

Status Report: 05
Status as of: 30 April 2000

Contract Title:

BOOSTER
APPPLICATIONS
FACILITY



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

Reporting Period: April 1, 2000 – April 30, 2000

1) Project Objective:

The purpose of this project is to provide a new experimental facility and beam line and undertake accelerator modifications required to take advantage of heavy-ion beams from the Brookhaven AGS Booster accelerator for radiation effects studies of importance for the NASA Space Program.

Heavy ions will originate in the Brookhaven MP-6 tandem accelerator and be transported to the Booster synchrotron for acceleration to the required energies.

Concurrent operation of the Booster for space radiation research and other kinds of research applications will be achieved by utilizing independent tandem injectors. The beam species and energy for both applications will be independent. Beams from either Tandem will be switched into the common injection line. At the Booster a new slow extraction system will be implemented which will require extensive accelerator modifications and rearrangements. A new beam line and tunnel enclosure will be built to transport the extracted beam to the experimental facility. Uniform beam intensities will be provided over rectangular areas ranging in size from about 1 cm to about 20 cm.

Other existing on-site facilities, such as the medical Department's extensive animal handling installations will also be utilized. Dosimetry and local access control will be provided through a local facility control room.

The conventional facilities to be constructed for the Booster Applications Facility will provide experimental space and support facilities. A labyrinth connects the experimental area with the laboratory support building. The target room is provided with a concrete beam stop imbedded in the back wall. The entire facility is shielded by 15 feet of earth equivalent shielding over the top of the target rooms and transport lines. The laboratory building contains support laboratories, including temporary biological specimen holding and preparation areas, as well as radiological laboratories for work with cell cultures and tissues. Also included are a dosimetry control room, a mechanical service equipment area and rooms for radioactive storage and miscellaneous items.

Power supplies for the beam transport magnets and various other equipment will be located in a power supply building, a pre-engineered steel frame construction.

The funds requested will also provide for spares and facility commissioning.

2) Technical Approach Changes:

No change.

3) Project Head's Summary Assessment:

	Last Month	This Month
Cost:	satisfactory	satisfactory
Schedule	satisfactory	satisfactory
Technical	satisfactory	satisfactory
Overall	satisfactory	satisfactory

The MP-6 Tandem has routinely operated at 14MV. The commissioning of the Negative Ion Injector (NII) was delayed by repeated failures of its 300kV isolation transformer. New transformer coils have been installed and the failures have not reoccurred.

W.B.S. 1.0 BAF Construction Summary

Progress continues on the conventional construction design package, Booster Modifications and Beam Line design.

W.B.S. 1.1 Conventional Construction

The status of conventional construction is as follows:

Task	Design Status	Expected Design Completion Date
1. Experimental Support Building	90%	6/2/00
2. Target Building & Labyrinth	60%	6/9/00
3. Beam Tunnel	40%	6/9/00
4. Access Alcove	30%	6/16/00
5. Power Supply Building	35%	6/31/00
6. Site Work-Road, Fencing, Ret. Walls	75%	6/2/00
7. Site Utilities	40%	6/12/00
8. Earth Shielding & Liner	95%	6/12/00
9. Design Package out for Comment		6/30/00
10.Design Package to DCP		7/15/00

W.B.S. 1.2 Booster Modifications:

1.2.1 New Extraction Equipment

	<u>% Complete</u>	<u>To Shops</u>
1.2.1.1 Thin Septum		
Engineering	40	
Design	0	
Fabrication	-	06/31/00
1.2.1.2 Thick Septum		
Engineering	100	
Design	100	
Fabrication		
Long lead items	0	03/30/00
Balance	-	06/15/00
1.2.1.3 Foil Stripper Assembly		
Engineering	100	
Design	100	
Fabrication		
Vacuum box	50	01/10/00
Long lead items	25	01/28/00
Balance	-	05/30/00

1.2.2 Power Supplies

The preliminary Design Review was held for the “Spill servo” which will control the parameters of the extracted beam duration and time structure. The basic concept, modeled after the AGS slow extraction scheme, was accepted. Design work continues for the power supply and magnet buss for the D6 Septum.

