B Factory Transition Plan

[Draft] Version 3.2

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1. Introduction

After nearly a decade of outstanding luminosity growth and performance by PEP-II, enabling a spectacular physics program pursed by the *BABAR* Collaboration, the *B* Factory is now nearing the completion of its scheduled program. At the end of Run 5, PEP-II peak luminosity had reached 1.2×10^{34} cm^{-2}s^{-1} or four times design, while integrated luminosity exceeded 900 pb^{-1}/day. Further improvement by a factor of two is anticipated in Run 6 and 7, following major upgrades to the vacuum and rf systems. When the *B* Factory is shutdown at the end of September 2008, an integrated data sample approaching 1 ab^{-1} will have been accumulated by *BABAR*, providing a unique data set for exploration of flavor physics in the coming years.

The transition from intense machine and detector operations at the highest luminosities to a post-operational maintenance mode requires careful planning. This document describes a plan for this transition and the requirements for maintaining the valuable equipment incorporated in the PEP-II collider and the *BABAR* detector. In broad outline, we envision FY09 as a transition year, during which PEP-II and *BABAR* will be put into a long-term minimal-maintenance state (MMS). This will allow the substantial investment in accelerator and detector components to be protected as a resource for the US and international communities. It is likely that many of these components could be incorporated as valuable contributions to future projects over the succeeding 5 years or more (FY10-FY14). We propose to impose a requirement of strategic and controlled dismantling to maximize the impact of the *B* Factory equipment on such future opportunities. Any subsystems remaining in FY15 will be dismantled and either disposed or stored as appropriate.

A major factor in our planning for the disposal of equipment is a memorandum of July 13, 2000 from former Energy Secretary Bill Richardson, which placed a hold on materials that have been in a beam line tunnel during operation. At present, materials from these areas cannot be shipped offsite, unless used at another laboratory; this policy remains rigorously in force at SLAC. In the event that the moratorium remains in effect for the foreseeable future, the safest and most effective storage of the accelerator components will continue to be the PEP-II tunnel. Detailed planning for dismantling and disposal of the *B* Factory is underway assuming various scenarios for eventual disposal.

In order to set out the transition plan for the *B* Factory, we will describe the existing planning by the *BABAR* Collaboration for the post-operations phase (Section 2), discuss SLAC/*BABAR* operational planning assumptions (Section 3), SLAC/*BABAR* manpower and budgets (Section 4) that follow from this planning, PEP-II transition planning assumptions (Section 5) and manpower and budget projections (Section 6), and finally our assumptions in developing scenarios for dismantling and disposal of the *B* Factory (Section 7).

2. BABAR Collaboration Post-Operations Planning

The *BABAR* Collaboration is in the process of defining a proposed post-operations plan for the experiment. This plan envisions that there will be an intense analysis effort for 2-3 years after completion of the final data set, followed by long-term analysis effort on more challenging or systematics-limited topics. A set of key physics topics has been identified for the intense analysis period, covering the full range of *CP* violation and rare decay topics in beauty, charm, and tau physics. These topics are listed in Table 1. The data sets collected by the two *B* Factories will remain unique and unsurpassed for the foreseeable future. It may well be that new and important physics questions will arise in coming years, perhaps in the light of LHC discoveries, which will continue to motivate physics studies with *B* Factory data well into the next decade.

Based on a survey of the *BABAR* collaboration, we are expecting involvement in the experiment to slowly drop to about 60% (200 FTE) of the present physicist manpower (330 FTE) during the intense analysis period (FY09-FY10). There will then be a further decline to about 30-100 FTE over the subsequent few years, with the large uncertainty driven by the uncertainties surrounding competing future physics opportunities. Corresponding to decline in the level of participation in *BABAR* analysis, there will also be a decline in user presence at SLAC. We are assuming that, during the intense analysis period, 35-50 collaborators will be present at SLAC full time, while another 150 collaborators will make short-term visits. This is approximately 50% of the present occupancy level for the Research Office Building (ROB). We expect that the space made available by the gradual reduction in *BABAR* user presence at SLAC will be filled by corresponding growth of the ATLAS user community over the same period.

One important factor in defining the post-operations plan is whether there will be a final reprocessing of the complete *BABAR* dataset and, if there is a reprocessing, when this will occur. A decision of this point will impact both the timing and level of the peak computing requirement for the experiment. While we are anticipating that this reprocessing question of will be resolved by *BABAR* later this spring, for the purposes of our transition plan we are assuming reprocessing will occur in FY08, in parallel with live initial processing of new data from Run 7.

Table 1. High-priority BABAR physics topics to be published during the initial intense analysis period within 1-2 years of the end of data taking.

