Status Report: 13
Status as of: 31 May 2001

Contract Title:

BOOSTER APPLICATIONS FACILITY

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

Reporting Period: April 1, 2001 – May 31, 2001

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.

Project Head's Summary Assessment:

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

W.B.S. 1.0 BAF Construction Summary

Overall good progress continues to be made and with the end of Winter, the pace of the conventional construction has accelerated. The Power Supply and Experimental Support buildings are well underway and should be completed in time for equipment installation .

W.B.S. 1.1 Conventional Construction

Foundations for Power Supply Building and Experimental Support Building are complete. Concrete Alcove and Target Room structures are complete. Installation of corrugated metal tunnel is complete. Backfill around tunnel is complete The earth retaining wall installation is complete. Underground plumbing and electrical work is completed for the Power supply and experimental Support buildings. Substation underground conduit installation has begun. Construction is 55% complete at end of May.

W.B.S. 1.2 Booster Modifications:

1.2.1.1 Thin Septum: The detailed design for the thin septum is 95% complete. Long lead items such as the drive mechanism, vacuum feed-throughs , bellows, motors and heating blankets have been ordered. An assembled magnet core which includes the copper septum is being fabricated. The magnet will be electrically tested and have magnetic measurements performed.

1.2.1.2 Thick Septum: Central Shop fabrication of magnet stand is complete. Manufacture of magnet iron core parts (2 sets) is complete.

All drawings, except for the conductors, have been completed and approved. Shop estimates for all parts, including conductors, have been received and approved.

Delivery of the BAF extraction tube and Booster beam tube parts of the vacuum chamber is expected by the end of June. The hollow tube, copper conductor was delivered on 14 June.

The current plan shows completion of all magnet parts and the start of magnet assembly by the end of July.

1.2.2 Power Supplies

1.2.2.2 Ejection Septum: The bus work was sent to the shops for fabrication. The copper bars are on order and delivery is expected August 1. The braided connectors are in house as well as the special "Everdur" hardware. We have started work on the Resistance Fault Monitor System which will be used to protect the Extraction Magnet Coils.

1.2.2.3 Tune Quads: No report of major manufacturing problem. Will check on vendor's progress during June 27 - 30 visit

1.2.2.4 Sextupoles: No report of major manufacturing problem. Will check on vendor's progress during June 27 - 30 visit.

1.2.2.5 Bumps: Draft of Final Design Report from Danfysik has been received. The need for capacitor bank discharge circuit has been established. Danfysik reported that they had problem fitting all components into their standard racks.

1.2.2.6 Spill Servo: no change

1.2.3 Equipment Modifications

1.2.3.1 D4 and D6: No Change.

1.2.3.2 D6 Beam Dump and Wall Current Monitor: Completed coating a vacuum break with a fired resistor and a fired conductor. The unit passed the leak check. The shop will weld the coated vacuum break with the beam pipe and CF flange. Continued to coat the second vacuum break as the spare.

1.2.3.3 D3 IPM and Beam Dump Kicker: No change.

1.2.3.4 Vacuum System Modifications: Approximately 70% of the heating blankets have been ordered for the Booster Modifications. The remaining blankets are in the detailed design stage of which is approximately 80% complete. A vacuum valve which will be used for security beam stop has been received. Detailed design of the modifications to the existing Booster Ring bakeout system is about 75% complete.

W.B.S. 1.3 <u>Beam Transport System</u>

1.3.1 Magnets

Magnet measurements of the air cooled trim magnets were completed. Due to the small beam size at the location of these trims only integrated field measurements were performed and it was verified that the trims provide the required kick.

The prototype of the beam line trim magnets (9x14D18) was completed and more extensive field measurement were done to evaluate higher field harmonics. The design goal was a field uniformity of 0.5% or better at a radius of 3". A long harmonic coil of radius 3.125" was used to measure harmonics in the integrated field up to the 14-pole, and all amplitudes of higher harmonics were found to be 0.14% or less at the maximum design current of 450A. This is in very good agreement with results from the TOSCA model that was used in the design of the magnet and predicted a field uniformity of about 0.2% at 3" radius. The measurements verified that the edge shims on the trim magnet poles have the right size, and the production of the eight 9x14D18 magnets can proceed.

