MONTHLY REPORT

February 1-28, 2009

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

I. Contractor Project Manager’s Assessment

Technical Progress and Accomplishments

During this reporting period more resources for construction and installation were made available from the C-A Department. In addition, contract labor for electrical installation was added to the installation effort. Good progress was made on the linac, with all cavity and drift tube machining complete and ready for rf measurements. The Test-EBIS continues to provide an invaluable proving ground for the final RHIC EBIS components, reducing the impact of the solenoid delay.

Issues and Concerns

Of major concern was the failure of Superconducting Solenoid during the initial stages of cooldown, due to damage to the support rods during shipping. The vendor has been responsive and plans to fabricate parts in Germany and repair the magnet at BNL. The project completion will not be affected by the expected delay caused by this repair.

II. Detailed Status by WBS

WBS 1.1 – Structural components

1.1.6 EBIS Hardware

Superconducting Solenoid

The solenoid was delivered to Brookhaven on Tuesday, 10 February 2009. Two ACCEL Instruments personnel arrived at BNL on 23 February for the acceptance testing. In the process of cooldown a cold spot was noticed on the inner bore. The cooldown was stopped and the unit was warmed up. Due to suspicions that the unit was damaged during transport to BNL, the internal ‘flight recorder’ with time-logged accelerations was shipped on Friday to ACCEL in Germany. On Sunday, 1 March, inspection of the cold mass suspension rod ends (visible on the external vacuum vessel) revealed that the rods were broken at one end. An insurance inspector for ACCEL was present on Monday and Tuesday to evaluate the damage and cause. ACCEL now plans to manufacture the replacement parts at their factory, send two technicians to BNL to install the parts and realign the magnet, and then the ACCEL engineer will return for final acceptance testing towards the end of April.

The design of the spare superconducting solenoid by Cryomagnetics is currently in process. Teleconferences are conducted weekly. The magnet system is expected to be delivered in October, 2009
Electron Collector

The manufacture of the beryllium copper electron collector by Brush Wellman is complete. The delivery date is estimated to be early March. The iron shield is being fabricated at BNL.

Central Drift Tube

The slanted drift tube, remanufactured from non-magnetic stainless steel, was received from central shops and installed in the drift tube structure. Glass tubing was installed inside the gas injection line feed to prevent depolarization in case polarized gases are used in the future.

The central vacuum chamber unit was completed and tested at the EBIS assembly area in the Bldg 930 high bay. This unit includes the chamber bakeout heaters, heat shields and cooling to protect the superconducting solenoid, and transverse magnetic steering coils.

The unit was tested under vacuum, but without the drift tube structure installed, to ensure that the appropriate temperature distribution could be achieved. The bakeout/cooling system was tested using several schemes, altering the number of zones and thermocouple feedback. Additional thermocouples were provided by a National Instruments system, to monitor temperatures in the regions not covered by the bakeout system.

In summary, at 50% of the available heater power, the required central drift tube temperature in excess of the required 450 deg C can be obtained, while maintaining the outer skin at room temperature, using a water flow rate of 1.5 gpm.
**LEBT and External Ion Injection**

The RHIC EBIS LEBT chamber has been delivered to the EBIS assembly area in Bldg 930 and will be leak checked during March. All internal electrodes are finished except for some mounting holes.

A 12” conflat gate valve body has been modified to allow the insertion of a 4” strip detector beam profile monitor and gate valve at the same axial position at the EBIS exit. Such a detector has proved useful for optimizing ion injection of the low intensity external source beam into the Test EBIS, but the compact RHIC EBIS optics did not allow room for an independent detector chamber. The actuator has been received. Multi-conductor ultrahigh vacuum electrical cable is in procurement.

The design of the internal electrostatic components in the switch chamber is in process. The design of the cylindrical deflectors just downstream of the ion sources is completed. The electrostatic quadrupole quadruplets (3 assemblies) are in the Central Shop for fabrication. The switch chamber is also in the shop.

The mounting of 5 fast electro-mechanical shutters for differential pumping after the external ion sources has been designed. The devices will be mounted in self contained double sided conflat flanges for easy removal from the beamlines. The modular units include electrical feedthroughs and mechanical actuators to hold the shutter open in the case of normal electrical operation failure. Vacuum compatibility of a large aperture shutter (45mm diameter), in the high vacuum section of the common injection line is under investigation.

**RF Structures**

**IH-Linac**

The machining of the Linac cavity is complete, and all internal surfaces have been polished. A ‘dummy’ triplet has been manufactured (See figure below). Low power RF testing at the PINK manufacturing plant is planned for early March. The results will determine the requirement for final machining of the upper and lower cavity face flanges. Copper plating of the finished cavity by GSI is planned for April, 2009. The manufacture of the internal triplet by Bruker is in process. Conference calls between BNL and U. Ratzinger of IAP continue weekly.

Right: IH Linac at the manufacturing facility, prior to rf measurements.
RFQ

See Test-EBIS section below.

