16

Cost and Schedule

16.1 Introduction

Since the *Letter of Intent*, the design of the BaBar detector has evolved as a result of a continuous performance analysis and cost optimization. These studies involved both individual systems as well as the detector as a whole. Much scrutiny was given to the requirements for acceptance, resolution, and granularity. Furthermore, the designs were updated following revisions of the fabrication, assembly and installation methods, and reassessments of the need for redundancy and reliability.

In cases where there were competing technologies, *ad-hoc* task forces were formed to evaluate the options taking into account the projected performance with regard to the *CP* measurements, the technical feasibility based on prototype measurements and comparisons with systems of similar design, the integration into the overall detector, and the projected cost and schedule implications. In this way the Collaboration selected the CsI calorimeter, the resistive plate chambers for the IFR, and the DIRC and aerogel for particle identification in the barrel section and forward sections, respectively.

The BaBar detector design is based on well established technologies and takes advantage of state-of-the art electronics, data acquisition and computing techniques. Furthermore, the design of each subsystem builds on extensive R&D work that was started, in some instances, well before the Collaboration was founded in December of 1993. The current focus is on detailed design, prototyping and testing; in some cases preproduction activities have been initiated. One of the highest priorities is the building of engineering teams to develop detailed designs and prepare the procurement of long lead-time items.

16.2 Project Cost

A cost estimate has been developed for the detector described in this Technical Design Report. This estimate includes all activities and materials associated with the project, except for R&D and the design, construction and tests of prototypes that are currently underway and are funded from other sources. The current estimate is mostly based on grounds-up analyses, though in some areas engineering estimates remain to be replaced. The estimates are based on specific designs and where applicable, comparable work performed by the same group. In many cases, in particular for large items, multiple vendor quotes have been obtained and samples have been purchased and tested.

All costs are stated in 1995 US$. The estimates cover the design, engineering, procurement and fabrication, the assembly, tests and installation. The duration of the project is assumed to be 42 months, beginning in April 1995 and ending in September 1998.

All activities necessary to complete the project have been organized into a detailed Work Breakdown Structure (WBS) which at present contains more than 8000 elements. Each WBS element is identified by a number and a short title. A description field is used for detailed definitions, key parameters, components, as well as information on the basis of estimate. Documentation related to the basis of estimate, vendor quotes, *etc.* will be collected separately in workbooks. The WBS is available in a uniform database format, and it is network accessible. At Level 2, the project is partitioned into nine systems, each headed by a system manager who is responsible for the design, construction and installation, as well as the cost and schedule management.

Because of the international nature of the collaboration, local conventions for cost accounting are being used. This means:

- The engineering and labor are recorded for each task in terms of the time required.
- All materials, fabrication and procurement costs are recorded on the basis of local rates.
- For work performed at US or Canadian institutions, local rates for engineering and labor are applied; the assigned rates are not burdened with operating overhead charges.
- For activities that are supported by non-US/non-Canadian institutions, expenses for engineering and labor are not recorded, they are included in operating budgets of those institutions.
- For items funded from US sources, contingency is added to the base cost to cover additional costs, above and beyond the base, that are necessary to ensure the completion of the task.
- For items funded from non-US sources, no contingency is added, since the base cost includes a certain allowance for uncertainties in the cost projections. Significant cost overruns can be dealt with by additional grants.
- In all cases support from operating or infrastructure funds are recognized and not included in the estimate. Also, work performed physicists is not charged to the project.

