US LHC Accelerator Project

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Lehman Review
26 July 2004

Outline

Project Technical and Schedule Status

Cost and Schedule Performance

Baseline Change Status

EAC and Contingency Analysis

Expected Subproject Completion

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Responses to October Review Recommendations

IR Quadrupole Production Status

IR Quadrupoles are well into production.

- 6 of 10* LQXB (2 MQXB + CERN corrector) have been built.
  - LQXB01 is at CERN, and LQXB03 is in transit
  - LQXB04 and LQXB05 ready to ship pending CERN acceptance.
  - LQXB06 is on the test stand.
  - LQXB07 is in cryostat assembly.
- 3 of 19 LQXA/C (KEK quad + CERN corrector) are ready to ship pending acceptance by CERN.
  - LQXA01 has been cold tested.
  - Subsequent LQXA will be warm measured only.
  - 1st LQXC starting cryostat assembly.
- Quadrupole production and cold testing of LQXB are just keeping pace with each other.

*#10 is replacement for LQXB02.

Beam Separation Dipole Production at BNL

Beam separation dipoles production is essentially complete.

D1 - 4 of 5 D1's are at CERN.
- 5th was retested and is now ready to ship, pending acceptance formalities.

D2 - Construction and testing of all 9 D2's is complete.
- 6 D2 are at CERN; acceptance of remaining 3 is pending.

D4 - 3 of 3 D4's are complete.
- 2 of 3 have been cold tested.
- 3rd is on test stand.

D3 - 3 of 3 D3's are complete.
- Testing follows D4's.

Dipole testing will be complete by November 2004.

Repairs to out-of-tolerance QQS on 3 magnets will delay shipping.

Last dipole to be shipped by spring 2005.

IR Feed Boxes (LBNL & FNAL) and Absorbers (LBNL)

DFBX Production moving forward well.

- Production proceeding well at Meyer Tool.
  . . . Dealing with issues as they arise.
- 19 of 20 HTS lead pairs cold tested, 2 pairs returned to Pirelli for repairs.
- All vapor cooled leads have been delivered to Meyer Tool.
  - He to air leaks repaired by AMI.
- Lab-built subassemblies nearly done.
- New production plan, including systematic use of overtime, instituted to recover schedule lost to a series of "minor" problems.
- On schedule to meet installation schedule requirements.

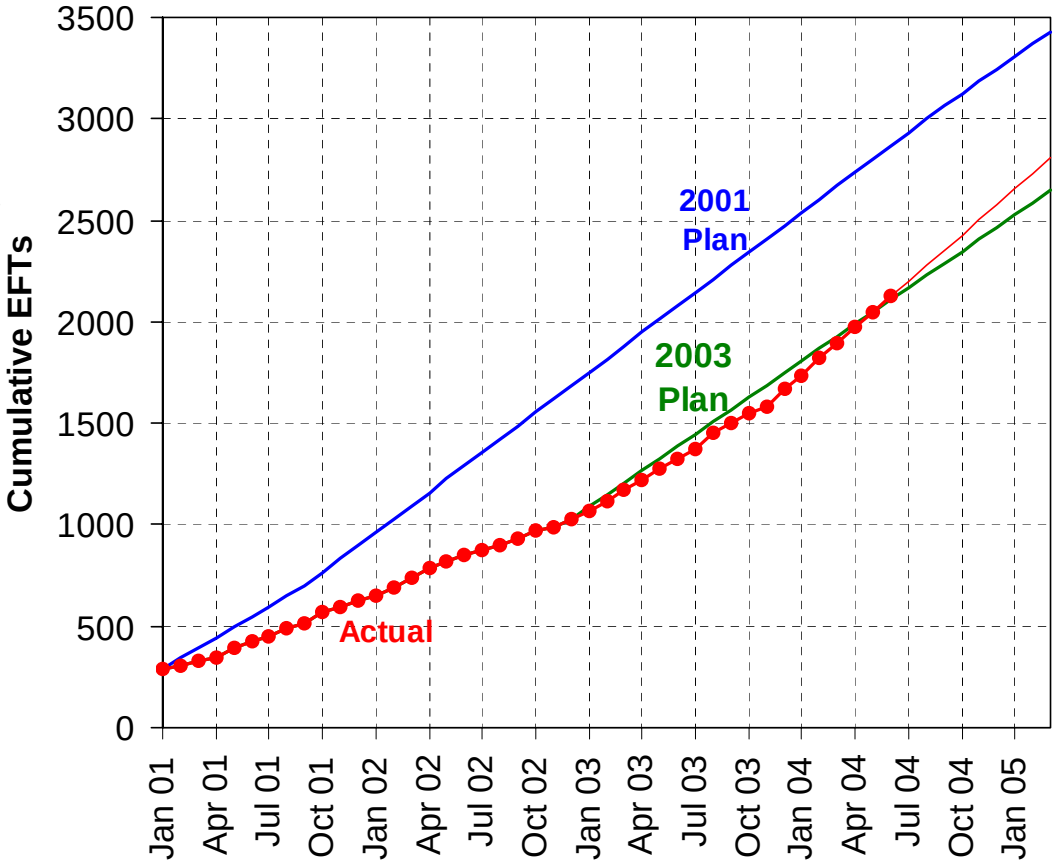
IR Absorbers production is complete.