Charmless:
$\sin2\beta$ in $b \to s$ penguin: $K^0 + (\eta',\ K^+K^-,\ K^0_S K^0_S,\ \pi^0, f_0,\ \rho,\ \omega,\ \pi^0\pi^0)$
BFs of color-suppressed decays for SU(3) limits: $B \to \eta'\pi^0,\ \eta\pi^0,\ \eta'\eta,\ \eta'\eta', \eta\eta)$
2-body (TD, BFs, $\mathcal{A}_{ch}$): $\pi\pi$ (also TD for α), $K\pi,\ KK$
Dalitz plots: $3\pi,\ K\pi\pi,\ 3K$
VV decays (BFs, $\mathcal{A}_{ch}$, polarization): $\rho\rho$ (also TD for α), $\phi K^*,\ \rho K^*,\ \omega\rho,\ \omega K^*$
Direct *CP*: $\rho^0 K^+,\ \eta K^+$, ...
$B \to$ Charmonium $+X$:
$\sin2\beta$ with $B \to c\bar{c}K^0$, $\cos2\beta$ with $B \to J/\psi K^*$
Measurements of γ:
$B \to DK$ (Dalitz,GLW,ADS), $D^{(*)0}K^{(*)0},\ D^{(*)}\pi,\ D^{(*)}\rho$
B semileptonic:
V_{ub} with both inclusive and exclusive $b \to X_u \ell\nu$
Radiative B decays:
inclusive and exclusive $b \to s\gamma,\ b \to d\gamma$ (BFs, $\mathcal{A}_{ch}$), $B \to K^*\gamma$ TD
Rare B decays:
inclusive and exclusive $b \to s\ell\ell$ (BFs, A_{FB}), $B \to K^{(*)}\nu\bar{\nu}$
B leptonic decays:
$B \to \ell\nu(\gamma),\ B \to \ell\ell$
LFV in τ decays:
$\tau \to \ell + (\ell\ell,\ \gamma,\ \pi^0,\ \eta,\ \eta',\ K^0_S,\ ...)$
Rare charm decays:
$D \to \ell\ell$, FCNC in D decays
D mixing and CPV:
Mixing ($D^0 \to K\pi,\ K\pi\pi,\ K3\pi$); CPV ($KK,\ \phi K^0_S,\ K^0_S\pi^0$)

In this model, the build-up of installed CPU and disk capacity at SLAC will continue in FY07 and FY08, while new data is still being accumulated. In the period FY09-FY11, computing hardware needs will be driven by sustaining for the most part the final FY08 CPU and disk levels with replacements as older equipment becomes obsolete. We assume that the remote Tier A centers will phase out during FY11, leaving SLAC as the sole site supporting *BABAR* physics analysis from FY12 onwards. At the same time, with the declining numbers of analyses being conducted with the data, we assume there can be a reduction in the number of physics skims maintained on disk. The resulting profile for new CPU and disk purchases is provided in Table 2.

Table 2. Requirements for new CPU and disk hardware in a model where reprocessing of Runs 1-6 occurs in parallel with initial processing of Run 7 data. Note that the requirements in FY09-FY11 are driven entirely by retirements of existing equipment.

	FY07	FY08	FY09	FY10	FY11
CPU requirement at SLAC [kSI2K units]					
New CPU capacity	1200	2600	0	-1200	0
Total installed SLAC capacity	5200	7800	7800	6600	6600
Replacement CPU	1000	1300	1950	750	1650
Total CPU requirement	2200	3900	1950	-450	1650
Disk requirement at SLAC [Tbytes]					
New disk capacity	60	270	0	-50	0
Total installed SLAC capacity	557	827	827	777	777
Replacement disk	124	139	207	157	194
Total disk requirement	184	409	207	107	194

3. Overview of Transition Planning for SLAC Effort on BABAR

FY07-FY08: Operations

With the completion of the *BABAR* IFR upgrade project, the mechanical support team for *BABAR* operations will be reduced to a level appropriate for occasional on-demand access to inner detector components. Support for online and offline computing by personnel paid from the *BABAR* Operating Common Fund (OCF) and direct support for *BABAR* from SLAC Scientific Computing and Computing Services (SCCS) will continue at present levels. CPU and disk space requirements will be driven by the anticipated growth in integrated luminosity (Table 2). Additional computing resources will be needed in FY08 to accommodate the simultaneous need to process the live Run 7 data, while reprocessing Runs 1-6 in parallel. We assume the existing Tier A computing network will remain in place, including commensurate growth at the offshore centers in proportion to the luminosity growth.

FY09: Transition

The *BABAR* detector will be brought into a minimal maintenance state (MMS), so that subsystems are preserved long-term in a condition that would be suitable for reuse in other applications. We have examined each individual *BABAR* detector subsystem to define a state of utilities and monitoring that is consistent with the MMS requirement. In broad summary, cooling systems will be drained and dried out, as will the DIRC water tank, and the magnet cryogenic plant and magnet will be brought to room temperature but vacuum maintained in the cryostat. Gas systems will be switched to inert gases to obviate the need for continuous shift coverage. Operational service coverage to monitor the detector systems will thereby be reduced to low levels. The existing continuous on-call coverage for the magnet cryogenic plant can be eliminated. Most online software and monitoring development and maintenance effort will be reduced to minimal levels, with the exception of an effort to develop a simplified standalone version of the slow controls system for monitoring the safe condition of the hardware systems. A modest level of offline development continues to support the completion of the data reprocessing. In addition, some computing professionals are required to support physics analysis access to data and regular skimming of physics data sets.

FY10-FY14: Minimal Maintenance State

The *BABAR* detector and its valuable subsystem components will be safeguarded in an ongoing minimal maintenance state. The stripped-down online monitoring system will allow long-term remote monitoring of the detector with automated generation of alarms if unusual conditions develop. The manpower requirements in this condition are minimal, typically small fractions of a few key technicians and experienced physicists. Offline software professional support will also be reduced to reflect the completion of the final reprocessing of the *BABAR* data set and the reduction in software development effort.

