Status Report: 12
Status as of: 31 March 2001

Contract Title:

BOOSTER APPLICATIONS FACILITY

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

Reporting Period: February 1, 2001 – March 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. Changes to the electrical power requirement coupled with the early on-set of winter weather slowed the progress on the power supply building.

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 in progress. The earth retaining wall installation has begun. Underground plumbing and electrical work is completed for the Power supply and experimental Support buildings. Substation underground conduit installation has begun. Construction is 45% complete at end of March.

W.B.S. 1.2 Booster Modifications:

1.2.1.1 Thin Septum: The vacuum chamber is about 95% complete in detailed design. The internal magnet assembly detailed design is complete. The drive mechanism detailed design is about 80% complete. Heating blankets are being detailed. A prototype magnet core was fabricated and received. The porcelain coating furnace has been fully tested. A mock-up magnet core has been fabricated and will be used as a baseline part to establish porcelain coating firing times. A copper septum is in fabrication for the prototype magnet along with other parts necessary for assembly.

A visit was made to the vendor that will be used for brazing of the septum. During the visit the details of the brazing fixture were defined.

1.2.1.2 Thick Septum Magnet: Central Shop fabrication of magnet stand is in process.

Manufacture of magnet iron core parts (2 sets) is complete. Drawings for other magnet steel parts, excluding cores, and vacuum chamber are complete and approved . Estimates from Central Shop for the fabrication of these items have been received and approved based on preliminary drawings. Schedule for completion of fabrication is estimated to be the end of June.

The BAF extraction tube part of the vacuum chamber has been ordered. The hollow tube, copper conductor has been ordered.

A study to verify the position of the thick septum magnet in the beamline has been completed.

Design of bus bar arrangement and lead connections to the thick septum magnet is in process.

1.2.1.3 Foil Stripper: The manufacture of the foil stripper, collimator and flag located upstream

of the Thick Septum Magnet is completed. The manufacture of a second vacuum chamber to house these components for the spare magnet is in process. Programming/Testing of the stepper/drive for the collimator is also in process. The stripper drive will be changed from a DC servo motor to a stepper. This modification has not been started.

1.2.1 Power Supplies

1.2.2.1 Thin Septum: As of March 23, 2001, the manufacturer reports that most of the components have been mounted and the wiring is about to begin and they are on schedule. The detailing process of buss bar is in process and orders for the bus copper and flexible connections have been placed.

1.2.2.2 Thick Septum: The design review was held at the Vendor's facility and the proposed design The manufacturer reports that most of the components have been mounted and the wiring is about to begin and they are on schedule. The orders for the bus copper and flexible connections have been placed.

1.2.2.3 Tune Quads: Manufacturing of power supplies in progress. Important technical issues such as rise-time improvement were resolved by computer simulation. Simple problems were addressed by email.

1.2.2.4 Sextupoles: Fabrication is in progress.

1.2.2.5 Bumps: Preparation of Final Design Report by Danfysik is in Progress.

1.2.2.6 Spill Servo: The Booster Active Filter Electronics Testing is in progress.

1.2.2 Equipment Modifications

1.2.3.1 D4 and D6: No Change.

1.2.3.2 D6 Beam Dump and Wall Current Monitor: Performed eight tests in February and March to learn the technique of how to fire the ceramic (conductor and resistor) around the circumference of the vacuum break successfully and consistently. The difficulty was that when firing the ceramic at 850^{o}C (following the manufacturer's instruction) the fired conductor would crack along the joint between the Kovar sleeve and the ceramic break. Currently we have determined that with a 600^{o}C firing temperature (a little bit under fired), we can obtain a reasonably good conductor coating around the joint. However, for the resistor coating, a much higher firing temperature would be required to cure the coating properly. More testing is required before we are ready to begin fabri-cating the production units.

1.2.3.2 D3 IPM and Beam Dump Kicker: The detailed design of the D3 straight section is 40% complete.

1.2.3.4 Vacuum System Modifications: Design continues. A solicitation package with drawings and a specification for heating blankets is being prepared to go out for bid. The heating blankets in this package will be used for ring half-cells and several different vacuum pumps.

W.B.S. 1.3 Beam Transport System

1.3.1 Magnets Quadrupole assembly is approximately 20% complete. Ten octupole coils and four trim magnet coils have been received from the vendor. Air cooled trim magnets assembly is complete and magnet measurements are being performed.