1.2.3 Equipment Modification

	<u>% Complete</u>	<u>To Shops</u>
1.2.3.2.1 Move D6 Beam Dump & WCM		
Engineering	100	
Design	100	
Fabrication	99	11/10/99
1.2.3.2.2 New WCM		
Engineering	100	
Design	100	
Fabrication	10	04/07/00
1.2.3.3 D3 IPM & Beam Dump Kicker		
Engineering	90	
Design	50	
Fabrication	-	08/31/00

W.B.S. 1.3 Beam Transport System

1.3.1 Magnets

The engineering design of the corrector magnets was completed and a design review scheduled for 5/4/00. The magnet gap was increased to 9" to allow the installation of heating blankets in the first corrector pair which will be located in the bakeable part of the beam line. This led to a minor decrease in the field strength while further improving the field homogeneity. The 3D TOSCA calculations for the octupole magnets were finished and the resulting field was analyzed. The calculations show that a 20" long magnet will provide sufficient integral field. The calculated field map yields a pure octupole field with all higher multipoles below 0.1% relative to the octupole term at the edge of the aperture. Of course the model assumes perfect symmetry of the magnet poles and the real magnets will have to be mapped carefully to determine the field errors.

1.3.2 Power Supplies

The development of specifications for procurement of the beam line power supplies continued.

1.3.2 Vacuum System

Several changes were incorporated into the design of the BAF vacuum system. The pipe diameter changes from 6 inches to 8 inches through the penetration wall and then increases to 12 inches downstream of the Q8 magnet. The instrumentation boxes before the D1 magnet have vacuum windows through which the beam passes. These windows will be need to be very robust since the Fast closing valve cannot protect the Booster ring vacuum from a catastrophic window failure. A higher safety factor than normal will be used for these two windows especially since they will be baked. The Fast valve was moved from the BAF tunnel into the Booster tunnel to accommodate the changes in pipe diameters. The vacuum pipe in the first two Quads will be 7" O.D. in order to leave space for the heating jackets. Detailed design and layout of the vacuum system continues with the effort focused in the Booster tunnel. An all metal gate valve and fast closing valve were received and tested.

1.3.4 Instrumentation

No change.

W.B.S. 1.4 Controls and Personnel Safety System

1.4.1 Controls

Testing of data acquisition software for the MP6 Bypass beamline continued, following the hookup of all three instrumentation racks. Debugging was slowed by the potential for interference with running software needed for RHIC commissioning support.

The chassis for the Booster Event Link and the Realtime, Gauss, and Supercycle interface were built this month. Engineering was completed on the V197 and V198 timing boards

and the designs were submitted to drafting. The Event Link input (V101) PC boards were received along with most parts.

Specification and design efforts were also underway in several other areas. A preliminary discussion was held with Vacuum Group personnel about requirements for controls. Agreement was reached on the interfacing of security system “Chipmunks” via VME scalars like those used for instrumentation inputs, and the foil-positioner design will be modified to incorporate a stepper motor as planned for the adjacent collimator. This convergence of designs will optimize sharing of common hardware and software interfaces.

1.4.2 Personnel Safety System

The BAF Access Controls System hardware specification document was developed. The preliminary design of the software specification document (State Table) was started. We continue to procure hardware components for the programmable logic controller (PLC) subsystem.

W.B.S. 1.5. Experimental Area Outfitting

1.5.1 Dosimetry Control

Preparations were completed for the USER/BNL review of the Dosimetry system.

1.5.2 Support Rooms General

No change

1.5.3 Support Room A

No change.

1.5.4 Support Room B

No change.

W.B.S. 1.6 Long Term Support Lab

No change.

W.B.S. 1.7 Installation and Services

1.7.1 Electric Power Distribution

Work continues on development of the one-line power distribution drawing.

1.7.2 Equipment Cooling Water

Detailed design work continued.

1.7.3 Installation

Work has started on the Security and Communications conduits between Building 911 and the BAF Facility. Cable tray design for the BAF Transport Line Tunnel has started.

W.B.S. 1.8 Project Services

1.8.1 Project Management

No change

1.8.2 Fiscal

No change.

1.8.3 Quality Assurance

No change.

1.8.4 Environment, Safety and Health

No change.

4) Open Items:

Complete action items from December 1999 review: Confirmation has been received that DOE ES&H requires meet NASA ES&H requirements. This action brings the number of items closed to 7 out of 26.