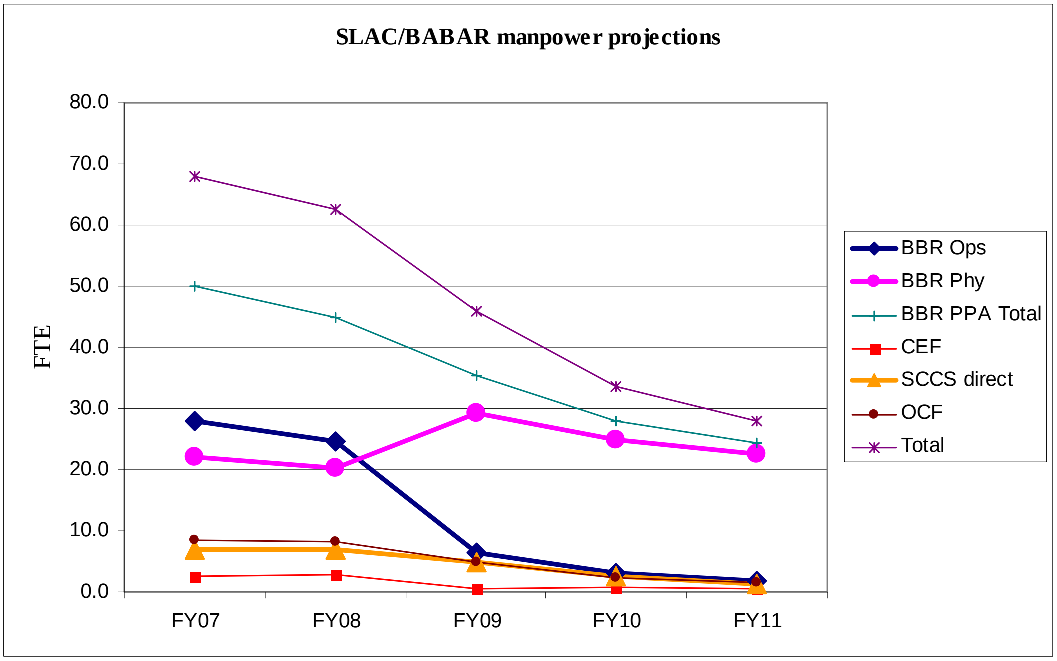
During this period, we anticipate that there will be requests to reuse detector components for other applications. Our proposed approach is to impose a strategic or controlled decision process to control the disposal of hardware for use in appropriate future opportunities, e.g. Super *B* Factory elsewhere or some other new initiative. If instead, hardware subsystems are allowed to be dismantled piecemeal, they will quickly lose their value for such future opportunities. The *B* Factory components represent a valuable resource for the US HEP community, one that should be redeployed in the most effective way when opportunities arise.

FY15: Dismantle and Dispose

We propose to continue a policy of controlled disposal. Whatever remaining subsystems of the *BABAR* detector will be disassembled and IR-2 cleared to enable other functions in this space. Detector components with a long shelf-life (magnet coil, CsI crystals, DIRC quartz bars) that could still be reused in other applications will be identified and stored. All other components will be sold off or disposed, subject to the restrictions of the moratorium on off-site recycling of metal from the accelerator housing areas. Note that the FY15 date reflects the estimated re-usable shelf life for many detector components; it may be that demand for re-use of the IR-2 space drives the dismantling phase earlier.

4. Budget and Personnel Implications for SLAC/BABAR Plan

A bottoms-up transition model for all personnel presently supporting *BABAR* operations and computing has been developed consistent with the assumptions described above. This includes PPA physicists, engineers, and technicians who presently are directly supported from detector operations or physics R&D B&R funding, Operations Directorate (OD) personnel who provide operational support, *i.e.*, Conventional and Experimental Facilities (CEF) or SCCS, and personnel who are supported from the *BABAR* OCF. In the



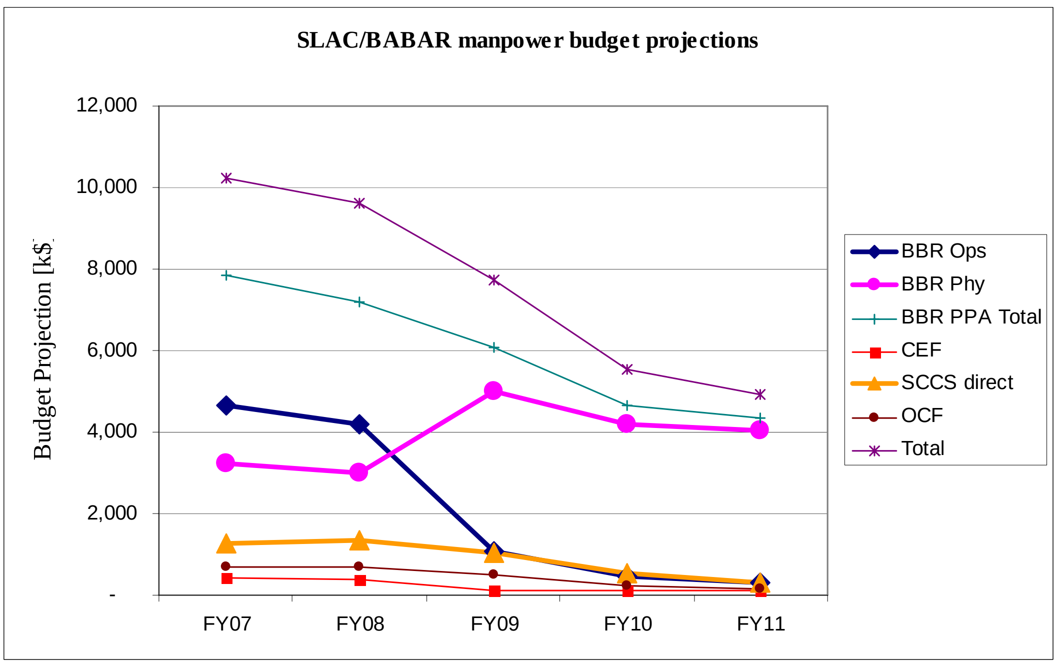


Figure 1. Projection of overall BABAR manpower FTE and budget needs in the period FY07-FY11, based on a bottoms-up analysis of operational requirements and anticipated participation in post-operational physics analysis.