	US Cost in US Accounting (1995 k$)									
	Description	Funding Agency	EDI&A (mm)	EDI&A ($)	Labor (mm)	Labor ($)	M&S	Base Cost	Contin gency	Total
1.1	Vertex	US DoE	112	821	114	527	733	2,081	25%	2,599
1.2	Drift Chamber	US DoE	3	24	16	103	255	382	22%	467
1.3.1	DIRC	US DoE	122	1,049	183	897	1,862	3,808	26%	4,799
1.3.2	Aerogel	US DoE	1	7	12	63	198	268	25%	334
1.4	Calorimeter	US DoE	136	1,219	436	1,507	11,257	13,983	16%	16,258
1.5	IFR	US DoE	7	58	63	219	196	473	16%	551
1.7	Electronics									
1.7.1	Vertex	US DoE	59	506	0	0	132	638	27%	813
1.7.2	Drift Chamber	US DoE	84	296	2	6	493	795	32%	1,051
1.7.3	DIRC	US DoE	79	529	9	56	341	926	20%	1,111
1.7.4	Calorimeter									
1.7.5	IFR									
1.7.6	Aerogel	US DoE	6	37	0	2	8	47	32%	62
1.7.7	Trigger Level I	US DoE	44	409	0		154	563	28%	718
1.7.8	Trigger Level II/DAQ	US DoE	60	523	0		187	710	32%	938
1.7.9	Controls	US DoE	5	44	0		47	91	37%	125
1.7.D	System Engineering	US DoE	71	533	0			533	42%	757
1.8	Computing	US DoE	156	1,289	137	446	243	1,978	31%	2,600
1.9	Management/Integration									
1.9.1	Tech. Coordination	US DoE	504	3,097	126	529	1,027	4,653	12%	5,227
1.9.2	QA/ES&H Oversight	US DoE	84	696			10	706	8%	764
SUM			1,533	11,137	1,098	4,355	17,143	32,635	20%	39,174

Table 16-1. *Estimated Detector Cost in FY1995 US dollars, for items supported by US Institutions. Not included in these tables are items that might be financed through the Common Fund. These include the magnet and some of the infrastructure, some of the expenses for computing equipment, the electronics common to all systems, and expenses for detector installation and project coordination.*

Following a procedure developed at other HEP laboratories, the contingency was derived for each WBS elements from a weighted sum of four factors that assess the potential risk or uncertainty in the design, engineering solution, cost and schedule. This method introduces a certain objectivity into the assessment, however, it can produce distortions. These have been corrected.

In Tables 16-1 and 16-2, the cost estimate is summarized at Level 2/3 of the WBS. The data are "rolled-up" from much more detailed information. Table 16-1 refers to the cost of items that are to be funded by US institutions, thus EDI&A and labor costs are fully accounted. Table 16-2 refers to items that are to be funded by non-US institutions. Not included in either table are items that could potentially be financed through a Common Fund. While there is consensus that such a fund should be established, the size of the fund,

	Non-US Cost in Local Accounting (1995 k$)										
	Description	Funding Agency	EDI&A (mm)	EDI&A ($)	Labor (mm)	Labor ($)	M&S	Base Cost	Contin gency	Total
1.1	Vertex	INFN Italy	60		162		2,864	2,864	0%	2,864
1.2	Drift Chamber	NSERC Canada	95	316	149	602	888	1,806	0%	1,806
1.3.1	DIRC	France	111		106		2,641	2,641	0%	2,641
1.3.2a	Aerogel	France	12		12		173	173	0%	173
1.3.2b		INFN Italy	0		4		146	146	0%	146
1.4a	Calorimeter	BMFT Germany	0		89	286	2,768	3,054	0%	3,054
1.4b		PPARC U.K.	72		151		2,268	2,268	0%	2,268
1.5	IFR	INFN Italy	8		21		1,060	1,060	0%	1,060
1.7	Electronics									
1.7.1	Vertex	INFN Italy	0		0		120	120	0%	120
1.7.2	Drift Chamber	NSERC Canada	55	364	0		1,945	2,309	0%	2,309
1.7.3	DIRC	France	84				1,734	1,734	0%	1,734
1.7.4	Calorimeter	PPARC UK	185		18		1700	1,700	0%	1,700
1.7.5	IFR	INFN Italy	19		29		409	409	0%	409
1.7.6a	Aerogel	INFN Italy	6		0		126	126	0%	126
1.7.6b		France	2		0		33	33	0%	33
1.7.7	Trigger Level I	PPARC U.K.	23		0		78	78	0%	78
1.8	Computing	France	53		0		0	0	0%	0
SUM			785	680	741	888	18,953	20,521	0%	20,521

Table 16-2. *Estimated Detector Cost in FY1995 US dollars, for items supported by non-US Institutions. Not included in these tables are items that might be financed through the Common Fund.*

the obligations of various national funding agencies to this fund, and the list of items that should be supported from this fund remain to be negotiated.