1.3.2 Power Supplies

A design review was held on March 29th and 30th at Danfysik and went very well. The beam line supplies are very similar to previously manufactured supplies and should present no difficulty for Danfysik. All power supplies are scheduled to be finished on October 31, 2001.

At the review some modifications to our original specifications were presented and accepted. The changes are:

1. Steerer supplies will now be 460 Amps from 450 mps to accommodate standard DCTT head.
2. Added automatic tap changers for the transformer taps so that we can easily accommodate different particle species.
3. Added water mat boards with solenoid valves to inhibit water flow to power supply in case of a water leak.
4. Pre-drilled holes will be added for the installation of Kirk key lock systems at BNL.

1.3.3 Vacuum System

1.3.3.1 Beam Tubes, Bellow and Valves: The bellows, pump tee and support stand drawings for the vacuum pumps have been checked and are being released for fabrication. The interference of the extraction line with the D7 half-cell has been eliminated and the parts are being detailed. The interference was eliminated by making offsets in the vacuum flanges of 0.25 inches at the extraction septum flange and then making another offset after the quad to center the vacuum pipe on beam centerline. The NEG pipe(contains "getter" strip for vacuum pumping) in the wall separating the Booster from the BAF tunnel is being detailed.

1.3.3.2 Pumps, Power Supplies and Gauges: A partial shipment of ion pumps was shipped to Brookhaven. The ion pump power supplies will not be shipped to Brookhaven until August. The vendor is releasing an upgraded version of the supply at this time

1.3.3.3 Instrumentation and Controls: The ion pump cable was ordered and has been delivered. Gauge cable was ordered and received. The equipment racks for Vacuum, Controls, and Instrumentation have been received. Rack power requirements were updated. The Vacuum PLC model has been selected with input from the Controls Group: it will be an Allen Bradley Control Logix PLC. Heating blankets are being design for the bake-able section of the vacuum system.

1.3.3.3 Transport Line Bake-out System: No change

1.3.4 Instrumentation

1.3.4.1 Flags and Cameras: No Change.

1.3.4.2 Collimators: The stepping motor for the collimator was successfully tested on long cables. The collimator assembly was brought to the motion development building for test and evaluation.

1.3.4.3 and 1.3.4.4 Ion Chamber, Scintillator and SWICS: Testing continues on the Vacuum Windows to finalize the thickness. Current results indicate that a .012 inch (0.3 mm) thick window will satisfy the burst pressure rating of 2.5 times vacuum. A vendor has been found to fabricate the bi-metallic flange and vacuum chamber. The large bellows have been ordered and will be received in 26 weeks. These are the longest lead-time items in this assembly. Detailed drawings are being created for signature and release.

Effort continues on the procurement/assembly of SWIC electronics, scanners, integrators and crates. Development continues of instrumentation interface with controls. Assembly of detailed cable lists in preparation for procurement has started and development has begun of signal transfer interface between C-AD and NASA.

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

1.4.1 Controls

1.4.1.1 Distributed systems: The BAF vacuum system interface has been specified. The Vacuum Group will use Alan Bradley Control net hardware for the vacuum PLC in bldg. 957. The control connect to the system will be a VMD/Controlnet board in the power supply VME chassis. The RS232 interface for the gauge read-backs will also be located n that VME chassis. A meeting was held to discuss a proposal for a BAF beam permit link, which will allow the dosimetry system to control the extraction of beam to the target area. Fiber-optic chassis power supplies were ordered. Detailed documentation of sub-system designs continued.

1.4.1.2 Central Services: No activity.

1.4.1.3 Process Controls**:** Preliminary discussions took place with Plant Engineering concerning the long-run, fiber optic cables for the BAF project. Preliminary plans were made for routing and patch locations. Controls patching from these locations will be laid out after a follow-up meeting scheduled for early April. New fiber will be patched to existing Booster infrastructure at Bldg. 930A.

VME microprocessor boards and parts for waveform generator transition modules were ordered during this period.

1.4.2 Personnel Safety System: The procurement of the PLC components is at the final stage. A number of modules have arrived at BNL. The field cabinet's construction is progressing and should be ready for installation in the service building in June.

W.B.S. 1.5. Experimental Area Outfittng

1.5.1 Dosimetry Control

Software: The various software components that implement the protocol for the manipulation of the fast scaling lists of the VMS-based system have been written and tested for the SUN-based BAF system.