case of PPA, we envision a movement of mechanical and electrical engineering and technician support to ILC and ATLAS, while retaining a small fraction of certain key personnel for *BABAR* long-term monitoring and maintenance. There is a significant migration of physicist staff and postdocs from *BABAR* detector operations to physics analysis, along with a transition in some cases to the ILC detector and ATLAS programs. In the case of CEF, some reduction begins already in FY07, reflecting the completion of the IFR installation project. Technician support for monitoring the magnet cryogenics system continues through FY09 and then is substantially reduced in FY10 and onwards. The decline in SCCS personnel directly supporting *BABAR* starts in FY09 with reduced online support and continues to a long-term base level beginning in FY10.

Figure 1 shows the resulting manpower (FTEs) and budget projections for *BABAR* detector operations and physics support. Included are physicists, postdocs, students, engineers, and technicians directly supported within PPA either on *BABAR* detector operations or *BABAR* physics analysis. Operations Directorate personnel include both operational personnel and SCCS computing support personnel. Some core operational and computing support tasks are support through the *BABAR* OCF. While this is subject to review on an annual basis by the *BABAR* International Finance Committee (IFC), we include projections of how this may evolve through FY11. Since US fractional share of PhD members in *BABAR* is approximately 50%, the budgets from OCF sources are prorated by this factor. Our assumption is that the *BABAR* IFC will continue to be responsible for the detector while operational, but this will become a SLAC responsibility in the minimal maintenance state. Therefore, we assume the OCF will continue to cover some detector operational needs through FY08 only, while computing professionals required for exploitation of the data will continue to be supported through at least FY11.

The budget implications of this model are provided in Tables 3 (personnel) and 4 (M&S). We have again broken down the personnel budget elements into direct PPA operations and physics support, support for CEF and SCCS services, and *BABAR* OCF support.

Note that the *BABAR* model for OCF support of computing professionals will be examined by the *BABAR* IFC in July 2007 and so may be revised compared to our assumptions. In addition, not included in this plan is the core PPA general program support, which is essential to all PPA program elements. For example, FY07 budgets for PPA and OD are direct *BABAR* only and do not include a large component of general PPA program support presently supported from the detector operations B&R code. For the purpose of this plan, the resources identified as the direct *BABAR* program support in FY07 are then consistently used for extrapolation to FY08-FY11.

The M&S budget projections are divided into SLAC operations and computing (based on the CPU and disk model provided in Table 2), and *BABAR* OCF requirements (prorated by the 50% share for US PhD members of *BABAR*). In FY07 and FY08, computing hardware investments in the offshore Tier A Centers result in a prorated offset for the foreign agencies against their OCF payment. It is unclear whether these credits will continue after FY08, since computing hardware investments are based on replacement of existing equipment only. We assume there will be no Tier A credits beyond FY08. The computing hardware investments for FY09-FY11 are the average of the *BABAR* plan, smoothing out the otherwise substantial variation in the profile. In FY07-FY08, we assume the *BABAR* program will support about 50% of the scheduled replacement of the SCCS mass storage system scheduled for this period. By agreement of the *BABAR* IFC, computing hardware investments at off-short Tier A Centers can be used to offset a fraction of OCF contributions by foreign agencies. Uncertainties in the level of these Tier

A credits for FY07-FY08 results in an uncertainty of about $0.5-1.15 million on the budget needs for SLAC funding of detector operations.

A summary of issues and assumptions that could have a significant impact on the SLAC/*BABAR* transition plan are summarized in Table 5.

Table 3. Budget projections for SLAC/BABAR personnel, broken down into direct operations and physics analysis support from the PPA Directorate, operations and SCCS computing support from the OD, and BABAR OCF supported activities. The BABAR OCF personnel costs in the table are 50% of the overall OCF estimate, reflecting the approximately 50% fractional share for US PhD members in BABAR. A 4% salary escalation is assumed. FY07 budgets for PPA and OD are direct BABAR only and do not include a large component of general PPA program support presently included in the detector operations B&R code.

SLAC/BABAR budget [k$]		**FY07**	**FY08**	**FY09**	**FY10**	**FY11**
PPA Directorate	Operations	4600	4200	1100	460	320
	Physics	3200	3000	5000	4200	4000
Operations Directorate	Operations	430	380	110	110	110
	SCCS	1300	1350	1000	530	300
BABAR OCF personnel [50%]	Operations	220	220	80		
	Computing professionals	460	480	415	235	170
Total		**10210**	**9630**	**7705**	**5535**	**4900**

Table 4. Projected M&S needs for SLAC/BABAR operations and computing. The BABAR OCF M&S costs in the table are 50% of the overall OCF estimate, reflecting the approximately 50% fractional share for US PhD members in BABAR. Inflation is not included.

