



# *U.S. LHC Research Program*

*HEPAP Meeting*  
*July 14, 2001*

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# *OUTLINE*



## U.S. LHC Program

- Scope
- Organization

## U.S. LHC Construction Project Status

- Scope & status (**summary – details already presented**)
- Completion strategy

## U.S. LHC Research Program

- Scope
  - ATLAS and CMS software & computing
  - ATLAS and CMS maintenance & operations
  - LHC machine
- Status and Plans
- Costs and Funding Estimates

## Next Steps



# *U.S. LHC PROGRAM*



U.S. LHC Program has two major components:

- U.S. LHC Construction Project – U.S. participation in the design and construction of the Large Hadron Collider machine and the ATLAS and CMS experiments.
- U.S. LHC Research Program – U.S. participation in the LHC operations and research.

DOE/NSF Joint Agency Coordination and Program Management

- New approach to address the new challenges of the LHC.



# *DOE/NSF ORGANIZATION*



## DOE/NSF – CERN

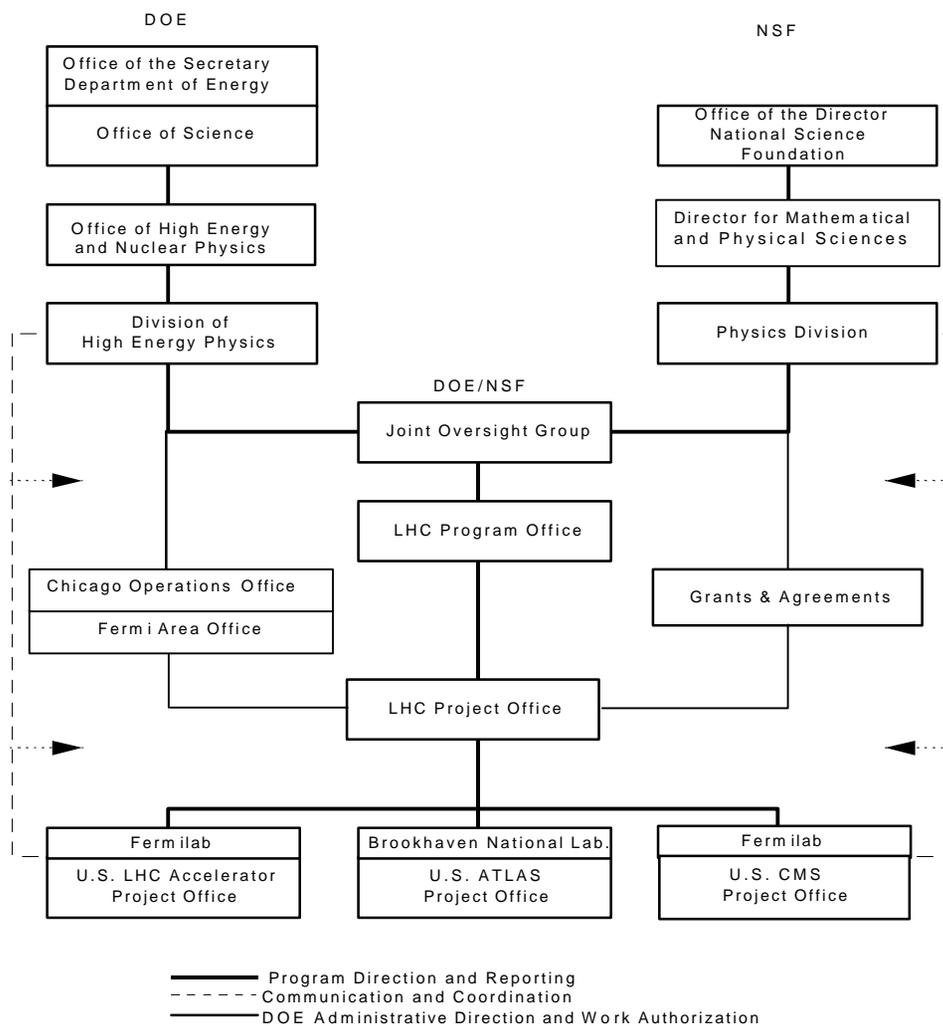
- CERN Committee of Council
- DOE/NSF – CERN Cooperation Committee
- ATLAS and CMS Resource Review Boards
- LHC Board

DOE/NSF Joint Oversight Group (**U.S. coordination on the LHC Research Program**)

NB: Significant participation by U.S. scientists in LHC related Scientific and Technical Advisory Committees



# DOE/NSF LHC ORGANIZATION





# *U.S. LHC CONSTRUCTION PROJECT*



Cost performance is good.

Schedule performance is satisfactory.

