

Project Director's Quarterly Progress Report – 4th Quarter FY 2003
U.S. Large Hadron Collider Construction Project

1. PROJECT IDENTIFIERS

Reporting Period:	Through September 30, 2003
Program Sponsors:	DOE High Energy Physics Division/NSF Physics Division
DOE/NSF Program Manager:	M. Pripstein, (301) 903-4115, moishe.pripstein@science.doe.gov
DOE/NSF Associate Program Manager:	M. Goldberg, (703) 306-1894, mgoldber@nsf.gov
Operations Office:	Chicago Operations Office/Fermi Area Office
DOE/NSF Project Director:	P. Carolan, (630) 840-2227, pepin.carolan@ch.doe.gov

2. PROJECT DESCRIPTION

The Department of Energy (DOE) and the National Science Foundation (NSF) have signed agreements committing to collaboration in the construction of the Large Hadron Collider (LHC) at CERN (European Laboratory for Particle Physics) and two of its associated detectors. The U.S. fabrication effort will be carried out at, or under the supervision of, U.S. universities and national laboratories under the terms and conditions described in the International Collaboration Agreement (Agreement) and its Accelerator and Experiments Protocols. The U.S. LHC Construction Project is defined by the goods and services to be provided to CERN under the terms of the Agreement between DOE, NSF, and CERN. These goods and services include DOE contributions to the LHC accelerator, and DOE and NSF contributions to the ATLAS (A Toroidal LHC Apparatus) and CMS (Compact Muon Solenoid) experiments.

The DOE contribution to the LHC accelerator consists of items provided by DOE National Laboratories and CERN direct purchases from U.S. industrial firms. The scope of these contributions is addressed in the Accelerator Protocol and described in detail in an Implementing Arrangement between the collaborating DOE National Laboratories and CERN. The DOE and NSF contributions to the ATLAS and CMS detectors consist of items supplied by the collaborating U.S. universities and DOE National Laboratories. The scope of these contributions is addressed in the Experiments Protocol and described in detail in Memoranda of Understanding for collaboration on construction of each experiment.

The U.S. LHC Construction Project includes the U.S. ATLAS, U.S. CMS, and U.S. LHC Accelerator Construction projects. This report summarizes the overall status of the U.S. LHC Construction Project effort and includes more detailed status information on each sub-project. Additional information can be accessed at the following web sites:

U.S. LHC Project - <http://doe-hep.hep.net/lhc.html>

LHC Project - <http://www.lhc.cern.ch/> U.S. LHC Accelerator - <http://www-td.fnal.gov/LHC/USLHC.html>

ATLAS - <http://atlasinfo.cern.ch/Atlas/Welcome.html> U.S. ATLAS - <http://www.usatlas.bnl.gov/>

CMS - <http://cmsinfo.cern.ch/Welcome.html> U.S. CMS - <http://uscms.fnal.gov/>

**Project Director's Quarterly Progress Report – 4th Quarter FY 2003
U.S. Large Hadron Collider Construction Project**

3. PROJECT DIRECTOR'S NARRATIVE HIGHLIGHTS

The current list of DOE/NSF project reviews and status meetings is provided below:

U.S. LHC Construction Project	Event	Date
U.S. LHC Accelerator Project	DOE Review	October 15-16, 2003
U.S. ATLAS Detector Project	DOE/NSF Status Meeting	November 19, 2003
U.S. CMS Detector Project	DOE/NSF Status Meeting	November 20, 2003
U.S. LHC Accelerator Project	DOE Status meeting	February 12, 2004

The results of these activities are documented in formal reports and meeting notes. The U.S. CMS and ATLAS projects submit monthly reports and the U.S. LHC Accelerator project submits a quarterly report. Current performance data is summarized in the following tables:

Table 3.1, Schedule Performance Indices

	Planned Complete (BCWS/BAC)	Actual Complete (BCWP/BAC)	Schedule Performance (BCWP/BCWS)
U.S. ATLAS	86%	84%	98%
U.S. CMS	87%	80%	92%
U.S. LHC Accelerator	94%	89%	95%

Table 3.2, Contingency Status (in thousands of dollars)

	Total Project Cost (TPC)	Budget at Completion (BAC)	Contingency	Budgeted Cost of Work Performed (BCWP)	Remaining Work to be Performed (BAC-BCWP)	Contingency/ (BAC-BCWP)
US ATLAS	163,750	145,837	17,913	123,147	22,690	79%
US CMS	167,250	151,528	15,722	120,897	30,631	51%
US Accelerator	110,000	106,237	3,763	94,331	11,906	32%

Table 3.3, Cost & Schedule Performance (in thousands of dollars) Indices

	Cumulative Costs to Date					Costs at Completion		
	Budgeted Cost		Actual Cost	Variance		Budgeted	Revised Estimate	Variance
	Work Scheduled	Work Performed		Schedule	Cost			
U.S. ATLAS	125,028	123,147	115,305	-1,881	7,842	163,750	163,750	0
U.S. CMS	131,301	120,897	122,271	-10,404	-1,374	167,250	167,250	0
U.S. LHC Accelerator	99,409	94,331	97,286	-5,078	-2,955	110,000	110,000	0
CERN Invoices	48,619	48,619	48,619	0	0	90,000	90,000	0
U.S. LHC Total	404,357	386,994	383,481	-17,363	3,513	531,000	531,000	0

Project Director's Quarterly Progress Report – 4th Quarter FY 2003
U.S. Large Hadron Collider Construction Project

4. PROJECT DIRECTOR'S ASSESSMENT

The U.S. projects continue to meet their goals and are reliable and influential partners in the construction of the ATLAS and CMS detectors and the LHC machine.