It turned out that the data from the Crocker Nuclear Laboratory radiotherapy system was not easily usable for checking the fast scaling system for the BAF system, so a software simulation capability for the copy of the (VMS-based) AGS system running at LBL was developed. With the data from this, the fast scaling for the (SUN-based) BAF system has been checked out for the ion chambers, EGG chamber, and the SEM.

The various software components for the software interlock capability of the VMS-based system have been written and tested for the SUN-based BAF system.

Work is now in progress on the data monitoring system.

The trace logger is very close to being completed.

An initial version of the display system is close to being completed.

Hardware: The prototype Ion-Chamber is close to completion. Many of the ion-chamber foils have been made, and production continues. The prototype Recycling Integrator functioned well, until it was discovered that when the input current was high enough to saturate the input op-amp, the amp shorts its own input terminal to the negative power supply. This caused the amp to self-destruct and also destroys the analog discharge switch. The manufacturer of the op-amp was contacted. They know of the problem and suggested a new part. We have some samples on order, and will put them on the same prototype board when they arrive.

Other portions of the system such as the binary filter are being designed and fabrication will start soon.

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: All substation switch gear has been re-manufactured and is awaiting acceptance testing at the vendor.

1.7.2 Equipment Cooling Water: All Pump Room and associated drawings have been completed for the following:

1. All pump room equipment in the Bldg #957 .
2. PS piping from Bldg #957 underground to Bldg #931.
3. PS piping and connection to the existing system in Bldg #930.
4. PS piping to power supply area within #957.
5. Magnet piping through Bldg #957 through double containment piping to the tunnel.
6. Magnet piping and distribution in the tunnel.

All major equipment has been ordered.

The double containment piping has been installed by the contractor.

The underground piping between Bldg #957 and Bldg #931 has been installed and pressure tested.

There is no active on site pump room work in progress. The mechanical contractor is expected to proceed with active work on the pump room beginning in April. This is dependant on the status of the building construction at that time.

BNL design and the mechanical contractor are currently in communication on their material order. All changes are being noted and will be reflected in an updated version of the "as

1.7.3 Installation: Cable tray layout for Bldg 957 is approximately 40% complete. Copper for water cooled buss has been ordered.

W.B.S. 1.8 Project Services

1.8.1 Project Management

A low level milestone, Beneficial Occupancy for the Power Supply Building, has been rescheduled from April1,2001 to July 31,2001.This slip has been caused by the early on- set of freezing weather and modifications to the electrical system to handle increased power supply loads. This change has no effect on the project completion date. The power supplies that will be installed in the building are scheduled to be delivered after October 31,2001.This modification has been integrated into the project schedule.

1.8.2 Fiscal

No change.

1.8.3 Quality Assurance

No Change.

1.8.4 Environment, Safety and Health

The first draft of the Safety Analysis Document (SAD) is complete.

3) Open Items:

4) Summary Status Assessment and Forecast

a) Financial Status

A total of $16,715,359 was expensed or obligated of the $19,925,000 available. Costs represented $10,115,001 and open commitments stood at $6,600,358. 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 at period end the trend is upward.

