Status Report: 15
Status as of: 30 September 2001

Contract Title:

BOOSTER APPLICATIONS FACILITY

Performing Organization:	Brookhaven Science Associates
Location:	Brookhaven National Laboratory Upton, New York 11973-5000
Reporting Period:	August 1, 2001 – September 30, 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: Excellent progress continued on the conventional facilities, Booster Modification components and Beam Line magnets and instrumentation. Installation of water- cooled buss and Beam Line magnets has started. Beneficial Occupancy of the Power Supply Building was permitted in early September

W.B.S. 1.1 Conventional Construction : The Power Supply Building structure is complete, painting and partition walls completed, and electrical installation 75% complete. The Experimental Support Building structure is complete, metal siding and roofing 95% complete, interior walls, painting, electric and plumbing in progress. The Beam Tunnel electric conduit, cable trays, process water piping and lighting are 90% complete, painting is complete. Tunnel partially occupied by CA installation activities. Site work and utilities 90% complete, asphalt paving complete. HVAC and process water piping is in progress. Switchgear and transformer in place and energized. Construction is 80% complete.

W.B.S. 1.2 Booster Modifications:

1.2.1.1 Thin Septum: A complete Thin Septum Magnet has been fabricated and assembled. The assembled magnet passed a high pot and was powered up to 2000 amps Dc. The stepping motors, the motion drive system, position sensors and bellows have been received.

1.2.1.2 Thick Septum Magnet: All magnet parts for the first unit and the spare magnet have been manufactured The vacuum chamber for the first magnet has been assembled and welded. The magnet conductors for both units are 90% complete. The pre-assembly of the first magnet to verify design and fit is completed. Final assembly is expected during October.

1.2.1.3 D6 Foil Stripper/Collimator: The fabrication, assembly, and evaluation of the foil stripper/collimator/flag assembly for the first unit is completed. The manufacture of the parts for the spare is about 75% complete.

1.2.2 Power Supplies

1.2.2.2 Ejection Septum: The manufacturer has completed the construction of the power supply except for the development of a new control card The new card is necessary to make the power supply controls compatible with the upgraded Control System. The interface control units which will be necessary for the manufacturer to complete his development have just arrived at BNL and will be sent out as soon as they are tested here.

1.2.2.3 Tune Quads: One of the power supplies had undergone preliminary testing during our Sept. 11 -14 visit. Based on these tests, no major problem is expected in the final testing.

1.2.2.4 Sextupoles: Manufacturing in progress.

1.2.2.5 Bumps: Three power supplies are scheduled for delivery before the end of December 2001 The manufacturer(Danfysik) will ship the remaining three at the end of January, 2002.

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(WCM): The Beam dump is complete and the assembly of the "bakeable" WCM, in which a vacuum fired resistor and conductor were used, is complete.

1.2.3.3 D3 IPM and Beam Dump Kicker: No change.

1.2.3.4 Vacuum System Modifications: Approximately 95% of the heating blankets have been ordered for the Booster Modifications.

W.B.S. 1.3 Beam Transport System

1.3.1 Magnets: Octupole assembly and magnet measurement is 100% complete. All Trim magnet parts have been received and magnet assembly has begun.

1.3.2 Power Supplies : Manufacturing continues without problems at the vendor's facility and delivery is scheduled to begin at the end of November**.**

1.3.3 Vacuum System

1.3.3.1 Beam Tubes, Bellow and Valves: Approximately 90% of the detailed design is complete. A purchase order for special vacuum chambers, heating blankets and the collimator has been submitted for purchasing. Drawing for NEG strips are in checking. A purchase order was written for the NEG strip. Pump tee support stands are being fabricated in Central Shops and are approximately 50% complete. Two residual gas analyzers heads have been received. Drawings for the beam pipe support stands and bellows restraints are being released for fabrication. The fast closing valve was received and tested.

1.3.3.2 Pumps, Power Supplies and Gauges: The turbo roughing pumps have been received and are being assembled with controls and gauging. The beam-line vacuum gauges and controllers were received and tested. The gauges and controllers have passed acceptance tests.

