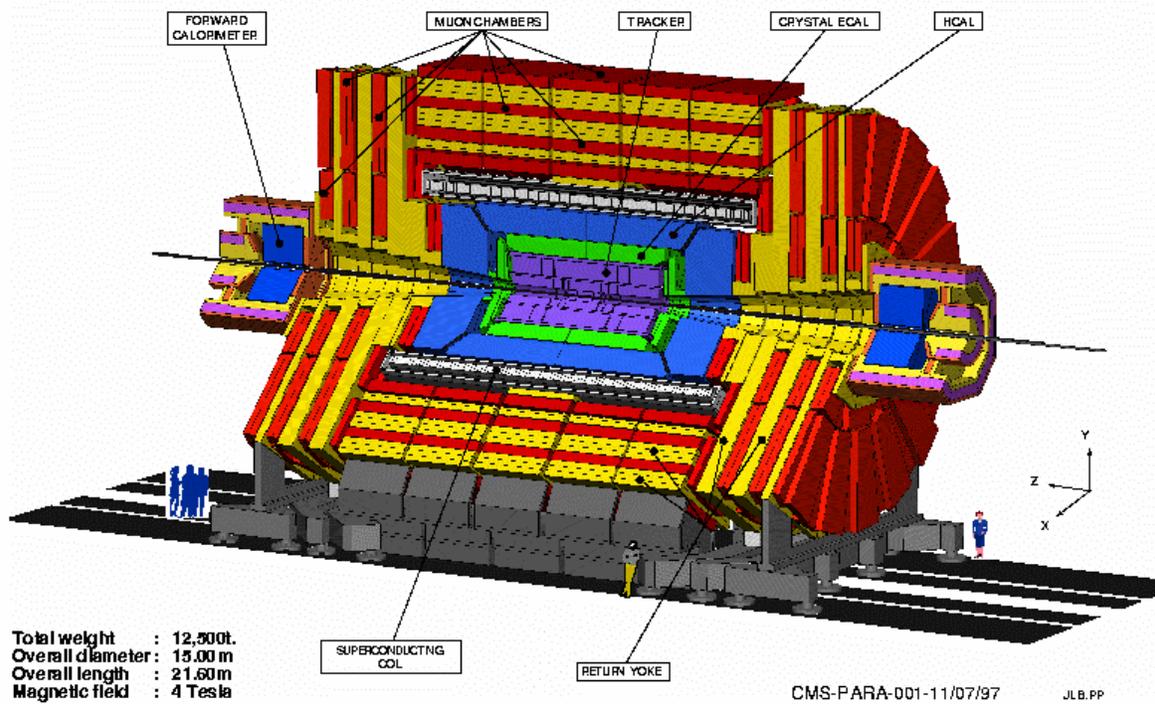


U.S. CMS

Research Program

Management Plan



May 2005 – Revision 5.0

Submission and Approvals

This Management Plan defines the plans, organization, systems and relevant interfaces for the U.S. CMS Collaboration's research program for the CMS Detector as part of the Large Hadron Collider (LHC) at the European Laboratory for Nuclear Research (CERN). The U.S. role in the operation and exploitation of the CMS detector is funded jointly by the U.S. Department of Energy and the National Science Foundation.

Submitted and Accepted by:

U.S. CMS Research Program:

Daniel R. Green
U.S. CMS Research Program Manager

Robert Cousins
U.S. CMS Deputy Research Program Manager

Fermilab:

Michael S. Witherell
Fermilab Director

Kenneth C. Stanfield
Fermilab Deputy Director

LHC Program Office:

Thomas Ferbel, DOE
U.S. LHC Program Manager

James J. Whitmore, NSF
U.S. LHC Associate Program Manager

Approved by:

DOE/NSF Joint Oversight Group

John O'Fallon, JOG Co-Chair
Office of High Energy Physics
U.S. Department of Energy

John W. Lightbody, Jr., JOG Co-Chair
Physics Division
National Science Foundation

US CMS Research Program Management Plan (Revision 4.0)

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1. INTRODUCTION

1.1 OVERVIEW AND SCOPE OF THE U.S. CMS RESEARCH PROGRAM MANAGEMENT PLAN

This document is the Research Program Management Plan (RPMP) that the U.S. Compact Muon Solenoid (CMS) Collaboration will follow to meet the technical, cost, and schedule objectives of the U.S. CMS Research Program. This RPMP covers the commissioning, operation, research and development for upgrade, and exploitation of the U.S. CMS part of the CMS detector at CERN.

This RPMP describes the management, organization, systems and procedures used to manage those aspects of the U.S. CMS Research Program (RP) that are internal to the U.S. CMS Collaboration. This includes control of budget, schedule and work within all U.S. CMS institutions, the management structure of the U.S. CMS RP, and the relationship between the DOE, NSF and the Host Laboratory, Fermilab.

This RPMP establishes the technical, cost and schedule plan to which the U.S. CMS RP will be managed and to which the performance of the RP will be measured. The RPMP defines the highest level Work Breakdown Structure (WBS) for the program and presents a corresponding organizational structure with responsibilities assigned to the major subsystems. Major schedule milestones are defined, along with the cost estimate of each major subsystem to support this schedule. This RPMP also describes the management control mechanisms, configuration and changes in management, reporting requirements, and procedures for allocation of management reserve. Although the RP is not a project, many of the procedures appropriate to a project will be followed, with the notable exception that earned value reporting will not be used.

This RPMP covers the Maintenance and Operations (M&O) activities for the CMS experiment of the components delivered at CERN. The mission of M&O is to commission the CMS detector, align and calibrate it so that physics results may be expeditiously extracted. Thereafter the M&O task aims to operate the detector in good working order and refine the algorithms used to define physics objects such as jets or electrons. Note that R&D for detector upgrades resides within the M&O plan. Additionally, this RPMP includes all efforts related to

the U.S. CMS Software & Computing (S&C) Program, whose mission is to develop the software and computing resources necessary to enable U.S. physicists to fully participate in the physics of CMS. The M&O and S&C programs are the two parts of a single, cohesive U.S. CMS Research Program that will be managed coherently. Additional clarification on the defined boundaries between M&O and S&C can be found in the reference documents (Ref. 12, Ref. 13).

This RPMP will be reviewed and revised, as required, to reflect new developments or agreements among the participants. Revisions will be endorsed by the U.S. CMS Research Program Manager, the U.S. CMS Deputy Research Program Manager, the Director and Deputy Director of Fermilab, the Program Manager and Associate Program Manager for the U.S. LHC Program, and approved by the U.S. LHC Joint Oversight Group (JOG), representing the DOE Office of High Energy Physics and the NSF Physics Division.

1.2 REFERENCE DOCUMENTS

Additional documentation related to agreements that support the U.S. CMS Collaboration in its work on the CMS detector, are listed below. Copies of all associated documents, including their most recent and applicable revisions, as consistent with the International Cooperation Agreement between CERN, DOE and NSF (December 1997), reside in the U.S. CMS Program Office at Fermilab.

1. General Conditions for Experiments Performed at CERN (April 1989) – Defines the roles and responsibilities of CERN, as the Host Laboratory, and the CMS Collaboration.
2. U.S. CMS Collaboration Letter of Intent (September 1995) – Proposal for U.S. participation in the construction of the CMS Detector.
3. CMS Constitution (September 1996) – Organization, structure, and management systems governing the CMS Collaboration.
4. International Cooperation Agreement between CERN, DOE and NSF (December 1997) – Defines the program of work, responsibilities and funding for the U.S. participation in the LHC.

5. MOU between U.S. CMS and U.S. Collaborating Institution (June 1998) – Defines the program of work, responsibilities and funding for the U.S. institution's participation in the U.S. CMS Project.
6. U.S. CMS Project Management Plan rev. 1 (December, 2002) – Plan describing the management of the U.S. CMS Detector Construction Project.
7. The U.S. LHC Project Execution Plan rev. 1 (October, 2002) – Mission need, scope and goals of U.S. participation in the LHC, and description of management and executive processes governing the U.S. LHC effort.
8. MOU between DOE and NSF concerning the LHC (December 1999) – Communication and coordination of funding agencies as it applies to U.S. participation in the LHC.
9. U.S. CMS Constitution (June 2000) – Organization, structure, and management systems governing the U.S. CMS Collaboration.
10. U.S. CMS Technical Baseline Document (October 2002) – Controlled document that describes the technical scope of the U.S. CMS Project.
11. MOU for M&O with CERN
12. U.S. CMS S&C Program Management Plan (2004) –
http://uscms.fnal.gov/pub/pmp/Software_Computing/
13. U.S. CMS M&O Program Management Plan (2004) –
http://uscms.fnal.gov/pub/pmp/Maintenance_Operations/
14. Letter, JOG to: FNAL Director re: U.S. CMS Program Management (November 7, 2003).
15. U.S. Research Program for the Large Hadron Collider, Research Program Execution Plan, January 2005.

2. CMS DETECTOR OBJECTIVES

2.1 SCIENTIFIC OBJECTIVES

The Compact Muon Solenoid (CMS) Detector is a general purpose colliding beam detector designed to study proton on proton collisions with center of mass energy of 14 TeV and a design luminosity of $10^{34} \text{cm}^{-2}\text{s}^{-1}$ at the Large Hadron Collider (LHC) located at the European Laboratory for Nuclear Research (CERN) near Geneva, Switzerland. CMS is expected to operate at the LHC for twenty or more years, observing collisions of protons, and with appropriate upgrades, is expected to record more than 10^9 events per year.

The critical scientific objectives needed to achieve these goals are:

- Excellent muon identification and momentum resolution.
- Excellent photon and electron identification, as well as energy and directional resolution.
- Calorimetry to provide accurate measurement of direction and magnitude of energy flow and excellent reconstruction of missing transverse momentum, which require fine segmentation and excellent coverage.
- Efficient charged-particle track reconstruction and good momentum resolution.
- Efficient tagging of b-decays and τ -jets.
- Well-understood trigger and data acquisition systems to reduce the ~ 1 GHz interaction rate to a ~ 100 Hz readout rate, without significant loss of interesting events.