Quadrupole assembly is approximately 70% complete.

All octupole coils and trim magnet coils needed for the beam line have been received from the vendor.

Dipole assembly is 15% complete.

1.3.2 Power Supplies

BAF beam-line power supplies are still on schedule from Danfysik. We are maintaining close contact with Danfysik to finalize the details of the changes resulting from the final Design Review.

1.3.3 Vacuum System

1.3.3.1 Beam Tubes, Bellow and Valves: Approximately 75% of the detailed design is complete. Vacuum flanges were ordered and received. The bellows and pump tees are on order and due at BNL July 17th. Special vacuum chambers, the collimator, and NEG pipe are in checking. Beam pipe support stands have been detailed and also in checking. Vacuum hardware such as bolts and seals are on order.

1.3.3.2 Pumps, Power Supplies and Gauges: The ion pumps and power supplies are on order and a partial shipment was received. The NEG pumps were received. The Residual gas analyzers as well as the vacuum gauges are on order. QC was performed on The NEG pumps.

1.3.3.3 Instrumentation and Controls: Approximately 60% of the heating blankets are out for bid. The remaining blankets are in the final stages of detailed design. Heater tapes and TC wire have been purchased. The detailed design of the bake-out system for the transport line is approximately 80% complete.

1.3.3.4 Transport Line Bake-out System: The order for vacuum gauges and controllers was placed, with delivery expected in July. Fast valve cable was ordered & received. Additional coaxial cable was ordered, due in late June. ControlLogix PLC system evaluation and design is underway.

1.3.4 Instrumentation

1.3.4.1 Flags and Cameras: Orders were placed for radiation hardened cameras for upstream flag locations.

We are testing media converter performance and compatibility for use in digitizing the analog video from the radiation hardened cameras and have begun detailed design of flags, mechanical actuators, vacuum chambers, and filter wheels.

1.3.4.2 Collimators: The collimator assembly (upstream of D6) was successfully tested using VME controls and a high level application.

Preparations are underway for motion/control tests for the stripping foil/flag assembly.

1.3.4.3 and 1.3.4.4 Ion Chamber, Scintillator and SWICS:

- Effort continues on the procurement/assembly of SWIC electronics.
- Ordered VME based high voltage power supply system.
- Ordered Scintillator signal conditioning electronics.
- Further development of instrumentation interface with controls.
- Assembly of detailed cable lists in preparation for procurement.
- Continue development of signal transfer interface between C-AD and NASA.
- Received racks for electronics in building 957.
- Considering alternative solutions for Instrumentation motion techniques and control.
- Completed structural tests of candidate vacuum window materials and thickness. Test results indicate a machined 0.012 inch (0.3mm) thick 2219 aluminum window will meet or surpass yield and ultimate stress requirements.
- Submitted RFQ to Central Shops for fabrication of instrument stands.

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

1.4.1 Controls

1.4.1.1 Distributed systems: A simpler monitor module will be used for sensing the state of the BAF beam permit link than originally planned. Detailed documentation of sub-system designs continued at a reduced level because of resource limitations All procurements were on schedule.

1.4.1.2 Central Services: More detail was added to the WBS in this area and tentative assignments were discussed for software development, which was expected to begin during the summer.

1.4.1.3 Process Controls**:** VME microprocessor boards and parts for waveform generator transition modules were received. The Digital and Analog I/O boards for instrumentation interfaces have been ordered. The motor control board has also been ordered, after an investigation of the effect of a vendor model change was completed. Continuing with the documentation of the controls.

1.4.2 Personnel Safety System:

The field cabinet's construction is over 75% complete. The design for the gate and tunnel systems is at the final stage.