- 4 of 4 TAS and 4 of 4 TAN are at CERN.

Superconductor Testing at BNL

Production SC cable testing is proceeding well.

- Testing for past 6 months has been well above the planned rate
  . . . 76/mo average
  vs. 60 "promised."
- BNL testing is keeping up with CERN sample delivery.
- Test program is now tracked as a level-of-effort task.
- Budgetary limitations may force end of cable testing ~3 months early.



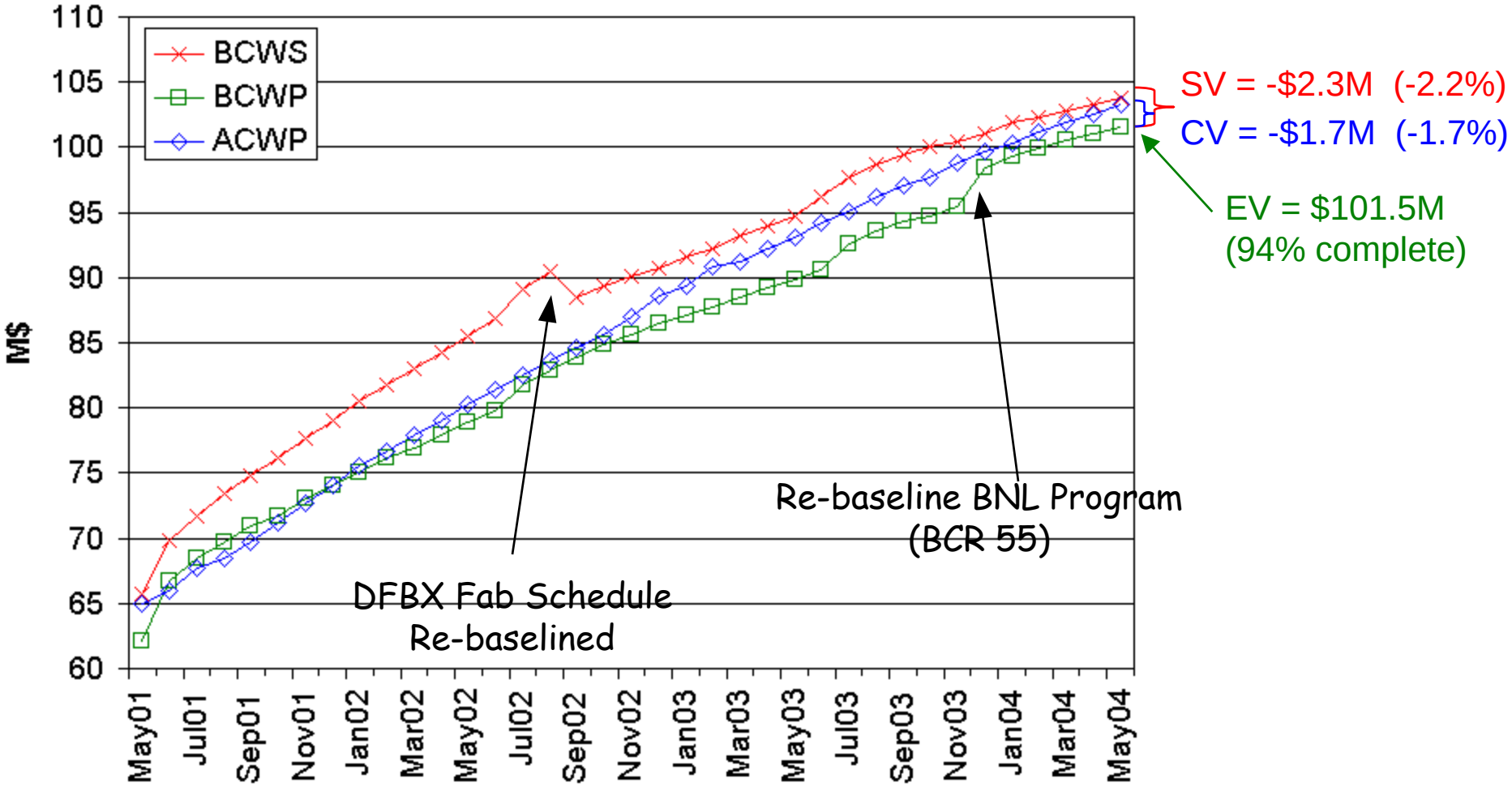
US LHC Accelerator Project Status
Schedule Summary