5) Summary Status Assessment and Forecast

a) Financial Status

A total of \$4,606,684 was costed or obligated of the \$11,450,000 available. Costs represented \$3,199,230 and open commitments stood at \$1,407,450. The Project Total Estimated Cost (TEC) is \$30,507,000. The Total Project Cost (TPC) is at \$33,100,000.

b) Table II shows detailed expenses and commitments.

c) Table III shows projected project spending profile.

d) Schedule Status

<u>Milestones completed</u>	<u>Baseline</u>	<u>Actual</u>
Title I Start	11/01/98	11/01/98
Booster Modification Start	04/01/99	04/01/99
Title II Start	04/01/99	04/01/99
Title I Complete	06/31/99	06/31/99
Conventional Construction-Start	08/15/99	08/15/99
Booster Penetration Complete	10/15/99	10/29/99
<u>Milestones Upcoming</u>	<u>Baseline</u>	<u>Forecast</u>
Title II Complete	06/30/00	06/30/00
Booster Mod. Design-Complete	06/30/00	06/30/00

e) Baseline Change proposals – None.

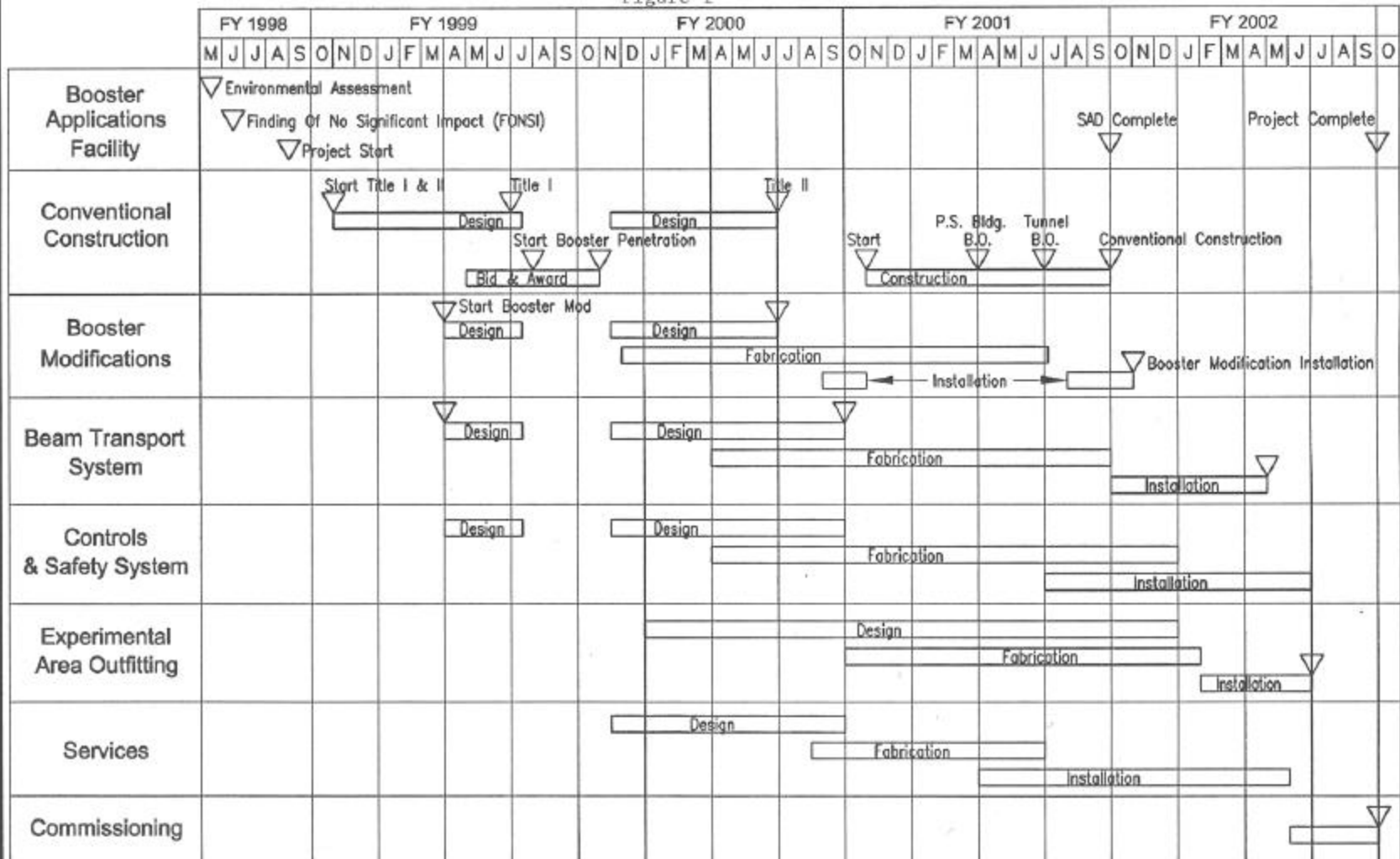
6) **Performance Analysis:** – method to be determined.