W.B.S. 1.5. Experimental Area Outfittng

1.5.1 Dosimetry Control

Software: The data monitoring system is complete and partially tested.

The startup of the control system has been automated - - it is no longer necessary to start individual software components by hand.

The trace logger is complete, and is being integrated into the control system.

The display sub-system is complete, and is being integrated into the control system.

Hardware: We have resolved the problem with the Recycling Integrator analog switches. (See previous report).

We ordered and have received 1000 SD-5000 analog switches, which perform to the requirements necessary to implement a high performance Recycling Integrator. The Recycling Integrator is the front-end electronics for measuring the delivered dose. The design for BAF requires approximately 400 of these devices; thus we have 150% spares. The logic of getting so many spares is that the SD-5000 is no longer in production.

The difficulties with the analog switches have pushed back that portion of the project by 4-5 months. However, absent any more unforeseen obstacles, the Recycling Integrators will be completed on time.

1.5.2 **Support Rooms – General:** No change.

1.5.3 **Support Room A:** No change.

1.5.4 **Support Room C:** 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: The unit substations are being installed and approximately 40% complete. The 15 kV feeder to the substation is 90% complete.

The design for the distribution to the UEB is near completion and will be going out for bid soon. The switchboard procurement is with purchasing.

1.7.2 Equipment Cooling Water: All major change orders with the piping contractor, to date, have been resolved. Most all BNL material orders have been received and are in storage. There is no active pump room work in progress. Pump room activity is dependent on the progress of building construction. Construction activity is currently in progress at this time. The change orders for the tunnel piping and in Bldg 930 has been received and is currently being authorized.

1.7.3 Installation: Cable tray layout for Bldg 957 is approximately 80% complete. CPVC for water cooled buss has been ordered.

W.B.S. 1.8 Project Services

1.8.1 Project Management: No issues

1.8.2 Fiscal: No change

1.8.3 Quality Assurance: No Change

1.8.4 Environment, Safety and Health

3) Open Items:

4) Summary Status Assessment and Forecast

a) Financial Status

A total of $18,516,574 was expensed or obligated of the $21,281,000 available. Costs represented $11,865,718 and open commitments stood at $6,650,856. The Project Total Estimated Cost (TEC) is $31,207,000. The Total Project Cost (TPC) is at $33,900,000.

b) Table II shows detailed expenses and commitments.

c) Table III shows the projected project spending profile.

d) Schedule Status

Milestones completed	Baseline	Actual
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
Title II Complete	06/30/00	06/30/00
Beam Transport Design-Complete	09/30/00	09/30/00
Milestones Upcoming	**Baseline**	**Forecast**
Booster Mod. Design-Complete	06/30/01	06/30/01

e) The critical path for the Project is indicated in Figure 1. The crucial part of the critical path are items in WBS 1.2. The items in this WBS can only be installed when the Booster is in a scheduled shutdown. If the appropriate window of opportunity is missed the Project completion will be delayed .The projected schedule now provides a schedule contingency of 3 months between being ready for installation of Booster modification and start of the shutdown.

f) Baseline Change proposals – During this reporting period, there have been no baseline change proposals.

g) Cost Performance: Figure 2 provides a measure of project performance relating the planned budget profile versus expenses and commitments. Obligations and expenses fell slightly below expectations for this period but the rate is increasing. Management focus has increased in this area.

Table I
BAF Project Milestones

	Modified
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	06/30/01
Beam Transport System Design Complete	09/30/00
Safety Analysis document (SAD) Complete	09/30/01
Conventional Construction Complete	06/30/02
Booster Modifications Installation Complete	08/31/02
Beam Transportation System Installation Complete	12/30/02
Experimental Equipment Installation Complete	03/31/03
Project Complete	06/30/03