2.2 TECHNICAL OBJECTIVES

The overall dimensions of the CMS detector are immense, with a length of 21.6m (HCAL Forward Calorimeters excluded), a diameter of 15.0m, and a total weight of 12500 tonnes. Its central feature is a high field (4 Tesla) solenoid of 13m length and 2.95m radius. CMS will be one of the most complex scientific instruments ever built. The U.S. CMS collaboration will take responsibility to operate the deliverables specified in the U.S. CMS Detector Construction Project.

For all subsystems, the U.S. CMS strategy has been to assume responsibility for deliverables that focus on a particular area of U.S. expertise. Furthermore, U.S. CMS has attempted to assume responsibilities for major deliverables along with its subparts, providing an opportunity for vertical integration and some autonomy in optimizing resources and schedule for maintenance and operation of U.S. deliverables.

2.3 COST OBJECTIVES

The U.S. CMS Collaboration has taken responsibility to operate roughly 20-25% of the CMS detector. In addition, the Collaboration takes responsibility for roughly 25% of the software costs. The host laboratory, Fermilab, will be the site of a “Tier 1” computing center for CMS and about six “Tier 2” centers will be sited at U.S. CMS universities, and supported partially by the RP.

2.4 SCHEDULE OBJECTIVES

The U.S. CMS Construction Project was initiated with the U.S. CMS Collaboration’s Letter of Intent (Ref. 2) in September 1996, with the cost, schedule, and technical baseline for the U.S. CMS Construction Project approved in May 1998. In June 2002, CERN announced a schedule delay in the LHC Project that directly impacts CMS. As discussed in references 6-7 of section 1.2, U.S. CMS has adopted a phased “Critical Decision-4” (CD-4) for completion of the construction project. The revised definition of CD-4 includes a milestone CD-4A for completion of approximately 97% of the scope of U.S. CMS deliverables by the end of FY 2005, as originally planned, and a milestone CD-4B for completion of the final few percent of the scope of U.S. deliverables by the end of FY 2008. The final percentage of activities includes deliverables with schedules that depend on the completion and start-up schedule for the LHC machine.

In discussions with CERN, LHC and U.S. CMS management, CMS management has prepared a new baseline schedule (version 34), calling for first collisions at CMS in July 2007, with the first data run scheduled for July 2008. This schedule is consistent with current LHC and CMS planning.

The schedule for the S&C and M&O aspects of the RP are congruent with the CMS schedule. The highest level milestones for U.S. CMS are shown in Appendix 1. Both the U.S.

schedule and cost depend on the approved rate of funding from the DOE and NSF; the guidance for which is indicated in Appendix 2. The projected partition of RP funds into the S&C and M&O components is also indicated in Appendix 2.

3 OVERALL CMS ORGANIZATION

The overall responsibility for the exploitation of the CMS detector resides with the CMS Collaboration, consisting of over 1800 physicists and engineers from 31 countries and 150 institutions. The U.S. CMS Collaboration is part of the international CMS Collaboration, and presently consists of 380 scientists and engineers from 40 U.S. universities and one national laboratory, as shown in Appendix 3.

The U.S. CMS Research Program operates within the context of the internationally funded CMS experiment located at CERN. The general responsibilities of the U.S. participants, and CERN as the Host Laboratory for the CMS experiment are described in the Protocol signed between CERN, DOE and NSF [Ref.4] and in a related CERN document [Ref.1].

3.1 THE INTERNATIONAL CMS COLLABORATION AND ITS MANAGEMENT

The CMS detector ranks among the most ambitious and challenging technical endeavors ever undertaken by the scientific community. The CMS approach to this challenge is to base most of the CMS governance on the collaborating institutions rather than on national blocks. The organization of the full CMS Collaboration is described in the CMS Constitution of December 11, 1998 [Ref. 3], and is shown hierarchically in Appendix 4.

CERN management has the ultimate responsibility for CMS, and CMS reports to it. The Resource Review Board (RRB), with representatives from the constituent funding agencies, acts as an oversight board and liaison to CERN management to ensure that the CMS detector has sufficient resources to proceed on cost and on schedule.

Within CMS, the principal organizational entity is the Collaboration Board (CB), consisting of one voting representative from each collaborating institution, regardless of size or national origin. The CB is the overall governing body of the CMS experiment, and must ratify all policy and technical decisions and all official appointments to CMS positions. The Chairperson of the CB is elected by the members of the CB and, along with the Deputy Chairperson, serves a renewable three-year term.

The executive function in CMS is provided by the CMS Management Board (MB) and the Steering Committee (SC). Diagrams for these two bodies are shown in Appendix 4 and

Appendix 5. The CMS spokesperson is advised on financial matters by the Finance Board. All important matters of a scientific, technical, organizational and/or financial nature are discussed in the SC and the MB, which are chaired by the CMS Spokesperson. The Spokesperson is elected by the members of the CB and, along with the Deputy Spokesperson, serves a renewable three-year term. The nomination of the Deputy Spokesperson must be endorsed by the MB and the CB. In most cases, issues that require the deliberation and/or ratification of the CB are submitted to the SC and thence to the MB.

The MB, through the Spokesperson, is responsible for directing the CMS project and for formulating policy. The MB, again through the Spokesperson, also represents the Collaboration in dealing with other CMS bodies such as the Finance Board and the Technical Coordination Group, and organizations and committees outside of CMS. The MB structure is defined in the CMS Constitution.

The CMS Steering Committee (SC) is a subset of the MB and supervises and reviews the progress and planning of CMS. The SC provides assistance and guidance to the Spokesperson, and its task is to optimize the resources available to the Collaboration to assure that the best possible detector is built and operated to address the physics of the LHC. As indicated in Appendix 5, the U.S. has strong representation within the CMS MB and SC structures.

4. MANAGEMENT ORGANIZATION AND RESPONSIBILITIES

The U.S. CMS Research Program is a subset of international CMS. Successful exploitation of the CMS detector will enable U.S. high-energy physicists to participate in research at the physics frontier of the LHC. Related objectives of the U.S. CMS RP, through participation in R&D for the LHC luminosity upgrade are to take advantage of opportunities in developing state of the art technologies related to high-energy physics.

The U.S. CMS Collaboration within international CMS has a parallel structure, as described in the governance document “The U.S. CMS Constitution” of June 5, 2000, [Ref. 9]. Elected representatives of the U.S. CMS Collaboration include a Chair as the Collaboration Board, a Deputy Chair and a U.S. CMS Advisory Board. The U.S. CMS Collaboration advises the Managers of the U.S. CMS RP through advisory boards. U.S. CMS is financially responsible to Fermilab, and ultimately to DOE and NSF, that are, in turn, responsible to the U.S. Congress.

4.1 PROGRAM OVERSIGHT ORGANIZATION STRUCTURE

4.1.1 U.S. Department of Energy (DOE) and National Science Foundation (NSF)

The DOE and NSF have negotiated and signed a joint agreement and protocols with CERN for U.S. participation in the construction of the LHC accelerator and the ATLAS (A Toroidal LHC ApparatuS) and CMS detectors, [Ref. 4, Ref. 11] that will carry out the LHC scientific program.

Program oversight for the U.S. CMS Research Program is the responsibility of the U.S. Department of Energy (DOE) and the National Science Foundation (NSF), under the general purview of a Joint Oversight Group (JOG), with specific responsibilities as described in the Research Program Execution Plan (Ref. 15). DOE and NSF have requested, via the JOG, that the Fermi National Accelerator Laboratory (Fermilab), in Batavia, Illinois act as the Host Laboratory and assume management responsibilities for the U.S. CMS RP [Ref. 14]. Fermilab is a DOE Laboratory operated under contract DE-AC02-76-CH-03000 by Universities Research Association, Inc. (URA). The present U.S. CMS Research Program Manager is a Fermilab employee. Appendix 6 provides an overall depiction of the oversight function for the Research Program, which has evolved from the structure that guided the U.S. LHC Construction Project.

The DOE has delegated responsibility for the U.S. CMS RP to the Office of High Energy Physics within Office of Physics. The NSF has delegated responsibility for the U.S. CMS Project to the Division of Physics. These divisions in DOE and NSF function together to provide oversight through the JOG [Ref. 8].

4.1.2 U.S. LHC Joint Oversight Group (JOG)

The DOE and NSF established the U.S. LHC Joint Oversight Group as the highest level of joint oversight of the U.S. LHC Research Program. The Joint Oversight Group will establish programmatic guidance and direction for the U.S. CMS RP and coordinate DOE and NSF policy and procedures as it applies to the U.S. CMS. Specific responsibilities include the following tasks:

1. Providing programmatic guidance and direction for the U.S. LHC Research Program and coordinating DOE and NSF policy and procedures,
2. Approving the RPEP and the attendant Research Program Management Plans, and any future modifications,
3. Formally concurring on the assignment of DOE or NSF employees to positions of U.S. LHC Program Manager, Associate U.S. LHC Program Manager, and Assistant Program Managers for specific areas,
4. Formally concurring on the assignment of university or laboratory employees to positions as Research Program Managers and Deputies for the three main elements of the Research Program, and concurring on the appointment of U.S. representatives to appropriate CERN committees dealing with LHC issues,
5. Assessing the effectiveness of the managers of the Program Office,
6. Representing U.S. funding agencies at meetings of the CERN LHC Resource Review Board (RRB),
7. Conducting semi-annual JOG meetings to review the status of the Research Program,
8. Reviewing and concurring on the overall Research Program funding plans,
9. Reviewing quarterly reports from the Research Program.

4.1.3 U.S. LHC Program Office

The U.S. LHC Program Office, led by the U.S. LHC Program Manager, will provide day-to-day program management and support for the U.S. participation in the LHC. The U.S. LHC Program Office receives direction from and directly reports to the JOG.

The U.S. LHC Program Office is staffed by a Program Manager and Associate Program Manager. They are Federal employees (or their equivalents) who manage the Research Program for the funding agencies. Specific responsibilities include the following tasks:

1. Day-to-day oversight of the Research Program,
2. Coordination of budgetary requests from the Research Program with DOE and NSF research plans and priorities,
3. Approving budgets for the Research Program, including balance of allocations among M&O, S&C and R&D components,
4. Oversight of activities at CERN related to the Research Program, including frequent discussions with the Research Program Managers,
5. Reporting to JOG any major developments or external events that can affect the Research Program,
6. Conducting reviews of the technical scope, status, and overall management of the Research Program,
7. Organizing regular agency discussions of the LHC Working Group,
8. Representing the Research Program at host laboratories and at CERN.