Table I
BAF Project Milestones

Project Start	10/01/98
Title I Start (Preliminary Design)	11/01/98
Booster Modification Design Start	04/01/99
Title II Start (Final Design)	04/01/99
Title I Complete	06/31/99
Conventional Construction Start	08/15/99
Booster Penetration Complete	10/15/99
Title II Complete	06/30/00
Booster Modifications Design Complete	06/30/00
Beam Transport System Design Complete	09/30/00
Safety Analysis document (SAD) Complete	09/30/01
Conventional Construction Complete	09/30/01
Booster Modifications Installation Complete	10/30/01
Beam Transportation System Installation Complete	04/30/02
Experimental Equipment Installation Complete	06/03/02
Project Complete	09/30/02

Booster Applications Facility Master Milestone Schedule

Figure I



* Milestones are for task completion unless otherwise noted.

TABLE II

**BOOSTER APPLICATIONS FACILITY (BAF)
EXPENSE and COMMITMENTS
As of April 30, 2000**

	Budget	EXPENSES				TOTAL EXPENSES	COMMIT.	TOTAL EXP. & COMMIT	BALANCE AVAILABLE
		Salary & Wage	Other Labor	Material & Contracts	Overhead				
1.1 Conventional Construction	3,098,000	63,043	214,418	321,673	136,995	736,129	92,393	828,522	2,269,478
1.2 Booster Modifications	2,407,000	466,419	105,784	69,429	136,532	778,164	63,331	841,495	1,565,505
1.3 Beam Transport System	1,829,000	291,310	357	31,714	62,155	385,536	45,015	430,551	1,398,449
1.4 Controls & Personnel Safety System	547,000	132,276	0	47,360	36,766	216,402	11,368	227,770	319,730
1.5 Exp. Area Outfitting	1,220,000	0	0	84,068	0	84,068	1,115,932	1,200,000	20,000
1.6 Long Term Support Lab	110,000			51,904	6,411	58,315	65,824	124,139	-14,139
1.7 Installation & Services	419,000	179,830	0	6,516	34,094	220,440	9,091	229,531	189,469
1.8 Project Services	1,669,500	329,889	0	20,016	270,271	720,176	4,500	724,676	944,824
Spares	150,000					0		0	150,000
1 BAF Construction	11,450,000	1,462,767	320,559	632,680	783,224	3,199,230	1,407,454	4,606,684	6,843,316

TABLE III
BOOSTER APPLICATIONS FACILITY (BAF)
COST ESTIMATE
Spending Profile
(\$ in Thousands)

	TOTAL	FY 1998	FY 1999	FY 2000	FY 2001	FY 2002
1.1 Conventional Construction	3,803	202	83	2,400	1,118	0
1.2 Booster Modifications	3,742		219	1,831	1,301	391
1.3 Beam Transport System	4,478		44	1,441	2,336	657
1.4 Controls & Personnel Safety System	1,236		33	431	509	263
1.5 Exp. Area Outfitting	2,710		0	1,042	1,169	499
1.6 Long Term Support Lab	351			110	141	100
1.7 Installation & Services	1,708		7	194	730	777
1.8 Project Services	1,129		96	338	338	357
	19,157	202	482	7,677	7,752	3,044
Contingency	3,796	38	0	1,484	1,623	651
Overhead	4,649	52	100	1,819	1,862	816
1 BAF Construction (FY98 \$)	27,602	292	582	10,980	11,237	4,511
Escalation	1,912		0	560	876	476
Full Cost Recovery @ 3%	993	9	18	357	375	234
1 (TEC) BAF Construction (BA AY \$)	30,507	300	600	11,897	12,488	5,222
Spares	1,294			3	12	1,279
Commissioning	1,299					1,299
1 (TPC) Total Project Cost (BA AY \$)	33,100	300	600	11,900	12,500	7,800
1 (TPC) BAF Construction (BO AY \$)	33,100	300	600	10,000	12,000	10,200