Schedule situation remains tight in places . . . vigilance is required:

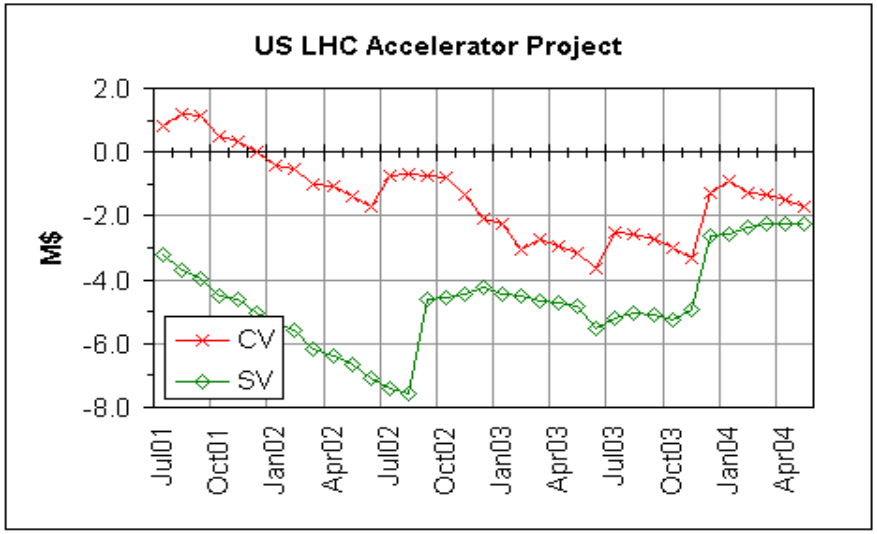
- Overall the project remains ~4-5 months behind our schedule.
- We remain ahead of schedule for installation in LHC.
  - Dipoles and absorbers are well ahead of CERN need dates.
  - Must continue to watch quadrupole production:
    - Quad production is currently the pacing activity.
    - ~ 0 float for deliveries first quad to CERN (relative to obsolete installation schedule)
    - ~ 2-3 months float for final delivery to CERN.
  - Must continue to watch feedbox production:
    - ~ 0 float for delivery of first DFBX to CERN (relative to obsolete installation schedule)
    - Typically 1-2 month float for most deliveries to CERN;
    - ~2 months float for final delivery to CERN.