SLAC/BABAR budget [k$]	**FY07**	**FY08**	**FY09**	**FY10**	**FY11**
Operations	820	830	820	890	810
Computing hardware	3400	3300	580	400	400
BABAR OCF [50%]	710	750	305	225	180
Total	**4930**	**4880**	**1705**	**1515**	**1390**

4.1 Transition Tasks

Substantial experience exists for putting *BABAR* into a medium-term minimal maintenance state. This has occurred during each of the annual down periods between runs. However, there are new elements for the long-term minimal maintenance transition. These include draining and drying most cooling circuits, the flourinert calibration system for the electromagnetic calorimeter (EMC), and the DIRC standoff box. The exception is the flourinert cooling for the barrel and endcap EMC crystals, which must be maintained in a temperature stable environment. The flammable gas mixture for the Drift Chamber

(DCH) will be replaced with dry nitrogen instead of the helium. The superconducting coil and its associated cryogenic plant will be raised to room temperature, but the cryostat will be maintained under vacuum. The neutron generator, which is used at present for EMC calibration, will be secured or used in other applications. A summary of the minimal maintenance state for each *BABAR* system in provided in Table 6.

Table 5. Summary of main uncertainties in transition model for SLAC/BABAR effort.

Issue	**Current Assumption**	**Potential Impact**	**Decision Timeframe**
Timing and duration of any final reprocessing of the full *BABAR* data sample	Reprocessing in FY08, in parallel with initial processing of Run 7 data	Budgets for computing hardware M&S in FY08 and/or FY09	July, 2007
Long-term OCF support for computing professionals	Estimated decline in FTE fractions for existing OCF supported personnel through FY11	Early withdrawal of international funding for core computing professionals, increase in support from SLAC	July, 2007
OCF support for operations during transition year FY09	Reduced to zero OCF support in FY09	Decrease in operational support from SLAC	July, 2007
Size of Tier A credits for hardware investments	Not included in budget estimates; historically Tier A credits have varied from cost neutral to about $500k	Could reduce OCF and increase SLAC contributions to detector operations by $0.5-$1.25 million, integrated over FY07-FY08	July, 2007
Long-term evolution of Tier A Centers	Phased out in FY11, leading to reliance on SLAC in FY12 onwards	Phase out could occur earlier, leading to need for increase in installed computing resources at SLAC in FY10-FY11	Nominally one year notice, but could be variable
Computing hardware and infrastructure costs for SLAC SCCS installations	Hardware costs based on current purchases for new and replacement equipment; GPP funds for support upgrades in SCCS power and water utilities	Significant increase in effective computing costs, due to early retirement of power inefficient equipment, addition of infrastructure costs, or curtailment of computing resources	Mainly FY07-FY08, unless new demands arise due to Tier A evolution

Table 6. Planned condition for BABAR hardware systems and IR-2 infrastructure during minimal maintenance period.

System	Front-end electronics	Power supplies	Gas	Cooling	Other utilities
SVT	Off	Off	dry air	off, drained	
DCH	Off	Off	dry nitrogen	off	
DRC	Off	Off	dry nitrogen	off, empty	SOB drained, purification system off
EMC	Off	Off	dry nitrogen	fluorinert circulating	water system drained and dried; source system drained
IFR-RPC	Off	Off	dry nitrogen	off, drained	
IFR-LST	Off	Off	dry nitrogen	off, drained	
Trigger	Off	Off	n/a	n/a	
DAQ	Off	Off	n/a	n/a	
Online farm	Off	Off	n/a	n/a	
Safety systems/monitoring/UPS	On	On	n/a	EH cooling on	UPS maintained
Infrastructure	n/a	n/a	n/a	EH cooling on	UPS maintained
Magnet	On	Off	n/a	n/a	vacuum pumps on
IR2 complex	n/a	On	On	On	gas shack limited use

The two main transition tasks for *BABAR* are the draining of cooling systems and development of stand-alone slow controls; all other activities to shutdown the detector systems will occur a few days following the end of normal running. A summary of the two main *BABAR* transition tasks and corresponding milestones, which include schedule contingency, is shown in Figure 2. Table 7 provides a summary of manpower and budget directly associated with the transition tasks and the detector minimal maintenance requirements.

Draining and drying cooling systems:

Water cooling loops and chiller systems exist for the SVT, DCH, DRC EMC, IFR-LST and IFR-RPC systems. In each case, existing expert technicians and system management will need about 2 months to drain these circuits, blow them dry to avoid corrosion, and then periodically inspect and monitor the status of the equipment. The total manpower involved in this effort is equivalent to 2.2 FTEs of technician and engineering effort, and 0.7 FTE of physicist supervision.

Development of a stand-alone slow controls system:

Extensive slow control and alarm handling systems have existed since the beginning of data taking. These systems are embedded in the *BABAR* online hardware and software environment. Maintaining the full online system in the long-term, in particular, keeping hardware, software and security patches up-to-date, would be labor intensive and inefficient. On the other hand, the slow control and alarm system is essential to allow automated monitoring of the detector status, thereby removing any need for frequent direct inspection by personnel. We will therefore develop a version of the slow controls system that is standalone and maintainable long-term. This development cannot start until regular operations are ended and there will likely be a period of 3-6 months overlap with the existing system during development. Our estimate is the project will require a full-time software developer for 6 months and a physicist supervisor.