1.3.3.3. The vacuum control system PLC and gauge controller mounting kits were received. Vacuum control rack wiring components and PLC communication cable were ordered and received. Gauge controller serial communication protocol was forwarded to the Controls Group

1.3.3.4 Transport Line Bake-out System: Instrumentation and Controls: Approximately 90% of the heating blankets are out for bid. The remaining blankets are in the final stages of detailed design. The detailed design of the bake-out system is approximately 95% complete.

1.3.4 Instrumentation

1.3.4.1 Flags and Cameras: We are investigating alternative CCD cameras for the BAF transport. The Sony DFW-300 CCD camera recently failed, we are troubleshooting this unit to identify the failed component. This camera was installed in the A line transport cave during the last NASA run with low energy iron beams.

The design of the flags is complete and machined parts are in fabrication, and most purchased parts have been received (except flag material). The flag uses a 24-volt ball screw actuator with automatic "freewheel" when full in or full out position is achieved. A timed relay (about 8 seconds) will be used and a trip switch will be installed after assembly for position indication for in and out.

Mirrors & Cameras: Design of stand and adjustable mirror mount and camera cubby with adjustable sliding support is in progress .

1.3.4.2 Collimators: No change in motion control status. We will continue when the mechanical group finishes the assemblies, and they are ready for testing.

Beam Plug (mechanical): Design of stand and vacuum box in progress. All actuator hardware has been received. This will have the same exact motor and rotary trip switch as the SWIC-Ion-Scintillator system. The accuracy of the rotary trip switch is more than adequate for this application.

1.3.4.3 and 1.3.4.4 Ion Chamber, Scintillator and SWICS

Design of vacuum components and motion system is in checking .The stands and vacuum box are being fabricated . The first thin-window vacuum chamber should be received shortly. All actuators, gearboxes and auxiliary hardware have been received. The motion system uses 110/220-volt motor with a rotary trip switch mounted directly to actuator drive shaft. Tests are planned to insure the required accuracy . (The "coast phase" needs to be repeatable within +/- .010 inches). If accuracy specifications are not met, a mechanical stop will be required . As above, a trip switch can be installed for position indication.

Effort continues on the assembly of SWIC electronics and development of signal transfer interface between beam line and experimental area.

The electrical design of the SWIC boards and assembly is complete. Vendor quotes are being solicited for production. (A new, larger "foil stretcher" for HV planes is needed.) Ion Chamber will use same planes as SWIC HV planes.

W.B.S. 1.4 <u>Controls and Personnel Safety System</u>

1.4.1 Controls

1.4.1.1 Distributed systems: The schematic and layout for the permit monitor board is complete. The board is now being routed. All parts for the board are now in house.

1.4.1.2 Central Services: No change

1.4.1.3 Process Controls**:** The MADC buffered input panels and the required power supply have been built and tested. The optically isolated RS232 boards for the vacuum interface have come in. The I/O boards for instrumentation controls and power supply controls also have come in. The documentation for installation of the controls is complete.

1.4.2 Personnel Safety System: Construction of PLC cabinets is completed. Good progress has been made on the key tree and gate box design.

W.B.S. 1.5. Experimental Area Outfittng

1.5.1 Dosimetry Control

Software: The integration of the display sub-system it into the control system has been mostly completed. Work continues on the process of adding channels for the new ring quad ion chambers and for the 16 by 16 ion chambers. The tune procedure, the Bragg procedure and the Hardware/Software Interface Document are finished.

QC1 test displays written (per Pulse counts, Accumulated Counts & Dose Displays).The System Print has been drawn and issued. Operator Control Display Window structure was written and tested. The structure has been partially populated with calls to completed procedures like tune and Bragg. Calls to other procedures will be added as they are completed.

Hardware: System level electronic hardware is complete. BNL has a copy of the complete system diagram.

The final design phases for the Recycling Integrator module and Irradiation Control Module are in progress

Interface signals to/from the Booster have been settled upon.

The Binary filter System has been designed but not yet drafted.

The High Voltage system has been designed but not yet drafted either, but some fabrication is proceeding.