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

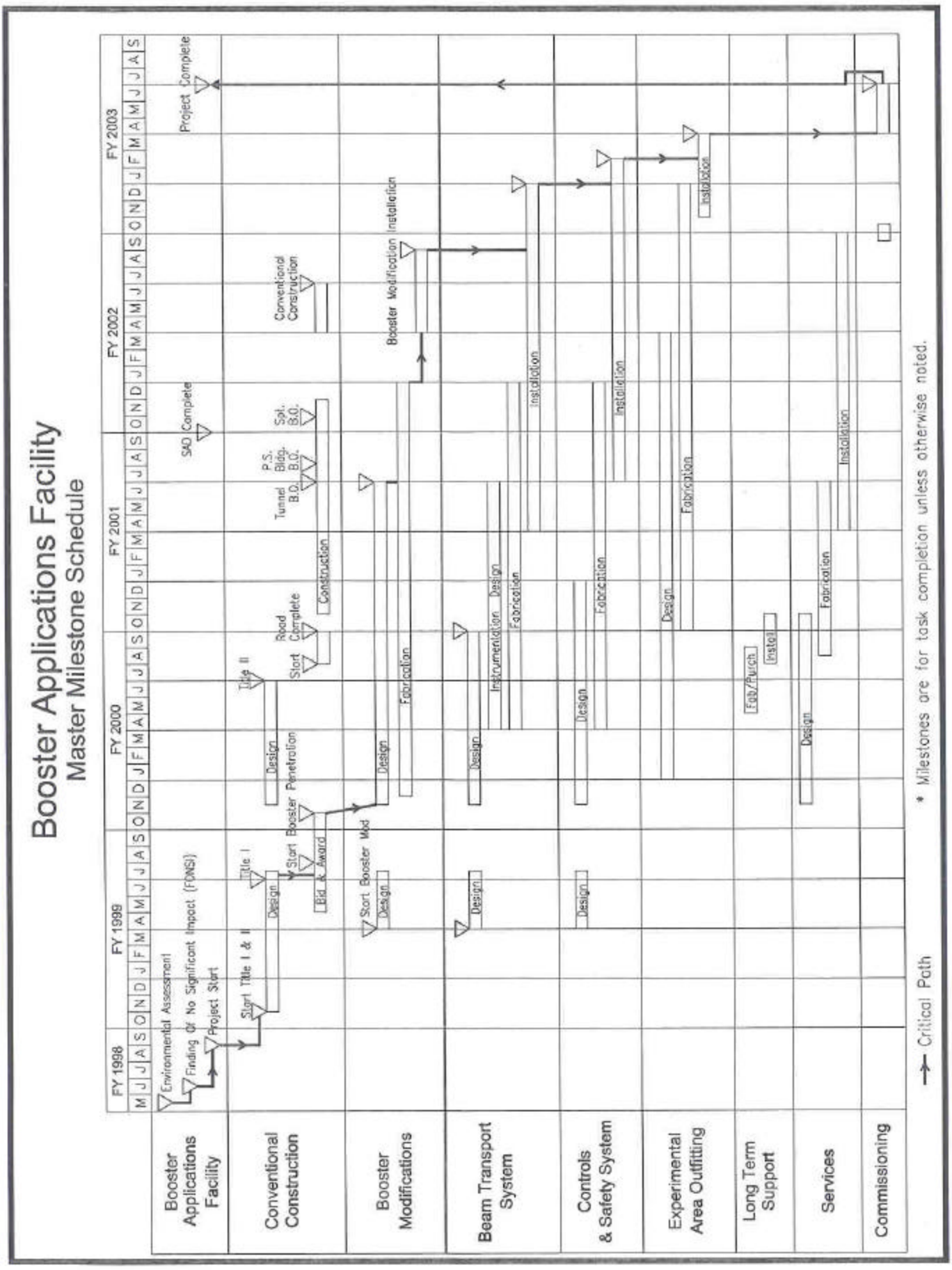
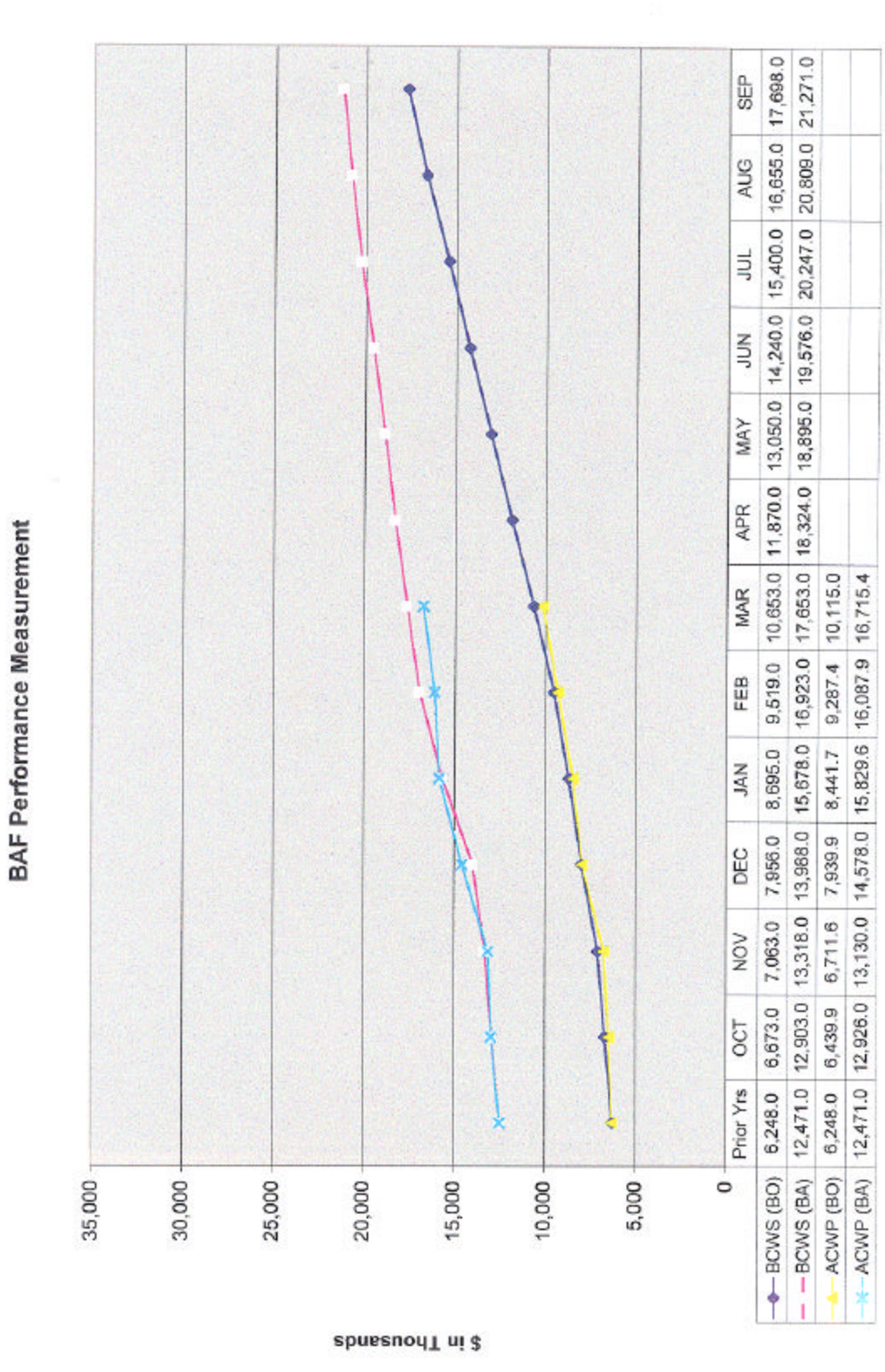