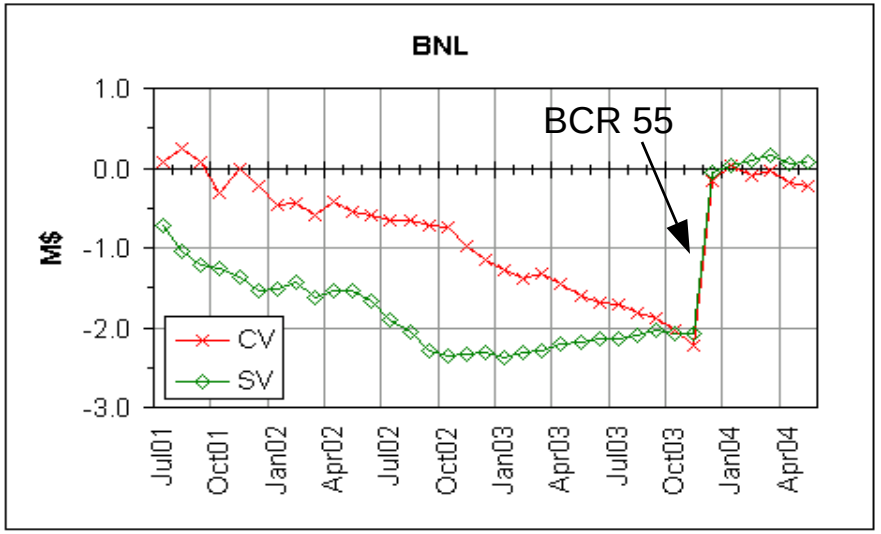
Cost and Schedule Performance

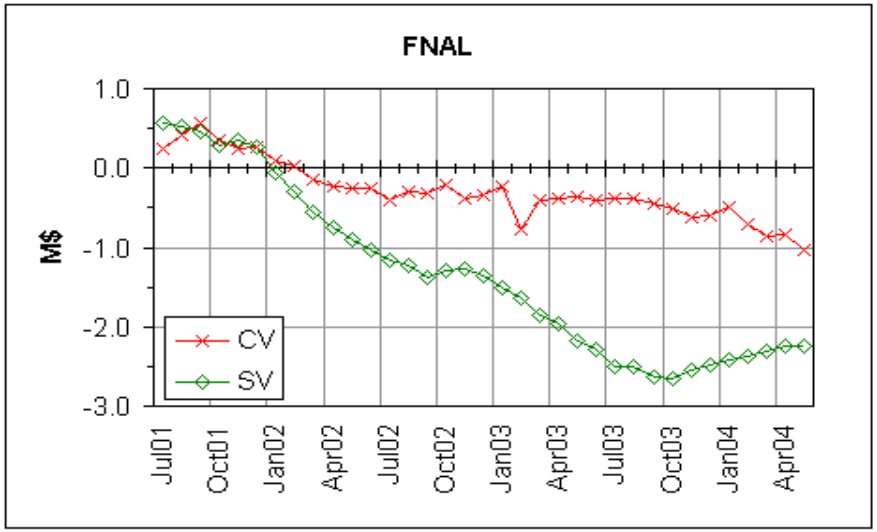
through May 2004

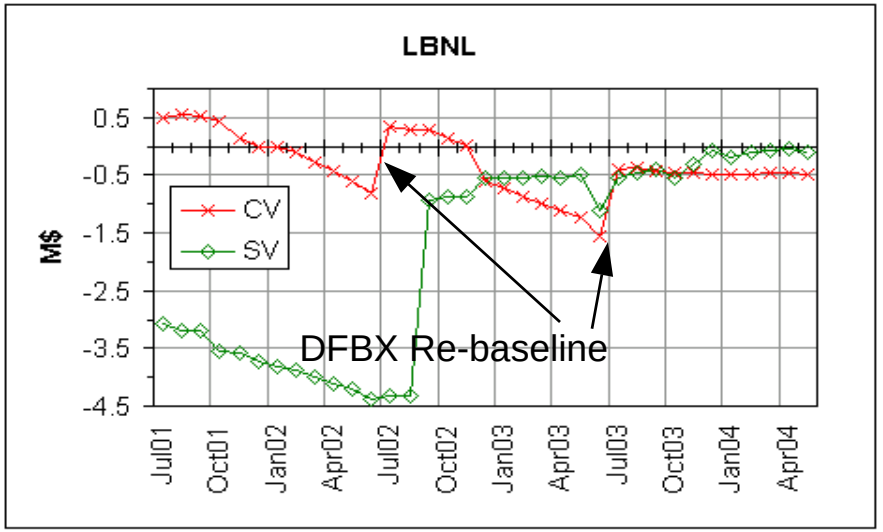


Cost and Schedule Performance









Cost and Schedule Performance

Principal causes of unfavorable cost trends:

- Extension of magnet testing and acceptance effort at BNL.
- Higher than budgeted monthly cost for SC cable testing.
  Cost recovery has started after replacement of leaking HX.
- Negative variances in FNAL quad parts and shipping costs.
  Quad costs are addressed in BCR 59, just approved.

Principal schedule trends:

- Overall schedule variance largely unchanged since October review.
- Fermilab quad production and testing is approaching planned rate.
- Completion of dipole testing at BNL has slipped to the fall.
- Production of 1st 2 feedboxes is 2 months behind schedule.
  New production plan, should recover the lost schedule.

