Project Manager's Quarterly Progress Report
3rd Quarter FY 1998

U.S. Large Hadron Collider Project (U.S. LHC)

1.0 PROJECT IDENTIFIERS

Reporting Period:	Through June 30, 1998
Program Sponsors:	DOE Division of High Energy Physics/NSF Physics Division
Program Managers:	DOE - D. Sutter, (301) 903-5228/NSF - M. Goldberg, (703) 306-1894
DOE Operations Office:	Chicago Operations Office/Fermi Group
Project Manager:	J. Yeck, (630) 840-2530

2.0 PROJECT DESCRIPTION

The U.S. 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 Project is defined by the goods and services to be provided to CERN for the LHC Project under the terms of the Agreement between CERN, DOE and NSF. 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 Project includes three sub-projects: U.S. ATLAS, U.S. CMS, and U.S. LHC Accelerator projects. This report summarizes the overall status of the U.S. LHC Project effort and includes status specific to each sub-project.

3.0 PROJECT MANAGER'S NARRATIVE HIGHLIGHTS

The DOE/NSF Memorandum of Understanding (MOU) has been initialed by the co-chairs of the DOE/NSF Joint Oversight Group (JOG) and submitted for approval within the respective agencies. The MOU describes the responsibilities of the DOE/NSF Joint Oversight Group (JOG) and related joint coordination activities.

The DOE/NSF JOG conducted a second meeting in June 1998. The meeting focused on general status and issues. The JOG co-chairs assigned action items that are tracked by the U.S. LHC Program and Project Offices.

A DOE/NSF review of the U.S. CMS project was held in May 1998. The review committee recommended approval of the project baselines and provided a number of detailed recommendations. A final report was published.

The U.S. LHC Project Manager continues to participate in various internal reviews conducted by the contractor project management teams. The projects have progressed beyond the baseline development phase and the project offices are using the management systems defined in the project management plans. There is good communication among project participants.

The work carried out at the collaborating universities and laboratories can be generally described as pre-production work including the design and fabrication of prototype components. The detector projects are in advanced stages of design and procurement for components that are supported by the entire international collaboration. These items are referred to as "common projects" given the responsibility to produce these items, e.g., cryostats and solenoid magnets, is shared among the entire international detector collaborations. There is an extensive amount of information available through the internet. Principal web sites include:

LHC Project	http://wwwlhc.cern.ch/
U.S. LHC Project	http://www.hep.net/doe-hep/lhc.html
ATLAS Experiment	http://atlasinfo.cern.ch/Atlas/Welcome.html
U.S. ATLAS Project	http://usatlas.bnl.gov/
CMS Experiment	http://cmsinfo.cern.ch/Welcome.html
U.S. CMS Project	http://uscms.fnal.gov/
U.S. LHC Accelerator	tbd

4.0 PROJECT MANAGER'S ASSESSMENT

Project Manager's Summary Assessment – Satisfactory. The project technical, cost, and schedule baselines are defined. The U.S. ATLAS and U.S. LHC Accelerator baselines have been approved and the U.S. CMS baselines are expected to be approved by the end of this fiscal year. All baselines are subject to formal change control procedures and performance reporting has begun. Cost and schedule performance analysis will be included in the next quarterly report.

Cost Assessment – Satisfactory. The U.S. LHC project total cost is fixed at $531 million. The U.S. ATLAS and U.S. CMS detector projects and the U.S. LHC Accelerator project have developed cost baselines within this overall funding constraint. Recent DOE and NSF sponsored reviews of these projects found that the projects have appropriate cost and contingency estimates. Cost performance is in accordance with plans with very limited use of contingency funds expected this fiscal year.

Schedule Assessment – Satisfactory. The LHC is scheduled to complete construction and commence initial operations in 2005. The scheduled completion of the U.S. LHC construction activities is also 2005 with the construction schedules of U.S. ATLAS, U.S. CMS, and U.S. LHC Accelerator projects developed to be consistent with the overall LHC schedule. Numerous DOE/NSF control milestones have been developed to track progress and are included in this report. Near term progress is satisfactory.

Technical Assessment – Satisfactory. Considerable effort has been devoted to define a set of deliverables to CERN that the U.S. collaborators are confident can be realized given present funding expectations. The U.S. ATLAS, U.S. CMS, and U.S. LHC Accelerator projects have each developed a separate list of deliverables that has been accepted by DOE and NSF. The projects fully expect to deliver the entire list of deliverables and hope that additional deliverables can be provided to CERN should cost performance be favorable.

