

Status Report: 20
Status as of: 31 July 2002

Contract Title:

BOOSTER
APPLICATIONS
FACILITY



Performing Organization:
Location:

Brookhaven Science Associates
Brookhaven National Laboratory
Upton, New York 11973-5000

Reporting Period:

June 1, 2002 – July 31, 2002

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:

	<u>Last Month</u>	<u>This Month</u>
Cost:	satisfactory	satisfactory
Schedule	satisfactory	satisfactory
Technical	satisfactory	satisfactory
Overall	satisfactory	satisfactory

W.B.S. 1.0 BAF Construction Summary: The conventional construction effort is complete except for minor punch list items. Power supply testing is on going and vacuum system installation in the Beam line is nearing completion and testing is in progress. All Booster Modification components and power supplies are complete and installation and testing is in progress. Commissioning continued this reporting period. The project is estimated to be 85 % complete.

W.B.S 1.1 Conventional Construction: Complete

Minor punch list items remain.

W.B.S. 1.2 Booster Modifications: (Critical Path)

1.2.1 New Extraction Equipment: 99 % complete.

1.2.1.1 Thin Septum: Complete and installed.

1.2.1.2 Thick Septum Magnet: Field measurement and evaluation of the spare magnet has been completed. The field measurements were found to be in accordance with the design specification. The evaluation of the first article magnet will be conducted at a later date. The first article magnet was baked out under vacuum. Due to out-gassing rates beyond the stringent specifications, the collimator and foil stripper were removed and baked out separately at higher temperatures. The magnet assembly will be baked out again to evaluate the out-gassing rate.

1.2.1.3 Foil Stripper Assembly: The assembly is complete and the control system for the first article stripper/collimator/flag assembly is in test. The assembly of the spare is about 75% complete.

1.2.2 Power Supplies: Complete; testing and installation in progress.

1.2.2.1 Thin Septum Supply: Supply tested and installed; buss work installation in progress.

1.2.2.2 Ejection Septum Supply: Supply tested and installed; buss work installation in progress.

1.2.2.3 Tune Quads Supplies: Supply tested and installed; ring cable installation in progress

1.2.2.4 Sextupole: Supplies tested and installed; ring cable installation in progress

1.2.2.5 Bumps: Supplies tested and installed; ring cable installation in progress

1.2.2.6 Spill Servo: Cable installation scheduled. Active Filter P.S. moved into place in Building 930A

1.2.3 Equipment Modifications: 75 % complete.

1.2.3.1 D4 and D6: Modifications and installation in process.

1.2.3.2 D6 Beam Dump and Wall Current Monitor: Complete and installed

1.2.3.3 D3 IPM and Beam Dump Kicker: Complete and installed.

1.2.3.4 Vacuum System Modifications: Installation underway.

W.B.S. 1.3 Beam Transport System

1.3.1 Magnets: Complete.

1.3.2 Power Supplies: The final supply is to be received by mid September. All other supplies have been received and installed and testing continues.

1.3.3 Vacuum System: 80 % complete.

1.3.3.1 Beam Tubes, Bellow and Valves: Installation is 90 %Complete

1.3.3.2 Pumps, Power Supplies and Gauges: Installation Complete

1.3.3.3 Vacuum System Instrumentation & Controls: The PLC was installed in building 957. Ethernet communication with the PLC for remote valve control and status has been tested using RSView (PC) and pet (VME) applications. The ion pump and gauge controller RS-232 cables were installed. Serial communication of pump and gauge readings through the VME are in development. Gauge and pump cable terminations in 957 are complete; terminations in the tunnel are nearly complete. This WBS is 81% complete.

1.3.3.4 Transport Line Bake-out System: Installation 20% complete.

1.3.4. Instrumentation: 85 % complete.

1.3.4.1 Flags and Cameras: The 5 Sony DFWV-500 Fire-Wire CCD cameras were received and set up in the controls lab with an external trigger for testing. The controls group continues writing interface code and testing the frame grabber software and hardware. Engineering level application code has been written and tested for the plunging flag, neutral density filter, and control of the rotating D6 foil/flag assembly. A Gadolinium-Terbium phosphor flag was made based on the BAF transport parameters. It will be baked, and tested for vacuum compatibility. Three of the four vacuum chambers have been installed and surveyed in the beam line. The Camera Rail Assemblies are complete.