The total cost of materials and services (in Europe referred to as investment costs) to be financed from the US and non-US resources, including the Common Fund, amounts to 45 million US$.

16.3 Schedule

Having a detector ready to confront *CP* violation physics of PEP-II on a time scale commensurate with the PEP II completion date of October 1998 is a formidable task.

Detailed schedule information will be incorporated into the Integrated Project Schedule. The summary level schedule presented in Table 16-3 serves mainly to identify interactions between systems and critical path items. This schedule is technology-limited and allows installation and commissioning of *BaBar* at a date compatible with the PEP-II schedule.

16.4 Detector Systems

A brief discussion of the cost and schedule projections for the individual detector systems follows.

16.4.1 Vertex Detector

The five-layer double-sided silicon strip vertex detector chosen for *BaBar* is an extrapolation of existing designs. The emphasis is on precision in the z direction, basic to the main physics thrust of the experiment. Reduction of material to decrease multiple scattering is a primary design requirement. The performance of $300\,\mu$m double-sided silicon strip detectors has been satisfactorily tested. For the read-out electronics, radiation-hard fabrication techniques developed for SSC and LHC are more than sufficient for the PEP-II environment.

Members of the vertex detector group have been active in the design and construction of similar devices for CLEO-II, SDC, ALEPH, D0, CDF and Mark II. There is substantial expertise within the group in detector and readout chip design, in trigger design and in mechanical structures. The cost estimate is based on this recent experience and actual vendor quotes. Full size prototype detectors are on order. The design and prototyping of the VLSI read-out chip is underway, it is on the critical path for the assembly and tests of the prototype detector modules and the beam tests scheduled for later this year. The assembly of the detector modules is a delicate, time consuming task that will be performed in parallel in the US and Italy.

16.4.2 Tracking Chamber

Several technical innovations in the main tracking chamber are motivated by the requirement of minimal multiple Coulomb scattering. Low-mass gases have been developed within the group over the past several years. Several chambers of comparable design and dimensions have been constructed for HEP experiments. Low-mass field wires can be made of aluminum, although thin gold plating of the Al wires remains to be developed.

Construction of the main tracking chamber on the needed timescale requires the early resolution of mechanical engineering issues involving endplate and feedthrough design, and choice of field wire material. The electronics and data acquisition are reasonably straightforward. It is planned to use a full-length prototype test chamber as a test bench for chamber operation and monitoring, electronics and data acquisition.

The stringing of the wires is the most time consuming task and it is judged to be a critical path item. The task will be performed at a laboratory where chambers of similar dimensions have been assembled recently.

16.4.3 Particle Identification

While the DIRC is a novel concept for a Cherenkov detector, its construction is conceptually simple. The production and assembly of the quartz Cherenkov radiators present a relatively well-characterized problem that should have no schedule impact. Tests with small samples of quartz bars have produced excellent results. A test with a full length prototype detector is in preparation.

The readout system uses large numbers of conventional photomultiplier tubes; system engineering is thus the principal concern. A first-article procurement of 500 phototubes is the basis of the cost estimate, a firm offer for the whole photomultiplier purchase is in hand; it has a significant savings for large quantities. Concerns about the detailed design of the water tank and the modifications to the flux return have been addressed. Access to inner detector components has become easier with the elimination of the backward calorimeter endcap.

The aerogel threshold counter extends the coverage for particle identification in the forward direction to 300 mr. This system is by far the smallest in *BaBar*, but requires sizable support for R&D, engineering and photon detectors that can operate in the 1.5 T magnetic field. The present choice, fine-mesh photomultipliers, will become commercially available in the near future. The cost estimate is based on a preliminary vendor's quote. Several other experiments are in need of such tubes, and it is expected that the price will drop over the next few months.