SIGNIFICANT PROBLEMS/VARIANCE ANALYSIS

There are no significant problems to address.

Progress on the U.S. components is typically dependent on technical progress on components that interface with the U.S. responsibilities. There are early indications that delays in design and analysis work on ATLAS may cause adverse schedule impacts to the U.S. ATLAS work. This issue will be monitored closely.

ITEMS REQUIRING HEADQUARTERS ACTION

DOE/NSF Joint Oversight Group is meeting on a quarterly basis to review progress and expedite approval of key project planning documents. The status of these documents is shown below:

Document	Status
DOE/NSF Memorandum of Understanding	approval pending
U.S. ATLAS Project Management Plan	approved 3/98
U.S. CMS Project Management Plan	submitted 7/31/98
U.S. LHC Accelerator Project Management Plan	submitted 6/3/98
U.S. LHC Project Execution Plan	to be revised 8/31/98

The goal is to have all of the above documents approved by the end of this fiscal year.

5.0 FINANCIAL STATUS AND PLANS

TOTAL PROJECT FUNDING PLAN (in millions of dollars)*

Fiscal Year	FY96	FY97	FY98	FY99	FY00	FY01	FY02	FY03	FY04	FY05	Total
DOE LHC Funding Profiles (then-year $M)											
Machine	2.00	6.67	14.00	30.60	31.20	31.20	31.20	29.00	24.13	0.00	200.00
Detectors	4.00	8.33	21.00	34.40	38.80	38.80	38.80	36.00	29.87	0.00	250.00
Total	6.00	15.00	35.00	65.00	70.00	70.00	70.00	65.00	54.00	0.00	450.00
NSF LHC Funding Profiles (then-year $M)											
Detectors	0.00	0.00	0.00	22.15	15.90	16.37	16.86	9.72	0.00	0.00	81.00
Machine Funding Profiles (then-year $M)											
LHC Accelerator	2.00	6.67	10.00	15.80	17.00	17.00	17.00	14.70	9.83	0.00	110.00
CERN Direct	0.00	0.00	4.00	14.80	14.20	14.20	14.20	14.30	14.30	0.00	90.00
Total	2.00	6.67	14.00	30.60	31.20	31.20	31.20	29.00	24.13	0.00	200.00
Detector Funding Profiles (then-year $M)											
US ATLAS	1.70	3.70	10.05	27.83	27.44	27.59	27.85	22.89	14.70	0.00	163.75
DOE	1.70	3.70	10.05	11.20	15.50	15.30	15.20	15.60	14.70	0.00	102.95
NSF	0.00	0.00	0.00	16.63	11.94	12.29	12.65	7.29	0.00	0.00	60.80
US CMS	2.30	4.63	10.95	28.72	27.26	27.58	27.81	22.83	15.17	0.00	167.25
DOE	2.30	4.63	10.95	23.20	23.30	23.50	23.60	20.40	15.17	0.00	147.05
NSF	0.00	0.00	0.00	5.52	3.96	4.08	4.21	2.43	0.00	0.00	20.20
Detector Totals	4.00	8.33	21.00	56.55	54.70	55.17	55.66	45.72	29.87	0.00	331.00

FUNDS, COSTS, & COMMITMENTS THROUGH 6/30/98 (in thousands of dollars)†

Project Element	A Funds Allocated	B Costed	C Open Commit.	(B+C) Total	A-(B+C) Funds Available
Detectors					
U.S. ATLAS	15,450	6,876	2,854	9,730	5,720
U.S. CMS	17,880	10,176	3,634	13,810	4,070
Machine					
U.S. LHC Accelerator	18,670	14,200	756	14,956	3,714
CERN Direct Purchases	4,000	0	0	0	4,000
TOTAL	56,000	31,252	7,244	38,496	17,504

* The actual annual funding distribution among the U.S. LHC projects is subject to change. The total funding for these projects is fixed.

† The figures presented in this table are estimates only. The estimates are based on financial reports from the U.S. ATLAS, U.S. CMS, and U.S. LHC Accelerator project offices.