Baseline Changes

Baseline budget changes:		BAC
BAC as of February 2004 Status Meeting		$107,427k
BCR 61 (D3 cryostat modifications)	+11k	$107,438k
BCR 62 (CS Analysis at LBNL)	+47k	$107,485k
BCR 63 (Quad cable at LBNL)	+33k	$107,518k
BCR 59 (re-baseline FNAL program)	+1020k	$108,538k
BCR 66 (IR Absorber closeout)	+138k	$108,676k

Controlled milestone changes:

BCR 64 – Change definitions (and dates) of L2 delivery milestones to be "approved for shipment."

BCR 65 – Update definition of SC Test completion milestones to correspond to new Implementing Arrangement Appendix 3.

Delivery Milestones

New Milestones – "Ready to Ship"		
2-1.1-13C	IR8 left	20-Aug-04
2-1.1-26C	IR2 right	24-Sep-04
2-1.1-16C	IR8 right	4-Feb-05
2-1.1-19C	IR1 left	4-Feb-05
2-1.1-23C	IR5 left	17-Jun-05
2-1.2-4C	IR4 right	17-Jun-05
2-1.2-6C	IR4 left	19-Aug-05
2-1.1-25C	IR5 right	30-Sep-05
2-1.1-27C	IR1 right	30-Sep-05
2-1.1-32C	IR2 left	30-Sep-05

Milestones are derived from from CERN installation schedule as of March 2003, the last "official" release.

=> Doesn't incorporate effect of delays due to QRL, etc.

Earliest desired shipment (not an official milestone) is for warm assembly of 1st triplet on the surface this fall.

=> OK for D1, Q1, Q2
Tight for Q3, DFBX.

BAC and EAC Changes Since February Status Meeting

		Baseline Budget				Estimate at Completion		
		Feb 04	Jul 04	Change		Feb 04	Jul 04	Change
1.1.1 + 1.1.5	IR Quads	28,945	29,831	886		29,635	29,831	196
1.1.2 + 1.2.1	Beam Sep Dipoles	22,232	22,241	8		22,240	22,506	266
1.1.3	DFBX	8,850	9,007	157		8,903	9,007	104
1.1.4	Absorbers	4,558	4,668	110		4,558	4,668	110
1.3.1	SC Testing	8,726	8,726	0		8,726	8,461	-265
1.3.2	Cable Prod Support	936	936	0		936	936	0
1.4	AP	2,626	2,626	0		2,626	2,626	0
1.5	PM	10,863	10,653	-210		10,649	10,653	4
	G&A+Overhead	19,972	19,988	16		20,170	19,988	-183
	Total	107,708	108,676	968		108,444	108,676	232

To achieve EAC = BAC, has required:

- Some scope management at BNL, including ~3 month reduction in cable testing.
- Active support from local management at all 3 labs.

This is necessary to preserve contingency for future risks.

EAC and Contingency History

	As of 31 May 04			26Jul04	12Feb04	10Oct03	27Aug03	12Feb03	9Jun02
	BCWP	ACWP	BAC	EAC	EAC	EAC	EAC	EAC	EAC
BNL	43,544	43,775	45,071	45,071	45,351	44,941	44,823	44,434	44,469
FNAL	39,031	40,054	42,001	43,021	42,727	42,653	42,617	42,353	41,720
LBNL	18,970	19,449	20,447	20,585	20,367	20,447	20,651	20,268	19,559
Total	101,545	103,278	107,518	108,676	108,444	108,041	108,091	107,056	105,748
TPC			110,000	110,000	110,000	110,000	110,000	110,000	110,000
%compl	94.4%	95.0%							
Contingency (TPC-EAC)				1,324	1,556	1,959	1,909	2,944	4,252
ACWP as of end of previous month				103,278	99,718	96,167	95,059	88,572	79,340
Cost to go (EAC - ACWP)				5,398	8,726	11,874	13,031	18,484	26,408
Congingency as a fraction of:									
Cost to go (EAC - ACWP)				25%	18%	17%	15%	16%	16%
Required contingency in dollars				1,120	1,714	2,306	2,490	3,571	5,110
Rqd ETC reduction for 20% conting				-204	158	346	581	627	858

Contingency computed from EAC (=BAC as of July) is above 20% of cost to go. *BUT:*

- Only small contingency allocation will drop us below 20%.
- Risk analysis (see below) suggests that contingency is marginal.