4.2 Minimal Maintenance Tasks

Provision is made for a small fraction of several key technicians to be available for infrequent but periodic inspections of the state of the detector systems. We will also need to perform regular maintenance and inspection of the IR-2 crane, lights, UPS system and VESDA fire protection systems.

Table 7. Budget projections for BABAR detector transition and minimal maintenance. A 4% salary escalation is assumed, but no inflation for M&S. The transition tasks occur in FY09.

	FY09		FY10		FY11	
	FTE	Budget [k$]	FTE	Budget [k$]	FTE	Budget [k$]
PPA Labor	2.1	440	0.6	120	0.6	125
Operations Directorate Labor	0.9	150	0.4	90	0.4	90
M&S		100		80		80
Total		690		290		295

5. Transition Planning for PEP-II

FY07-FY08: Operations

PEP-II was shutdown from August 21, 2006 through January 12, 2007, to install luminosity upgrades and to perform safety checks. PEP-II resumed colliding e^+e^- beams for *BABAR* on January 13, 2007. Accumulation of physics data in Run 6 will continue until September 1, 2007. PEP-II will then be in a shutdown from September 1, 2007, through December 1, 2007, to install small luminosity upgrades and perform annual safety checks. Colliding beams for *BABAR* Run 7 will resume on or about December 1, 2007, and continue until September 30, 2008. A full complement of accelerator physicist, engineering, and technical support, both within the Accelerator System Division of PPA, and from the Operations Directorate, will be required throughout FY07 and FY08.

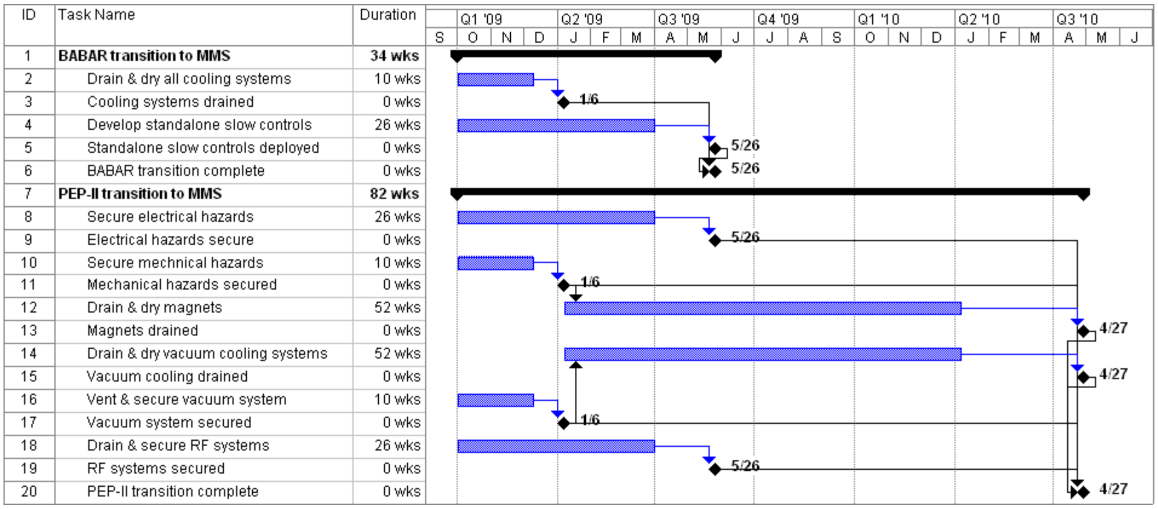


Figure 2. Summary of tasks and milestones for the BABAR and PEP-II transition to a minimal maintenance state (MMS).

FY09: Transition

PEP-II will be brought into a minimal maintenance state (MMS), so that the significant investment in equipment is preserved long-term in a condition that would be suitable for reuse in other applications. Lights, air handling, water seepage pumps, control systems, and diagnostics need to be maintained. Electrical and mechanical hazards will be secured. Cooling circuits for electromagnets and vacuum systems will be drained and dried; the RF systems will be drained and secured. The vacuum systems for the two rings will be carefully vented to preserve these components for future use. Power requirements for PEP-II throughout the transition year FY09 are estimated to average about 2.1 MW versus the present requirement of about 22 MW for full operations.

FY10-FY14: Minimal Maintenance State

PEP-II and its valuable subsystem components will be safeguarded in an ongoing minimal maintenance state. This will require maintenance of the fire-protection systems, the tunnel water seepage system and removal system, and tunnel lighting and mechanical integrity. As for the detector, we anticipate that there will be requests to reuse machine components for other applications. Our proposed approach for PEP-II subsystems is to impose a strategic or controlled approach to the disposal of hardware for use in appropriate future opportunities, e.g. Super *B* Factory elsewhere or some other new initiative. Power requirements will be reduced throughout the year in the minimal maintenance state to an average of about 0.8 MW (1.5 MW in FY10).

FY15: Dismantle and Dispose

We propose to continue a policy of controlled disposal for PEP-II. Any remaining PEP-II equipment will be removed in a controlled fashion. Remaining vacuum chambers, RF system, magnets and supports will be removed, secured and shipped to appropriately-approved internal and external groups. However, pending resolution of the moratorium on off-site shipment of materials from the accelerator housing, the PEP-II tunnel represents the best storage site for this equipment.