4.1.4 DOE Fermi Site Office

The DOE Fermi Site Office (FSO) has contract responsibility for Fermilab and provides day-to-day DOE oversight of Fermilab. FSO receives management and other support from the DOE Chicago Office. The FSO Manager will also provide FSO staff support when necessary and appropriate.

4.1.5 U.S. LHC Project Office

The U.S. LHC Project Office at Fermilab, which has provided day-to-day management and support of the U.S. LHC Construction Project since its inception, is expected to continue its active role in carrying out its responsibilities. Until the completion of the Project, the U.S. LHC Project Office will support any requests for information and will function as a repository for any formal reports and other documents pertaining to the overall U.S. LHC Program, including the Research Program. Upon closeout of the U.S. LHC Project Office following the successful completion of the U.S. LHC Construction Project, the DOE Site Office hosting the U.S. LHC Project Office will be responsible, along with the DOE Office of High Energy Physics and the NSF Directorate for Mathematical and Physical Sciences, for ensuring that appropriate functions and management systems needed to support the Research Program are maintained.

4.1.6 Host Laboratory (Fermilab) Organization

The DOE and NSF have jointly assigned management oversight for the U.S. CMS RP to the Fermi National Accelerator Laboratory (Fermilab), in Batavia, Illinois. Fermilab is a DOE Laboratory operated under contract DE-AC02-76-CH-03000 by Universities Research Association, Inc. (URA). A U.S. CMS Program Office has been formed, with its principal office sited at Fermilab, and has been charged with meeting the technical, cost, and schedule objectives of the U.S. CMS RP.

The use of Fermilab facilities and services, as is the case with the use of assets at any U.S. CMS institution, shall be agreed upon via a MOU with the U.S. CMS Collaboration. The use of these resources will follow procedures consistent with the Fermilab's current policies. To the extent agreed by Fermilab and the U.S. CMS Collaboration, the U.S. CMS Research Program will receive support from the Laboratory through contributions in:

- Accounting and Budgeting
- Environment, Safety and Health
- Human Resources
- Legal issues
- Facilities Management

- Quality Assurance
- Information and Business Services

All support functions will be provided through Fermilab's normal organizational lines of authority and responsibility, according to agreed upon priorities. The services may include those provided to Fermilab's U.S. CMS group or to other U.S. CMS institutions. Within the framework of the MOU, specific items shall be negotiated annually by Fermilab (as host laboratory) by the U.S. CMS RP Manager and Deputy RP Manager and by the collaborating U.S. CMS institutions. Any specific items will specify the commitments and the associated estimated costs provided in an annual Memorandum of Understanding (MOU).

It is recognized that all entities, DOE, NSF, Fermilab, and the U.S. CMS Collaboration, will work together to accomplish the goals of the U.S. CMS Research Program.

4.1.7 Fermilab Director

The Fermilab Director has management oversight responsibility to ensure that the RP effort is well managed, that technical progress proceeds in a timely way, that technical and financial problems are identified and properly addressed, and that an adequate management organization is in place. Specific responsibilities of the Fermilab Director are:

1. In consultation with the U.S. CMS Collaboration, appoint the U.S. CMS Research Program Manager and Deputy Research Program Manager, subject to the concurrence of the Joint Oversight Group;
2. Establish an advisory structure external to the U.S. CMS RP for the purpose of monitoring both management and technical progress for all U.S. CMS activities;
3. Ensure that the U.S. CMS RP Manager has adequate staff and support, and that the U.S. CMS management systems at Fermilab are matched to the needs of the program;
4. Consult regularly with the U.S. CMS RP Manager to ensure timely resolution of management challenges;
5. Review and concur on the international Memoranda of Understanding with CERN that specify U.S. CMS responsibilities funded by DOE and NSF;

6. Review and concur with the institutional Memoranda of Understanding for the U.S. CMS collaborating institutions that specify the deliverables to be provided and the resources available at each institution;
7. Ensure that accurate and complete reporting to DOE and NSF is provided in a timely manner, and;
8. Review and approve significant program changes as prescribed in this document.

The responsibilities of the Fermilab Director are further described in a letter of joint appointment from DOE and NSF to the Fermilab director, dated November 30, 1997. The Fermilab Director may delegate certain responsibilities and authorities to a duly appointed Fermilab staff member. The Fermilab Director has delegated certain responsibilities and authorities to the Fermilab Deputy Director.

4.1.8 Fermilab Deputy Director

Upon delegation from the Fermilab Director, the Fermilab Deputy Director is responsible for management oversight of the U.S. CMS RP. The U.S. CMS RP Manager reports to the Fermilab Deputy Director. The Fermilab Deputy Director must concur with the Memorandum of Understanding between CERN and U.S. CMS and in the Memoranda of Understanding and Statements of Work between U.S. CMS and the collaborating U.S. institutions. In addition, the RP Management Plan, cost estimate, schedule, and financial plan for the U.S. CMS RP, all require the approval of the Fermilab Deputy Director, DOE and NSF, with concurrence of international CMS and CERN.

4.1.9 Program Management Group

To exercise management oversight for the U.S. CMS RP, a Program Management Group (PMG) will be organized and convened by Fermilab. The Deputy Director chairs the PMG, and monitors the progress of the U.S. CMS RP. The PMG will include members from Fermilab, the RP line management [the RPM, DRPM and the S&C and M&O program managers], with PMG meetings attended by members of the U.S. LHC Program Office as appropriate. The Board Chair of the U.S. CMS Collaboration is also a member of the PMG, thereby ensuring communication of any scientific issues to the U.S. CMS Collaboration.

The PMG approves change requests to the RP. The PMG receives and reviews the Quarterly Reports of the U.S. CMS RP. The PMG will meet regularly, as deemed necessary by the Fermilab Deputy Director, in order to provide routine interactions with the U.S. CMS RP management. The PMG will identify actions and initiatives to be undertaken to achieve the goals of the RP, including the allocation of both financial and human resources. As necessary, the PMG will be used as a review board to assess critical areas of the U.S. CMS RP.

4.2. U.S. CMS PROGRAM ORGANIZATIONAL STRUCTURE

4.2.1 General Management Structure

To facilitate interactions with the U.S. funding agencies and for effective management of U.S. CMS activities and resources, a U.S. CMS Program Office (PO) has been established at the host laboratory, Fermilab. Appendix 7 shows the management structure of the U.S. CMS Research Program. The U.S. CMS Research Program Manager (RPM) has overall responsibility to provide programmatic coordination and management for the work performed at the participating institutions to meet the objectives of the U.S. CMS RP. The U.S. CMS Deputy Research Program Manager (DRPM) is appointed by the Fermilab Director with the concurrence of the JOG. Program managers for the S&C and M&O programs within the U.S. CMS RP are appointed by the Fermilab Director with the consultation of the RPM and DRPM and with the concurrence of the JOG. All of the line managers of the U.S. CMS RP must have the concurrence of the Collaboration Board. U.S. Level 2 Managers are appointed by the S&C and M&O PM for each of the major subsystems of the respective programs. The details of the program management plans for S&C and M&O can be examined in Ref. 12 and Ref. 13 respectively.

U.S. CMS planning and management is conducted in close communication and cooperation with overall CMS management. The U.S. RPM and DRPM maintain close contact with the CMS Spokesperson and the CMS Steering Committee.

Annually, the RPM determines the allocation of funds to the S&C and M&O programs, in light of funding provided by the DOE and NSF [see Appendix 2]. The model used for planning the program captures all U.S. CMS commitments to international CMS and is the approved global CMS schedule. Commitments of each institution to the U.S. CMS RP are

explicit, as defined in each annual U.S. CMS Memorandum of Understanding (MOU). Subcontracts, e.g., Memorandum Purchase Orders (MPO's) are issued to institutions (including Fermilab, as a member U.S. CMS institution), in agreement with their respective MOUs, either for S&C or for M&O deliverables.

In what follows it has been assumed that the RPM is a Fermilab employee and that the DRPM is a staff member at a collaborating university. Clearly, the RPM may be a university employee, while the DRPM may be a Fermilab employee. In either case, DOE financial interactions reside with the FNAL employee (or guest scientist with a Fermilab appointment), while NSF financial interactions reside with the university employee.

4.2.2 The U.S. CMS Research Program Manager

The U.S. CMS Research Program Manager (RPM) has overall responsibility for coordination and management of the U.S. CMS RP. The RPM represents the U.S. CMS RP in interactions with CMS management, CERN, DOE, NSF, Fermilab and the U.S. collaborating universities. Although not required to be a Fermilab employee, the RPM is appointed by the Director of Fermilab, with concurrence of the U.S. LHC JOG, in consultation with the U.S. CMS Collaboration, and reports to the Fermilab Director (or an appointed representative). Specific responsibilities require the RPM to:

1. Provide general administration, planning, organization and control on a day-to-day basis of the execution of the U.S. CMS RP on schedule and within the authorized budget;
2. Consult with the Fermilab Director on the appointments of the S&C and M&O program managers;
3. Recommend to the Fermilab Director the appointment of the DRPM.
4. Prepare yearly funding requests to DOE and NSF for the anticipated U.S. CMS activities;
5. Recommend to DOE and NSF, upon advice of the DRPM, M&O PM and S&C PM, the institution-by-institution funding allocations within the RP (MOUs), in support of the U.S. CMS efforts;
6. Establish, with the support of Fermilab management, a U.S. CMS Program Office with appropriate support services;

7. Establish, as needed, and with the support of Fermilab management, advisory groups or other mechanisms that Fermilab management finds necessary to carry out its oversight responsibility;
8. Maintain close communication with the Fermilab Director or any delegated representative, and with the U.S. LHC Program Office, on progress of the U.S. CMS effort, and report promptly any problems that may benefit from the joint efforts of the RPM, DRPM, Fermilab and Program Office management;
9. Interact with CMS and CERN management on issues affecting resource allocation and availability;
10. Serve as the DOE/NSF link-person to the CMS Finance Board and Resource Review Board;
11. Sign the U.S. Institutional MOUs representing agreements between the U.S. CMS RP and the U.S. CMS collaborating institutions specifying institutional responsibilities, deliverables to be provided and the resources available on an institution-by-institution basis;
12. Publish a quarterly report on the activities, issues, performance and fiscal status of the U.S. CMS RP;
13. Make periodic reports to the JOG and at reviews of the RP conducted by the Program Office on the status and issues of the U.S. CMS RP;
14. Make periodic reports to the U.S. CMS Collaboration Board to ensure that the U.S. CMS Collaboration is fully informed about major issues.