DOE/NSF COST BASELINE (in thousands of dollars)

U.S. ATLAS Cost Baseline

WBS No.	Description	Original	Change	Current
1.1	Silcon System	15,677	0	15,677
1.2	Transition Radiation Tracker	6,563	0	6,563
1.3	Liquid Argon Calorimeter	34,922	0	34,922
1.4	Tile Calorimeter	6,576	0	6,576
1.5	Muon Spectrometer	17,928	0	17,928
1.6	Trigger/Data Acquisition System	13,245	0	13,245
1.7	Common Projects	8,089	0	8,089
1.8	Education	270	0	270
1.9	Project Management	6,863	0	6,863
	Contingency	37,068	0	37,068
	Total in FY 1997 dollars	147,201	0	147,201
	Escalation (FY 1997 to as spent $)	16,549	0	16,549
	U.S. ATLAS Total Cost Baseline	163,750	0	163,750

U.S. CMS Cost Baseline

WBS No.	Description	Original	Change	Current
1.1	Endcap Muon	26,551	0	26,551
1.2	Hadron Calorimeter	30,255	0	30,255
1.3	Trigger and Data Acquisition	12,393	0	12,393
1.4	Electromagnetic Calorimeter	7,728	0	7,728
1.5	Forward Pixels	5,208	0	5,208
1.6	Common Projects	23,714	0	23,714
1.7	Project Office	5,738	0	5,738
	Contingency	48,743	0	48,743
	FY 1996 & FY 1997 Expenditures	6,920	0	6,920
	U.S. CMS Total Cost Baseline	167,250	0	167,250

U.S. LHC Accelerator Cost Baseline

WBS No.	Description	Original	Change	Current
1.1	Interaction Region Components	36,638	5,509	42,147
1.2	Radio Frequency Strait Section	14,424	(1,788)	12,636
1.3	Superconducting Wire and Cable	11,817	(1,209)	10,608
1.4	Accelerator Physics	4,739	(231)	4,508
1.5	Project Management	14,494	(319)	14,175
	Escalation (FY 1997 to as spent $)	11,270	(4,149)	7,121
	Total in as spent $	93,382	(2,187)	91,195
	Contingency	16,618	2,187	18,805
	U.S. LHC Accelerator Total Cost Baseline	110,000	0	110,000

6.0 SCHEDULE STATUS AND PLANS

U.S. ATLAS Schedule Baseline

WBS Identifier	Milestone Description	Baseline Date	Forecast (F)/ Actual (A)
1	Project Start	10/01/95	10/01/95 (A)
	Project Completion	09/30/05	09/30/05 (F)
1.1 Silicon	Start Full Silicon Strip Electronics Production	05/03/99	
	Start Full Strip Module Production	10/15/99	
	ROD Design Complete	04/14/00	
	Complete Silicon Strip Module Production	05/01/02	
	ROD Installation Complete	09/30/04	
1.2 TRT	Mechanical Design Frozen	12/31/98	12/31/98 (F)
	Select Final Electrical Design	07/31/00	
	Start Production (Electrical)	07/31/00	
	Module Production Complete	03/29/02	
	Barrel Construction Complete	12/31/02	
	Installation Complete (Electrical)	09/30/04	
1.3 LArCal	Cryostat Contract Award	07/24/98	08/05/98 (A)
	Barrel Feedthroughs Final Design Review	09/30/98	01/31/99 (F)
	Start Electronics Production	06/01/99	
	FCAL Mechanical Design Review	12/14/98	12/14/98 (F)
	FE Board SCA Production Chip Submission	11/01/99	
	Level 1 Trigger Final Design Complete	03/01/00	
	ROD Final Design Complete	06/01/00	
	Motherboard System Production Complete	01/01/01	
	Cryostat Arrives at CERN	03/30/01	
	Barrel Feedthroughs Production Complete	07/18/01	
	FCAL-C Delivered to EC	09/03/01	
	FCAL-A Delivered to EC	11/01/02	
1.4 Tile Cal	Start Submodule Procurement	09/01/97	09/01/97 (A)
	Technology Choice for F/E Electronics	11/15/97	11/15/97 (A)
	Start Module Construction	05/01/99	
	Start Production Motherboards & Digitizerboards	07/02/99	
	Start Installation at CERN	06/01/02	
	Module Construction Complete	10/01/02	
	Installation at CERN Complete	05/01/04	
1.5 Muon	Start MDT Chambers Lines 1 and 2	01/04/99	
	Start CSC Chamber Production	07/01/99	
	ASD Chip Design Complete	10/29/99	
	Final Design Global Alignment Devices Complete	04/28/00	
	CSC IC Production Complete	06/30/00	
	MDT Supports,Mounts,Connect. Design Complete	01/30/01	