6. Budget and Personnel Implications for PEP-II Plan

In the transition period to the MMS, PEP-II will need about 2.2 FTEs in the Accelerator Systems Division including one accelerator physicists to oversee work and take decisions on PEP-II, 0.2 FTE of a mechanical engineer, and a Technical Area Manager to watch over the PEP-II hardware and dispatch repair work as needed. The transition tasks will draw from the SLAC Operations Directorate, requiring, on average, 6.8 mechanical maintenance FTEs, one klystron department FTEs, 4.5 utility maintenance FTEs (water and tunnel), and 1.5 power conversion department FTEs, for a total of about 16 FTEs in FY09. Allowing for schedule contingency and the sequential nature of some of the tunnel activities, some tasks will extend partly into FY10. The total M&S to carry out this work is estimated to be $1.0 M. In addition, we estimate the power requirements at 2.1 and 1.5 MW in FY09 and FY10, while these tasks are ongoing. A summary of these requirements is provided in Table 8. The personnel numbers will decrease partway through FY10 to the minimal maintenance level. This is reflected fully in the FY11 budget. In the MMS, the manpower requirements will consist of a physicist (0.2 FTE) and Area Manager (0.4 FTE) from ASD, supported by 1.6 FTEs from utility maintenance (water and tunnel) and 0.25 FTE the klystron department. The minimal power requirements are an average of 0.8 MW, with an estimated cost of $400k/year. The FY11 budget would apply throughout the period prior to dismantling PEP-II.

Table 8. Budget projections for PEP-II transition and minimal maintenance. A 4% salary escalation is assumed, but no inflation for M&S. The transition tasks are extend throughout FY09 and partway into FY10.

	FY09		FY10		FY11	
	FTE	**Budget [k$]**	**FTE**	**Budget [k$]**	**FTE**	**Budget [k$]**
Accelerator Systems Labor	2.2	330	1.7	270	0.6	100
Operations Directorate Labor	13.8	2070	6	940	1.9	280
M&S		600		400		200
Power		950		650		400
Total		3950		2260		980

The majority of the manpower and resources currently supporting PEP-II and Linac operations will transition as rapidly as possible to support LCLS operations, the ILC tests and design, NLCTA operations, and SABER operations in FY2009 and beyond. This has been detailed and reviewed in the 2006 BES Linac Operations review, held in September 2006. Approximately $14M of manpower and resources currently supporting PEP-II and Linac operations will not be transitioning to LCLS. This manpower represents core competencies for the laboratory in accelerator physics, in electrical and in mechanical engineering. The design and construction expertise in these areas include high power RF sources, and in core pulsed and DC power conversion and modulator technology. These technical resources will be redirected to the ILC program as well as SABER and NLCTA programs starting in 2009.

6.1 Transition Tasks

The main transition tasks for PEP-II are securing electrical and mechanical hazards, draining and drying cooling systems for electromagnets, vacuum systems, and RF systems, and venting vacuum systems. A summary of these PEP-II transition tasks and corresponding milestones, which include schedule contingency, is shown in Figure 2. We assume the draining and drying tasks for the magnet and vacuum systems follow securing the mechanical hazards in the tunnel and venting respectively, although some overlap may be possible.

Securing electrical hazards:

There are many electrically powered circuits needed to operate PEP-II, ranging from electromagnets, feedback systems, instrumentation, high power RF systems, water pumps, vacuum pumps, personnel protection system, and tunnel lights. These systems are designed to be secure and safe as long as SLAC management groups, in the form of the Accelerator Systems Division, CEF Division and others, are constantly watching. After PEP-II ramp-down these systems will be not be monitored as closely. As a result all electrical breakers will be turned off and secured with safety locks. Only the fire systems, lights, and tunnel seepage water pumping will remain on. Approximately two technicians, a supervisor, and an electrical engineer will be needed for six months to secure all these electrical breakers.

Securing mechanical hazards:

The mechanical hazards in PEP-II have been secured safely for the lifespan of PEP-II. However, there are unique hazards which may appear during the early ramp-down months of PEP-II that will need to be addressed, especially near the interaction region. Approximately, one technician and a mechanical engineer will be needed for two months.

Draining and drying the electromagnets:

The water pumps for PEP-II will be turned off shortly after ramp-down has commenced. Cooling water left standing in the coils of PEP-II electromagnets will corrode the coils over a period of time, making the magnet useless for other future projects. The plan is to drain and blowout the coils to protect the magnet coils. The water is very slightly tritiated (but well below drinking water standards) and has to be handled using the usual ES&H procedures. There is a potential for mixed waist. There are approximately 1000 magnets to drain and dry. Assuming a technician can drain two to four magnets a day, two technicians and a supervisor are needed for a year to carry out this procedure.

Draining and drying the vacuum cooling system:

Similarly, cooling water left standing in the water channels of the vacuum chambers will corrode the chambers over a period of time, making the chambers useless for other future projects. The plan is to drain and blowout the vacuum chamber cooling lines. The water is very slightly tritiated (but well below drinking water standards) and has to be handled using the usual ES&H procedures. There is a potential for mixed waist. There are approximately 1000 chambers to drain and dry. Assuming one technician can drain and dry two to four chambers a day, two technicians and a supervisor are needed for about year to carry out this procedure.

