009

I. Contractor Project Manager's Assessment

Technical Progress and Accomplishments

The linac fabrication continues on schedule, and the unit has been shipped to GSI for copper plating. The manufacture of the two electron collectors has been completed successfully. Installation continues to go well. The rebuncher cavity has been delivered and passed low level testing. Test EBIS continues to be used for testing of RHIC EBIS components, minimizing the impact of the delay in the delivery of the superconducting solenoid.

Issues and Concerns

The saga of the repair at BNL of the ACCEL superconducting solenoid continues but ACCEL remains committed to delivering a working magnet. The project has scheduled many EBIS source construction activities in parallel with the solenoid repair to keep the overall project schedule on track.

II. Detailed Status by WBS

WBS 1.1 – Structural components

EBIS Hardware

Superconducting Solenoid

On Thursday, April16, two technical representatives from ACCEL (now Brucker Research Instruments, soon to become Bruker Advanced Supercon) arrived at Brookhaven for reassembly of the magnet system. The tooling box arrived later that morning, and the new heat shield bore tube arrived on Monday, April 20. As soon as they arrived, the reps noted that the vacuum vessel inner bore tube at the o-ring sealing areas was in very poor condition. Bernhard Fischer was emailed photographs and was called to discuss the plan for repair. Bernhard stated that he would order a new tube. By Wednesday, the magnet suspension system was repaired, the heat shield bore tube installed, cold mass and shield aligned, and the superinsulation reinstalled. The reps left Brookhaven on April 22. ACCEL will return in a few weeks to replace the inner bore tube and start system cooldown for the acceptance test.

The design of the spare superconducting solenoid by Cryomagnetics is currently in process. The Preliminary Design Review is set for Tuesday, May 12. Teleconferences continue weekly.

Electron Collector

By the end of April, all testing and assembly of the beryllium copper electron collector by Brush Wellman are completed, including water manifold installation and water flow testing, hydrostatic pressure test at 450 psig, welding of the end vacuum chamber and inlet flange, and finally the last vacuum leak test. At this point the manufacture of two electron collectors is considered complete. The manufacture of the iron shield and internal electrostatic lenses for the BeCu unit is still in process and about 50% complete.

LEBT and External Ion Injection

The following items are currently in the Central Shop for manufacture: switch chamber/stand and its internal electrostatic components; electrostatic quadrupole quadruplets (3 assemblies); and cylindrical deflectors near the ion sources.

RF Structures

IH-Linac

The Linac is currently at GSI for copper plating. Final drawings of the quadrupole triplet by Bruker were submitted and manufacturing is now under way.

RFQ

See Test EBIS.

Buncher Cavities

The rebuncher cavity (C-1) was received from IAP Frankfurt, and passed low level rf and vacuum testing at BNL.

Test EBIS

Component improvement for RHIC EBIS

A current transformer core and winding has been obtained from the Beam Diagnostics Group. A simple electrostatic shield was added so that it could be installed in a very limited axial space at the exit of the RFQ. This will allow us to test the suitability of the simplified current transformer for the RHIC EBIS and will allow us to make a non-destructive measurement of the total current transmitted through the RFQ during Test EBIS beam tests beginning in May.

We have continued to address spurious tripping of Test EBIS power supply interlocks related to pulsed high voltage EBIS platform operation. The electron collector supply, the drift tube power supplies and the cathode bias supplies were removed from the automatic fault shutdown circuits. Equipment is still protected since the anode supply still shuts down the electron beam if a fault is detected. This change has improved long term operation, and indicates that the system was indeed too susceptible to electrical interference.

Pepperpot modification for High Energy Beams

The pepperpot emittance head has been very useful for seeing beam profiles and emittances on a pulse to pulse basis, in contrast to the scanning emittance head which accumulates data from a series of pulses spanning several minutes. We currently use the pepperpot device, equipped with a channel plate detector followed by a fluorescent screen, both before and after the RFQ. Work is progressing on a pepperpot emittance measuring device more appropriate for high energy measurements after the RFQ and eventually after the linac. The device will employ a crystal which will be directly excited by the ion beamlets transmitted through the pepperpot mask. The mask to crystal distance will be increased greatly to increase the spot sizes, thereby improving the resolution of the measurement. The crystal holder and support rods have been machined for the modified design.

Ion Beam Measurements at Test EBIS

During April we primarily concentrated on measurements in the LEBT region, while we prepared the high energy beamline at the exit of the RFQ for charge state analysis. We disconnected and moved the RFQ ~ one meter in the downstream direction allowing us to reinstall the pepperpot emittance head at the RFQ entrance location. The larger version of the slit/scan emittance head and amplifier were installed just after pepperpot so that we could compare measurements.