Fully expect to meet our commitments to CERN and the experiments.

Percent Complete (performance through 4/30/01)

U.S. LHC Accelerator (\$110.0 M)	62 %
U.S. CMS (\$167.25 M)	55 %
U.S. ATLAS (\$163.75 M)	41 %
U.S. Industry/CERN Direct (\$90.0 M)	26 %



# CONTINGENCY STATUS



Contingency is adequate to complete our deliverables.

## Contingency as percent of “to go” costs (4/30/01)

	Project Cost (\$k)	Contingency (\$k)	%
U.S. CMS	\$167,250	28,576	45
U.S. ATLAS	\$163,750	29,938	38
U.S. LHC Accelerator	\$110,000	6,216	16



# *U.S. COMMITMENTS*



U.S./CERN – International Agreement and Protocols (1998) - \$531 million towards construction and participation in activities beyond construction.

Construction commitments are developed in detail by the international collaborations subject to conditions set by CERN and the funding agencies.

ATLAS & CMS Construction MOUs - between CERN, as host laboratory, and the Institutions/Funding Agencies of the Collaborations.

Implementing Arrangement for LHC Machine – between CERN and U.S. Collaborating Laboratories.

U.S. Management Plans, Letters, Baseline Documents, etc.

Research Program commitments to follow this model.



# LHC SCHEDULE STATUS



## LHC Draft Schedule

09 February 2001

Joint meeting LHC- Machine and Detectors

<u>Date</u>	<u>Activity</u>	<u>Conditions</u>
Apr 1 – Sep 30, 2004	Octant test	
Mar 31, 2005	Last dipole delivered	
Dec 31, 2005	<i>Ring closed and cold</i>	Full access to experimental caverns
Jan 1– 31, 2006	Full machine commissioning, Beam pipes in place	Full access to experimental caverns
Feb 1-Mar 31, 2006	<i>1 beam</i>	Restricted access to experimental caverns
Apr 1-30, 2006	<i>First Collisions. 4 week Pilot run</i>	Luminosity: $5 \times 10^{32}$ to $2 \times 10^{33}$
May 1-Jul 31, 2006	Shutdown	Full access to experimental caverns
Aug 1-Feb 28, 2007	<i>Physics run: 7 months</i>	Luminosity: $\approx 2 \times 10^{33}$ ( $\approx 10 \text{ fb}^{-1}$ )
Mar 1-Apr 12, 2007	Lead ion run, 6 weeks	



# *U.S. STRATEGY*



Complete U.S. deliverables within our baseline cost & schedule.

- most cost effective use of funding supporting maximum deliverables
- no change to the U.S. total project cost of \$531 million

Issues:

U.S. construction activities will ramp-down well before the LHC physics run.

- support for extended pre-operations period
- stable base program support

Schedule interfaces between U.S. and non-U.S. activities

- some construction work will be delayed due to issues with parts, installation, and the desire to delay purchases for some items
- participation in staged or deferred items



# *U.S. LHC RESEARCH PROGRAM*



## U.S. LHC Research Program Scope

- U.S.-CERN International Agreement extends beyond construction to the LHC research program.
- Scope
  - software and computing to support physics analysis
  - U.S. internal and transatlantic networking
  - maintenance and operations of the experiments
  - participation in the commissioning and performance improvements to the LHC machine

The scope will be defined in detail in MOUs (computing and M&O) for the experiments and in bilateral arrangements with CERN for the machine.



# *U.S. LHC S&C STATUS AND PLANS*



## CMS and ATLAS Collaboration S&C Status and Plans

- U.S. collaborators actively participate and assume leadership roles
- Ongoing effort to further define the scope, costs, schedules, and mgmt

## CERN Status and Plans – Developing a response to “Hoffman” Review

### U.S. Planning

- Investment commensurate with level of participation in the experiments (>20%)
- U.S. based investment in core application software and distributed hardware (grid)
- Use construction type management approach to get started, i.e., Host laboratories, Project Managers (J. Huth and L. Bauerdick), and Project Management Plans, etc.
- Agency internal U.S. reviews (Crawford committees) and discussions w/ CERN

### U.S. CMS and ATLAS and Technical Progress

- Software development – U.S. contributing ~20% of the estimated needs
- Tier 1 production capability established – Fermilab (CMS) and BNL (ATLAS)
- Tier 2 prototypes selected and R&D participants – CA, FL, IN, and MA universities
- Grid development – significant U.S. r&d