	MDT Chambers Production Complete	09/30/03
	MDT Supports,Mounts,Connectors Fab. Complete	12/31/03
	ROD Production Complete	01/30/04
	MDT Off-Chamber Electronics Product. Complete	05/28/04
	CSC Assembly/Testing at CERN Complete	12/31/04
	Global Alignment Final Assembly Complete	12/31/04
1.6 Trigger	Select Final LVL2 Architecture	12/31/99
DAQ	LVL2 Trigger Design Complete	12/31/01
	LVL2 Trigger Development/Prototype Complete	12/31/01
	Start Production	01/08/02
	Start Installation and Commissioning	03/05/02
	Production Complete	12/31/04
	LVL2 Installation and Commissioning	12/31/04

U.S. CMS Schedule Baseline (Proposed)

WBS Identifier	Milestone Description	Baseline Date	Forecast (F)/ Actual (A)
1	DOE/NSF CERN Agreement	12/08/97	12/08/98 (A)
	Approve Baseline	06/30/98	09/30/98 (F)
	Approve Project Management Plan	09/30/98	09/30/98 (F)
	US CMS Project Complete	09/30/05	09/30/05 (F)
	Move 2nd Year Funding for Common Package A	10/01/98	10/01/98 (F)
	Muon CSC Factory Start	01/01/99	
	HCAL Optics Factory Start	01/01/99	
	1st 18 Wedges HCAL Cu @ CERN	05/01/00	
	1st 18 Wedges Optics @ CERN	06/01/00	
	FPIX Cooling Distribution Design Complete	01/04/01	
	4th Year CP Package A Payment Complete	06/22/01	
	1st 17 EMU CSC Chambers Complete	06/27/01	
	HCAL Electronics Complete	01/21/02	
	Finish Production Cu Wedges	02/01/02	
	Finish Production Optical System	02/01/02	
	Final Production ECAL Serializer Wafer	02/01/02	
	Trigger MPC Board Assembly Complete	01/07/03	
	Start CMS Installation in Pit	01/28/03	
	HE + YE + Connect	01/28/03	
	HB in Vacuum Tank Test	03/03/03	
	HE - YE - Connect	05/15/03	
	1st Half CSC Assembly at CERN Complete	07/01/03	
	DAQ Event Manager Boards Complete	08/25/03	
	Magnet Full Field Test	09/05/03	
	BO Underground Counting House	09/18/03	

	Complete Production of APDs	09/30/03
	Install Magnet in Collision Hall	10/01/03
	All ME234/2 Assembled & Tested	10/10/03
	EMU Electronics Complete	12/15/03
	Forward Pixels Shipped to CERN	09/24/04
	US CMS Construction Complete	09/30/04

U.S. LHC Accelerator Schedule Baseline

WBS Identifier	Milestone Description	Baseline Date	Forecast (F)/ Actual (A)
1	Project Start	10/01/95	10/01/95 (A)
	Decision on RF Region Quadrupoles	07/01/01	
	Delivery of D3 and D4 for IR4 Right	01/01/02	
	Delivery of D3 and D4 for IR4 Left	11/01/02	
	Complete Delivery of Inner Triplet System for IR 8	12/01/02	
	Complete Delivery of Inner Triplet System for IR 1	11/01/03	
	Complete Delivery of Inner Triplet System for IR 5	04/01/04	
	Complete Delivery of Inner Triplet System for IR 2	07/01/04	
	Project Completion	09/30/95	
1.1 IR Region	Absorber Performance Approved	01/01/99	
	Absorber Interface Specifications	01/01/99	
	MQX Field Quality Requirements Approved	02/01/99	
	MQX Cold Mass-Cryostat Interface Spec. Apprvd	03/01/99	
	ISR Jacks Delivered to LBNL	04/30/99	
	All MQX Performance Specifications Approved	07/01/99	
	MQX-Correction Coil Interface Spec. Approved	07/01/99	
	Inner Triplet Compen. and Correct. Schm. Apprvd	07/01/99	
	Z-Placement of TAN Approved	07/01/99	
	Support for TAS Approved	07/01/99	
	All Cryogenic Feed Box Interface Specs. Approved	07/12/99	
	MQX Alignment Requirements Approved	01/01/00	
	All MQX-LHC Infrastructure Inter. Specs. Apprvd	06/01/00	
	Beam Position Monitors Delivered to Fermilab	08/01/00	
	1st KEK MQX Delivered to Fermilab	01/01/01	
	IR1 and IR5 Feed Boxes Ready to Ship	06/26/01	
	1st Correction Coil Delivered to Fermilab	07/01/01	
	IR2 and IR8 Feed Boxes Ready to Ship	10/29/01	
	Absorbers Ready to Ship	04/30/02	
	Ionization Chamber Inter. & Perf. Spec. Approved	06/30/02	
	IR8 MQX Ready to Deliver	09/01/02	
	IR1 MQX Ready to Deliver	04/01/03	
	IR5 MQX Ready to Deliver	10/01/03	