In the past, the production of high quality aerogel has been a serious concern. Facilities exist for the production of the required quality and modest quantities. Prototype pieces have been tested in a beam and have shown very satisfactory light yield and absorption length.

The mechanical mounting structure, and the calibration and readout systems are relatively simple and of limited scale, requiring a modest engineering effort.

16.4.4 CsI(Tl) Calorimeter

Large CsI calorimeters of similar design and comparable volume have been built in the past and have proven to work well at e^+e^- storage rings. Nevertheless, the production of 6,780 crystals of high quality is the principal challenge in this system, it is also the principal cost driver. The procurement of the crystals is clearly on the critical path, and there remain concerns about the projected rate of delivery of the crystals.

The *BaBar* calorimeter is divided into a barrel and a forward endcap section, with a total volume of $6\,\mathrm{m}^3$. The procurement plan assumes that a production rate of 250 crystals per month can be established by the end of 1996 and can be sustained for more than a year. The crystal procurement relies on three vendors in three different countries, each with prior experience in growing non-alkaline halide crystals and with interest in increasing the capacity of their production facilities. Extensive contacts with all three crystal manufacturers have been established and it it expected that new, more advanced growing techniques can be applied (similar to those being developed at SLAC) which will produce excellent quality at significantly lower prices than in the past. The choice of a single supplier for the raw material will assure uniform quality and will bring the benefit of volume and delivery discounts. It also allows for a beneficial arrangement for the recycling of crystal material.

The engineering and fabrication of the low mass structure that will support the crystals is the second largest item. The proposed concept is rather simple. The design has been tested using finite element analysis and involves the use of Kevlar-epoxy composites, while allowing fabrication by low-technology and relatively inexpensive methods. The present endcap design is based on more conventional support structure, but an alternate design, similar to the barrel is under study.

Based on experience in other experiments the readout system based on photodiodes and wavelength-shifters can be expected to be reliable and perform as designed. Prototypes for the silicon PIN photodiodes are presently being tested. The price for the 13,560 photodiodes is being negotiated. Since the production capacity is more than adequate, the delivery schedule is not expected to be a problem.

The modular design of mechanical support structure is simple and inexpensive and it provides great flexibility in scheduling the assembly and installation. The schedule allows for about one year of final assembly and tests. The production and assembly of the wavelength shifter/photodiode/preamplifier readout will be widely distributed and will be performed in parallel to the crystal production.

16.4.5 Flux Return Instrumentation

The construction of large area chambers for muon detection is a task of a scale that has been achieved by nearly every major 4π detector built in the last decade. The design and operation of large numbers of resistive plate chambers (RPC) is well established. Facilities with adequate capacity for the fabrication of the RPCs exist, as do experienced teams of scientists at collaborating institutions where these chambers will be tested.

The schedule foresees the installation of the chambers prior to the assembly of the steel structure, and thus places constraints on the schedule for the chamber fabrication, tests, and final assembly at SLAC.

16.4.6 Magnet

The specified superconducting solenoid is similar in dimensions and specifications to several existing magnets. The preliminary design is being prepared by a collaboration of scientists and experienced engineers in the UK and Italy and will be completed in April 1995. It forms the basis for the cost estimate and will also be used to initiate the procurement process.

The segmented flux return is also similar in design to other detectors. It must be completely specified in the next few months, so procurement can be initiated in FY1995. The superconducting solenoid and the steel structure forming the flux return are both on the critical path since they must be completely assembled and the magnetic field must be measured prior to the installation of all other detector systems.

16.4.7 Electronics

Great emphasis has been placed on the adoption of a common architecture and the use of common solutions wherever possible. This approach is not only attractive from a design and operational point of view, it is also most cost effective, since it minimizes duplication of effort and allows for economies of scale.