Figure 1

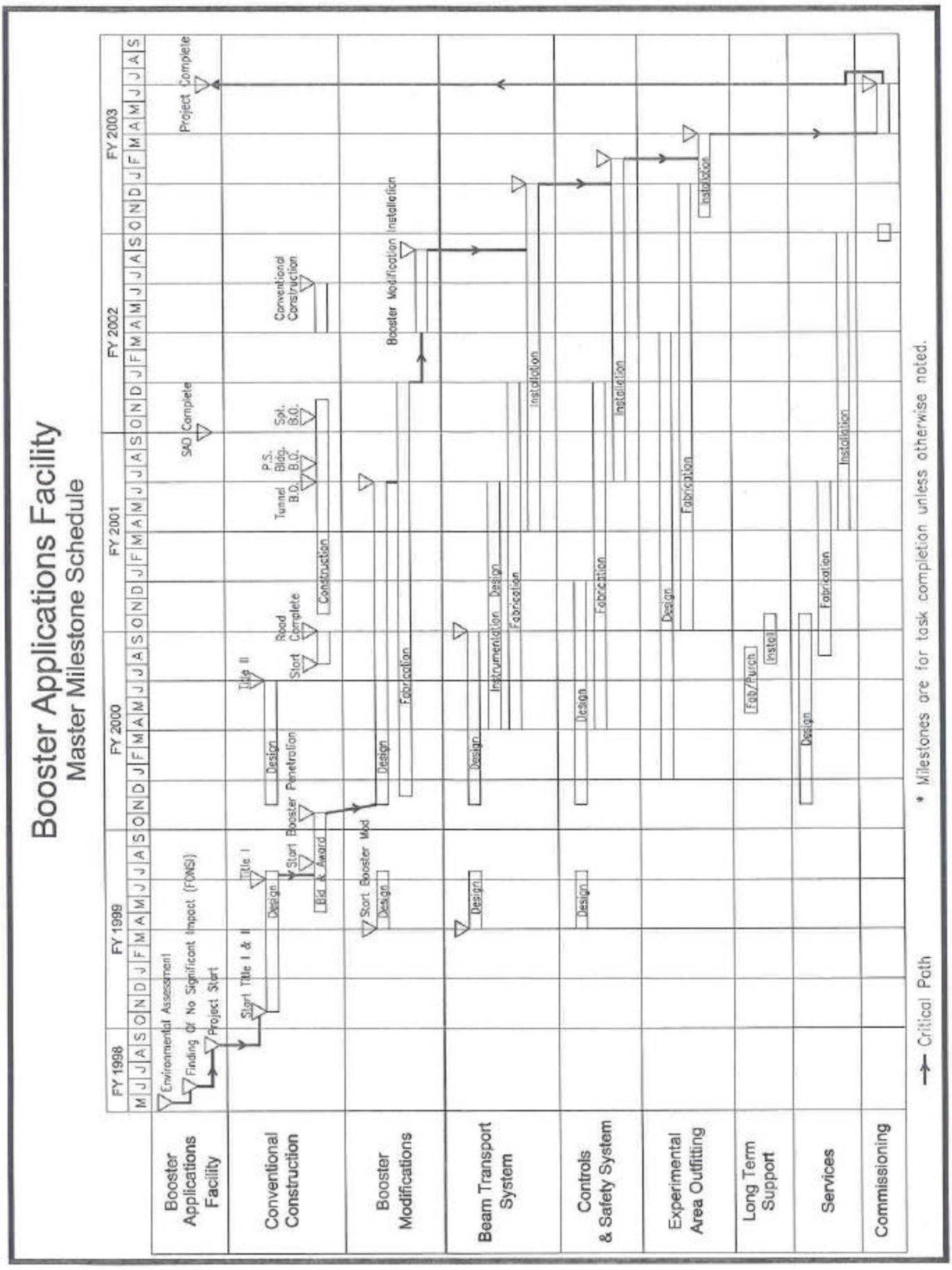