4.2.3 U.S. CMS Deputy Research Program Manager and Related Issues

The Deputy Research Program Manager (DRPM) reports to the RPM in the line management of the Research Program. Reference 14 (of Section 1.2) establishes the Program Management structure applicable to U.S. CMS. The U.S. CMS DRPM represents the RPM in all U.S. CMS RP functions when the RPM is not available.

Regarding the Research Program Manager and Deputy Research Program Manager, it is anticipated that one be from a National Laboratory and the other from a U.S. University. Therefore, in addition to duties traditionally associated with managing a program, the university-based physicist of the management team (or a designate) will serve as a conduit for

communications of special interest to the universities, both to and from the line management. In addition, the university-based RPM or DRPM will serve as the effective Principal Investigator for the NSF Cooperative Agreement covering funding of the research program.

In this capacity, this individual will be responsible for ensuring that the NSF Research Program funds are allocated in a manner consistent with the decisions of the U.S. CMS Research Program Manager. Much of the work of the Research Program will be carried out or overseen by physicists funded from the Core Programs of both NSF and DOE. Thus, the university-based manager will stay in contact with the program officers in each of the agencies in order to coordinate support of university groups. A formal meeting of U.S. CMS management with each agency will take place annually.

In addition, the responsibilities require the DRPM to:

1. Maintain the overall management coordination, integration, and planning for the U.S. CMS RP with respect to NSF/DOE funds;
2. Track and report NSF/DOE funding to the U.S. CMS Program Office in a timely manner;
3. Act as liaison with the Fermilab management on such U.S. CMS issues as Fermilab resources and infrastructure and liaison with the U.S. CMS university groups;
4. Act as the point of contact between the university programs of NSF and DOE and the RP;
5. Act as the U.S. CMS advocate for the university groups within the collaboration;
6. Represent the RP of U.S. CMS to external committees, such as HEPAP, URA and other reviews;
7. Serve as link-person to NSF or DOE on the CMS Finance Board and advise the NSF or DOE representative to the Resources Review Board;
8. Work with the U.S. CMS Education Coordinator to define RP support of education/outreach.

4.2.4 S&C and M&O Program Managers

The S&C and M&O PM are appointed by the Fermilab Director with the consultation of the U.S. CMS RPM and the DRPM, and the concurrence of the JOG and the U.S. CMS collaboration. The PMs are members of the Program Management Group, and have the specific responsibilities spelled out in the program management plans included in Ref. 12 and Ref. 13.

4.2.4.1 S&C Program Manager

The Software and Computing Program Manager (SCPM) represents U.S. CMS Software and Computing in interactions with the U.S. CMS Research Program Manager, CMS management, CERN, DOE, NSF, Fermilab, the collaborating universities, and related external R&D projects. He/she reports to the U.S. CMS Research Program Manager and the director of Fermilab or his designee and through them to DOE and NSF. The SCPM has authority to negotiate on behalf of the U.S. CMS Software and Computing Project with collaborating institutions and with Fermilab for collaboration or laboratory resources and for their optimal utilization and management.

The SCPM is responsible for completing the work plan by achieving the approved scope within budget and on schedule. He/she must also ensure that the deliverables of U.S. CMS Software and Computing conform to the technical specifications that are set for them. Finally, he/she is responsible for doing all this in manner consistent with CMS scientific policy. During his/her tenure, the SCPM will be a member of Fermilab's staff. Administratively, the SCPM will be a member of the Fermilab Computing Division (CD) and his/her staff organization will reside in the CD. It is expected that the SCPM will have experience and background in HEP experiment, software development, management and operations issues and skills that would predict success as a program manager in this role. The SCPM will serve as long as there is continuing confidence of the Fermilab Director, the U.S. CMS Research Program Manager, the Collaboration, and the funding agencies. Any changes of the SCPM will require this very same concurrence.

The specific responsibilities of the SCPM include:

1. developing the baseline work plan especially with respect to budget, personnel requirements, schedule, Level 1 (L1) milestones, and L1 deliverables;
2. executing the approved work plan in a manner consistent with the technical and scientific policies of U.S. CMS;
3. developing an integrated Cost and Schedule Plan;
4. establishing and maintaining the organization of U.S. CMS Software and Computing, within the Fermilab Computing Division, required to manage procurements, maintain schedules, submit reports, develop budgets, carry out quality assurance, maintain the

- work plan and the record of all revisions to it, and maintain safety standards and records;
5. developing the annual budget report to the DOE and NSF. This request is reviewed by the U.S. Advisory Computing and Software Board (ACSB) and requires concurrence by the U.S. CMS Research Program Manager and approval by the PMG;
 6. providing liaison between the U.S. CMS Software and Computing and the CMS Software and Computing Technical Board (CCS-TB) and Steering Committee (CCS-SC);
 7. at his/her discretion, in consultation with the U.S. ACSB and with the concurrence of the PMG, appointing a deputy or other supporting staff to assure management continuity during periods when he/she is absent or unavailable;
 8. appointing the Level 2 (L2) managers in consultation with the U.S. ACSB and with the concurrence of the PMG. Consulting on and concurring with the appointment of Level 3 (L3) managers by the L2 managers;
 9. developing or adopting general technical and quality assurance standards to which deliverables must conform. This includes making sure that U.S. CMS software and facilities conform to applicable CMS and CERN standards and practices, and can operate with them without unnecessary additional integration effort;
 10. providing coordination and oversight to the Level 1 and Level 2 projects. Oversight may be accomplished by requiring appropriate regular reports, following and tracking the results of technical reviews, and conducting reviews using both internal and external committees or experts. Coordination may involve making sure that the User Facilities Subproject can supply test beds to the Core Applications Subproject for major development activities;
 11. making adjustments to Memoranda of Understanding, MOUs, and Statements of Work, SOWs, with collaborating universities and laboratories. These MOUs and SOWs are initially formulated as part of the work plan but adjustments may be necessary in the course of the effort;
 12. allocating resources within U.S. CMS Software and Computing. These allocations are largely set by the work plan and the annual budget request. However, adjustments

- are often necessary. The work plan includes a management reserve that will be allocated subject to the formal change control procedure;
13. reporting variances from the scope, schedule or cost estimates to the PMG and developing action plans for dealing with them. The SCPM informs the U.S. ACSB of such variances;
 14. exercising change control authority as described in this plan and bringing change issues that exceed his/her authority to the attention of the PMG;
 15. establishing technical advisory committees where appropriate;
 16. providing reports and organizing reviews in conjunction with the funding agencies; responding to requests for information from U.S. CMS, Fermilab, and the funding agencies; and
 17. developing a technology-tracking plan, in conjunction with the Level 2 managers and with similar efforts at CERN, with the advice of the U.S. ACSB. The tracking plan should allow U.S. CMS Software and Computing to take advantage of new, more cost-effective technologies that may arise during the period of its execution.

4.2.4.2 M&O Program Manager

The U.S. CMS Operations Program Manager (OPM) has the responsibility of providing programmatic coordination and management for the U.S. CMS Maintenance and Operations (M&O) of CMS. He/she represents U.S. CMS Operations in interactions with overall CMS management, CERN, DOE, NSF, the universities and the Host Laboratory (FNAL). He/she reports to the FNAL Director (or his/her appointed representative), the RPM and DRPM and is advised by the U.S. CMS Advisory Board (AB). Consultation with the AB is part of the process by which the OPM makes important technical and managerial decisions.

The specific responsibilities of the OPM include:

1. Appointing, after consultation with the Collaboration, the U.S. L2 Subsystem Managers (L2Ms) responsible for coordination and management within each detector subsystem. A U.S. CMS Deputy Operations Manager may also be appointed if deemed necessary by the OPM.
2. Recommending to DOE and NSF the institution-by-institution funding allocations for adequate incremental support of the core program for U.S. CMS operational efforts.

These recommendations will be made with the advice of the L2Ms, and the U.S. CMS Collaboration Board, through consultation with the subsystem IBs.

3. Approving budgets and allocating funds in consultation with the L2Ms and managing the management reserve.
4. Establishing, with the support of FNAL management, a U.S. CMS Operations Office with appropriate support services.
5. Working with FNAL management to set up and respond to whatever advisory or other mechanisms FNAL management feels necessary to carry out its oversight responsibility.
6. Keeping the FNAL Director or his chosen representative well informed on the progress of the U.S. CMS operations effort, and reporting promptly any problems whose solutions may benefit from the joint efforts of the U.S. CMS Operations Manager and FNAL management.
7. Interacting with CERN on issues affecting resource allocation and availability, preparation of the international MOUs defining U.S. operations responsibilities and conferring in these MOUs.
8. Negotiating and signing the U.S. Institutional MOUs representing agreements between the U.S. CMS Operations Office and the U.S. CMS collaborating institutions specifying the deliverables to be provided and the resources available on an institution-by-institution basis.
9. Negotiating and signing the U.S. Institutional Statements of Work (SOWs) representing annual (fiscal year) agreements between the U.S. CMS Operations Office and the U.S. CMS collaborating institutions specifying the deliverables to be provided and the resources available on an institution-by-institution basis.
10. Periodically reporting on CMS operational status and issues to the Joint Oversight Group.

11. Meeting with the U.S. CMS Collaboration Board to discuss budget planning, milestones, and other U.S. CMS management issues.
12. Making periodic reports to the U.S. CMS Collaboration Board to ensure that the Collaboration is fully informed about important issues.
13. Ensuring that ES&H and QA/QC activities are managed effectively.

DOE funding will be a mixture of RP supplements to core program grants and R&D purchase orders issued through FNAL. NSF funding will be through subcontracts written by the Responsible University (RU), which is normally the home institution of the DRPM, and the NSF Branch Office (see section 4.2.5.1).