# *U.S. LHC S&C STATUS AND PLANS*



## Networking Needs

- Transatlantic
  - Study requested by the Joint Oversight Group
  - Draft Report of the Transatlantic Networking Committee (L. Price and H. Newman Co-chairs)
  - Bandwidth requirements projected to grow from 3,000 Megabits per second in 2002 to 18,000 Mbs in 2006
  - Recommendations to the JOG for further action
- Internal U.S.
  - Needs expected to grow (some discussion in draft report above)
  - Additional planning effort warranted



# *U.S. CMS and ATLAS M&O STATUS AND PLANS*



## CMS and ATLAS Collaboration M&O Status and Plans

- Ongoing effort to further define the scope, costs, and schedules
- Requesting M&O support in 2001

## CERN Status and Plans – Activities led by the Research Director, Roger Cashmore

- Developed draft guidelines for M&O and defined a process for developing MOUs
- Working with the Collaborations and the Funding Agencies on guidelines and costs
- Draft MOUs by the October meetings of the Resource Review Boards

## M&O Cost Categories

Category A – Costs shared by the Collaborations

Category B – Costs addressed by the institutions that built the equipment

Category C – Costs addressed by the host laboratories



# *U.S. CMS and ATLAS M&O STATUS AND PLANS*



## U.S. Agency Planning

- Foresee an investment commensurate with the level of participation in the experiments (~20%)
- Some concerns with CERN's proposed cost allocation model
- Will participate in "Scrutiny" Committee organized by R. Cashmore
- Commitment to a structured management approach with Host laboratories, Operations Managers, and Management Plans, etc.
- Reviews and discussions w/ CERN e.g., RRB and Cooperation Committee

## U.S. CMS and ATLAS and Status and Needs

- Developing plans and estimates and working with Collaborations and CERN
- Integrating M&O plans with "endgame" for the construction projects
- Identified needs beginning in 2002 (<\$500K total)



# *U.S. LHC ACCELERATOR PLANS*



## U.S. LHC Accelerator Construction Project

- Project deliverables are primarily hardware tested in the U.S. and delivered to CERN.
- Very limited support for participation in LHC commissioning activities.

## U.S. and CERN interested in a continuing U.S. role

- Shared desire for U.S. participation in LHC commissioning
- Discussions underway on other opportunities

## Agency Plans

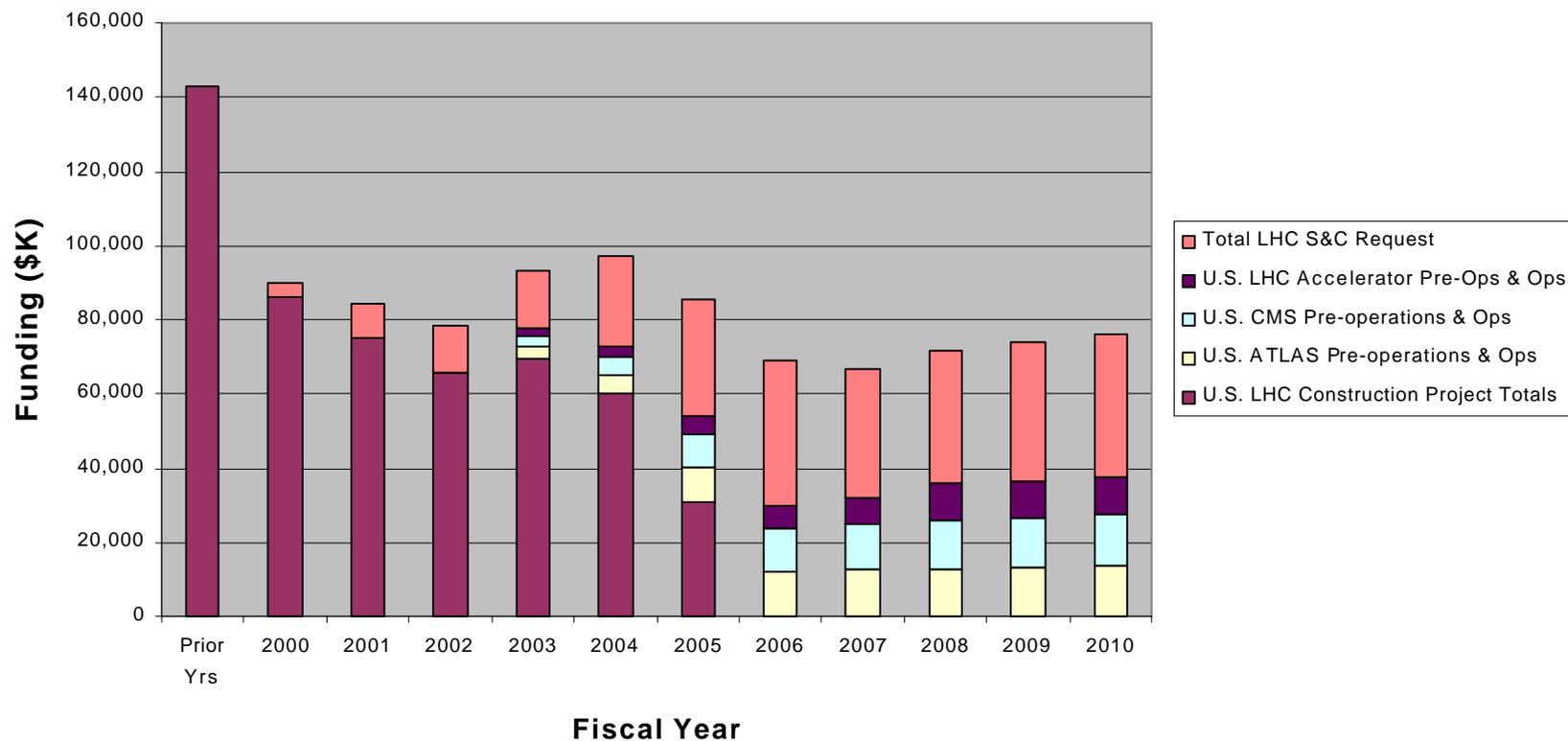
- Fermilab designated as Host Laboratory
- Jim Strait, U.S. LHC Accelerator Project Manager, to lead this effort (see Strait's presentation)