1.3.4.2 Collimators and Beam Plug: Engineering level application code has been written and tested for the D6 collimator. Beam Plug and Beam Plug Chamber have been baked and leak-checked. Motion Development, Survey and Installation into the beam line is also complete.

WBS 1.3.4.3 & 1.3.4.4 Ion Chamber, Scintillator & SWIC's

- The new SWIC electronics systems are nearly complete.
- The VME chassis (destined for bldg 957) testing with our instrumentation electronics using simulated beam signals continues. Definition, creation & testing of each individual Instrumentation/Controls simple and complex logical devices are underway.
- The VME chassis for building 930A is being assembled.
- The controls group is in the process of writing the necessary firmware to download into

the VME boards for the BAF interface. The connectors for the cable patch are in-house.

- Discussions about the high level Controls application requirements for data analysis and display continue.
- The racks for building 957 have been installed and powered, blowers & fans wired in.
- We now have the entire Bira High Voltage VME installed in the 957 service building.
- We continue cable terminations and inter-rack wiring in building 957, and installation of various rack hardware including the scintillator NIM electronics.
- The plunging SWIC/IC/Scintillator motion control contactor boxes have been received, modified and installed in the BAF transport tunnel. Cable dressing and termination in the BAF transport tunnel continues.
- Work has begun in the racks in building 930A for instrumentation and motion control for the BAF related items in the Booster ring.
- Rack DC power supplies chassis were assembled and tested. They will soon to be installed in 957 & 930A.

All Wire planes and HV Planes for SWIC's and Ion Chambers have been fabricated. Instrument Chamber parts are near completion. Scintillator material has been ordered Air SWIC fabrication is ongoing .

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

1.4.1 Controls: 80 % complete.

1.4.1.1 Distributed systems: The event link and the reset link for 957 and 958 is operational. Permit monitors were assembled and tested and installed in 930UEB, 930A, and 914. Fiber optic cables between 957, 939A, 930UEB, and 914 are installed and are being terminated.

1.4.1.2 Central Services: Field testing of power supply and vacuum system interfaces is beginning. Software development is beginning for instrumentation systems. Test platforms are being supported for engineering level testing of instrumentation. The first stage of software development and testing for Main Magnet application modifications is complete. Work has begun on modifications to the Optics Control application.

1.4.1.3 Process Controls: The power supply and vacuum control chassis was installed and is operational in 957. The fibers for power supplies control in 957 were also installed. All the Power supply interface chassis' were updated to the latest revision. The 930UEB power supply control chassis was assembled and tested and installed and is operational. The fibers for power supply control in 930UEB are also installed. The control chassis for 958 is installed. The instrumentation group is testing equipment with the control chassis for 957 instrumentation. The instrumentation chassis for 930A is being assembled.

1.4.2 Personnel Safety System: The BAF Access Controls System installation is completed. All sub-systems have been integrated and initial verification testing has started.

W.B.S. 1.5 Experimental Area Outfitting:

1.5.1 Dosimetry Control:

Software: In the report for April and May of 2002, it was reported that work had been started on a program to create setup files for radiobiology experiments. This program has been completed, as has a program to invoke a setup file created by this program. Both of these programs have been integrated into the menus for the control system.

The process of replacing the CAMAC crate, station, sub-address, function with VME crate number and address throughout the control system is complete. This required changes in the format of the hardware-specific input files, data structures and programs. With these changes in place, software simulation of the hardware is now implemented. This makes it possible to do software simulation of some hardware-related channels, while reading and commanding real hardware for other hardware-related channels. This will be of crucial importance as different hardware items become available at different times between now and the end of this calendar year. The first item of hardware to be integrated will be the range absorber.