4.2.5 The U.S. CMS Program Office (PO)

The day-to-day control of the U.S. CMS RP will be performed by the U.S. CMS Program Office (PO) at Fermilab. This office consists of the RPM, DRPM, Budget Officer, Resource Manager, and Administrative Support. In addition, the PO includes administration functions that, depending on the position of the DRPM, may be located off Fermilab site, to facilitate and track NSF disbursements (“NSF Branch Office”), and a “branch” at CERN to monitor U.S. activities at CERN and to act as liaison and support for U.S. visitors at CERN.

A separate management reserve, annually assigned, is held by the S&C and M&O program managers. The size of this reserve will be defined annually by the RPM and the DRPM. Allocations of reserve funds during the fiscal year are based upon Change Requests submitted by the respective M&O or S&C PM and approved by the RPM and the Fermilab PMG, which acts as a change control board for the RP. In practice, the PMG for S&C and for M&O may differ in composition due to their specialized missions.

The PO will maintain all official documentation for the RP and ensure that the U.S. CMS Collaboration and its sponsors, the DOE and NSF, are fully informed of the latest developments, action items, and/or changes that affect the U.S. CMS RP, the CMS Detector, or the overall LHC Research Program. Within the RP, the S&C and M&O PMs report performance and status of their respective programs to the PO on a quarterly basis.

4.2.5.1 NSF Branch Office

Presently, the U.S. CMS Program Office includes a Responsible University (RU) which will administer NSF Funds as indicated in Appendix 7. The DRPM currently acts as the Administrator of NSF Funds and is responsible for administration, disbursement, and reporting on the use of NSF funds in accordance with the NSF cooperative agreement with the RU. The NSF Administrator is a member of the Program Management Group. Should the RPM be university based and the DRPM be Fermilab based, the financial responsibility for NSF funds still will reside with the university based administrator.

As a member of the program management team, the NSF Administrator (DRPM) reports to the U.S. CMS RPM and under his/her direction, arranges for the appropriate procurement instrument (e.g. subaward) to be issued from the RU to the respective U.S. CMS participating institutions. Disbursement and utilization of funds provided by the NSF for U.S. CMS are subject to this management plan and the configuration, change control, and reporting procedures herein defined. The annual Memorandum of Understanding (MOU) describes a work plan for each institution that is consistent with the scope of the U.S. CMS RP and approved by the DOE and NSF. Subcontracts issued by the RU will authorize expenditures at the lowest level of the WBS in a manner consistent with the approved MOU for each institution. The NSF funded institutions will invoice the RU by WBS activity. U.S. CMS RPM approval is required before invoices are paid. The RU will track and record all NSF funds disbursed on behalf of U.S. CMS and will report this information monthly to the U.S. CMS Program Office.

4.2.5.2 CERN Branch Program Office

A branch office of the U.S. CMS Program Office is located at CERN to facilitate activities of U.S. CMS and CERN, and to improve the coordination and communication between the CMS Collaboration and the U.S. CMS collaborating institutes. The duties and responsibilities for the CERN branch office include:

1. Serving as liaison to CERN financial officers with regard to U.S. CMS L2 Team Accounts, used by U.S. groups to make purchases at CERN;
2. Acting as liaison for U.S. CMS institutions on communications, computing and database support with CERN and CMS;

3. Acting as liaison for U.S. CMS to CERN Accounting;
4. Acting as liaison for U.S. visitors to CERN and CMS;
5. Expediting travel, housing, computing support and shipping requests from U.S. CMS collaborators at CERN.

4.2.5.3 Fermilab Branch Office

Fermilab maintains a central office to track DOE expenditures and invoices, to report on overall RP costs and to report on the state of the RP.

4.2.5.3.1 U.S. CMS Budget Officer

The U.S. CMS Budget Officer reports to the RPM, and is the primary source of communication between U.S. CMS and other financial offices of Fermilab and U.S. CMS collaborating universities. The U.S. CMS Budget Officer's responsibilities include:

1. Providing quarterly summaries of budgets, costs, and obligations for the U.S. CMS RP;
2. Aiding and coordinating the Fermilab Purchase Orders using DOE funding support and any other Subcontracts to provide consistency with the approved Level 2 program files at the lowest WBS for both S&C and M&O;
3. Ensuring that the U.S. CMS RP Quarterly Report provides accurate statement of obligations and budgets at the lowest WBS;
4. Acting as liaison between the U.S. CMS RP and Fermilab's Business Services Section.
5. Preparing all budget-planning documents and financial reports;
6. Produce ad-hoc reports and queries, as requested, to determine status of requisitions, purchase orders, and procurements;
7. Produce ad-hoc reports and queries, as necessary, to track effort charged to the U.S. CMS RP and bring any discrepancies to the attention of the U.S. CMS RPM/DRPM;
8. Overseeing all U.S. CMS procurements, including ProCard purchases, and providing gate-keeping oversight of the requisition process;
9. Auditing the U.S. CMS RP financial reports.

4.2.5.3.2 U.S. CMS Resource Manager

The U.S. CMS Resource Manager reports to the RPM, and is the primary source of communication for U.S. CMS on international financial matters related to the U.S. CMS RP. The U.S. CMS Resource Manager also has responsibilities to:

1. Act as a liaison between U.S. CMS and the CMS Resource Management at CERN;
2. Monitor all U.S. CMS Team Account activity at CERN and report regularly on the budgets, costs and obligations for each team account;
3. Act as a liaison to the U.S. CMS Program Office at CERN, providing instruction on budgetary and cost reporting methodologies and formats;
4. Maintain and oversee the U.S. CMS commitments, funding and performance projections.

4.2.6 U.S. CMS Collaboration Board

The U.S. CMS Collaboration acts through a Collaboration Board (CB), consisting of one member from each collaborating institution and a Chair elected by the CB, to address policy issues affecting the U.S. CMS Collaboration. The Chair serves for a two-year renewable term. All voting is by CB members only, except in the case of the absence of a member when the missing member may give his proxy to an alternate.

The CB members represent the interests of their institutions and serve as points of contact between the U.S. CMS management structure and the collaborators from their institutions. They are selected by the CMS participants from their respective institutions.

The Chair of the CB organizes meetings on issues of general interest. The CB Chair will recommend to the Collaboration Board the establishment of any standing committees to deal with collaboration wide issues if the need arises. The Collaboration Board also provides its concurrence on the appointment of the RPM, DRPM, SCPM and OPM to the FNAL Director, and DOE and the NSF.

4.2.7 U.S. CMS Advisory Board

The purpose of the U.S. CMS Advisory Board is to facilitate the participation of U.S. physicists in the CMS experiment, and to consider any policy issues brought to the U.S. CMS

Collaboration Board. The Advisory Board has meetings at least twice per year, and has the following membership:

- U.S. Collaboration Board Chair
- U.S. Collaboration Board Deputy Chair
- U.S. CMS Subsystem IB Chairs
- U.S. CMS Education/Outreach Coordinator
- U.S. CMS Physics Coordinator
- Additional members as deemed appropriate by the U.S. CMS CB Chair

The Subsystem IB Chairs are elected for two-year renewable terms by the IB members whose institutions are associated with the given subsystem.

The Education/Outreach Coordinator, elected for a two-year renewable term by the full CB, is expected to actively promote educational programs associated with CMS and with the U.S. member institutions, and to report to the Advisory Board on these issues. He/she will also act as liaison to DOE and NSF for educational activities.

The Physics Coordinator, elected for a two-year renewable term by the full CB, is expected to actively promote physics programs, conferences, and publications, associated with CMS and with the U.S. member institutions, and to report to the Advisory Board on these issues.

4.2.8 Education Outreach

The U.S. CMS Program Office includes an education liaison function to promote the development of proposals for U.S. CMS educational and outreach activities for communicating the purpose of high-energy physics research in general, and the benefits of CMS, in particular, to the public at large. In support of these and other educational activities, the U.S. CMS Program Office provides funding for programmatic travel and for material and service supplies. The U.S. CMS Educational Outreach Coordinator is a member of the U.S. CMS Collaboration, that works with personnel from other laboratories and institutions to maximize the effectiveness of the overall educational outreach program. The DRPM serves as the point of contact between the RP and the U.S. CMS education/outreach.

5. PROGRAM REPORTING, COMMUNICATION AND REVIEW

5.1 U.S. CMS QUARTERLY REPORT

The objective of the reporting activity is to provide for the collection, integration and transmission of information needed for managing and monitoring the US CMS RP. For this purpose, the U.S. CMS RPM will produce a quarterly report on the status, progress and ongoing issues relevant to the U.S. CMS RP. The U.S. CMS RP Quarterly Report will typically contain a narrative describing technical progress of the U.S. CMS RP, including international issues. Financial information will be provided for the given quarter, and cumulative annual total to date. Management reserve will be reported in U.S. dollars. Milestone performance will be reported against the baseline dates. Documented change requests for the given quarter will also be included.

The U.S. CMS RP Quarterly Report is the primary form of written communication for use outside of U.S. CMS. The quarterly report is submitted by the U.S. CMS RPM to the U.S. LHC Program Office, the Fermilab Deputy Director, and to other appropriate DOE and NSF agency officials in Washington D.C..

5.2 PROGRAM COMMUNICATIONS AND REVIEW

The U.S. CMS RP requires the close collaboration between U.S. CMS, international CMS, CERN, the U.S. LHC Program Office, and Fermilab. To succeed, these parties must be in regular communication on current progress, plans, issues, problems, solutions, and achievements. To facilitate good communication and coordination within the CMS and U.S. CMS Collaborations, regularly scheduled meetings and reviews are conducted, several of which are described below.