Venting and securing the vacuum system:

Proper venting of the vacuum system will help preserve the usability of the PEP-II components for future projects. The inventory of chambers includes not only the arc and straight section vacuum components for the two rings, but also high power RF cavities, feedback kickers, beam monitors, ceramic kickers, synchrotron light monitors, and interaction region chambers. There are approximately 15 regions to vent in each ring and 10 more in the injection lines. Assuming that one region can be vented per day, it will take two months for two technicians and one supervisor to vent and secure all the PEP-II systems.

Draining and securing the RF systems:

The high power RF systems for PEP-II are a complex collection of components ranging from 2 MW high-voltage power supplies, 1.2 MW CW klystrons, copper cavities, circulators, to high-power dumps cooled by high conductivity water. These subsystems need special attention in order to bring them to a condition for long-term steady state maintenance. Special factors to be considered include, among several issues, the hundreds of gallons of cooling oil in the transformers and the corrosive high conductivity water. Two technicians, one mechanical and one electrical, are needed for six months to secure this RF system.

6.2 Minimal Maintenance Tasks

Maintaining the fire-protection system:

The fire protection systems for the 2.2 km (1.4 mile) PEP-II tunnel must be maintained at all times for personnel safety. Approximately one technician and a half a supervisor will be needed on an ongoing basis to maintain this system.

Maintaining the tunnel mechanical integrity:

The mechanical systems (wall, floor, hoop supports, shafts, …) for the 2.2 km (1.4 mile) PEP-II tunnel must be maintained at all times for personnel safety. Approximately one technician and a half a supervisor will be needed on an ongoing basis to maintain this system.

Maintaining the tunnel water seepage removal system:

The water seepage collection systems for the 2.2 km (1.4 mile) PEP-II tunnel must be maintained at all times for personnel and environmental safety. Ground water enters the tunnel at many positions around the ring through slightly porous walls. This water is routinely fully collected and disposed of carefully to avoid any possible distribution of contaminants. Approximately two technicians and a half a supervisor will be needed on an ongoing basis to maintain this water pumping and collection system.

Maintaining the tunnel lighting system:

The lighting systems for the 2.2 km (1.4 mile) PEP-II tunnel must be maintained at all times for personnel safety. Approximately one technician and a half a supervisor will be needed on an ongoing basis to maintain this system.

Removal of components desired for other programs:

There will be requests for use of PEP-II equipment coming from other parts of the SLAC program, other US programs, and from around the world. Dispersal of this equipment must be carefully controlled to avoid damage during removal and shipment, including damage to any nearby components. Furthermore, the physical area that remains must be left in a safe condition. On average, two technicians, one mechanical engineer, and one electrical engineer are needed to help disperse equipment for the first two years, and about half of this level thereafter.

7. Dismantling and Disposal of the B Factory

Restrictions on removal of salvage components:

A major factor in the planning for disposal of PEP-II accelerator components is a memorandum of July 13, 2000 from former Energy Secretary Bill Richardson, which placed a hold on materials that have been in a beam line tunnel during operation. At present, materials from these areas cannot be shipped offsite, unless used at another laboratory

From Richardson’s note: “On January 12, 2000, I placed a moratorium on the Department’s release of volumetrically contaminated metals pending a decision by the Nuclear Regulatory Commission (NRC) whether to establish national standards. The NRC continues to review the issue, and the moratorium remains in effect.”

This moratorium remains rigorously in force at SLAC. For example, all metals removed in the dismantling SPEAR-2 and the FFTB are still stored on site today, several years after these activities were completed.

With this restriction in force, if PEP-II magnets, vacuum chambers, cables, cable trays, water pipes, supports, and instruments were to be removed from the tunnel enclosure, they would have to be store on site for the foreseeable future. The storage of such a large quantity materials would require construction of a suitable structure or building to protect valuable equipment and prevent any environmental contamination from exposure to the elements.

Our proposal is to leave PEP-II in place in the tunnel until the moratorium is resolved. There is little planning that can be done at SLAC on how to salvage metals from PEP-II until guidance is received from DOE. The salvage plan will then depend significantly on the content of the new regulations.

Again to quote from Richardson's note. "Once the revised directives and guidance are in place, the Department will require each DOE site to have local public participation before the site may resume the unrestricted release for recycling of scrap metals from radiation areas. These public participation requirements must address each of the above mentioned elements associated with release criteria and information management. In addition, the Department will require individual sites to certify, through the responsible Program Secretarial Officer (PSO), that they have met all requirements of the revised order before the release of scrap metal from radiation areas for recycling can resume."

Planning Scenarios:

Detailed planning for dismantling PEP-II and *BABAR* is now underway. Two scenarios are under consideration:

> **Scenario 1.** Assuming the moratorium on removal of metals from accelerator housings remains in effect, suitable on-site storage will need to be developed to protect components removed from inside the radiation controlled access areas of the PEP-II tunnels and IR halls. This restriction does not extend to material in service buildings at ground level or regions of the IR halls outside of controlled access. A variant of this scenario is to plan on clearing the IR halls only, since these buildings may be in demand for other uses.
>
> **Scenario 2.** Assuming the moratorium is resolved, material with no residual radioactivity can removed from PEP-II and recycled off-site.

We are in the process of identifying those PEP-II and *BABAR* components that have particularly long-term value (more than 5 years) so that plans can be developed, including costs and requirements, for long-term storage of these specific components. Options under consideration for the PEP-II tunnel range from back-filling within the existing concrete tunnel walls to complete removal of all tunnel materials and restoration of the surface profile for the SLAC site. We will also determine the cost and manpower needed to remove all surface buildings and pump pads, in order to restore the area to a natural state.