Cost – Cost performance is good. The cumulative Cost Performance Index (CPI) for the total U.S. LHC Construction Project (U.S. ATLAS, U.S. CMS, and U.S. LHC Accelerator) is 1.01, which is slightly favorable overall. An area of cost concern is the U.S. LHC Accelerator Project contingency situation, where remaining contingency is relatively low based on the latest estimate to complete and project need based upon potential risks. The Accelerator project will capture the cost estimates at completion for each Laboratory and incorporate these as effective budgets for completion, emphasizing stringent project management to these costs. Support and commitment to the project success on the part of the Fermilab, BNL and LBNL Laboratory Directors also remains important.

U.S. CMS contingency remains healthy, and financial performance good. In coordination with CMS, additional scope been adopted within the Electromagnetic Calorimeter baseline to implement the new front-end electronics design that will achieve better technical performance. U.S. ATLAS financial performance has also been good, and contingency remains robust. U.S. ATLAS has confirmed with ATLAS a commitment to apply contingency toward detector installation. Contingency use is also anticipated for Liquid Argon calorimeter power supply production, although the U.S. has reached agreement with ATLAS that the full collaboration will share in the costs for this system.

Schedule – Schedule performance is measured by milestone completion and by earned value. The total U.S. LHC Construction Project schedule overall is slightly behind plans with a cumulative Schedule Performance Index (SPI) of 0.95, unchanged from the previous Quarter and indicating no major slippages in schedule. The total U.S. LHC Construction Project is eight-four percent complete based on earned value. The CERN schedule calls for first beams in April 2007. A period of beam commissioning will be followed by start of the LHC Physics Program in the latter half of 2007. The U.S. LHC Project completion baseline milestones remain as follows:

Critical Decision-4A: 97% complete, September 30, 2005 (Accelerator and Detector deliverables)

Critical Decision-4B: 100% complete, September 30, 2008 (final detector installation and technology procurements)

The U.S. LHC Accelerator Project remains ahead of schedule for delivery of components to CERN by required installation dates, although float is minimal in some instances that are being carefully watched. Delivery of corrector magnets from CERN is becoming critical path for quadrupole production. Delays in these components have been brought to management's attention, resulting in discussion with CERN LHC management and CERN agreement to better match U.S. production needs. U.S. CMS is updating its schedule to the latest approved CMS installation schedule, and the CD-4A completion milestone remains de-coupled from this, as planned. U.S. ATLAS has updated the baseline schedule and float for each subsystem to reflect ATLAS required delivery dates. The CMS and ATLAS detector collaborations are both prepared to mitigate schedule delays (e.g. ATLAS barrel toroid, CMS solenoid magnet production) through revisions to detector installation and testing plans, e.g. plans for additional surface testing of detector sub-systems or changes to

Project Director's Quarterly Progress Report – 4th Quarter FY 2003

U.S. Large Hadron Collider Construction Project

underground installation sequence. Both detector collaboration schedules continue to support and work toward meeting the April 2007 LHC turn-on date.

Technical - Good technical progress continues across the project, and we remain confident that the U.S. deliverables to CERN can be realized with the planned funding. The U.S. LHC Construction Project deliverables are accepted by CERN and approved by the DOE/NSF Joint Oversight Group. We expect to provide additional items to CERN, within the approved funding, should cost performance be favorable. Important achievements or milestones continue to be met. U.S. LHC Accelerator dipole magnets continue to arrive and to be accepted at CERN. All U.S. CMS forward hadron calorimeter absorber wedges are delivered to CERN, with insertion of quartz fibers nearly complete. U.S. ATLAS muon endcap Monitored Drift Tube chambers were completed by the University of Michigan. Additional technical Project highlights are given in the report.

ISSUES

LHC Construction Completion— In October 2003, CERN Management confirmed the LHC schedule as: completion of the LHC machine in the last quarter of 2006; first beams injected during the spring of 2007; first collisions mid 2007. Challenges for LHC construction include increasing main dipole cold mass production rate by a factor of ~3 by spring 2004, increasing quadrupole cold masses delivered (delivery rate of required corrector packages must be improved), completing testing of magnets, and maintaining progress on ring cryogenic line fabrication and installation. Dipole cold mass delivery from the three vendors is reaching the required rate and ring cryogenic line installation started in late July 2003. CERN Council has confirmed the current LHC Project Leader, Lyn Evans under the new CERN organizational structure that will be implemented January 1, 2004 under the new Director General.

ATLAS and CMS Resources— Both collaborations have presented updated financial plans to the detector Resource Review Boards (RRBs) in October, 2003. The updated plans address funding shortfalls previously identified, and the collaborations have had some success identifying funds and actions to significantly reduce those shortfalls. Additionally, costs of sub-detectors have been updated to cover the shortfalls through reducing redundancy, using existing contingencies, or further detector staging. In cases of detector staging, acceptability of physics impact is considered for initial physics running. The funding profiles present cash flow problems in some areas, which the collaborations are working with the funding agencies and RRBs to solve or minimize. There may be potential impact on overall detector installation schedules if the cash-flow situation cannot be successfully managed. The collaborations continue the process of firming up commitments internationally from those funding agencies that can provide additional resources (U.S. LHC construction funds are capped), a process likely to continue over the final years to completion. If successful, this process could allow the collaborations to gradually improve the expected performance and capability of the initial detectors to more fully exploit physics opportunities.