Hardware: The new set of longer cables is being fabricated. These cables will make it possible to locate all dosimetry system electronics outside of the target hall.

The recycling integrator board is in fabrication.

The irradiation control module is in final layout.

Xilinx development is ready for initial checkout when the recycling integrator board is complete.

System Handover

C-AD staff visited LBNL in June to meet with their LBNL counterparts and begin the process of learning the system in order to take ownership at the beginning of calendar 2003. To facilitate this process, they will participate in some system development and integration tasks over the coming months.

1.5.2 to 4 Support rooms: Purchasing of equipment and installation continues.

W.B.S. 1.6 Long Term Support Lab: Outfitting 93 % complete.

W.B.S. 1.7 Installation and Services: 96% complete.

1.7.1 Electric Power Distribution: Complete

1.7.2 Equipment Cooling Water: Complete; testing in process.

1.7.3 Installation: All magnets have been installed and some cabling and termination work remains in the upper stub tunnel section.

Commissioning: Development of the detailed commissioning plan continues and subsystem commissioning has begun. On June 14th we tested the Booster Main Magnet Program (BMMP) for a planned BAF operating cycle successfully. The BMMP was modified so that during the power cycle flat top only one of the two high current units unit is on and the other bypassed. This was done to minimize

the current ripple during the flat top, as well as to limit stresses of the phase shifting transformers. Minimizing current ripple during flat top improves extracted beam quality. A 5000 ampere cycle with a one second flat top was used and the Booster Main Magnet system performed as predicted. The modification of the BMMP incorporated an automatic bump on the current reference at the end of the flat top. The bump amplitude was 0.5% of the main cycle and the width was 50 milliseconds. As a result of this bump the voltage change was all incorporated in a single voltage reference, enabling the second unit to turn on during invert. As a result of this test the available voltage during ramp up and down is 2000 Volts maximum (both units are on), and the ripple during the flat top is only the ripple from a single unit.

W.B.S. 1.8 Project Services

- 1.8.1 Project Management: In consultation with the DOE Project Manager \$274,000 was assigned from contingency. This leaves a balance of \$656,000 on \$3,341,593 remaining to be expensed and committed. The details of these actions are outlined in section 3(f) and Table IV.

The Booster Accelerator shut started on June 15 and after allowing a cool down period for reducing radiation exposure to personnel, installation of Booster components started .

- 1.8.2 Fiscal: No change.

- 1.8.3 Environment, Safety and Health: The Accelerator Readiness Review process has been started and the final report approval is scheduled for completion before October 7th.

Quality Assurance: No issues.

3) Summary Status Assessment and Forecast

- a) Financial Status

A total of \$29,902,407 was expensed or obligated of the \$31,105,000 available. Costs represented \$28,592,954 and open commitments stood at \$1,309,453. The Project Total Estimated Cost (TEC) is \$31,657,000. 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

<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
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
Conventional Construction Complete	06/30/02	07/31/02
<u>Milestones Upcoming</u>	<u>Baseline</u>	<u>Forecast</u>
Booster Modification Installation Complete	09/30/02	09/30/02

- d) The critical path for the Project is indicated in Figure 1. WBS 1.2 is now on the critical path. The majority of the items in this WBS can only be installed during the Booster shutdown which is now in progress. The current estimate for installation is 3.5 months, including time to allow “cool-down” of radioactive components. The Booster shutdown began on June 15 and beam operations in the Booster are scheduled to resume October 7, 2002. This is a tight schedule and it is essential that adequate staffing is available. Sixteen additional technicians have been added to the Department staff to augment our resources.
- e) Baseline Change Proposals – During this reporting period, the budgets for the following W.B.S.’s were augmented/decreased with transfer of funds to and from contingency. The justifications for the modifications are given in Table IV. There is no change in scope or total project cost.