Contingency Need Analysis

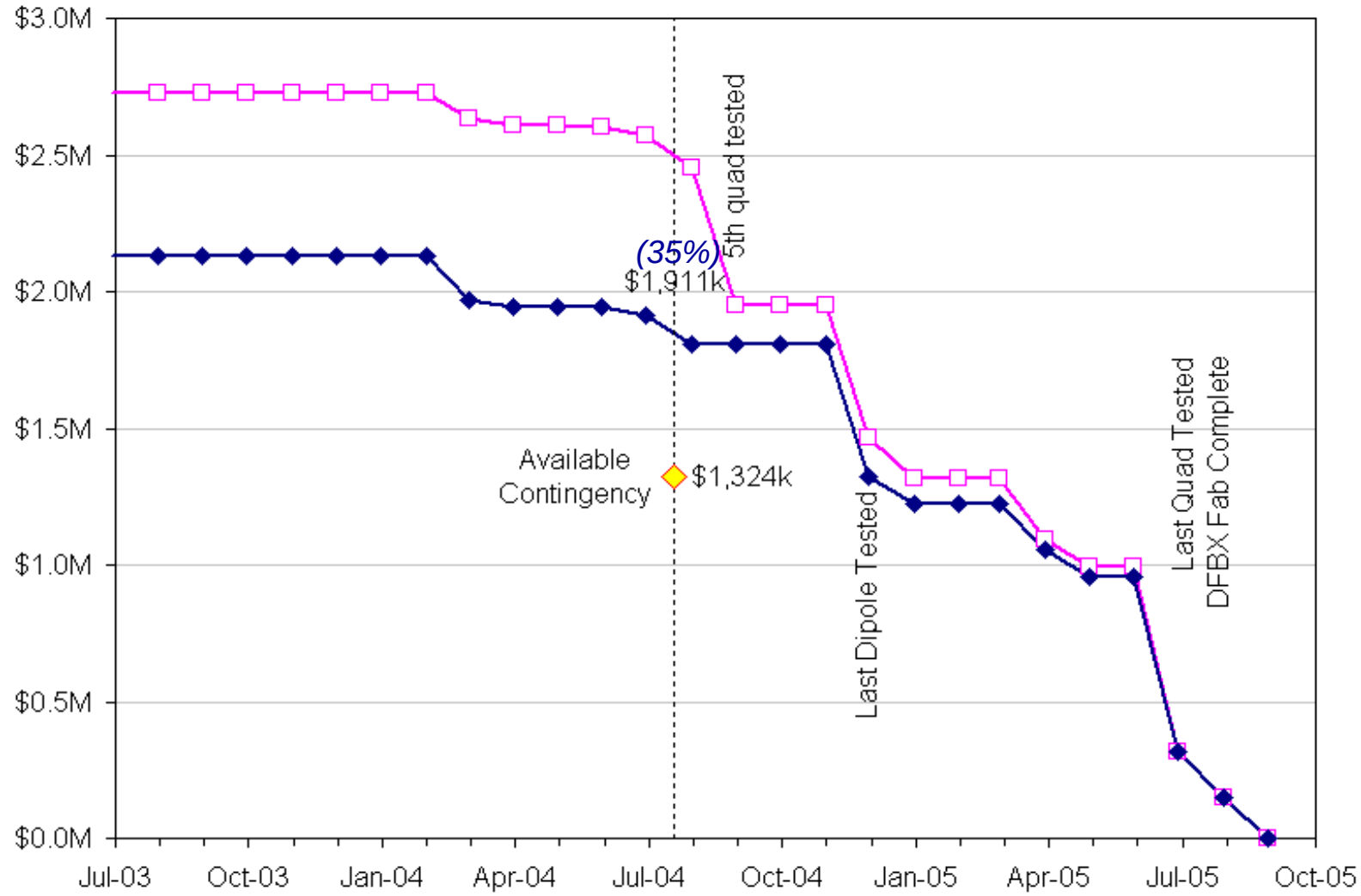
Risk Analysis Performed:

- List all plausible things that can go wrong, with associated cost.
- Determine time up to which contingency must be held against event.
- Only significant change from previous reviews is to extend the time up to which some pieces of contingency must be held, due to delays in completing certain tasks.