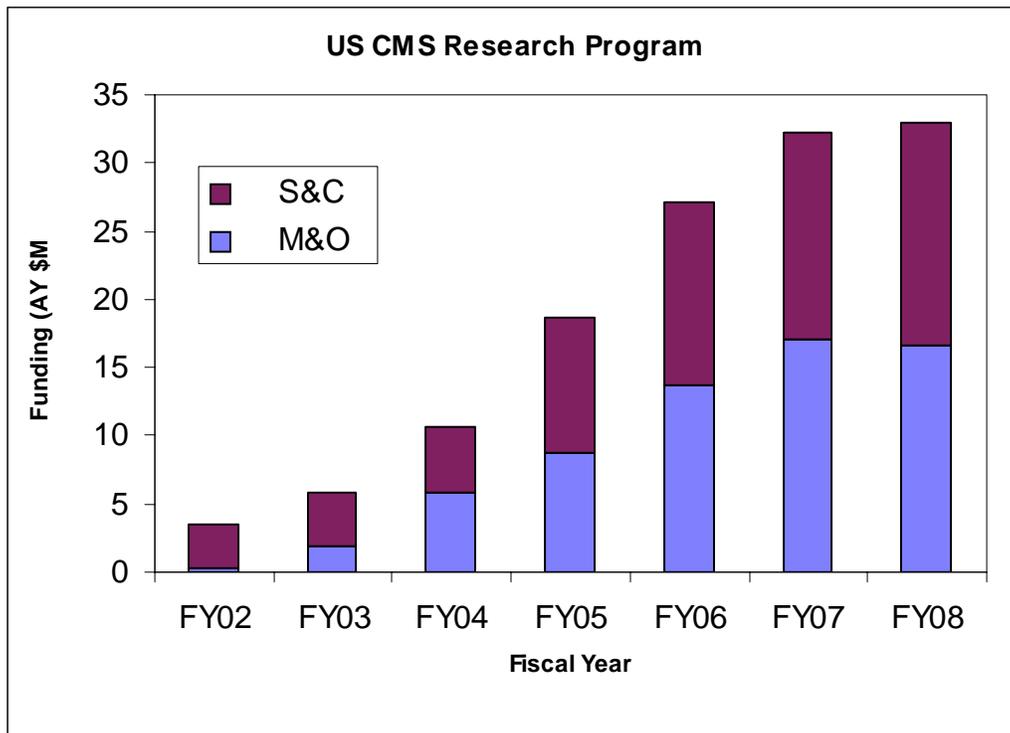
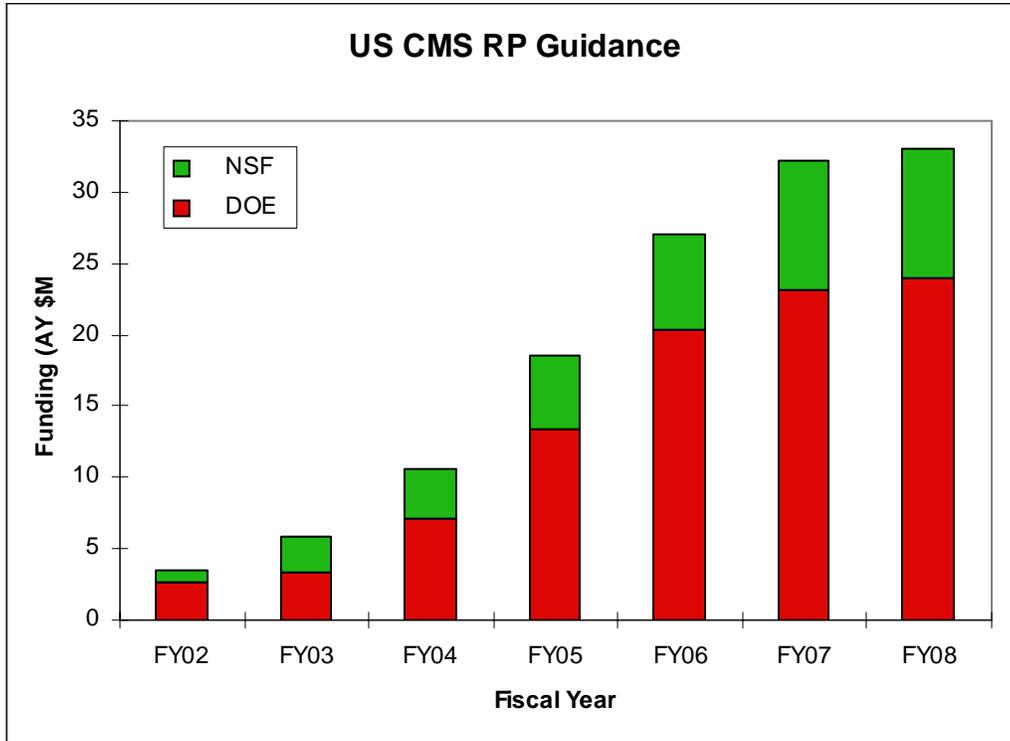
- a) CMS Collaboration Meeting (all CMS Collaborators). Quarterly meetings for members of the collaboration to meet and discuss progress on the overall CMS experiment, as well as work through issues of integration. This collaboration-wide quarterly meeting, also known as ‘CMS Week’, includes meetings of the CMS Collaboration Board, CMS Management Board, CMS Technical Board, CMS Finance Board, CMS Safety Working Group, and other technical and integration meetings at the subsystem level.

- b) CMS Technical Coordination Meeting (CMS Technical Coordination Group and CMS Collaborating Institutions). Monthly meetings between U.S. CMS managers and CMS Technical Coordination to discuss technical issues pertaining to the operation of the CMS detector.
- c) CMS Resource Review Board Meeting (CMS and ATLAS Management, U.S. CMS and U.S. ATLAS RPM, and DOE/NSF Representatives). Biannual meeting at CERN, representation for funding agencies, to review costs and schedules of the LHC RP.
- d) CMS Steering Committee Meeting (CMS Management and Level 2 Program Managers). Monthly meetings to supervise and review technical progress of the CMS detector and to formulate solutions to technical problems.
- e) Reviews by DOE/NSF (U.S. CMS Collaboration, and joint DOE/NSF Management). Annual agency review of the technical, cost, schedule, and scope aspects of the U.S. CMS RP, to address both M&O and S&C components with the assistance of technical and management experts external to the program.
- f) DOE/NSF Joint Oversight Group Meeting (U.S. CMS RPM, U.S. ATLAS RPM, JOG Committee) Bi-annual meeting to coordinate all three U.S. LHC Programs, as specified in the RPEP.
- g) DOE/NSF Core Program Support Meeting (U.S. CMS RPM/DRPM, and U.S. Collaboration Chair and Deputy Chair, U.S. LHC Program Office and DOE/NSF Core-Program Managers). Annual presentations by U.S. CMS management to the managers of the U.S. core program of the DOE and of the NSF, made by the U.S. CMS RPM and DRPM.
- h) U.S. CMS Program Management Group Meeting (Fermilab Management, U.S. CMS PO, DOE/NSF FAO Managers). Monthly meetings on the technical, cost, schedule and management reserve performance of U.S. CMS.
- i) Research Program Management Meeting (U.S. CMS RPM/DRPM and S&C and M&O PMs). Monthly meetings to coordinate the efforts of the U.S. CMS Collaboration at the highest level within the RP.

- j) U.S. CMS Program Office Meeting (Fermilab, the RU and CERN). Biweekly meeting to coordinate the efforts of the branches of the U.S. CMS RP Program Office.