1.5.2 Support Rooms – General: No change

1.5.3 Support Room A: Analysis of current needs is underway .

1.5.4 Support Room B and C: Vendors are being contacted, to obtain current model information, pricing and delivery times for equipment and furnishings for these rooms. Items include: microscopes, incubators, HEPA-filtered hoods, water purification systems, biochemical ice machines, and furniture (tables, chairs, cabinets, etc.).

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: No change.

1.7.2 Equipment Cooling Water: Progress is on schedule. Presently there are no known major obstacles. Overall Completion Estimate – 60%

Cooling Tower - The Cooling Tower installation is near complete. Supply and Return lines are in place, Ozone lines are currently being installed, and the drain line installation is complete. Heat tracing and insulation remain to be completed along with ancillary tower controls. Completion Estimate – 85%

Pump Room – Pump Room activity is in high speed. The tower pumps have been installed along with their respective temperature control valves. The Power Supply and Magnet Pumps and their Heat Exchangers are being installed as well as the piping to the tunnel. The PLC cabinet preparation has been completed for Pump Room installation in the coming months. Completion Estimate – 60%

Tunnel Piping - The major portion of tunnel piping is complete. The remaining uncompleted portion can't be installed until access to the Booster Tunnel is provided. This is expected early next year. Completion Estimate – 85%

Power Supply Piping – Piping to the supplies in Bldg 957 is small and is still under design. The major piping underground betweenBldgs.957 and 930 was installed early in the construction stage. The piping distribution within Bldg.930 remains to be completed. This can't be started because of limited AGS Booster Operations and is scheduled for the shutdown early next year. The contract for this effort is in place and awaiting the schedule. Completion Estimate – 20%

1.7.3 Installation: The Beneficial Occupancy review was held for Building 957 (Power Supply Building). Quadrupole magnets Q7 & Q8 have been placed in the tunnel. Survey control has been established in the tunnel and layout of magnet locations has begun. Water Cooled Buss (DC power to magnets) installation is approximately 25% complete.

W.B.S. 1.8 Project Services

1.8.1 Project Management: This reporting period was marked by accelerated project activity in all major areas .Manpower assignments peaked for the year due to the start of installation of beam line components and continued effort on Booster Modification component fabrication. Contingency was augmented by the transfer of $160,000 from Project Services. This was possible due to reassessment of expected burdens and overheads, fiscal expenses and ES&H effort associated with the preparation of the Safety Analysis Document. The remaining contingency for fiscal year 2001 was allotted to conventional construction ($200,000) and to Installation and Services($160,000). The increased construction costs included Plant Engineering increased design effort for electrical work and modifications of floor drains, doors and HVAC systems. The increased funding for Installation and Services covered increased costs in the equipment cooling water system that were underestimated in the design stage of the project.

1.8.2 Fiscal: The fiscal year ended with the virtual total commitment and expense of all the available funds. The year end balance was $19,785.

1.8.3 Quality Assurance: No issues.

1.8.4 Environment, Safety and Health: Open Items: None

3) Summary Status Assessment and Forecast

a) Financial Status

A total of $21,261,215 was expensed or obligated of the $21,281,000 available. Costs represented $18,180,036 and open commitments stood at $3,081,179. 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
Booster Mod. Design-Complete	06/30/01	06/30/01
Safety Analysis Document (SAD) Complete	09/30/01	06/15/01
Milestones Upcoming	**Baseline**	**Forecast**
Conventional Construction Complete	06/30/02	06/30/02

e) The critical path for the Project is indicated in Figure 1. The crucial parts 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, the budget for W.B.S. 1.8 (Project Services) was reduced by $160,000, the budget for W.B. S. 1.1 (Conventional Construction) was increased by $200,000 and the budget for W.B.S. 1.7 (Installation and Services) was increased by $160,000.

g) Cost Performance: Figure 2 provides a measure of project performance relating the planned budget profile versus expenses and commitments. Obligations and expenses met the predicted profile, while expenses exceeded the plan. This result was due in part to the early start of

Beam line installation and the early completion of magnet production. Reserves are adequate to meet project requirements until funding is made available in early October.