# ***COSTS AND FUNDING ESTIMATES***



### U.S. LHC Funding Profiles





## ***NEXT STEPS***

### U.S. LHC Software & Computing

- U.S. responsibilities defined in Interim MOUs (CMS) and Software Agreements (ATLAS) – software deliverables and mock data challenges
- U.S. project “baseline” review in November (G. Crawford Committee)
- Participation in the CERN response to the “Hoffman” report
- Networking - Respond to the Report of the Transatlantic Networking Committee (Expect our S&C PMs to play a major role)

### ATLAS and CMS Maintenance & Operations

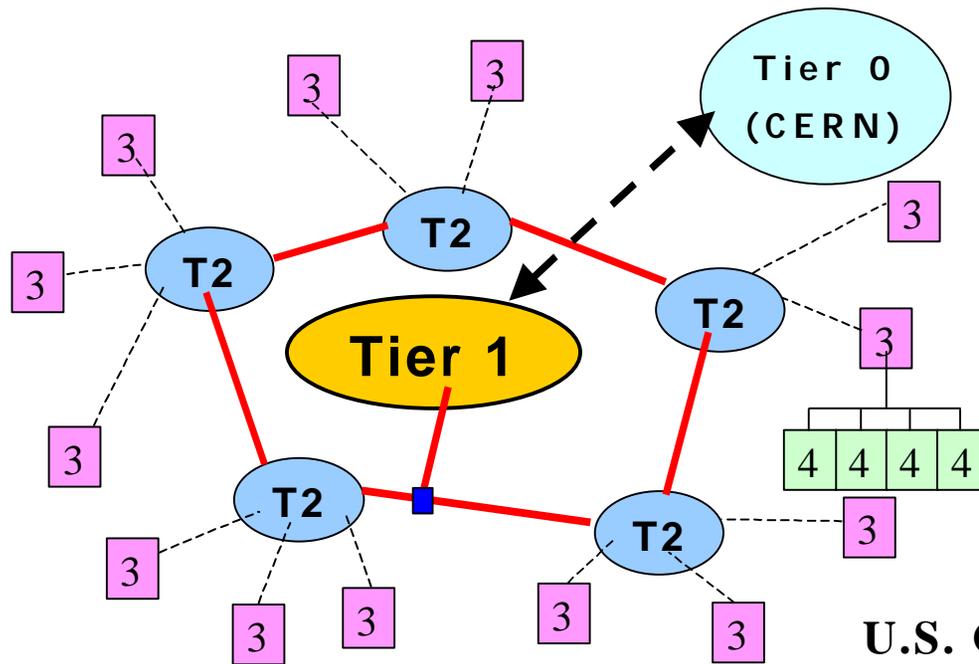
- Continue to develop and refine estimates
- Work with CERN on guidelines and draft MOUs
- Define U.S. management arrangements and baseline scope, costs, schedules

### Continued U.S. Participation in the LHC machine

- Develop more detailed plans with CERN and DOE program office



# U.S. LHC Computing Facilities



**U.S. CMS Tier 1 Facility hardware at Fermilab Computing Center (Linux Farm with 40 dual processor nodes)**



**U.S. ATLAS Tier 1 Facility hardware at BNL/RHIC Computing Facility (Linux Farm with 62 dual processor nodes)**