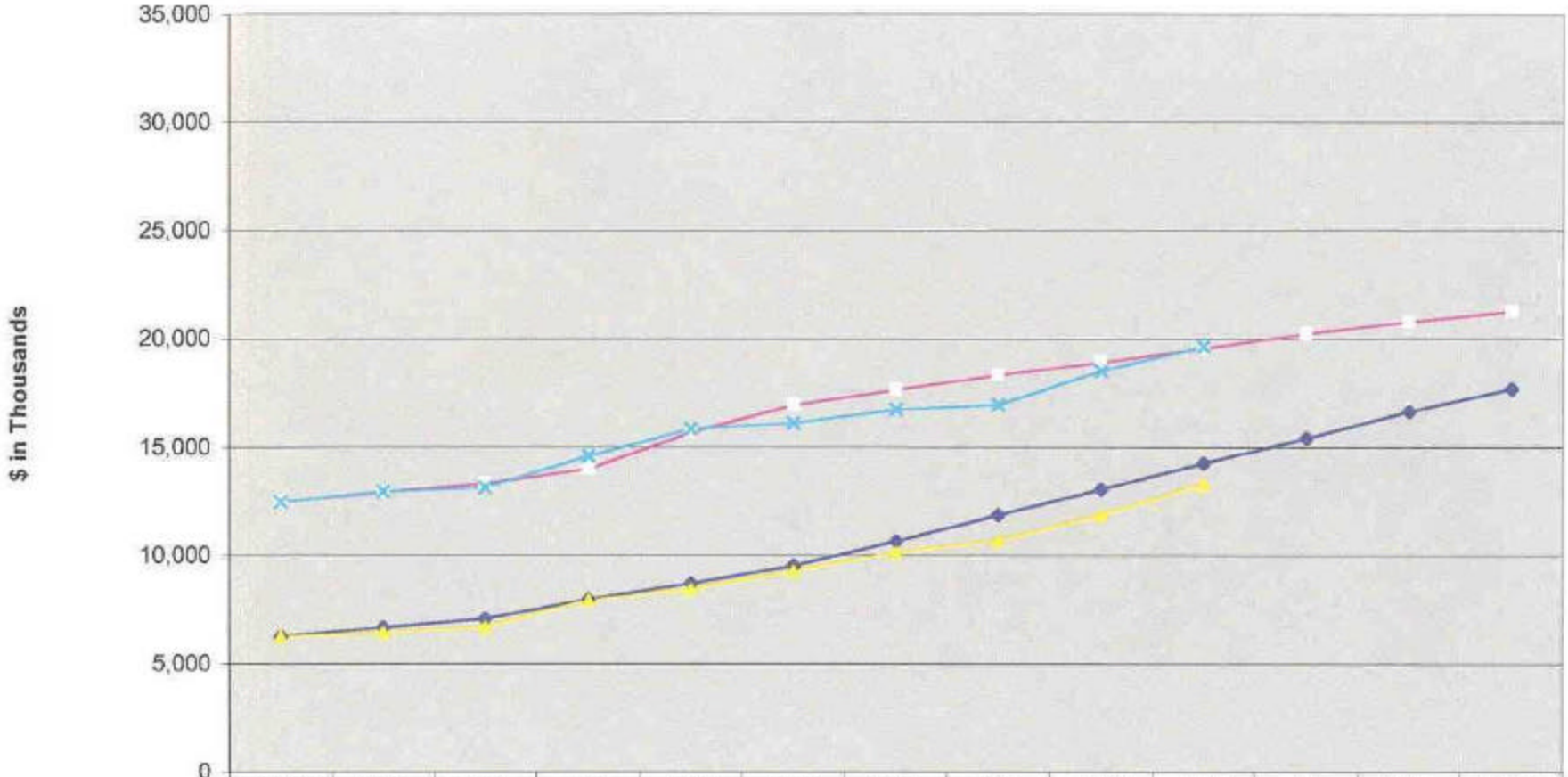