<u>WBS</u>	<u>Description</u>	<u>New Budget</u>
1.1	Conventional Construction	\$6,635,000
1.2.1	New Extraction Equipment	\$1,765,000
1.2.2	Power Supplies	\$2,792,000
1.2.3	Equipment Modifications	\$1,331,000
1.3.3	Vacuum System	\$1,582,000
1.4.2	Personnel Safety System	\$ 651,000
1.7.1	Electric Power Distribution	\$ 735,000
1.7.2	Equipment Cooling Water	\$1,261,000
1.7.3	Installation	\$1,660,000
1.8.4	ES&H	\$ 397,000

- g) Cost Performance: Figure 2 provides a measure of project performance relating the planned budget profile versus expenses and commitments. Obligations and expenses were \$166,000 less than planned, and expenses were \$802,000 less than forecast. These differences are not significant at this stage of the Project.

Table I
BAF Project Milestones

	<u>Projected</u>
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	07/31/02
Booster Modifications Installation Complete	09/31/02
Beam Transport System Installation Complete	12/30/02
Experimental Equipment Installation Complete	03/31/03
Project Complete	06/30/03

Figure 1

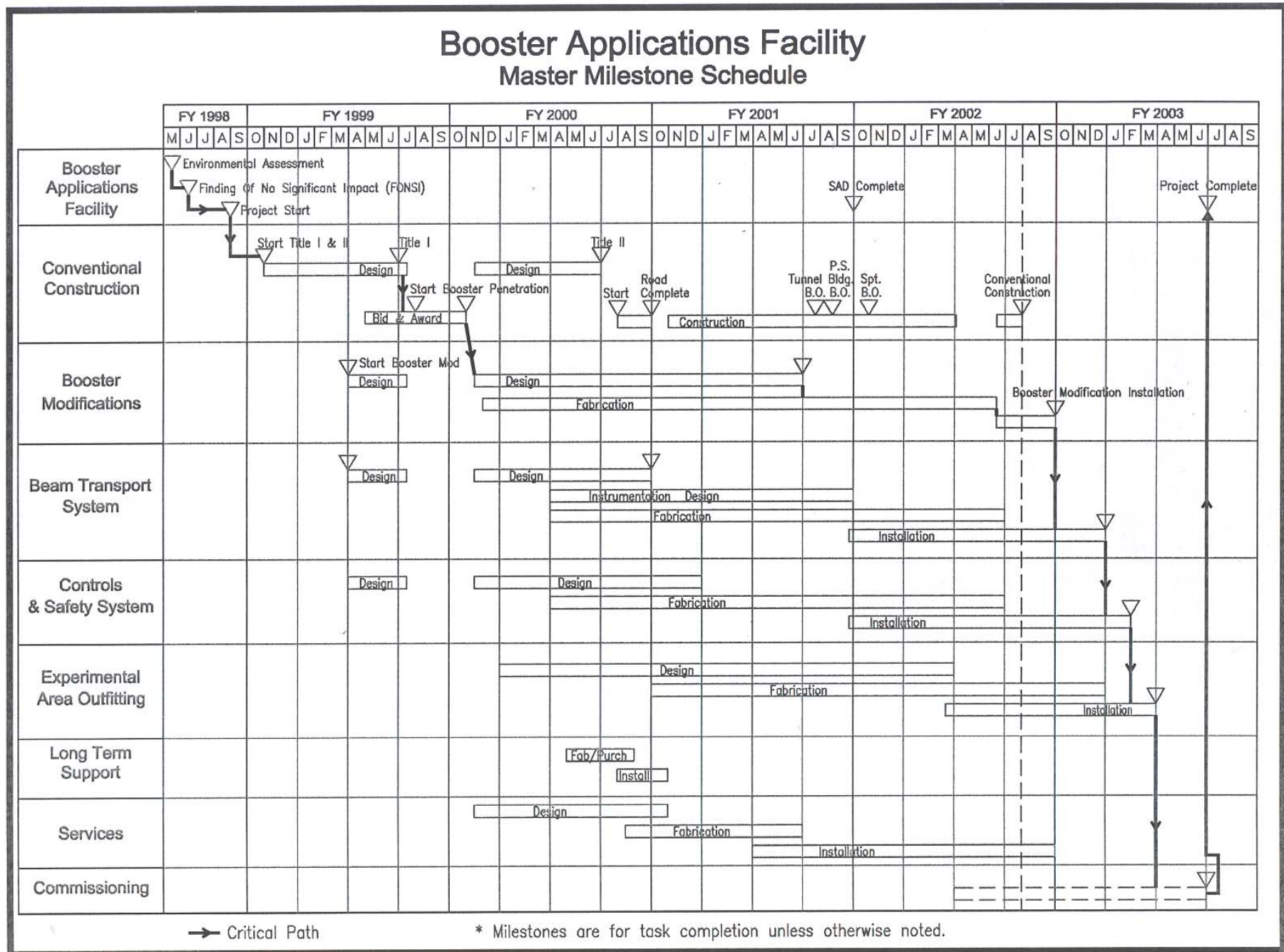


Figure 2

BAF Performance Measurement