Booster Applications Facility
Master Milestone Schedule
FY 1998
FY 1999
FY 2000
FY 2001
FY 2002
FY 2003
M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S
Booster Applications Facility
Conventional Construction
Booster Modifications
Beam Transport 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
Booster Modification Installation
Project Complete
Start Booster Mod
Design
Design
Fabrication
Design
Instrumentation Design
Fabrication
Installation
Design
Fabrication
Installation
Design
Fabrication
Installation
Fabrication
Installation
Design
Fabrication
Installation
Critical Path
* Milestones are for task completion unless otherwise noted.

Figure 2



	Prior Yrs	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
BCWS (BD)	6,248.0	6,673.0	7,063.0	7,956.0	8,595.0	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 (BD)	6,248.0	6,439.9	6,711.6	7,939.9	8,441.7	9,287.4	10,115.0						
ACWP (BA)	12,471.0	12,926.0	13,130.0	14,578.0	15,829.6	16,087.9	16,715.4						

TABLE II
BOOSTER APPLICATIONS FACILITY (BAF)
EXPENSE and COMMITMENTS
As of March 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	84,159	521,650	2,070,871	494,337	3,171,017	2,491,482	5,662,499	35,501
1.2 Booster Modifications	3,223,000	890,282	178,091	315,597	301,906	1,685,876	1,026,717	2,712,693	510,407
1.3 Beam Transport System	3,635,000	752,345	108,181	236,510	197,788	1,294,824	1,139,578	2,434,402	1,200,598
1.4 Controls & Personnel Safety System	765,000	283,566	49,193	188,817	107,486	629,062	104,793	733,855	31,145
1.5 Exp. Area Outfitting	1,800,000	3,140	0	788,414	101,919	893,473	894,213	1,787,686	12,314
1.6 Long Term Support Lab	383,000	0	2,095	286,650	44,859	333,604	342	333,946	49,054
1.7 Installation & Services	1,989,000	395,314	23,704	209,139	115,369	743,526	933,941	1,677,467	311,533
1.8 Project Services	2,109,000	601,448	0	44,397	678,242	1,324,087	8,745	1,332,832	776,168
CONTINGECY	200,000					0		0	200,000
SPARES	123,000		11,235	21,471	6,826	39,532	547	40,079	82,921
1 BAF Construction	19,925,000	3,010,254	894,149	4,161,866	2,048,732	10,115,001	6,600,358	16,715,359	3,209,641

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 10/31/03					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

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.