APPENDIX 2: US CMS RESEARCH PROGRAM FUNDING GUIDANCE

as of December, 2004

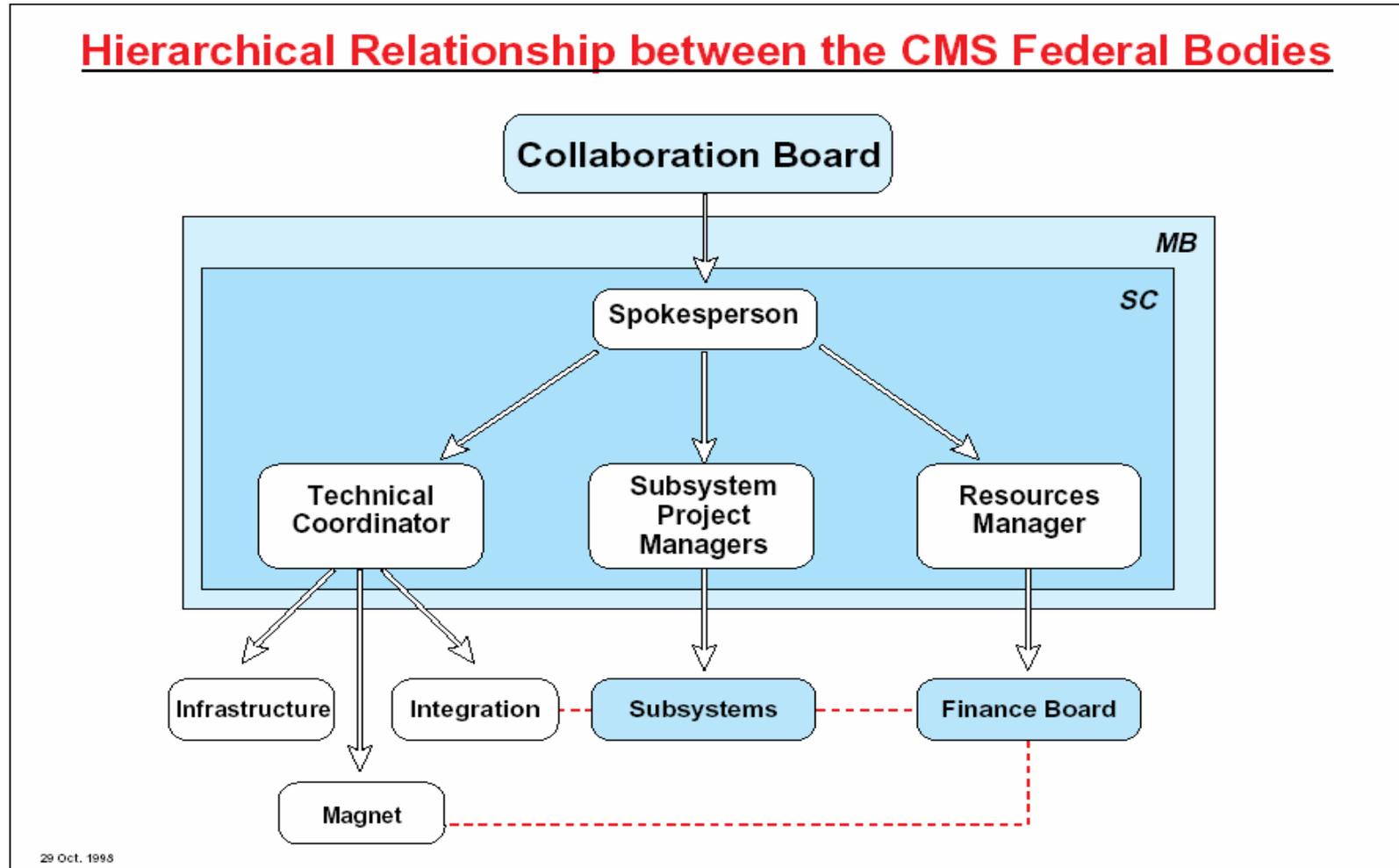


APPENDIX 3: U.S. CMS COLLABORATING INSTITUTIONS

Institution	Agency Support
Boston University	DOE
Brown University	DOE/NSF
University of California at Davis	DOE
University of California at Los Angeles	DOE/NSF
University of California at Riverside	DOE
University of California at San Diego	DOE/NSF
University of California at Santa Barbara	DOE
California Institute of Technology	DOE
Carnegie Mellon University	DOE
Fairfield University	DOE
Fermi National Accelerator Laboratory*	DOE
University of Florida	DOE
Florida Institute of Technology	DOE
Florida International University	NSF
Florida State University	DOE
University of Illinois at Chicago	NSF
University of Iowa	DOE
Iowa State University	DOE
Johns Hopkins University	NSF
University of Kansas	NSF
Kansas State University	DOE
Louisiana Tech University	DOE
University of Maryland	DOE
Massachusetts Institute of Technology	DOE
University of Minnesota	DOE
University of Mississippi	DOE
University of Nebraska	NSF
Northeastern University	NSF
Northwestern University	DOE
University of Notre Dame	NSF
Ohio State University	DOE
Princeton University	DOE
Purdue University	DOE
Rice University	DOE
University of Rochester	DOE
Rutgers University	NSF
University of Texas at Dallas	DOE
Texas Tech University	DOE
Virginia Technical Institute	NSF
University of Wisconsin at Madison	DOE
Yale University	DOE

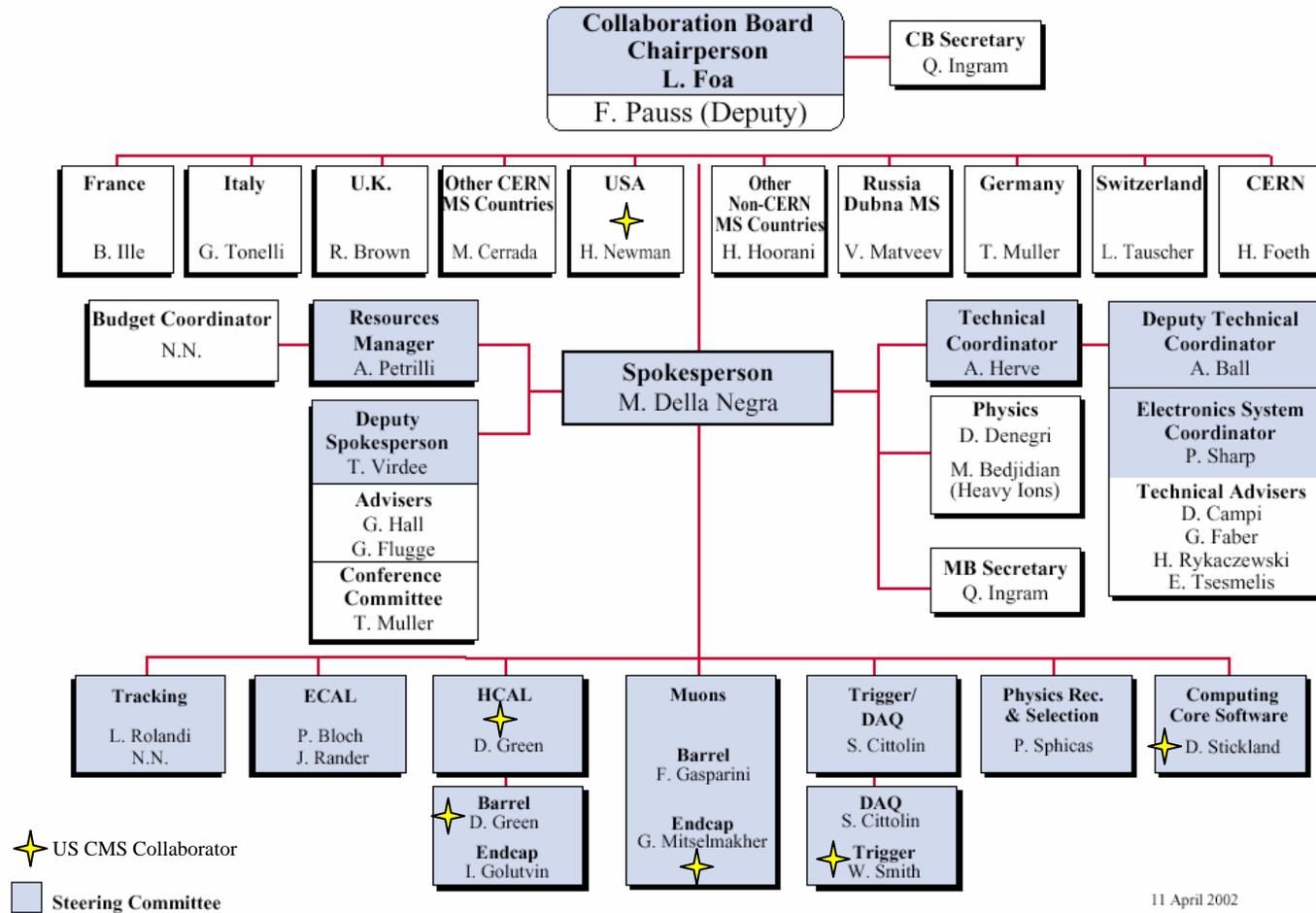
* Designated as Host Laboratory for the U.S. CMS Research Program