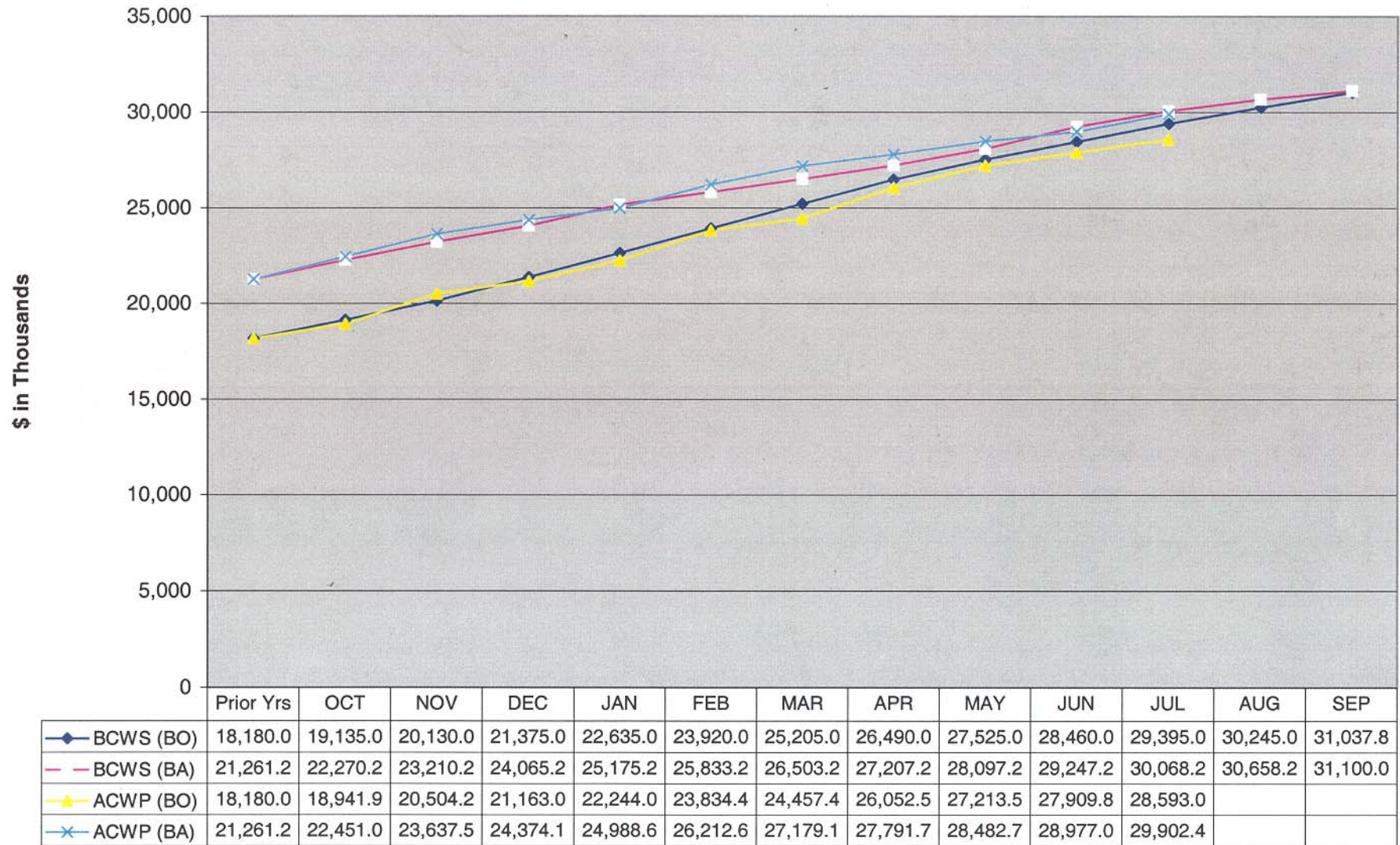


TABLE II
BOOSTER APPLICATIONS FACILITY (BAF)
EXPENSE and COMMITMENTS
As of July 31, 2002

	Budget	Salary & Wage	EXPENSES Other Labor	Material & Contracts	Overhead	TOTAL EXPENSES	COMMIT.	TOTAL EXP. & COMMIT	BALANCE AVAILABLE
1.1 Conventional Construction	6,635,000	133,094	966,384	4,828,761	584,678	6,512,917	95,903	6,608,820	26,180
1.2 Booster Modifications	5,888,000	1,968,220	615,596	2,107,983	931,618	5,623,417	56,120	5,679,537	208,463
1.3 Beam Transport System	5,491,000	1,959,428	332,357	1,824,676	801,645	4,918,106	318,876	5,236,982	254,018
1.4 Controls & Personnel Safety System	1,647,000	583,657	107,973	547,060	255,241	1,493,931	32,316	1,526,247	120,753
1.5 Exp. Area Outfitting	3,264,00	57,287	10,317	2,462,693	198,172	2,728,469	511,362	3,239,831	24,169
1.6 Long Term Support Lab	456,000		2,095	340,202	59,676	401,973	19,710	421,683	34,317
1.7 Installation & Services	3,656,000	983,414	259,095	1,827,764	462,162	3,532,435	38,025	3,570,460	85,540
1.8 Project Services	3,139,000	1,030,523	62,582	185,237	1,558,865	2,837,207	108,210	2,945,417	193,583
CONTINGECY	101,000					0		0	101,000