The electronics system described in the *TDR* serves as a model based on present day technology and experience. The WBS divides the electronics system into three principal segments:

- the detector specific electronics, *i.e.,* front-end electronics,

- the trigger and data acquisition combined with electronics that are shared among detector systems, and
- the system engineering and the infrastructure.

For most detector systems, the design and prototyping is a very significant expense. The costs for the front-end electronics for the drift chamber, calorimeter and DIRC are largely driven by the channel count. For the drift chamber and calorimeter, the requirement for analog information and the extraction of trigger information adds significant costs. The fabrication costs include expenses for QC and tests. The front-end electronics for the vertex detector are very closely integrated with the detector design and assembly and they are therefore included in the detector costs.

The scale of the trigger and data acquisition system is conventional. Technical innovations relate mostly to the asynchronous nature of the system and its fully pipelined architecture. Trigger, data, acquisition and other electronics contribute about 20% to the total cost, shared about equally between engineering and M&S.

The schedule for the detector mounted electronics is given by the assembly and installation schedule for a given detector system, *i.e.,* the vertex detector, the drift chamber, PID, calorimeter, and the IFR. This means that there are 12 to 18 months for design and prototyping, and another 12 to 18 months for fabrication and testing. For all these systems it is crucial that prototype front-end circuits be available for the beam tests later this year.

The bulk of the off-detector electronics will not be needed until the assembly and installation is completed in early 1998, thus allowing a total of three years for design, prototyping and fabrication. However, it is planned to have a production model of the data acquisition system available for testing more than a year before the completion date, so that design problems that might not be apparent on a single circuit test can be detected and corrected prior to the large production. This would allow for complete system tests, *i.e.,* from a prototype detector to the DAQ for a substantial number of channels.

16.4.8 Computing

The quantity of data that will need to be transferred from the *BaBar* detector to mass storage and then analyzed pose significant challenges for the computing and network systems. For costing purposes the system is divided into two major segments:

- the online infrastructure, consisting of Level 3 data acquisition, control and monitoring hardware, as well as the networking, and

- the software development, including both online-specific items such as VxWorks, EPICS, expert system tools; and general items like IDL, methodology software, OODBMS, GUI builder, documentation and development aids.

Not costed are items that are conventionally part of laboratory or university infrastructure (*e.g.,* the large clusters of workstations that perform the offline analysis and simulation tasks), and activities that are generally supported from operating funds (*e.g.,* maintenance of hardware and software, software engineering that is available on a continuing basis throughout construction and operations, and data-aide activities). Also not included in the computing system cost estimate are computers for administration and workstations for engineering and design (covered in WBS 1.9), and workstations for software development (covered in WBS 1.7), as well as embedded CPUs in the DAQ/trigger systems (covered in WBS 1.7).

The largest cost items for the computing system are the required software engineering and the hardware for the Level 3 compute farm. The engineering effort is derived from three sources:

- professional software engineers, at a level of approximately three to four FTEs for the duration of the construction (not including the project computing engineer, covered in WBS 1.9);
- undergraduate students, who are frequently recruited from computer science departments. Past experience has proven that many of the programming tasks (such as development of specific computing utilities) can be performed by this kind of low-cost part-time student labor; and
- physicists, who will form a large part of the team for developing application code, but are not included in the construction cost.

For the purpose of this estimate, it assumed that the Level 3 farm will consist of a networked system of UNIX workstations. The principle data flow will be via FDDI connections, with a DEC Gigaswitch to provide routing.

Future cost savings that can be expected from advances in technology over the next few years are presently being examined. While there is incentive to delay the acquisition of the computing hardware in order to take advantage of rapid developments and lower costs, a large portion of the computing system needs to be in operation well before the detector is ready to take data. Prototype framework, data model, and code management capabilities need to be in place as soon as possible, because so many other development activities depend on them. Hence, these items represent relatively early expenditures in the *BaBar* project.

The software for detector simulation, data reconstruction and analysis will be developed and used by a large number of members of the collaboration, involving very few computer specialists. Because of the geographic diversity of the collaboration, coordination is a complex task and organizational and technical systems are being developed to facilitate communication and remote operation.

