

Appendix 1.A

DOE/NSF MOU on U.S. Participation in the LHC Project at CERN



*U.S. Department of Energy
and the
National Science Foundation*



Memorandum of Understanding
between
the U.S. Department of Energy
and
the U.S. National Science Foundation
concerning
U.S. Participation in the Large Hadron Collider Program

December, 1999

**Memorandum of Understanding
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(This version supersedes the June, 1998 document.)

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1. Introduction

The European Organization for Nuclear Research, CERN, in collaboration with the U.S. and other non-Member States, has undertaken construction of a new high energy physics research facility, the Large Hadron Collider (LHC), at its laboratory site outside Geneva, Switzerland. This facility, scheduled for completion in 2005, will include the LHC accelerator and two very large, general purpose detectors, ATLAS (A Toroidal LHC ApparatuS) and CMS (Compact Muon Solenoid). The accelerator is designed to collide two counter rotating proton beams, at a center-of-mass collision energy of 14 TeV, the highest in the world. The products of the collisions will be detected and recorded by ATLAS and CMS, which are being built by large international collaborations of universities and laboratories, including many in the U.S. CERN has responsibility for the construction and operation of the LHC accelerator. In addition CERN is contributing to the construction of, and is providing coordination and administrative support for, the ATLAS and CMS detectors and their research programs.

U.S. participation in the construction of the LHC accelerator and in the design and fabrication of the ATLAS and CMS detectors is hereinafter referred to as the U.S. LHC Construction Project. U.S. participation in the operation of the detectors and in the scientific program following completion of the facility and commissioning of the detectors is hereinafter referred to as the U.S. LHC Research Program.

2. Purpose of the Memorandum of Understanding

It is the purpose of this DOE/NSF Memorandum of Understanding (MoU) to define the relationship between the two agencies relative to the LHC Program, which comprises the programmatic coordination of U.S. participation in LHC Activities. The U.S. participation includes both the U.S. LHC Construction Project and the U.S. LHC Research Program¹.

¹ See **Glossary** for definition of these terms.

3. The U.S.-CERN LHC Agreement and Protocols

DOE and NSF responsibilities for the U.S. involvement in the LHC Program are set forth in three documents. The International Co-operation Agreement Concerning Scientific and Technical Co-operation on Large Hadron Collider Activities of December 8, 1997, hereinafter called the International Agreement, defines the U.S. responsibilities common to all parts of the LHC Program. The Experiments Protocol Concerning Scientific and Technical Cooperation on the Large Hadron Collider ATLAS and CMS Detectors of December 19, 1997, hereinafter called the Experiments Protocol, describes DOE and NSF responsibilities for the detectors. Finally, only DOE has responsibilities for U.S. participation in the LHC accelerator construction, and these are set forth in the Accelerator Protocol of December 19, 1997, hereinafter called the Accelerator Protocol. Copies of these three documents are attached as appendices A, B, and C, respectively.

3.1 Responsibilities

In accordance with the Agreement, DOE is solely responsible for providing funding of \$200 million for goods and services for the LHC accelerator construction. In addition, DOE and NSF are responsible for providing funding of \$250 million and \$81 million, respectively, for goods and services toward the fabrication of the ATLAS and CMS detectors. The total funding for the U.S. LHC Construction Project is \$531M. The DOE contribution of \$450 million is budgeted from FY 1996 through FY 2004, and the NSF contribution of \$81 million is budgeted from FY 1999 through FY 2003.

In accordance with the Experiments Protocol, the sum of \$331 million that DOE and NSF are to provide during the ATLAS and CMS construction is to be divided approximately equally between the two detector projects, with each agency responsible for its own funding commitments. The responsibilities of DOE- and NSF-supported institutions to the ATLAS and CMS international collaborations for the construction of these detectors are specified in the MoU with CERN for each collaboration that is signed by the authorized representatives of the participating institutions.

Each MoU describes the organizational, managerial, and financial guidelines of the collaboration, including the tasks, costs, schedules, and other responsibilities of all participating institutions, both foreign and domestic.

In accordance with the Accelerator Protocol, DOE is solely responsible for providing an estimated \$110 million worth of goods and services for the LHC accelerator from DOE national laboratories. DOE is also to provide approximately \$90 million to be used for accelerator related procurements by CERN from U.S. industrial firms. These goods, services and procurements have been agreed upon by CERN and the DOE. An Implementing Arrangement between CERN and the participating DOE national laboratories sets forth the technical responsibilities of CERN and the DOE national laboratories to the LHC accelerator construction.