	IR2 MQX Ready to Deliver	02/01/04	
	Ionization Chambers Shipped to CERN	10/01/04	
1.2 RF	D3/D4 Field Quality Requirements Approved	07/31/98	07/31/98 (F)
Region	All D3/D4 Perf. & Interface Specs. Approved	07/01/99	
	Cryostat Parts Delivered to BNL	07/01/00	
	Decision on Inclusion of RF Region Quadrupoles	07/01/01	
	D3/D4 Ready for Delivery	11/01/01	
1.3 SC	Deliver 4 Cable Measuring Machines to CERN	10/01/97	10/01/97 (A)
	Deliver Powered Turkshead to CERN	05/31/98	05/31/98 (A)
	Deliver Eddy Current Flaw Detector to CERN	09/01/98	09/01/98 (F)
	Complete Superconductor Test Facility Upgrades	03/01/99	
	Begin Pre-Series Testing	03/01/99	
	Begin Series Testing	03/01/00	

7.0 TECHNICAL BASELINE STATUS

Project Element	Reference Document	Forecast
US ATLAS	US ATLAS PMP Appendix 3	No change. Approved 3/18/98
US CMS	US CMS PMP - Appendix 2	Approval Pending
US LHC Accelerator	US LHC Accel. PMP Annex II	Approved 6/15/98

U.S. ATLAS

The U.S. ATLAS collaboration has defined a list of initial deliverables representing the U.S. contribution to ATLAS. This list was approved by the DOE/NSF Joint Oversight Group in March 1998 and the U.S. ATLAS leadership (T. Kirk and B. Willis) sent this list to the CERN Director of Research in April 1998. Additional deliverables have already been identified as potential future contributions should cost performance permit.

U.S. CMS

In May 1998 there was a DOE/NSF Joint Oversight Group sponsored review of the U.S. CMS Project baselines. The U.S. CMS collaborations' proposed list of initial deliverables was accepted by review committee and the "U.S. CMS Baseline Document" was submitted to DOE/NSF for approval in June 1998. Approval is still pending.

U.S. LHC Machine

U.S. LHC Accelerator Project - The U.S. deliverables to CERN are defined in the Implementing Arrangement to the Accelerator Protocol between CERN and DOE concerning Scientific and Technical Co-operation on the LHC. The DOE Director of High Energy Physics approved the initial baseline list of deliverables in June 1998. The Implementing Arrangement is expected to be signed by the CERN and U.S. signatories in July 1998.

CERN Direct Purchases - CERN will procure from U.S. industrial firms supplies required to construct the LHC Accelerator including superconducting alloy, cable, insulation, and other

materials. CERN is currently negotiating contracts with U.S. suppliers for Niobium-Titanium bars, Niobium sheets, and superconducting cable.

8.0 BASELINE CHANGE ACTIVITY

Baseline Control Level	Baseline Change Description
Level 1, DOE/NSF Joint Oversight Group	No changes this quarter
Level 2, DOE/NSF Project Office	4 changes this quarter
Level 3, US ATLAS	1 change this quarter
US CMS	2 changes this quarter
US LHC Accelerator Project	No changes this quarter

There were four changes at Level 2, DOE/NSF Project Office, during the reporting period. These changes restored the 13 interaction region beam separation dipole magnets to our list of deliverables to CERN under the U.S. LHC Accelerator Project. These changes were approved by the U.S. LHC Project Manager following concurrence by the DOE Director of High Energy Physics.