SPARES	653,000	31,646	73,818	340,507	87,212	533,183	124,431	657,614	(4,614)
Commissioning	175,000	5,135	0	4,003	2,178	11,316	4,500	15,816	159,184
1 BAF Construction	31,105,000	6,752,404	2,430,217	14,468,886	4,941,447	28,582,954	1,309,453	29,902,407	1,202,593

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

WBS	ELEMENT	TOTAL	FY 1998	FY 1999	FY 2000	FY 2001	FY 2002	FY 2003
1.1	Conventional Construction	6,635	290	80	4,628	989	648	0
1.2	Booster Modifications	5,888		282	1,747	1,886	1,973	0
1.3	Beam Transport System	5,491		56	961	2,547	1,927	0
1.4	Controls & Personnel Safety System	1,722		8	497	579	563	75
1.5	Exp. Area Outfitting	3,364		0	1,200	679	1,385	100
1.6	Long Term Support Lab	456		0	343	0	113	0
1.7	Installation & Services	3,656		9	1,237	1,117	1,293	0
1.8	Project Services	3,789	10	165	985	650	1,329	650
		31,001	300	600	11,598	8,447	9,231	825
	Contingency	656	0	0	0	0	101	555
1 (TEC)	BAF Construction (BA AY \$)	31,657	300	600	11,598	8,447	9,332	1,380
	Spares	844			50	266	337	191
	Commissioning	1,399					175	1,224
1 (TPC)	Total Project Cost (BA AY \$)	33,900	300	600	11,648	8,713	9,844	2,795
1 (TPC)	BAF Construction (BO AY \$)	33,900	300	600	5,348	11,932	12,858	2,862