Project Director's Quarterly Progress Report – 4th Quarter FY 2003
U.S. Large Hadron Collider Construction Project

5. NARRATIVE SUMMARY

5.1 U.S. ATLAS CONSTRUCTION PROJECT

ATLAS International.- An LHC Committee (LHCC) installation review took place in September 2003. It was reported that the Technical Coordination team is making excellent progress toward a viable installation plan, with an installation schedule that is reasonable but very challenging. Present funding arrangements are indicated to appear commensurate with the plans presented, noting that installation will be long and difficult with a great deal of work obviously remaining. The committee recommended close co-operation with CERN Technical Inspection & Safety division in addressing organization and management of the large number of workers in the underground cavern and related issues. Committee concerns should be addressed in a follow-up review in March 2004.

- the first detector “foot” (part of the massive main detector support structure) has taken place in the underground cavern; also installed are the underground and surface cranes.
- A delay in the barrel toroid due to technical problems with thermal shields (now appear to be under control by vendor) has resulted in a revision to the calorimeter installation schedule.
- Liquid Argon (LAr) calorimeter barrel cryostat integration work is completed, and the half-barrel cylinders have been inserted; the LAr cryogenics plant is progressing well.

U.S. ATLAS- As of September 30, 2003 the project is 89% complete vs. the schedule plan of 90% for the remaining work to complete the current baseline scope. There are no major technical issues- all U.S. ATLAS subsystems are now in production and detector components are being successfully delivered to CERN. Cost and Schedule performance is very good. Contingency planning, prioritization and allocation strategies are focused on ensuring that adequate contingency levels can be maintained through project completion. The current U.S. ATLAS schedule meets ATLAS needs. Forecast dates above have been revised to reflect the latest schedule estimates. Below are a few highlights of the U.S. ATLAS construction project:

- Silicon: Assembly of disk sectors is proceeding smoothly, design of the last piece of tooling for fabrication of the pixel support was completed and fabrication begun.
- Transition Radiation Tracker: All sites are nearing completion of the 102 modules and 30 modules have been shipped to CERN. Work related to installation has started.
- Liquid Argon Calorimeter: packaging of key electronics wafers is progressing and negative voltage regulators have showed satisfactory characteristics after irradiation. Forward Calorimeter performance appears to be excellent based on beam tests.
- Tile Calorimeter: Work continued on barrel cylinder pre-assembly and a final test beam run.
- Muon Subsystem: All 80 Monitored Drift Tube base chambers at U-Michigan were completed. The Michigan group is leading the effort in chamber integration and certification at CERN. Construction of the base Cathode Strip Chambers is proceeding well.
- TriggerDAQ: The preparations continue for baselining the system and assigning the U.S. responsibilities. Incorporation into the baseline is planned for January, 2004.

Project Director's Quarterly Progress Report – 4th Quarter FY 2003
U.S. Large Hadron Collider Construction Project

5.2 U.S. CMS CONSTRUCTION PROJECT-

CMS International- The LHC Committee (LHCC) met in July 2003 to monitor the critical CMS construction issues. The Electromagnetic calorimeter construction schedule, and magnet coil and Silicon Tracker production are critical path concerns, and continue to receive on-going and close attention. Critical path for the magnet has shifted from coil production to mandrel production, and the aim is to keep other delays (e.g. Silicon Tracker) within this shadow. There are no major changes in the overall financial outlook for CMS, as the collaboration maintains its planning efforts to bring in a working detector on schedule with all available funds directed toward reducing the existing shortfall.

- Delivery of the UXC55/SX5 complex (experiment cavern) is planned for summer 2004, to be followed by a water leak repair in the shaft, with no interference to the installation schedule; decision on whether to repair a service cavern shaft water leak to be reviewed in spring 2004.
- A third of silicon tracker sensors have been delivered and quality control is ongoing to establish fraction with acceptable quality (also important to U.S. silicon tracker production).
- 29 of 144 electromagnetic barrel modules have been produced with 21,000 (of 62,000) crystals; the Russian producer has installed two new cutting machines for crystal production.

U.S. CMS- As of September 30, 2003, the overall U.S. CMS construction project was 80% complete vs. the scheduled plan of 87%. Technical progress remains excellent, and the U.S. CMS construction project is on budget. There is no major schedule slippage, but delays exist in production of some subsystem electronics and components, particularly the calorimeter electronics and the silicon strip tracker. Silicon tracker module production is paced by slow arrival from CERN of a key component, and this situation continues to be monitored. U.S. CMS has adopted the CMS v. 33.2 schedule that incorporates a two-month delay in delivery of the magnet coils, which is compensated by suppressing an optional underground magnet test.

- Endcap Muon (EMU): Cathode Strip Chamber work at the UCLA Final Assembly and System Testing (FAST) site is complete, and the Florida FAST site is nearly complete.
- Hadron Calorimeter (HCAL): Modules of all geographic regions of HCAL were tested in a test beam this summer. All 36 forward absorber wedges are now delivered to CERN.
- Trigger and Data Acquisition System: Integration tests of detector primitives, the trigger system, and DAQ are underway. The U.S. groups are presently exploring the possibility to change responsibility for purchases so as to advance the U.S. schedule.
- Electromagnetic Calorimeter (ECAL): The new baseline ECAL front-end system (better performance and lower system cost overall), has lead to a revised U.S. contribution. In particular, there is a substantial increase in the U.S. optical data link responsibilities.
- Forward Pixels (FPix): Increased engineering resources are being deployed to complete the necessary R&D for the FPix system.
- Silicon Strip Tracker (SiTrk): All module components have entered production, but reliable parts flow (flexible hybrid connectors) remains an issue that is being resolved with cooperation from CERN.