1.1.1 + 1.1.5 IR Quads						
Unweighted sum				$1,555k		
Suggested contingency reserve				$968k		
Tooling failure	high	1	$50k		Apr-05	End of cryostat assembly
Minor assembly process failure	moderate	1	$50k		Apr-05	End of cryostat assembly
Major assembly process failure	low	0	$500k		Aug-04	Covered by "magnet rebuild" risk
New cable required; lower yield to coils	high	1	$30k		Jun-04	New cable bought
Substantial corrector delay	low	0.5	$100k		Dec-04	Assume at most one of these happens
Test system problems	low	0.5	$75k		Jun-05	
Slow quench training	moderate	1	$50k		Jun-05	Completion of cold testing
Magnet fails to meet acceptance criteria - accepted	high	1	$50k		Jun-05	
Magnet rebuild	low	1	$500k		Jun-05	
Magnet damage during shipment	low	1	$100k		Aug-05	Last magnet at CERN
Extended process to approve acceptance specs	high	1	$50k		Aug-05	

Contingency Need Analysis

Contingency required to cover plausible future problems.



Project Completion Schedule Summary

- Comfortable float relative to Project Completion milestone (30 Sep 05) exists for dipoles . . . And Absorbers are complete.
- Cable testing will continue at maximum possible rate as the Project budget allows, but early termination may be required.
- Have redefined Project completion to be based on readiness to ship, providing 1½ months additional float w.r.t 30 Sep 2005.
- Modest float for shipping of last quadrupole relative to Project Completion milestone.
  => require high priority at FNAL for quad production and testing.
- Modest float for shipping of last DFBX with respect to Project Completion milestone.
  => aggressive monitoring and timely support of vendor will be required.

Issues

Schedule pressures

- Need to complete dipole testing.
- Need to maintain or increase quadrupole production and testing rates . . . Learning curve!
- Need to continue to provide timely support to DFBX fabricator.
- Project budget limitations may require terminating SC testing ~3 months early.

No major technical issues at this point.

Issues

Internal cost pressures

- Management at each lab is working to manage to the agreed cost.
- A series of Baseline Change Requests (BCR) has converted the individual lab EAC's to baseline budgets, which define the remaining funding to be provided to each lab.
  - Process completed with BCR 55 (BNL),
    BCR 59 (FNAL) and
    BCRs 51, 56 and 66 (LBNL).
- Contingency will be allocated only for approved work scope changes.
- *Cost pressures exist at all labs – currently most severe at BNL. Holding the line on the BAC may require modest scope adjustments, most notably:*
  - Termination of SC Testing ~3 months early.
  - No cold test of spare D3.

US LHC Accelerator Project
Summary

- Technical progress is excellent.
- Schedule is remains a minor issue.
- Cost and contingency situation continues to require serious attention and action.

- Excellent and constructive working relations continue with CERN (and KEK).

- We remain fully committed to deliver on our commitments to CERN
  Full technical performance,
  On time,
  Within our budget,
  and every action is and will be taken to ensure success.

Response to Oct DOE Review Recommendations

IR Quadrupoles (WBS 1.1.1)		
1	Communicate the implications of late delivery of the correctors to the program at Fermilab to CERN LHC management.	This has been communicated many times. LHC management has addressed this issue and corrector deliveries are now well off the Fermilab critical path.
2	Investigate the possibility of BNL testing the correctors. This would have to be funded separately.	CERN has accelerated its testing schedule for the correctors, such that it does not make sense to pursue this option.
	(BNL recommendation 2: Evaluate the overall benefits and risks of the US-LHC management offering to measure the correctors needed to complete the US commitment to the LHC Program. Measurements of these correctors would be performed at BNL again on a seven day per week schedule. This would have to be funded separately.)	

Response to Oct DOE Review Recommendations

IR Quadrupoles (WBS 1.1.1)		
3	Eliminate the second temperature cycle from the magnet testing.	This has been done.
4	Work with Fermilab management to assure that the LHC magnets have a high enough priority in the Fermilab magnet test facility to stay on schedule.	This is being accomplished. The tests of LQXB03, LQXB04 and LQB04 have had sufficient priority to stay on schedule. Testing is currently not the activity pacing the schedule.