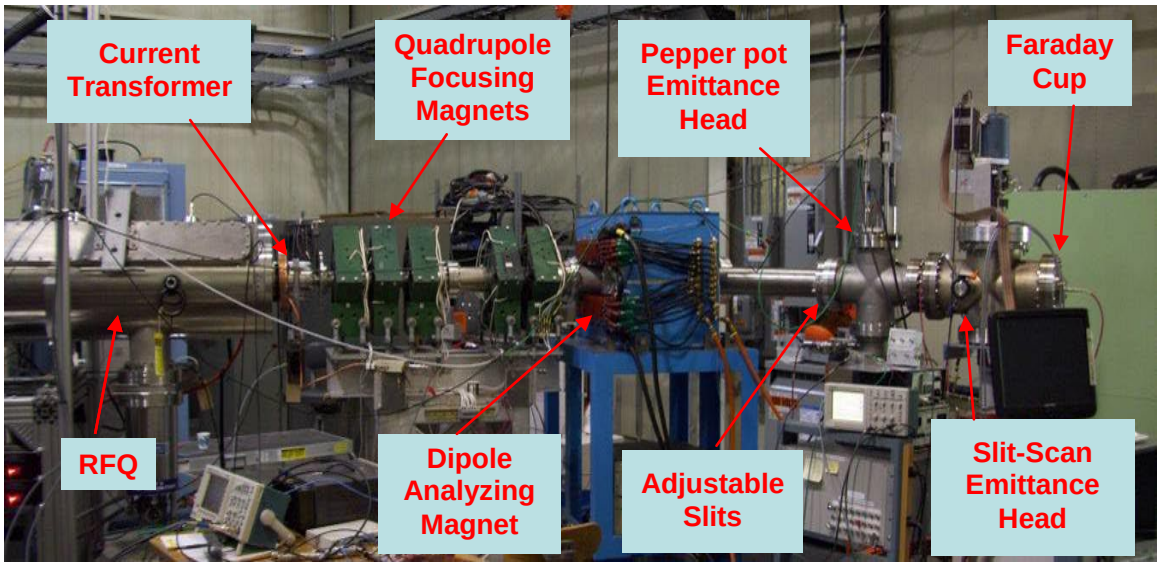
1) Emittance studies were repeated at the RFQ entrance after the LEBT solenoid to examine the characteristics of beams using settings that had previously been used for beams transmitted through the RFQ. The settings will also be used as input to our beam transport computer simulation models. During these studies we were able to make a crude separation of the ion beam species by changing the value of the LEBT solenoid and observing the profile on the pepperpot as different components were brought into focus. This provided us with a better understanding of the full beam profile and emittance patterns when using the pepperpot in the LEBT beam line, where multiple beam components are present. It provides a partial explanation for why the pepperpot emittance value of full beam is several times larger than corresponding slit/scan emittance observations, in which the components are more easily separated and excluded before obtaining a value.

2) Time of Flight (TOF) studies were made in which various optical elements where used as a TOF chopper rather than the dedicated high resolution TOF chopper in the off-axis beamline. TOF is important since it allows us to view the relative abundance of ion beam components in a single extracted pulse. By using existing optical elements, it may be possible to sample the ion beam pulse earlier in the beam line, before much charge separation has occurred due to electrostatic bending and time-of-flight effects. During the study using He gas injection, drift tubes 5-8, drift tube 9, and the LEBT chamber flat deflector were each varied rapidly to provide TOF chopping. This technique is similar to our earlier work with a low resolution in-line TOF and shows promise for incorporating such measurement capability in the RHIC EBIS.

3) Total emittance studies versus extraction conditions were also made. Rate of ion extraction and the value of the electron beam current during extraction where two of the parameters which were varied. So far the results have not been conclusive, but we intend to revisit these studies. The RFQ was reconnected to the LEBT and the fast Faraday cup was installed at the RFQ exit. This allowed some RF bucket measurements on He+ beams, before the high energy analysis line was installed.

Charge Analysis after the RFQ

A dipole magnet was added to the high energy beam line after the RFQ. This allows separation of the total beam current transmitted through the RFQ into single charge to mass ratio beams. The new setup includes a current transformer after the RFQ to provide a nondestructive current measurement, two sets of quadrupoles for focusing the beam through the dipole exit slits, pepperpot and slit scan emittance heads, and a Faraday cup to measure the analyzed beam intensity. Measurements of the analyzed beam will provide information on the intensity and emittance of single beam components during measurements expected in May.



WBS 1.2 – Controls

The console software prototype was been completed with the incorporation of all principal requested features. Iterative refinement and documentation will follow during system integration. Timing tests were carried out in support of planning for multi-cycle data reporting. A mechanism was agreed on for implementation of a triggered simultaneous load of waveforms to multiple function generators. Gate array programming was underway for the 16 power supply interfaces that will provide fast interlocking by externally triggered zeroing of set-points.