Project Director's Quarterly Progress Report – 4th Quarter FY 2003
U.S. Large Hadron Collider Construction Project

5.3 U.S LHC ACCELERATOR CONSTRUCTION PROJECT

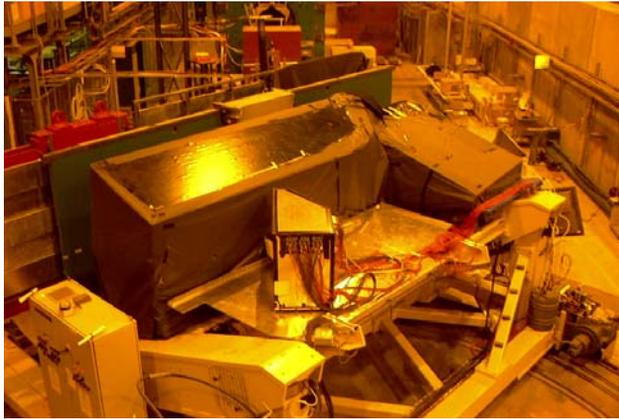
LHC Accelerator- The LHC Superconducting Cable and Magnet Production Review report was issued, indicating that diligent procurement management on the part of the CERN team and their vendors is required to meet delivery requirements and the 2007 completion schedule. Superconducting cable and dipole cold mass production appears to be going well. Ring cryogenic line installation began in July 2003 after a slow start due to deficiencies in organization of installation field work. CERN is working to improve delivery of corrector packages needed to maintain quadrupole cold mass production. Additional LHC Project highlights follow:

- LHC accelerator production progress can be tracked on the “LHC Dashboard” at, <http://lhc-new-homepage.web.cern.ch/lhc-new-homepage/DashBoard/index.asp>
- installation/commissioning of new winding machines, presses and finishing stations, along with improved welding procedures, is underway to support increased dipole production rate.
- Installation of new magnet test benches is underway.
- Nominal superconducting cable production rates have been met by all suppliers; steady technical performance of cables achieved and maintained.

U.S. LHC Accelerator- As of September 30, 2003, the overall project was 89% complete versus the scheduled plan of 94%. Overall technical progress remains good with all major items in production, including the cryogenic feedboxes. Contingency based on the EAC continues to be reduced to address engineering change requests, and this remains a concern that is being closely monitored and carefully managed by the project. The schedule of deliverables is slightly behind plans, but remains in advance of CERN requirements. Project highlights are listed below:

- Fermilab] The inner triplet quadrupole magnet production was put on hold following the first test in which a quadrupole was unable to reach operating field gradient. Subsequent quadrupole tests were successful and production later resumed, while alternatives to rebuild or replace the failed quadrupole are under evaluation. Corrector magnets from CERN are arriving just in time to support quadrupole assembly.
- [BNL] The fourth D1 dipole magnet arrived at CERN, and the final D1 remains at BNL for retesting before being shipped. All nine D2 magnets are cryostatted, seven tested and one accepted for shipment to CERN. All six D3 cold masses, are complete through shell and end plate welding. The second of the three D4 magnets is cryostatted. Superconducting cable testing continues to be paced by the rate of sample deliveries from CERN.
- [LBNL] The cryogenic feedbox vendor is progressing well, being on schedule overall and ahead of schedule on small parts. The TAS beam absorbers arrived at CERN. Two TAN absorber assemblies are complete. Two others are awaiting beam tubes from the vendor.

**Project Director's Quarterly Progress Report – 4th Quarter FY 2003
U.S. Large Hadron Collider Construction Project**



Left: U.S. CMS Hadron Calorimeter (HCAL) 2003 test beam setup at the CERN H2 beamline. Modules of all HCAL geographic regions (barrel, endcap, outer and forward) have been tested in beam.



Above- Eight U.S. LHC Accelerator liquid helium vessels at the cryogenic feedbox, or "DFBX" (Distributed Cryogenic Feedbox), vendor. One vessel will be installed in each DFBX assembly.



Above- The large-scale system test facility at CERN for alignment, mechanical and other system aspects. Shown here is the ATLAS muon chamber end-cap set-up, which tests system aspects of U.S. ATLAS-built muon endcap inner and middle layer chambers.

Project Director's Quarterly Progress Report – 4th Quarter FY 2003
U.S. Large Hadron Collider Construction Project

CERN Direct Purchases - DOE reimburses CERN for their payments to qualified U.S. vendors [Reference U.S.-CERN Agreement and Accelerator Protocol].

Table 5.1, Status of DOE Contracts (in \$000)*

Contract Item	Company (U.S. Supplier)	Contract Price	w/ options & escalation
Nb-Ti Alloy Bars; Ni Sheets	Wah Chang	44,300	55,382
Polyamide Insulation Film	Kaneka High Tech Materials	5,425	6,510
Superconducting Cable	Outokumpu-Advanced Superconductor	16,447	20,985
LHC BPMS Button Feedthroughs	Ceramaseal	898	1,003
Cryogenic Temperature Sensor	Lakeshore		
Cryogenic He Mass Flowmeters	(tbd-contract in process)	1,200	1,200
(tbd-contract in process)	(tbd-contract in process)	(tbd)	3,134
Totals		68,270	88,214

TOTAL Cumulative Payments from DOE to CERN (as of September 30, 2003): \$ 48,619k