Buncher Cavities

Manufacture of rebuncher cavity (C-1) continues. All brazing has been completed, and the resonant frequency measured and found to be correct.

Component testing on Test EBIS

16-pole deflector/lens - Hardware and software was completed and installed for rapidly multiplexing the voltages on the 16 pole lens. Therefore, injection values in the range of +/-2kV can be applied to all 16 electrodes, followed by independent extraction values a few milliseconds later. This new feature is important for RFQ beam optimization on Test EBIS during injection of Cu^{1+} and subsequent extraction of Cu^{10+}.

HV internal lens - The +/-60 kV fast internal lens supply is now fully operational and tested, but has not yet been installed at Test EBIS. We are now considering an alternative configuration for RHIC EBIS, which may provide more straightforward control and equipment protection features. Installation of this lens supply at TestEBIS is important for the RFQ beam tests, since it allows for the necessary independent injection and extraction settings.

Beam measurement --- The measured beam transmission from the Bergoz toroid after the EBIS HV acceleration break to the BNL toroid at the RFQ entrance was 25nC/25.4nC (>98%), with possible measurement errors due to amplifier gain and/or secondary electrons. At pulsed LEBT solenoid values above 1000A, the BNL toroid electronics is driven into saturation. We believe
this problem can be overcome through introduction of an appropriate reference current subtraction in the amplifier.

The EBIS ion beam was deflected to the Mamyrin (reflex) TOF in the 25 degree to verify the Cu\textsuperscript{10+} content. Some improvements to the ion optics were made by introducing higher voltage power supplies to the parallel plate bend and using a vertical deflector as a flat lens. To improve this type of measurement at RHIC EBIS, a new Mamyrin-type time-of-flight mass-spectrometer with a larger aperture, improved sensitivity and improved Faraday cup has been designed.

**Measurements after the RFQ**

Emittance measurements were made of beams at the RFQ output for He\textsuperscript{1+}, He\textsuperscript{2+} and were started for Cu\textsuperscript{10+}, using both pepperpot and slit-collector type devices. Transmission and bunch length vs. RF power were obtained. During the measurement with He, the highest transmission was 53%, while 48% was typical. The Cu\textsuperscript{10+} measurements required pulsed EBIS platform voltages of up to 95 kV. A pepper-pot modification for use after RFQ with high energy ion beams has been designed. The high energy version may use a scintillator as a target, eliminating the need for micro-channel plate amplification.

During the Cu\textsuperscript{10+} investigations, electrical noise associated with the 95 kV platform pulse resulted in excessive beam faults. Measurements were suspended, pending suppression of this interference. We also experienced failures in the both the high voltage platform pulser and platform impedance measuring circuit, as we operated at high voltages up to 105 kV. Early detection of such problems at Test EBIS, and correction through additional circuit protection, is valuable and should lead to a more reliable operation at the RHIC EBIS.

**WBS 1.2 – Controls**

The VME chassis assembly for MEBT and HEBT power supply control was completed and ready for installation.

The EBIS Global Interlock Matrix was updated and the designs for the receiver and transmitter modules were merged into one Platform Transceiver Signal Conditioning Module. Work continued on the designs for the EBIS Global Interlock System, and the completed design was sent to relevant personnel for a preliminary review. Coordination between the RHIC control system and EBIS operational requirements continued.

**WBS 1.3 – Diagnostic Systems**

There was no activity reported during this period.

**WBS 1.4 – Magnet Systems**

**MEBT Quads**

Test coils have been wound for the quadrupoles. During the winding, improvements were made to the winding fixture and winding techniques. Further test coil winding is required to reduce the coil clearance. The quadrupole magnetic design and assembly has also been improved.
Warm Solenoids
The collector solenoid coils have been epoxy potted. The next steps for the collector solenoid are to solder the electrical jumpers to the conductor and then attach the cooling lines.

WBS 1.5 – Power Supply Systems

Questions were prepared for the vendors who submitted proposals on the fast pulsed quadrupole power supply solicitation.

WBS 1.6 – RF Systems

Activity reported in Installation section

WBS 1.7 – Vacuum Systems

As noted in the section 1.1.6, work was done on the central drift tube assembly to enable a successful bakout and prepare it for installation in the superconducting solenoid magnet. The magnet insulating vacuum was leak checked in preparation for solenoid testing. Design work on the injection line is continuing with detailed design of the shutters. Custom cryopump refrigeration lines and HEBT instrumentation tees were ordered. Several orders of heating jackets were received.

WBS 1.8 – Cooling Systems

Installation continued on the main water system controls, and piping and hoses for the RFQ and Linac RF amplifiers.
WBS 1.9 –  Facility Modifications

No activity scheduled for this reporting period.

WBS 1.10 –  Installation

Work continued on the installation of buncher/debuncher amplifiers and the ac power distribution system.

WBS 1.11 –  Project Services

A PCR was created to correct the G&A rate used for the PreOps efforts. It is expected to be approved next month.

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.

The monthly telecon with the Office of Science took place on February 12th.

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

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* costs through Feb 2009