Progress continues to be made on the Global Interlock System. The work on the EBIS Platform Transceiver Signal Conditioning Unit pc board artwork design and EBIS HV Platform Impedance Measurement Unit pc board artwork design was completed A purchase order was placed for the fabrication of 2 units for each item. The schematic for the EBIS Beam Ground Fault Detector Unit was finished and system documentation was updated for the EBIS PLC and Interlock System Block Diagram and the draft EBIS Global Interlock Matrix.

WBS 1.3 – Diagnostic Systems

The Faraday cup amplifiers were tested. Some problems were found with failed components on two boards, but were fixed and re-tested. Testing on the current transformer amplifiers continued, with some modifications necessary to fix offsets when the amplifier is at high gain. Requirements for cable pulls (location of conduit, among other issues) were discussed and a plan was set.

WBS 1.4 – Magnet Systems

MEBT Quads
The order for the MEBT quad lamination stacks has been placed. Detailed designs of the quad magnets including the mounting system and stand are ongoing. Methods of moving the magnets for beam tuning were researched.

Warm Solenoids
The coils for the second electron gun solenoid are being wound.

WBS 1.5 – Power Supply Systems

The sixteen HV fast power supplies for the electrostatic quadrupoles in the external ion source beam line have been tested and are ready for installation.

The order was placed for the fast pulsed quadrupole power supplies with Applied Power Systems, of Hicksville, NY. There will be a design review at the vendor's facility either late June or early July.

The solicitation for the low noise, high stability power supplies for the HEBT quadrupoles was released in April, to allow this order to be placed in May.

A Kirk key system was designed to protect staff from voltages on the floating decks within EBIS. It will begin its reviews starting in May.

We have been monitoring the design and construction of the normal / emergency isolation transformer for the EBIS deck, with special attention given to personnel safety and ease of installation. It is still on track for a mid-June delivery.

WBS 1.6 – RF Systems

All systems are being prepared for high power testing. The water systems and power feeds are complete and only final hookup remains. PLC architecture was reviewed and purchase orders for additional units were placed.
The defective high power circulator for the linac power amplifier was repaired by the vendor and is in transit to BNL.

WBS 1.7 – Vacuum Systems

Central shops is about 90% complete on HEBT stand fabrication for the ion pumps and instrumentation boxes. The magnetic shields for the EBIS cryopumps and turbos are about 50% complete as well. All heating jackets have been received. The cryo compressor mounting on insulated standoffs has been finalized. The HEBT ion pumps (from the REF project) are being refurbished and baked.

WBS 1.8 – Cooling Systems

Final hookup to the NSRL/Booster water system has been completed.

WBS 1.9 – Facility Modifications

No activity scheduled for this reporting period.

WBS 1.10 – Installation

Five contract electricians have been hired for the power distribution effort and this has resulted in excellent progress. The RFQ and Linac power amplifiers output coaxial transmission installation is 95% complete.

WBS 1.11 – Project Services

Labor continued to increase this month.

The quarterly report was submitted to the on-site DOE office. A risk mitigation plan for the solenoid, one of the recommendations from the Project's January review, was forwarded to the site office and DOE NP.

We continue to work on a "what if" file of the schedule, incorporating new dates from the group leaders. The major change is expected in Installation. All open commitments are being reviewed for surplus commitments.

The monthly telecon with the Office of Science took place on April 9th.

WBS 1.12 – Commissioning

No activity scheduled.

SAFETY

The draft Unreviewed Safety Issue (USI) document for the EBIS Preinjector remains at 90% complete.

PHYSICS

No activity this reporting period.

Financial Status

EBIS Project		Burdened k$					
WBS	Title	April Actuals	FY09 to date	Project to date (PTD) costs*	Commit-ments		Budget at Comple-tion
1.1	Structural components	143	469	3411	433		3395
1.2	Controls	14	110	727	0		756
1.3	Diagnostics/instrumentation	16	174	485	34		696
1.4	Magnet Systems	4	20	495	13		863
1.5	Power Supply Systems	68	568	2042	455		2332
1.6	RF Systems	12	276	2354	-20		2760
1.7	Vacuum systems	58	294	1724	41		1609
1.8	Cooling Systems	0	24	216	0		259
1.9	Facility Modifications	45	99	586	150		550
1.10	Installation	93	688	1233	72		2018
1.11	Project Services	26	191	1065	0		1074
1.12	Commissioning		0	0	0		217
1.13	R&D/CDR	71	0	1398	0		1400
	Contingency						1371
	Total	550	2914	15735	1178		19300
* costs through Apr 2009							