6. FINANCIAL/COST STATUS AND PLANS (as of September 30, 2003)

TOTAL PROJECT FUNDING PLAN (then year millions of dollars)†

Fiscal Year	FY96	FY97	FY98	FY99	FY00	FY01	FY02	FY03	FY04	FY05	FY06	FY07	Total
Machine Funding Profiles (DOE)													
US LHC Accelerator	2.00	6.67	14.00	15.40	24.92	19.16	10.10	8.70	6.13	2.92	0.00	0.00	110
CERN Direct	0.00	0.00	0.00	8.09	8.29	8.08	11.20	13.40	23.20	17.74	0.00	0.00	90
Machine Total	2.00	6.67	14.00	23.49	33.21	27.24	21.30	22.10	29.33	20.66	0.00	0.00	200
Detector Funding Profiles (DOE and NSF)													
US ATLAS	1.70	3.71	10.05	25.63	28.43	26.77	23.16	24.71	8.99	5.49	3.24	1.88	163.75
DOE	1.70	3.71	10.05	9.00	16.49	14.48	10.51	17.42	8.99	5.49	3.24	1.88	102.95
NSF	0.00	0.00	0.00	16.63	11.94	12.29	12.65	7.29	0.00	0.00	0.00	0.00	60.80
US CMS	2.30	4.61	10.95	38.03	24.26	21.25	21.40	22.91	10.48	5.56	4.20	1.30	167.25
DOE	2.30	4.61	10.95	32.51	20.30	17.15	17.19	20.48	10.48	5.56	4.20	1.30	147.03
NSF	0.00	0.00	0.00	5.52	3.96	4.10	4.21	2.43	0.00	0.00	0.00	0.00	20.22
Detectors Total	4.00	8.32	21.00	63.66	52.69	48.02	44.56	47.62	19.47	11.05	7.44	3.18	

TOTAL DOE & NSF FUNDS, COSTS, & COMMITMENTS (cumulative \$000)‡

U.S. LHC Construction Project	A = Funds Allocated	B = Estimate Actual Costs	C = Open Comittments	D= B+C Total	A-D =Funds Available
U.S. ATLAS	144,158	115,305	4,160	119,465	24,693
U.S. CMS	145,706	122,271	16,437	138,708	6,998
U.S. LHC Accelerator	100,950	97,286	0	97,286	3,664
CERN Direct Purchases	49,060	48,619	0	48,619	441
Total	439,874	383,481	20,597	404,078	35,796

* Total includes partial payment to Wah Chung in FY03, with remainder to be paid in FY04; Contracts with American Superconductor Corporation for HTS wire and Meggitt Safety Systems for semi-rigid co-axial cables will be approved and reported on in subsequent Quarters.

† The funding profile for the U.S. LHC Construction Project is extended through FY07, with no change in total funding, to address the impact of the CERN LHC schedule on U.S. project completion. This change was approved by the DOE Director, Office of Science through a U.S. LHC Project baseline change proposal.

‡ Based on financial reports from the U.S. LHC construction projects. NSF funding is provided after the beginning of the fiscal year and therefore it is necessary to carry-over funding into the subsequent fiscal years.

**Project Director's Quarterly Progress Report – 4th Quarter FY 2003
U.S. Large Hadron Collider Construction Project**

7. DOE/NSF COST BASELINES AT LEVEL 2 (in \$000)

U.S. ATLAS Cost Baseline

<u>WBS</u>	<u>Description</u>	<u>Previous</u>	<u>Change</u>	<u>Current</u>
1.1	Silicon System	21,376	0	21,376
1.2	Transition Radiation Tracker	11,386	0	11,386
1.3	Liquid Argon Calorimeter	44,169	0	44,169
1.4	Tile Calorimeter	11,007	0	11,007
1.5	Muon Spectrometer	27,032	0	27,032
1.6	Trigger/Data Acquisition System	10,973	0	10,973
1.7	Common Projects	9,179	0	9,179
1.8	Education	286	0	286
1.9	Project Management	8,279	0	8,279
1.10	Technical Coordination	2,150	0	2,150
	Contingency	17,913	0	17,913
	U.S. ATLAS Total Project Cost Baseline	163,750	0	163,750