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

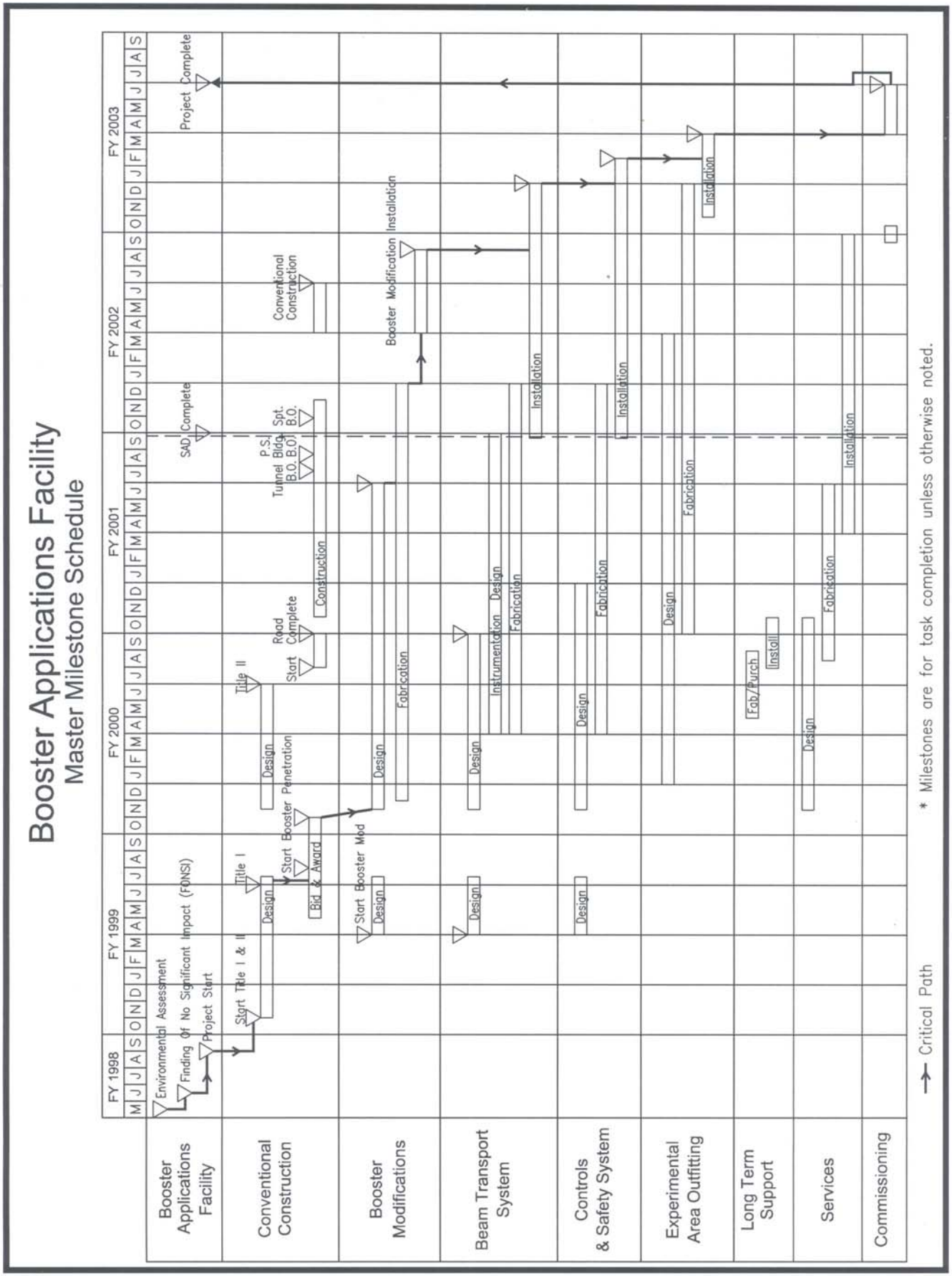
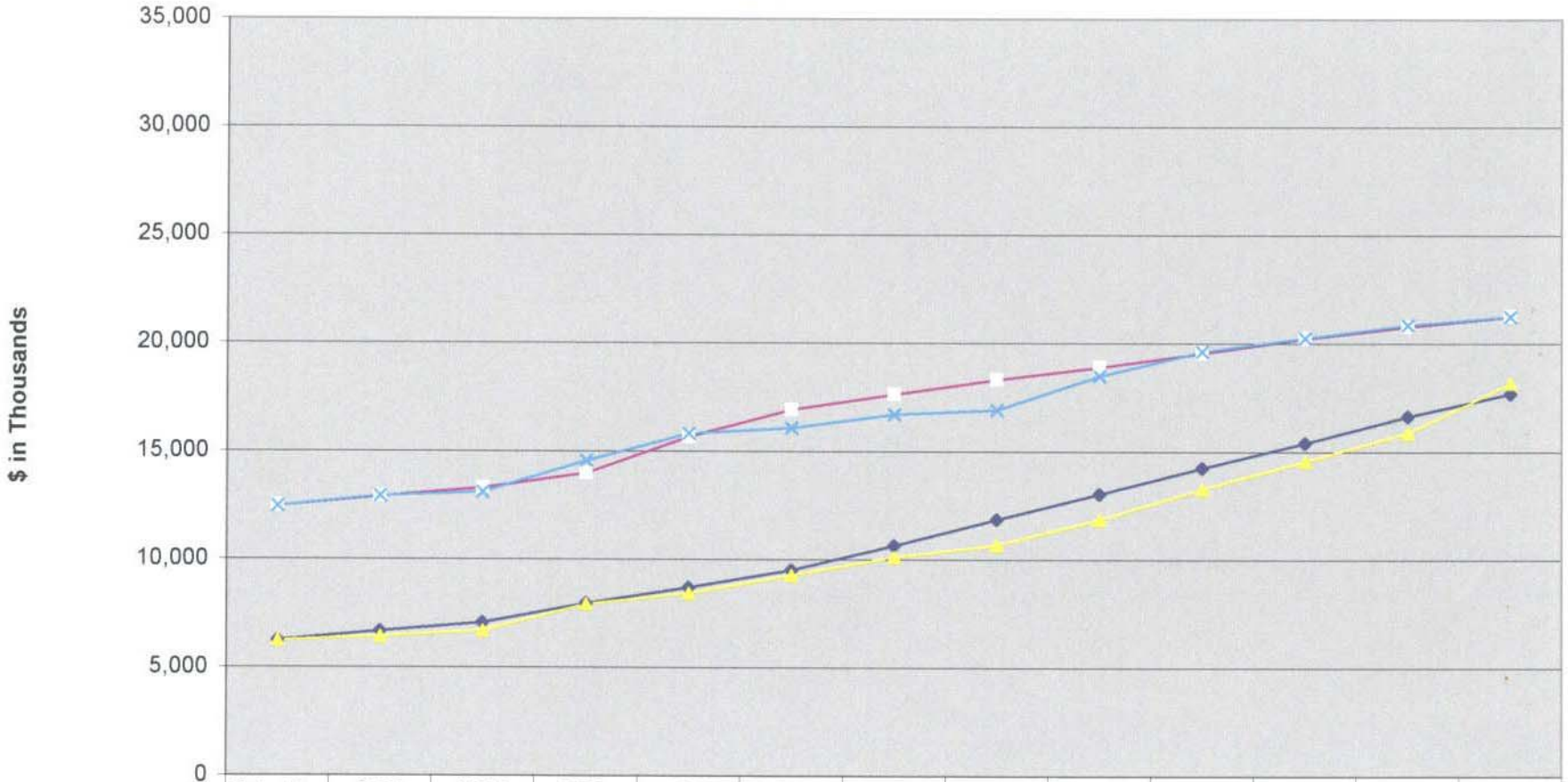