16.4.9 Management, Installation and Integration

This WBS item includes the support of the *BaBar* management and detector integration, the QA and ES&H management as well as the detector installation.

Substantial emphasis is being placed on system integration from the start of the project. This involves coordination of the service and utility requirements of the various subsystems, as well as detailed planning for the assembly of the detector and its commissioning. This effort will be coordinated by an experienced staff of engineers and physicists.

The overall plan, the cost estimate and schedule projections are based on recent experience with SLD at SLAC. In particular, the estimate for the installation relies on the availability of a sizable crew of laborers and electricians to prepare the hall, assemble the electronics building, install utilities, and install the detector components. Special jigs and tooling for the installation of the individual detector systems are considered the responsibility of that system. The same is true for any detector specific utilities like cables, cooling and gas supplies.

The development of the detailed installation procedure has resulted in a top down schedule, determining the date at which each of the detector systems will have to be delivered to the experimental hall, together with any special tooling and jigs required for installation.

Timeline: 1995 (Qtr 2, Qtr 3, Qtr 4) · 1996 (Qtr 1, Qtr 2, Qtr 3, Qtr 4) · 1997 (Qtr 1, Qtr 2, Qtr 3, Qtr 4) · 1998 (Qtr 1, Qtr 2, Qtr 3, Qtr 4)

ID	Task Name	Start	Bar	Finish
1	**INSTALL BaBaR**	/3		
2	**1.1 Vertex Detector**	/3		
3	Design & Prototype	4/3	Design & Prototype	12/23
4	Procure & Fabricate	10/30	Procure & Fabricate	7/7
5	Assemble & Test	3/4	Assemble & Test	
6	Install	9/4		
7	**1.2 Drift Chamber**	/3		
8	Design & Prototype	4/3	Design & Prototyp	3/8
9	Procure & Fabricate	11/6	Procure & Fabricate	12/11
10	Assemble & Test	12/11	Assemble	7/2
11	Install	7/16		7/
12	**1.3 Particle Identification**	/3		
13	**1.3.1 Barrel PID (DIRC)**	/3		7/
14	Design & Prototype	4/3	Design & Prototype	9/5
15	Procure & Fabricate	4/1	Procure & Fabricate	2/20
16	Assemble & Test	10/1		10/1
17	Install	11/17	Install	7/1
18	**1.3.2 Forward PID (Aerogel)**	/3		
19	Design & Prototype	4/3	Design & Prototype	5/23
20	Procure & Fabricate	1/2	Procure & Fabricate	6/30
21	Assemble & Test	7/1	Assemble & Test	7/1
22	Install	7/31		8/
23	**1.4 CsI Calorimeter**	/3		
24	**1.4.2 Barrel Calorimeter**	/3		4/24
25	Design & Prototype	4/3	Design & Pr	11/28
26	Procure & Fabricate	8/2	Procure & Fabricate	3/28
27	Assemble & Test	12/26	Assemble & Test	3/2
28	Install	3/16	I	4/24
29	**1.4.3 Forward Calorimeter**	/3		
30	Design & Prototype	4/3	Design & Pr	11/28
31	Procure & Fabricate	5/3	Procure & Fabricate	3/28
32	Assemble & Test	5/6	Assemble & Test	5/29
33	Install	8/7		
34	**1.5 Muon System**	/3		12/23
35	Design & Prototype	4/3	Design & Prototype	12/23
36	Procure & Fabricate	10/2	Procure & Fabricate	5/21

Table 16-3. *Projected project schedule, aimed at completion in October 1998, part 1.*