U.S. CMS Cost Baseline

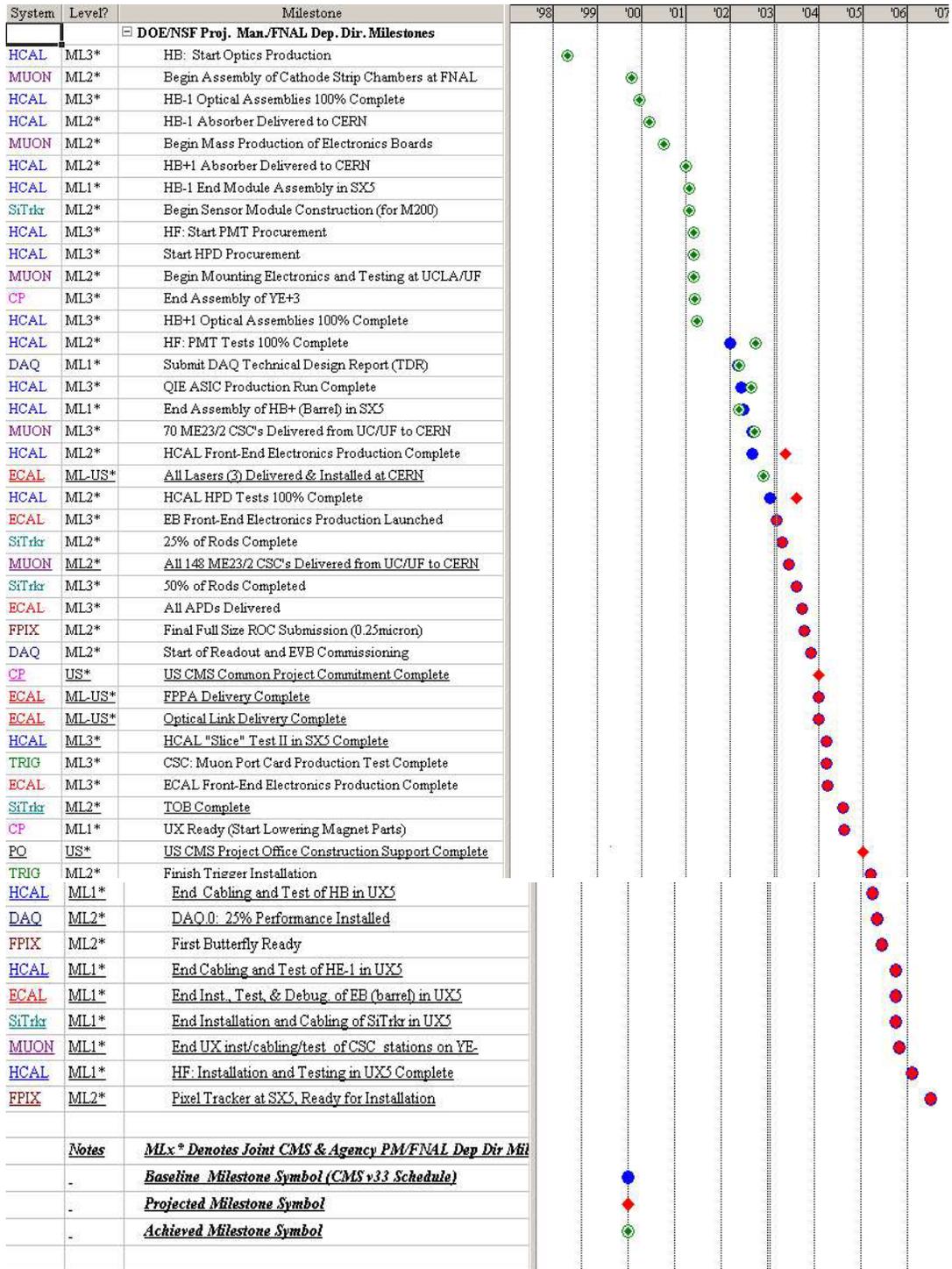
<u>WBS</u>	<u>Description</u>	<u>Previous</u>	<u>Change</u>	<u>Current</u>
1.1	Endcap Muon	39,787	1,027	40,814
1.2	Hadron Calorimeter	42,806	36	42,842
1.3	Trigger and Data Acquisition	14,635	0	14,635
1.4	Electromagnetic Calorimeter	11,083	776	11,859
1.5	Forward Pixels	7,372	- 10	7,362
1.6	Common Projects	23,349	0	23,349
1.7	Project Office	7,047	0	7,047
1.8	Silicon	3,382	238	3,620
	Contingency	17,787	-2,065	15,722
	U.S. CMS Total Project Cost Baseline	167,250	0	167,250

U.S. LHC Accelerator Cost Baseline

<u>WBS</u>	<u>Description</u>	<u>Previous</u>	<u>Change</u>	<u>Current</u>
1.1	Interaction Region Components	60,357	40	60,397
1.2	Radio Frequency Straight Section	16,120	0	16,120
1.3	Superconducting Wire and Cable	13,129	-38	13,091
1.4	Accelerator Physics	3,360	-1	3,359
1.5	Project Management	13,271	-1	13,270
	Contingency	3,763	0	3,763
	U.S. LHC Accelerator Total Project Cost Baseline	110,000	0	110,000

Project Director's Quarterly Progress Report – 4th Quarter FY 2003 U.S. Large Hadron Collider Construction Project

8.2 U.S. CMS Construction Project Milestones Below are shown agency Project manager milestones as compared to the baseline V33 CMS International milestones.



Project Director's Quarterly Progress Report – 4th Quarter FY 2003
U.S. Large Hadron Collider Construction Project

9. TECHNICAL BASELINE STATUS

U.S. ATLAS Construction Project - No change. The U.S. ATLAS collaboration defined a list of initial deliverables representing the U.S. contribution to ATLAS. This list was originally approved by the JOG in March 1998. Deliverables are listed in an Appendix to the U.S. ATLAS Construction Project Management Plan. The JOG approved a revision to the U.S. ATLAS Construction Project Management Plan in February 2003, incorporating changes to implement a two-phased project completion matched to CERN plans.

U.S. CMS Construction Project - No change. The U.S. CMS collaboration defined a list of deliverables representing the U.S. contribution to CMS. This list was originally approved by the JOG in October 1998 and is referenced in the U.S. CMS Project Management Plan. The JOG approved a revision to the U.S. CMS Construction Project Management Plan in February 2003, incorporating changes to implement a two-phased project completion matched to CERN plans.

U.S. LHC Accelerator Construction Project - No change. U.S. LHC Accelerator Project - The U.S. deliverables to CERN are defined in the Implementing Arrangement (IA) to the Accelerator Protocol. The IA is an annex to the U.S. LHC Accelerator Project Management Plan. The IA was signed by the CERN and U.S. signatories in July 1998 and revised in May 2002 to update delivery dates to match CERN schedule and address a CERN-directed change on RF region lattice design impacting U.S. work.

CERN Direct Purchases - No change. CERN will procure from U.S. industrial firms supplies required to construct the LHC accelerator. These supplies will include superconducting alloy, cable, insulation, and other materials.