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

TABLE IV
BAF CHANGE CONTROL
\$1000's
(continued)

Date	Change No.	W.B.S.		Base Line	Change	Adjusted Base Line	Contingency Increase (Decrease)	Contingency Balance	Description
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
11/30/01	23	1.1		5,698	602	6,300	(602)	2,238	Increase required for HVAC controls, doors and canopy at alcove, HVAC duct work, structural steel work, berm liner, engineering and inspection and overhead costs increases.
11/30/01	24	1.2		5,251	100	5,351	(100)	2,138	Increase required for D3 septum development and buss work fabrication for D3 and D6 power supply installation.
11/30/01	25	1.3.1		999	25	1,024	(25)	2,113	Increase required for magnet monitoring system and octupoles.
11/30/01	26	1.7		2,899	197	3,096	(197)	1,916	Increase required for electrical distribution system transformer rework and cooling system changes for power supplies.
01/31/02	27	1.1		6,300	300	6,600	(300)	1,616	Increased cost for engineering oversight.

TABLE IV
BAF CHANGE CONTROL
\$1000's
(continued)

Date	Change No.	W.B.S.		Base Line	Change	Adjusted Base Line	Contingency Increase (Decrease)	Contingency Balance	Description
01/31/02	28	1.2.1		1,472	100	1,572	(100)	1,516	Development and manufacturing costs exceeded estimates.
01/31/02	29	1.2.3		1,547	200	1,347	200	1,716	Design and manufacturing costs lower than estimate.
01/31/02	30	1.3.1		1,024	200	1,224	(200)	1,516	Fabrication and procurement exceeded estimate.
01/31/02	31	1.3.2		1,263	300	963	300	1,816	Procurement costs lower than estimate.
01/31/02	32	1.3.3		1,620	100	1,720	(100)	1,716	Fabrication costs exceeded estimate.
01/31/02	33	1.4.2		486	100	586	(100)	1,616	Design change added costs to building access system.
3/31/02	34	1.2.1		1,572	50	1,622	(50)	1,566	Cover increased manufacturing costs for thin septum magnet
3/31/02	35	1.2.2		2,532	150	2,682	(150)	1,416	Cover installation effort and materials for power supplies
3/31/02	36	1.5.1		2,706	296	3,002	(296)	1,120	Additional software and hardware effort required to complete Dosimetry system
3/31/02	37	1.7.3		1,245	50	1,295	(50)	1,070	Increased effort in survey and installation coordination
3/31/02	38	1.8.4		122	165	287	(165)	905	Funding to re-rout storm line located under Booster B 6 Dump
3/31/02	39	Spares		1,294	450	844	450	1,355	Spares estimate more than as built shops and manufacturer's costs
5/31/02	40	1.1		6,600	60	6,660	(60)	1,295	Cost increase for retaining wall
5/31/02	41	1.2.1		1,622	50	1,672	(50)	1,245	Magnet measurement cost increase
5/31/02	42	1.3.1		1,224	(135)	1,089	135	1,380	Magnet system came in under budget
5/31/02	43	1.7.1		700	25	725	(25)	1,355	Re-installation of repaired transformer
5/31/02	44	1.7.2		1,151	100	1,251	(100)	1,255	Control system cost increases
5/31/02	45	1.7.3		1,295	250	1,545	(250)	1,005	Rigging and survey costs exceeded estimates
5/31/02	46	1.8.4		272	75	347	(75)	930	Beam dump cap under estimated
7/31/02	47	1.1		6,660	(25)	6,635	25	955	Credits from Vendor
7/31/02	48	1.2.1		1,672	93	1,765	(93)	862	Installation underestimated
7/31/02	49	1.2.2		2,682	110	2,792	(110)	752	Buss work had to be reworked

TABLE IV
BAF CHANGE CONTROL
\$1000's
(continued)

[illegible]