ID	Task Name	1995 (Qtr 2, Qtr 3, Qtr 4) · 1996 (Qtr 1, Qtr 2, Qtr 3, Qtr 4) · 1997 (Qtr 1, Qtr 2, Qtr 3, Qtr 4) · 1998 (Qtr 1, Qtr 2, Qtr 3, Qtr 4)
37	Assemble & Test	10/1 Assemble & T 6/30
38	Install	7/2 Install 11/12
39	**1.6 Solenoid Magnet**	/3 3/13
40	Design & Prototype	4/3 Design & Prototype 1/1
41	Procure & Fabricate	3/14 Procure & Fabricate 9/10
42	Assemble & Test	3/13 Assembl 9/9
43	Install	7/11 Install 3/13
44	**1.7 Electronics**	/3
45	**1.7.1 Vertex Detector Electronics**	/3
46	Design & Prototype	4/3 Design & Prototype 12/31
47	Procure & Fabricate	1/1 Procure & Fabricate 12/30
48	Install	7/1 Install
49	**1.7.2 Drift Chamber Electronics**	/3
50	Design & Prototype	4/3 Design & Prototype 11/29
51	Procure & Fabricate	4/1 Procure & Fabricate 5/28
52	Install	9/1 Install 7/
53	**1.7.3 Particle ID Electronics**	/3
54	Design & Prototype	4/3 Design & Prototype 11/29
55	Procure & Fabricate	12/2 Procure & Fabricate 5/29
56	Install	6/1 Instal
57	**1.7.4 CsI Calorimeter Electronics**	/3
58	Design & Prototype	4/3 Design & Prototype 9/30
59	Procure & Fabricate	1/1 Procure & Fabricate 3/30
60	Install	9/2 Install
61	**1.5 Muon Electronics**	/3 10/29
62		4/3 9/30
63	Procure & Fabricate	4/1 Procure & Fabricate 10/29
64	Install	7/1 Instal 10/29
65	**1.7.7 Level 1 Trigger**	/3 6/
66	Design & Prototype	4/3 Design & Prototype 9/30
67	Procure & Fabricate	7/1 Procure & Fab 3/30
68	Install	4/1 Inst 6/29
69	**1.7.8 Level 2 Trigger & DAQ**	/3
70	Design & Prototype	4/3 Design & Prototype 7/31
71	Procure & Fabricate	7/1 Procure & Fabricate 6/29
72	Install	7/1 Install

Table 16-4. *Projected project schedule, part 2.*

ID	Task Name	Start	Bar label	Finish
73	**1.7.9 Controls & PEP II Interface**	/3		
74	Design & Prototype	4/3	Design & Prototype	7/31
75	Procure & Fabricate	7/1	Procure & Fabricate	6/29
76	Install	7/1	Install	
77	**1.7.B Common Electronics**	/3		
78	Design & Prototype	4/3	Design & Prototype	7/31
79	Procure & Fabricate	7/1	Procure & Fabricate	6/29
80	Install	7/1	Install	
81	**1.8 Computing**	/3		
82	**1.8.1 On-line Infrastructure**	/3		
83	Interactive Stations Procurement & Installation	4/3	Interactive Stations Procurement & Installation	5/29
84	Level 3 Farm Prototype	4/3	Level 3 Farm Prototype	9/30
85	Production Level 3 Farm	10/1	Production Level 3	
86	On-line File Server	10/1	On-line File	5/30
87	Networking R&D	4/3	Networking R&D	4/30
88	Network Procurement & Installation	5/1	Network Pro	12/31
89	**1.8.2 Software Development**	/3		
90	**On-line Software**	/3		
91	On-line Prototype	4/3	On-line P	9/29
92	Initial HER Operation	10/2	Initial HER Operation	3/31
93	HER Background Studies	10/2	HER Background Studies	12/31
94	BaBar Installation	1/1	BaBa	4/30
95	BaBar On-line	5/1	BaBar	
96	Infrastructure Prototype	4/3	Infr	6/30
97	**Reconstruction**	7/3		9/30
98	Design	7/3	Design	3/29
99	Implementation	10/2	Implementation	9/30
100	Simulation Design & Implementation	4/3	Simulation Design & Implementation	
101	Analysis Tools Design & Implementation	4/3	Analysis Tools Design & Implementation	

Table 16-5. *Projected project schedule, part 3.*