10. BASELINE CHANGE ACTIVITY

<u>Baseline Control Level</u>	<u>Baseline Changes</u>
Level 1, DOE/NSF Joint Oversight Group	No changes this quarter
Level 2, DOE/NSF Project Office	
U.S. ATLAS	Changes to the Level 2 cost, scope and schedule baseline.
U.S. CMS	Changes to the Level 2 cost, scope and schedule baseline.
U.S. LHC Accelerator	Changes to the Level 2 cost, scope and schedule baseline.

**Project Director's Quarterly Progress Report – 4th Quarter FY 2003
U.S. Large Hadron Collider Construction Project**

APPENDIX A - FUNDING BY INSTITUTION (in thousands of dollars), U.S. CMS*

U.S. CMS Construction Project

Institution	FY 1998				FY 1999				FY 2000				FY 2001				FY 2002				Grand Total	
	DOE		NSF	Total	DOE		NSF	Total	DOE		NSF	Total	DOE		NSF	Total	DOE		NSF	Total		
	Grant	Contract			Grant	Contract			Grant	Contract			Grant	Contract			Grant	Contract				Grant
FNAL	0	5,517	0	5,517	0	10,817	40	10,857	0	5,981	0	5,981	0	6,033	0	6,033	0	6,318	14	6,332	34,720	
Fairfield	0	29	0	29	0	0	0	0	0	10	0	10	0	13	0	13	0	8	0	8	60	
Maryland	90	65	0	155	0	132	131	263	0	250	0	250	0	189	0	189	0	1,361	0	1,361	2,218	
Boston U.	0	32	0	32	31	111	0	142	0	132	0	132	0	88	0	88	0	222	1,130	1,352	1,746	
Florida State	80	54	0	114	71	118	0	189	80	54	0	134	68	43	0	111	50	16	0	66	614	
U. of Minnesota	60	95	0	155	161	452	0	613	141	202	0	343	153	401	0	554	85	305	0	390	2,055	
U. of Iowa	77	62	0	139	20	5	0	25	0	453	0	453	0	843	0	843	0	48	0	48	1,506	
U. of Rochester	127	1,159	0	1,286	262	485	0	747	441	253	0	694	464	143	0	607	358	182	0	520	3,854	
Notre Dame	0	52	0	52	0	44	184	228	0	14	193	207	0	14	112	126	0	17	209	226	839	
Purdue	38	135	0	173	49	168	0	215	0	175	0	175	0	89	0	89	0	377	0	377	1,029	
U. of Miss.	46	100	0	146	68	91	0	159	69	108	0	236	0	235	0	235	34	109	0	143	919	
U. of Florida	44	95	0	139	184	412	0	596	332	853	0	1,185	432	293	0	725	171	310	0	481	3,126	
Ohio State U.	140	64	0	204	275	212	0	487	196	732	0	928	151	700	0	851	180	916	0	1,066	3,566	
Carnegie Mellon	0	113	0	113	0	291	0	291	0	312	0	312	0	258	0	258	0	301	0	301	1,275	
Rice	138	19	0	157	102	58	0	158	132	16	0	148	196	36	0	232	134	61	0	195	890	
U. of Wisconsin	533	1,052	0	1,585	471	3,598	0	4,069	722	2,995	0	3,717	504	4,489	0	4,993	193	1,620	63	1,878	16,240	
U.C. Davis	34	100	0	134	0	78	0	78	0	502	0	502	0	63	0	63	0	200	0	200	977	
UCLA	150	87	0	237	249	173	0	422	244	391	0	635	347	546	42	935	264	496	43	823	3,052	
U.C. Riverside	20	10	0	30	0	164	0	164	0	70	0	70	0	72	0	72	0	74	0	74	410	
John Hopkins	0	29	0	29	0	0	70	70	0	40	0	40	0	0	5	5	0	0	7	7	151	
Northwestern	0	59	0	59	5	28	0	31	0	114	0	114	0	39	0	39	0	33	0	33	276	
Rutgers	0	13	0	13	0	0	34	34	0	2	140	142	0	0	101	101	0	127	0	127	417	
Princeton	0	256	0	256	0	626	0	626	0	667	0	667	0	133	0	133	0	11	0	11	1,093	
Caltech	0	148	0	148	0	458	0	458	0	367	0	367	0	452	0	452	0	116	0	116	1,541	
U.C. San Diego	11	0	0	11	11	90	24	125	36	0	0	36	0	43	0	43	0	57	0	57	272	
Northeastern	0	0	0	0	0	0	3,370	3,370	0	0	1,741	1,741	0	0	1,482	1,482	0	0	3,073	3,073	9,866	
U. Ill.-Chicago	0	0	0	0	0	0	124	124	0	0	309	309	0	0	262	262	0	0	172	172	867	
U. of Nebraska	0	0	0	0	0	0	24	24	0	0	2	2	0	0	100	100	0	7	0	7	133	
MIT	0	37	0	37	15	67	0	82	0	78	0	78	0	87	0	87	0	58	0	58	342	
Iowa State	0	0	0	0	0	0	19	19	0	356	0	356	0	29	0	29	0	177	0	177	581	
Kansas State														66	0	66	0	28	0	28	94	
LBL														554	0	554	0	543	0	543	1,097	
Texas Tech														876	0	876	0	275	0	275	1,151	
UC Santa Barbara														13	0	13	0	461	0	461	474	
U. of Kansas														6	0	6	0	0	210	0	210	216
Florida Inst. Tech.																		60	0	60	60	
Subtotal	1,568	9,382	0	10,950	1,974	18,672	4,020	24,666	2,393	15,087	2,425	19,964	2,315	16,840	2,110	21,265	1,489	14,740	5,055	21,284	98,129	

As of 12/3/02

* An update to this table to include FY2003 will be provided in the next report.