Booster Applications Facility
Master Milestone Schedule
FY 1998
FY 1999
FY 2000
FY 2001
FY 2002
FY 2003
M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S
Booster Applications Facility
Conventional Construction
Booster Modifications
Beam Transport System
Controls & Safety 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 Mod
Booster Penetration
Bid & Award
Title II
Start
Road Complete
Construction
P.S. Tunnel Bldg. B.O. B.O.
SAD Complete
Spt. B.O.
Conventional Construction
Booster Modification
Installation
Project Complete
Fabrication
Instrumentation
Design
Fab/Purch
Install
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	14,576.3	15,879.9	18,180.1
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	20,277.0	20,889.4	21,261.2

TABLE II

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

	Budget	EXPENSES Salary & Wage	Other Labor	Material & Contracts	Overhead	TOTAL EXPENSES	COMMIT.	TOTAL EXP. & COMMIT	BALANCE AVAILABLE
1.1 Conventional Construction	5,898,000	101,229	725,457	4,012,490	471,339	5,310,515	676,267	5,986,782	(88,782)
1.2 Booster Modifications	3,963,000	1,389,738	277,186	892,909	529,058	3,088,891	825,901	3,914,792	48,208
1.3 Beam Transport System	3,635,000	1,223,590	178,156	923,990	433,104	2,758,840	805,511	3,564,351	70,649
1.4 Controls & Personnel Safety System	1,083,000	402,576	49,317	427,036	177,543	1,056,472	27,588	1,084,060	(734)
1.5 Exp. Area Outfitting	1,7432,000	19,874	0	1,599,158	98,890	1,717,922	161,100	1,879,022	(136,022)
1.6 Long Term Support Lab	383,000	0	2,095	294,318	46,722	343,135	342	343,477	39,523
1.7 Installation & Services	2,398,000	550,358	85,805	1,062,904	244,965	1,944,032	419,149	2,363,181	34,819
1.8 Project Services	1,861,000	750,574	339	61,054	991,841	1,803,808	5,745	1,809,553	51,447
CONTINGECY	0					0		0	0
SPARES	317,000		57,072	72,512	26,837	156,421	159,576	315,997	1,003
1 BAF Construction	21,281,000	4,437,939	1,375,427	9,346,371	3,020,299	18,180,036	3,081,179	21,261,215	19,785

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	5,898	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	2,899		9	1,237	827	666	0
1.8	Project Services	3,499	10	165	985	949	915	635
		28,168	300	600	11,750	8,004	6,754	759
	Contingency	2,840	0	0	0	0	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
06/30/00	1	1.1 1.2 1.3 1.4 1.5 1.6 1.7 1.8 	Contingency Overhead Escalation FCR	3,803 3,742 4,478 1,236 2,710 851 1,708 1,129 3,796 4,649 1,912 993	870 1,109 1,160 321 358 104 463 2,129 1,037 0 0 0	4,673 4,851 5,638 1,557 3,068 455 2,171 3,258 4,833 0 0 0	4,833	4,833	Modified WBS elements to include overhead, escalation and FCR.
08/31/00	2	1.1		4,673	425	5,098	(425)	4,408	Vendor bid exceeded estimate
08/31/00	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 coincide with NASA operating plan
11/30/00	5	1.0		Changed Project Completion Date from 09/30/02 to 06/30/03					Modified schedule to match spending profile
11/30/00	6	1.3		Changed Completion Date from 04/31/02 to 09/30/02					Modified schedule to match spending profile
11/30/00	7	1.4		Changed Completion Date from 05/30/02 to 03/31/03					Modified schedule to match spending profile
11/30/00	8	1.5		Changed Completion Date from 06/30/02 to 03/31/03					Modified schedule to match spending profile
11/30/00	9	Commissioning		Changed Completion Date from 09/30/02 to 06/30/03					Modified schedule to match spending profile
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 & 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 08/31/02					RHIC operating schedule modified, eliminating FY01 summer shutdown
01/20/01	19	1.2		Design complete extended from 12/31/00 to 06/30/01					Design effort extended due to loss of personnel
09/30/01	20	1.8		3,659	160	3,499	160	3,200	Reduced budget due to projected lower project burden and fiscal and FS&H expenses.
09/30/01	21	1.1		5,698	(200)	5,898	(200)	3,000	Increase engineering design effort for electrical distribution & building modifications
09/30/01	22	1.7		2,739	(160)	2,899	(160)	2,840	Increased budget required for higher than expected vendor bids