Booster Applications Facility
Master Milestone Schedule
FY 1998
FY 1999
FY 2000
FY 2001
FY 2002
FY 2003
M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S
Booster Applications Facility
Conventional Construction
Booster Modifications
Beam Transport System
Controls & Safety System
Experimental Area Outfitting
Long Term Support
Services
Commissioning
Environmental Assessment
Finding Of No Significant Impact (FONSI)
Project Start
Start Title I & II
Title I
Design
Start Booster Penetration
Bid & Award
Title II
Design
Road Complete
Start
Construction
P.S. Bldg. B.O.
Tunnel B.O.
Spl. B.O.
SAD Complete
Conventional Construction
Project Complete
Start Booster Mod
Design
Design
Fabrication
Booster Modification Installation
Design
Instrumentation Design
Fabrication
Installation
Design
Design
Fabrication
Installation
Design
Fabrication
Installation
Fab/Purch
Install
Design
Fabrication
Installation
Critical Path
* Milestones are for task completion unless otherwise noted.

Figure 2

BAF Performance Measurement



	Prior Yrs	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
BCWS (BO)	6,248.0	6,673.0	7,063.0	7,956.0	8,695.0	9,519.0	10,653.0	11,870.0	13,050.0	14,240.0	15,400.0	16,655.0	17,698.0
BCWS (BA)	12,471.0	12,903.0	13,318.0	13,988.0	15,678.0	16,923.0	17,653.0	18,324.0	18,895.0	19,576.0	20,247.0	20,809.0	21,271.0
ACWP (BO)	6,248.0	6,439.9	6,711.6	7,939.9	8,441.7	9,287.4	10,115.0	10,685.5	11,865.8	13,270.1			
ACWP (BA)	12,471.0	12,926.0	13,130.0	14,578.0	15,829.6	16,087.9	16,715.4	16,941.9	18,517.6	19,653.3			

TABLE II

BOOSTER APPLICATIONS FACILITY (BAF)
EXPENSE and COMMITMENTS
As of May 31, 2001

	Budget	EXPENSES Salary & Wage	Other Labor	Material & Contracts	Overhead	TOTAL EXPENSES	COMMIT.	TOTAL EXP. & COMMIT	BALANCE AVAILABLE
1.1 Conventional Construction	5,698,000	85,6691	590,089	2,499,669	444,942	3,620,369	2,099,167	5,719,536	(21,536)
1.2 Booster Modifications	4,157,000	1,041,919	199,436	327,248	337,342	1,905,945	1,389,357	3,295,302	861,698
1.3 Beam Transport System	3,635,000	851,512	126,845	290,138	230,543	1,499,038	1,619,554	3,118,592	516,408
1.4 Controls & Personnel Safety System	824,000	298,459	49,193	227,412	119,946	695,010	88,403	783,413	40,587
1.5 Exp. Area Outfitting	1,842,000	3,163	0	1,100,438	139,596	1,243,197	582,189	1,825,386	16,614
1.6 Long Term Support Lab	456,000	0	2,095	291,225	46,068	339,388	2,279	341,667	114,333
1.7 Installation & Services	2,073,000	436,630	34,949	395,600	149,647	1,016,817	812,525	1,829,342	243,658
1.8 Project Services	1,969,000	656,315	0	59,297	777,801	1,493,413	2,250	1,495,663	473,337
CONTINGECY	200,000					0		0	200,000
SPARES	427,000		17,548	25,834	9,159	52,541	55,132	107,673	319,327
1 BAF Construction	21,281,000	3,373,667	1,020,146	5,216,861	2,255,044	11,865,718	6,650,856	18,516,574	2,764,426