**Project Director's Quarterly Progress Report – 4th Quarter FY 2003
U.S. Large Hadron Collider Construction Project**

APPENDIX B - FUNDING BY INSTITUTION (in thousands of dollars), U.S. ATLAS*

U.S. ATLAS Construction Project

Institution	FY 1998				FY 1999				FY 2000				FY 2001				FY 2002				Grand Total
	DOE Grant	Contract	NSF	Total	DOE Grant	Contract	NSF	Total	DOE Grant	Contract	NSF	Total	DOE Grant	Contract	NSF	Total	DOE Grant	Contract	NSF	Total	
ANL	-	1,098	-	1,098	-	967	-	967	-	922	-	922	-	572	-	572	-	771	-	771	4,330
BNL	-	3,903	-	3,903	-	2,581	-	2,581	-	6,429	-	6,429	-	7,213	-	7,213	392	5,104	-	5,495	25,621
LBNL	-	633	-	633	-	715	-	715	-	420	-	420	-	1,775	-	1,775	-	2,049	-	2,049	5,592
SUNY/Albany	20	-	-	20	48	-	-	48	50	-	-	50	-	-	-	-	-	-	-	-	118
U. of Arizona	320	100	-	420	634	-	-	634	557	-	-	557	298	153	-	451	-	378	-	378	2,440
Boston U.	224	-	-	224	298	-	-	298	287	-	-	287	155	336	-	491	-	295	277	572	1,872
Brandeis U.	265	45	-	310	-	-	593	593	-	-	478	478	-	-	731	731	-	406	406	406	2,518
U.C. Irvine	193	-	-	193	-	-	93	93	-	-	-	-	-	-	296	296	-	-	-	-	562
U.C. Santa Cruz	404	-	-	404	63	-	-	63	-	-	568	568	-	-	2,702	2,702	-	442	442	442	4,179
U. of Chicago	-	54	-	54	-	-	1,069	1,069	-	-	264	264	-	-	723	723	-	159	159	159	2,269
Duke U.	190	-	-	190	601	-	-	601	417	-	-	417	501	158	-	659	-	375	375	375	2,242
Hampton U.	-	-	-	-	-	-	538	538	-	-	293	293	-	-	590	590	-	204	204	204	1,625
Harvard	234	-	-	234	-	-	654	654	-	-	390	390	-	-	3,882	3,882	-	953	953	953	6,113
U. of Illinois	50	159	-	209	347	-	-	347	294	-	-	294	76	-	-	76	99	-	-	99	1,025
Indiana U.	190	-	-	190	765	-	-	765	460	-	-	460	-	713	-	713	-	361	-	361	2,489
MIT	50	-	-	50	105	-	-	105	334	-	-	334	190	237	-	427	389	-	-	389	1,305
Michigan State	-	35	-	35	-	-	178	178	-	-	293	293	-	-	316	316	-	-	-	-	822
Nevis/Columbia	-	675	-	675	-	-	2,680	2,680	-	-	1,422	1,422	-	-	4,483	4,483	-	3,632	3,632	3,632	12,791
U. of New Mex.	20	-	-	20	30	-	-	30	24	-	-	24	-	127	-	127	-	57	-	57	258
Northern Illinois	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Ohio State U.	-	-	-	-	100	-	-	100	45	-	-	45	-	-	-	-	157	-	-	-	302
U. of Michigan	62	254	-	316	716	-	-	716	518	-	-	518	681	-	-	681	230	-	-	157	2,948
U. of Oklahoma	30	-	-	30	-	-	41	41	-	-	51	51	-	-	49	49	-	202	202	202	373
U. of Penn.	250	-	-	250	300	-	-	300	265	-	-	265	679	-	-	679	-	850	850	850	2,344
U. of Pittsburg	110	-	-	110	-	-	150	150	-	-	210	210	-	50	201	251	-	630	630	630	1,351
U. of Rochester	-	-	-	-	-	-	3,587	3,587	-	-	1,664	1,664	-	-	1,477	1,477	-	-	-	-	6,728
U.T. Arlington	50	82	-	132	-	-	474	474	-	-	230	230	-	-	584	584	-	-	-	-	1,420
S. Methodist	40	-	-	40	124	-	-	124	30	-	-	30	87	184	-	271	96	-	-	88	563
SUNY/Stony B.	27	-	-	27	-	-	1,045	1,045	-	-	1,037	1,037	-	-	426	426	-	89	89	89	2,624
Tufts University	50	-	-	50	20	-	-	20	20	-	-	20	-	-	-	-	11	-	-	11	101
U. Washington	-	-	-	-	-	-	240	240	-	-	318	318	-	-	1,377	1,377	-	737	737	737	2,672
U. of Wisconsin	230	-	-	230	429	-	-	429	665	-	-	665	1,112	-	-	1,112	377	-	-	377	2,813
Subtotal	3,009	7,038	-	10,047	4,580	4,263	11,342	20,185	3,966	7,771	7,218	18,955	3,779	11,518	17,807	33,104	1,752	9,014	9,343	20,108	102,399
Reserve	-	3	-	3	157	-	5,289	5,446	327	1,936	1,795	4,058	-	300	-	-	-	118	-	118	9,625
Total	3,009	7,041	-	10,050	4,737	4,263	16,631	25,631	4,293	12,309	11,941	28,543	3,779	11,818	17,807	33,104	1,752	9,132	9,343	20,226	117,554

* An update to this table to include FY2003 will be provided in the next report.