Response to Oct DOE Review Recommendations

IR and RF Region Dipoles (WBS 1.1.2 and 1.2.1)		
1	Evaluate the schedule benefits and risks of running the BNL magnet test facility seven days per week. A shortened measurement schedule may offset the costs of the additional staff. Completing the measurement program early, determining that the magnets are an acceptable quality will allow the US-LHC management more latitude in contingency management.	About 40% of the testing time is cool-down and warm-up, which are performed automatically largely under computer control, and can be considered to be 7-days per week operations. Other operations are performed during normal working hours with overtime used under highly leveraged conditions only. During the past 18 months manpower on the LHC has been reduced from 40->15 FTE's and continues to fall. It is impractical under these conditions to increase peak loading manpower.
2	(See quad recommendation 2)	
3	(Mgmt recommendation)	
4	Review the labor estimates proposed in ETC/BCR55 with the goal of reducing the total number of staff needed to support testing of both magnets and short samples. Cross training of staff should be considered in this review.	The cost estimate to complet in BCR 55 has been thoroughly reviewed by both the Project Office and BNL over the past six months. We have kept the cost estimate as presented at the October DOE review and it is now approved at the BNL baseline, with the clear understanding that it represents a cap on funding to BNL unless there is a specific work scope change, approved by a subsequent BCR.

Response to Oct DOE Review Recommendations

IR Absorbers (WBS 1.1.4)		
1	Continue aggressive pursuit of the TAN beam tube repairs that should include the following steps:	
1a	Repair leaks in the weld(s) in one beam tube, at the vendor's expense, by November 15, 2003.	Done.
1b	Fabricate a new beam tube using existing parts and subassemblies, by December 15, 2003	Done.
1c	Ship the damaged beam tube and all remaining subassemblies to CERN. No further repairs steps are to be undertaken.	Done.
1d	Obtain technical information concerning the provenance, properties and fabrication details of the copper material used in the damaged tube by Nov. 1, 2003.	This is under investigation at a low level. Having qualified all four TAN beam tubes makes this a less pressing issue than it was at the October review.

Response to Oct DOE Review Recommendations

IR Feedboxes (WBS 1.1.3)		
1	Require Pirelli, the HTS lead vendor, to send their representative to Fermilab without further delay and initiate the following steps:	
1a	Determine the cause of the leaks, the wiring defects and the extent of the shorting of the temperature sensors in conjunction with Pirelli by December 1, 2003.	Done.
1b	Develop a comprehensive repair and restoration procedure with Pirelli' applicable to all 40 leads by December 1, 2003.	Done.
1c	Establish a detailed test protocol in conjunction with Pirelli by December 1, 2003.	Done.

Response to Oct DOE Review Recommendations

IR Feedboxes (WBS 1.1.3)		
1d	Repair defects. All repairs should be the responsibility of Pirelli but if not feasible, under his immediate supervision by cognizant LBNL and Fermilab staff. At least one pair of tested leads should be available by January 15, 2004.	Done.
1e	Ensure that the vendor of the DFBX is made fully aware of the HTS situation, and that the repair of the leads proceeds in a manner to minimize the impact on the DFBX fabrication schedule by November 30, 2003.	Done.
1f	Ensure that a representative from LBNL and/or Fermilab are present to witness the testing of at least one set of leads at American Magnetics, Incorporated, Oak Ridge, by December 1, 2003.	Done.

Response to Oct DOE Review Recommendations

Cost and Schedule		
1	Finalize planned Baseline Changes to establish a revised Budget at Completion for each Laboratory by January 2004.	All LBNL BCRs were approved an in place as of the October DOE Review. BNL BCR 55 was approved on 15 December 2003. FNAL BCR 59 was approved on 19 July 2004.
2	Continue to aggressively manage cost and schedule to complete the U.S. deliverables on the baseline schedule by CD-4 of September 2005.	This is being done.

Response to Oct DOE Review Recommendations

Management		
1	Design changes requested by CERN estimated to exceed a limit established by the US-LHC Program Office should be reviewed and approved prior to implementation.	*Any* work scope changes that require an increase in a labs budget, and hence funding, must be approved by the Project Office prior to implementation, and must be documented by a BCR.
2	Continue to provide stringent management of cost and schedule and ensure that the Project has the support of the Fermilab, BNL and LBNL laboratory directors.	The Directorates of the three labs are kept informed and their support solicitied through, among other channels, meetings of the PAG, the most recent of which took place on 24 Nov 2003.
3	Investigate and implement ways to maintain the schedule such as alternates to testing the correctors at CERN and reducing the cold testing cycle at Fermilab.	These have been pursued (see Quadrupole recommendations 2 and 3)