APPENDIX 4: CMS EXECUTIVE HIERARCHY



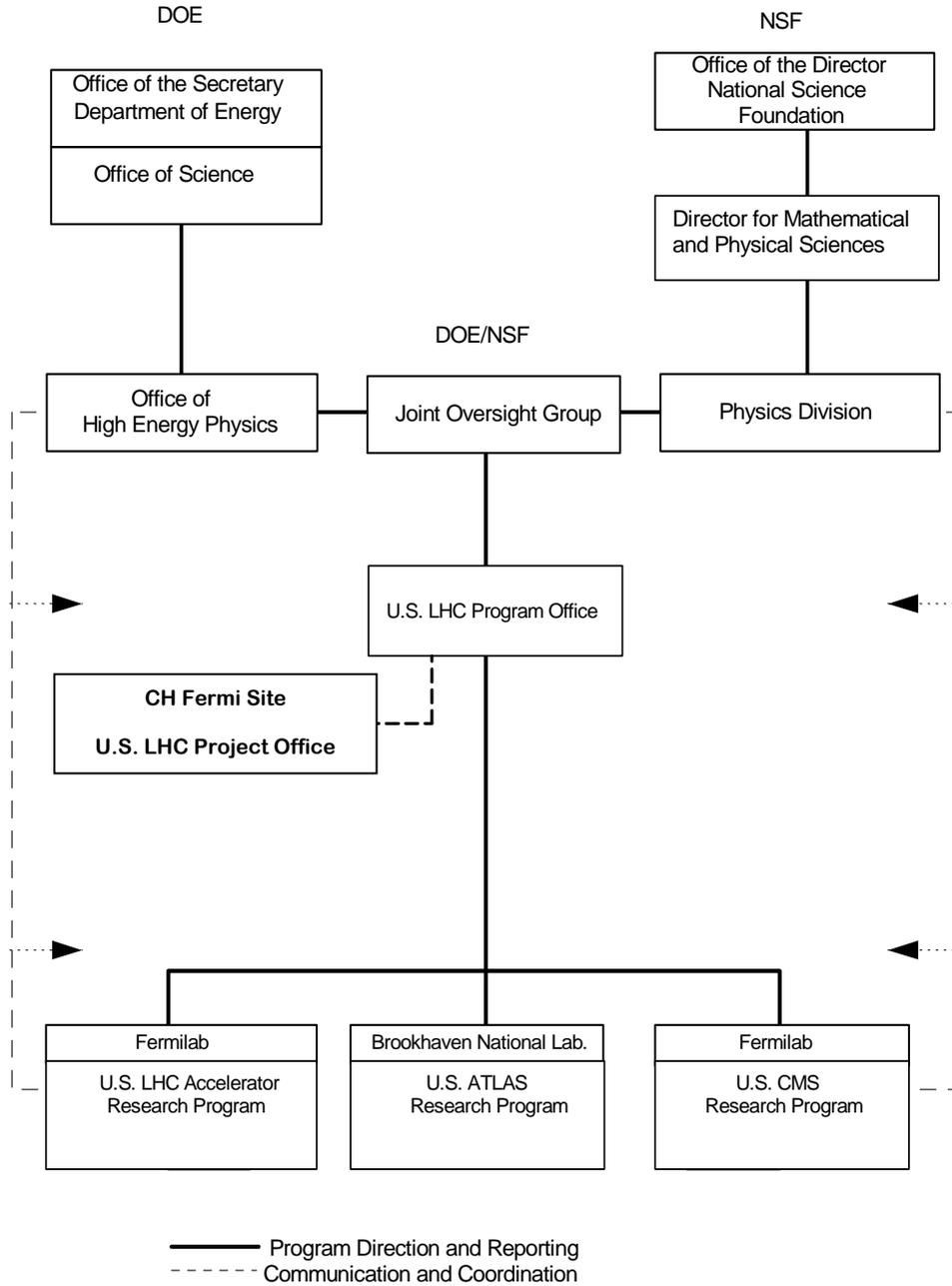
APPENDIX 5: CMS EXECUTIVE ORGANIZATION

CMS Management Board and Steering Committee

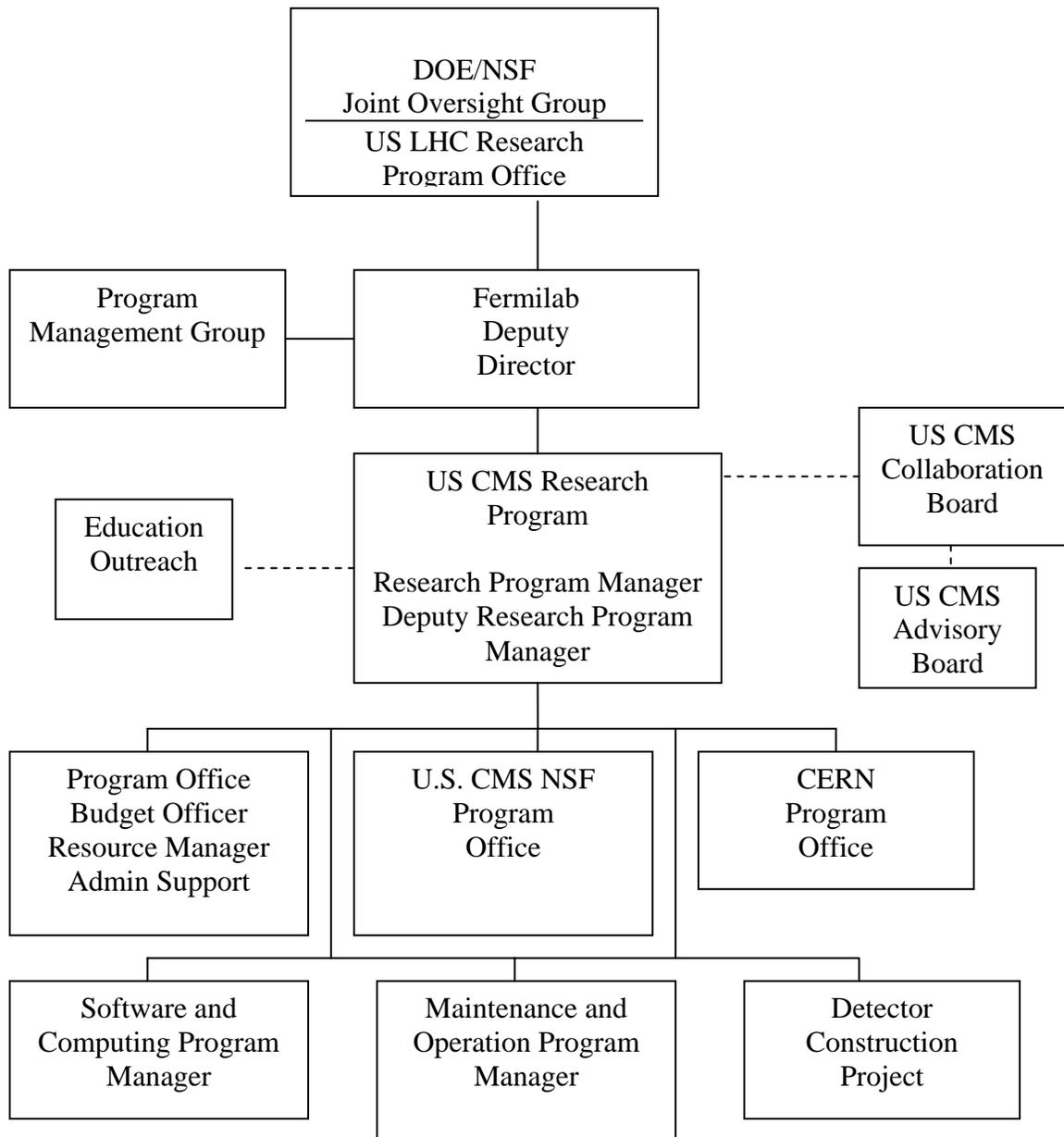


APPENDIX 6: DOE – NSF – U.S. CMS OVERSIGHT FUNCTION FOR RESEARCH PROGRAM

U.S. LHC Research Program Organization



APPENDIX 7: U.S. CMS RESEARCH PROGRAM OFFICE ORGANIZATION



APPENDIX 8: GLOSSARY

ATLAS (A Toroidal LHC Apparatus) – A general-purpose particle detector to be installed at Point 1 of the LHC ring. Distinctive features of ATLAS are a large volume, air-core toroidal magnet providing good momentum resolution and sign discrimination for muons and a fine-grained liquid argon electromagnetic calorimeter.

AY\$ (Actual Year Dollars). Dollars in the year spent. Allows the project to estimate out year expenditures while considering escalation estimates. The U.S. CMS project uses the inflation estimates for energy research projects as recommended by the DOE.

BA (Budget Authority). Cumulative funds currently allocated and authorized by the Department of Energy and the National Science Foundation that may be committed and spent by U.S. CMS institutions for project-related activities.

CERN (European Organization for Nuclear Research) – An intergovernmental organization established by Convention signed in Paris on 1 July 1953, revised on 17 January 1971. Also known as the European Organization of Particle Physics.

CERN Team Account – An accounts receivable service contract between a U.S. institution and CERN used to purchase goods and services at CERN.

CMS (Compact Muon Solenoid) – A general-purpose particle detector to be installed at Point 5 of the LHC ring. A distinctive feature of CMS is a high field solenoid surrounding a precision tracker providing high precision spatial information for decay vertices and particle tracking.

Host Laboratory – A designated DOE laboratory that has management oversight responsibilities for U.S. LHC Accelerator, U.S. ATLAS, or U.S. CMS activities.

JOG (DOE/NSF Joint Oversight Group) – The combined DOE/NSF operating group for the U.S. LHC Program. The Director of the DOE Division of High Energy Physics and the Director of the NSF Division of Physics serve as co-chairs of the JOG.

LHC (Large Hadron Collider) – A particle accelerator at CERN that will collide two counter-rotating beams of protons, each with energy of up to 7 trillion electron volts (TeV). The beams will collide at four intersection points at which appropriate particle detectors will be located. The accelerator will be fed by an existing cascade of lower-energy accelerators.

LHC Project – The activities by CERN to build the LHC accelerator and to contribute to the construction of, and to provide co-ordination and support for, the LHC experiments. (International Agreement, Article I, 1.5)

Management Reserve- The difference between planning commitments and budget authority, assessed for each fiscal year.

MOU (Memorandum of Understanding). A non-binding annual agreement between a U.S. CMS collaborating institution and the U.S. CMS Research Program that describes the amount of work, along with related costs and resources needed to achieve the work, which that institution is responsible for in any given fiscal year.

Project Complete – U.S. CMS Project Complete, scheduled for September 30, 2008, is broadly defined when all U.S. deliverables are installed with power, signal, and calibration cabling connected in their final location. Due to the international nature of CMS, the U.S. effort is inevitably coupled to its international partners, particularly during the installation phase of detector construction. The LHC schedule requires a two-phased closeout of the U.S. CMS Project, with the first phase (CD-4A) closing out ~97% of the U.S. CMS Project on September 30, 2005, and a second phase (CD-4B) to closeout the U.S. tasks that are directly tied to the LHC schedule on September 30, 2008.

RRB (Resource Review Board) – An oversight board, with representatives of the concerned funding agencies and the CERN management, for each of the LHC detectors, ATLAS, CMS, which reviews and allocates resources required for the project to proceed on cost and schedule. The Co-Chairs of the U.S. DOE/NSF JOG are ex-officio members of the RRB.

Upgrade – Improvement or optimization in the capability or function of a detector or accelerator component, subsystem or system intended to enhance its physics productivity.

U.S. LHC Construction Project – U.S. participation in the construction of the LHC accelerator and in the design and fabrication of the ATLAS and CMS detectors. Funding in the amount of \$450M has been provided in the DOE budget plan and \$81M in the NSF budget plan. Details of the U.S. "deliverables" are found in the respective Project Management Plans.

U.S. LHC Program – U.S. participation in construction of the LHC Accelerator and construction and operation at CERN of the ATLAS and CMS detectors. The U.S. LHC Program has two components, the U.S. LHC Construction Project and the U.S. LHC Research Program.

U.S. LHC Research Program – U.S. participation in the operation of the LHC detectors and in the physics investigations enabled by the detectors, following completion of the facility and commissioning of the detectors.

WBS (Work Breakdown Structure) – A method of hierarchically numbering tasks in a traditional outline numbering format. The WBS is used in US CMS to track all resources, schedules, and costs. A WBS# is one of the outline numbers that is used in the subproject for tracking.

APPENDIX 9: LIST OF ABBREVIATIONS

Item	Definition
APM-DD	Agency Project Manager-Fermilab Deputy Director
AY\$	Actual Year Dollars (Spent)
BA	Budget Authority
BCR	Baseline Change Request
BCWS	Budgeted Cost of Work Scheduled
CB	CMS Collaboration Board
CERN	European Organization for Nuclear Research
CH	DOE Chicago Operations Office
CMS	Compact Muon Solenoid
CO	Common Operations
CR	Change Request
DAQ	Data Acquisition
DOE	United States Department of Energy
DOE-SC	U.S. DOE Office of Science
DRPM	U.S. CMS Deputy Research Program Manager
ES&H	Environment Safety and Health
FB	CMS Finance Board
GLIMOS	Group Leader in Matters of Safety
FSO	U.S. DOE Fermi Site Office
Fermilab	Fermi National Accelerator Laboratory
FNAL	Fermi National Accelerator Laboratory
IB	U.S. CMS Collaboration Institutional Board
JOG	Joint Oversight Group
LHC	Large Hadron Collider
L2M	WBS Level 2 Manager
L3M	WBS Level 3 Manager
LHC	Large Hadron Collider
LHCC	CERN LHC Committee
M&O	Maintenance and Operations
MB	CMS Management Board
MCHF	Million Swiss Franc
MOU	Memorandum of Understanding
NSF	National Science Foundation
MPO	Memorandum Purchase Order
OER	DOE Office of Energy Research
OPM	Operations Program Manager
PEP	U.S. LHC Project Execution Plan
RPM	U.S. CMS Research Program Manager
PMG	Program Management Group
PMP	U.S. CMS Project Management Plan
PO	U.S. CMS Program Office
QA	Quality Assurance
R&D	Research and Development
RPEP	Research Program Execution Plan
RRB	CMS Resource Review Board
RU	Responsible University
SC	Steering Committee
SC/CMD	Office of Science/Construction Management Division
S&C	Software and Computing
SCPM	Software and Computing Program Manager
URA	Universities Research Association
WBS	Work Breakdown Structure