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

		TOTAL	FY 1998	FY 1999	FY 2000	FY 2001	FY 2002	FY 2003
1.1	Conventional Construction	5,698	290	80	4,728	600	0	0
1.2	Booster Modifications	5,251		282	1,747	2,128	1,094	0
1.3	Beam Transport System	5,739		56	963	2,616	2,104	0
1.4	Controls & Personnel Safety System	1,557		8	507	309	733	0
1.5	Exp. Area Outfitting	3,068		0	1,200	502	1,242	124
1.6	Long Term Support Lab	456		0	383	73	0	0
1.7	Installation & Services	2,739		9	1,237	827	666	0
1.8	Project Services	3,659	10	165	985	949	915	635
		28,168	300	600	11,750	8,004	6,754	759
	Contingency	3,040	0	0	0	200	2,390	450
1 (TEC)	BAF Construction (BA AY $)	31,207	300	600	11,750	8,204	9,144	1,209
	Spares	1,294			50	396	656	192
	Commissioning	1,399					0	1,399
1 (TPC)	Total Project Cost (BA AY $)	33,900	300	600	11,800	8,600	9,800	2,800
1 (TPC)	BAF Construction (BO AY $)	33,900	300	600	5,348	11,452	12,500	3,700

TABLE IV
BAF CHANGE CONTROL
$1000's

Date	Change No.	W.B.S.		Base Line	Change	Adjusted Base Line	Contingency Increase (Decrease)	Contingency Balance	Description
6/30/00	1	1.1		3,803	870	4,673			Modified WBS elements to include overhead, escalation and FCR.
		1.2		3,742	1,109	4,851			
		1.3		4,478	1,160	5,638			
		1.4		1,236	321	1,557			
		1.5		2,710	358	3,068			
		1.6		351	104	455			
		1.7		1,708	463	2,171			
		1.8		1,129	2,129	3,258			
			Contingency	3,796	1,037	4,833	4,833	4,833	
			Overhead	4,649	0	0			
			Escalation	1,912	0	0			
			FCR	993	0	0			
8/31/00	2	1.1		4,673	425	5,098	-425	4,408	Vendor Bid exceeded estimate
8/31/00	3	1.7		2,171	68	2,239	-68	4,340	Vendor Bid exceeded estimate
11/30/00	4	1.0		31,100	800	31,900	200	4,540	Modified spending profile to coinside with NASA operating plan
11/30/00	5	1.0		Changed Project Completion Date from 9/30/02 to 6/30/03					Modified schedule to match spending profile
11/30/00	6	1.3		Changed Completion Date from 4/31/02 to 9/30/02					Modified schedule to match spending profile
11/30/00	7	1.4		Changed Completion Date from 6/30/02 to 3/31/03					Modified schedule to match spending profile
11/30/00	8	1.5		Changed Completion Date from 6/30/02 to 3/31/03					Modified schedule to match spending profile
11/30/00	9	Commissioning		Changed Completion Date from 9/30/02 to 6/30/03					Modified schedule to match spending profile

TABLE IV continued
BAF CHANGE CONTROL
$1000's

Date	Change No.	W.B.S.	Base Line	Change	Adjusted Base Line	Contingency Increase (Decrease)	Contingency Balance	Description
11/30/00	10	1.1	5,098	600	5,698	-600	3,940	Vendor Change orders to cover soil conditions, upgrading water line under beam tunnel and Plant Engineering oversight
11/30/00	11	1.2.1	1,322	200	1,522	-200	3,740	Design effort exceeded estimate
11/30/00	12	1.2.2	1,982	200	2,182	-200	3,540	Vendor bid exceeded estimate
11/30/00	13	1.7.1	353	200	553	-200	3,340	Substation reconditioning more extensive than estimated
11/30/00	14	1.7.2	641	300	941	-300	3,040	Detailed Design increased cost
12/30/00	15	1.3.2	1,513	-250	1,263	250	3,290	Vendor bids lower than estimate
12/30/00	16	1.3.4	2,007	-150	1,857	150	3,440	Detailed design resulted in lower device costs
12/30/00	17	1.3.1	599	400	999	-400	3,040	Vendor bids exceeded estimate,design effort exceeded estimate
12/30/00	18	1.2	Booster Modification Completion Date changed from 10/31/01 to 8/31/02					RHIC operating schedule modified,eliminating fy'01 summer shutdown
01/20/01	19	1.2	Design complete extended from 12/31/00 to 6/30/01					Design effort extended due to loss of personnel.