The U.S. LHC Research Program consists of those activities and functions required for the active participation of the U.S. scientific community in the physics research to be carried out with the ATLAS and CMS detectors, as foreseen by the International Agreement. Customary base program support of university groups is not included in the Research Program. The activities and functions included in the Research Program are preparation for operation of the detectors, development of the software required for data analysis, maintenance and operation of the detectors, analysis of the data, publication of the physics results from the experiments, and related activities. The U.S. LHC Research Program will require additional resources for the laboratories and universities, analogous to the pre-operational and operational phases of a new research facility. These resources are complementary to the funding provided in Article VIII of the International Agreement. The DOE and NSF will consult with the U.S. ATLAS and U.S. CMS Collaborations to develop a long-range funding profile and mechanisms for implementing the Research Program. Within the U.S. LHC Research Program, the DOE will have primary responsibility for funding new activities based in the national laboratories, notably the regional centers for computing located at the two Host Laboratories. Beyond their traditional program support of the activities at U.S. universities, DOE and NSF will be jointly responsible for funding

common projects such as CERN-based support activities, software development, and new University-based computing initiatives.

3.2 Relationships with CERN

In accordance with the International Agreement, the U.S. is represented in key management bodies at CERN. Specifically, the United States, through DOE and NSF, has observer status at the CERN Council, the governing body of CERN. Further, DOE and NSF are to participate in those closed sessions of the CERN Council, that is, the Committee of Council, where major LHC policy issues are discussed. These meetings are to be held at least once each year. NSF and DOE will consult periodically about U.S. representation.

A U.S.-CERN Co-operation Committee, established by the International Agreement, provides a mechanism for resolving bilateral issues between the DOE/NSF and CERN, with particular emphasis on matters related to areas of involvement of U.S. contractors and grantees.

Representatives from the U.S. and CERN co-chair the Committee, which meets at least once each year. The Associate Director, DOE Office of High Energy and Nuclear Physics, is the U.S. Chair of the committee. The Committee also includes a representative of the NSF.

The Experiments Protocol provides that DOE and NSF representatives are full members of the ATLAS and CMS Resource Review Boards, which oversee resource-related matters for the detectors.

The Accelerator Protocol provides for DOE representation on the LHC Board. This board coordinates work on the LHC accelerator by CERN and non-Member States.

4. Authorities

The DOE is acting pursuant to authorities conferred in the Department of Energy Organization Act, 42 U.S.C. §7101, et seq., (42 U.S.C. § 7151), the Atomic Energy Act of 1954, 42 U.S.C. §2011 et seq., including, but not limited to, 42 U.S.C. §2051.

The NSF is acting pursuant to the National Science Foundation Act of 1950 as amended, and 42 U.S.C. §1861 et seq.

These authorizations for the two agencies, together with the internal policies and procedures of each agency, define the authority of the two agencies to establish and manage their respective programs in high energy particle physics. The DOE and NSF have signed the International Agreement, the Experiments Protocol, and the Accelerator Protocol within this context.

The program offices charged with responsibility for the U.S. LHC Program are the Division of High Energy Physics within the DOE Office of Science and the Division of Physics within the NSF Directorate of Mathematical and Physical Sciences. The authorities that the two program divisions bring to the joint management of the U.S. LHC Program are exactly those which they have independently as program offices within their respective agencies. In exercising their authority for joint oversight, management, and coordination of U.S. LHC collaborative activities, the two divisions will act as a single entity. In the implementation of the resultant joint actions and decisions, each will follow the policies and procedures of their respective agencies, particularly in the matters of contracting or of establishing grants with U.S. institutions, and in the subsequent management and funding of those contracts and grants.

5. Joint Oversight

The DOE and NSF have agreed to establish a Joint Oversight Group (JOG) as the highest level of joint U.S. LHC Program management oversight. The JOG has the responsibility to see that the U.S. LHC Program is effectively managed and executed so as to meet the commitments made to CERN under the International Agreement and its Protocols. The JOG provides programmatic guidance and direction for the U.S. LHC Construction Project and the U.S. LHC Research Program and coordinates DOE and NSF policy and procedures with respect to both. The JOG approves and oversees implementation of the U.S. LHC Project Execution Plan (PEP) and the individual Project Management Plans (PMP) which are incorporated into the PEP. (See Section 6.)

The specific responsibilities of the JOG include:

- approval of the initial scope, cost and schedule baselines, and subsequent changes to the baselines at Level 1 of the Work Breakdown Structures (WBS) for U.S. LHC Projects;
- approval of the PEP and the attendant project management plans and any modifications

thereto;

- formal concurrence on the assignment of DOE and NSF employees to the positions of U.S. LHC Program Manager, Associate U.S. LHC Program Manager, and U.S. LHC Project Manager;
- formal concurrence on the assignments of designated university staff or DOE national laboratory staff as managers of U.S. LHC Projects;
- ensuring that technical, cost, schedule, and management reviews are conducted in a timely and effective manner;
- reviewing U.S. LHC detector and accelerator plans, budgets, and status reports;
- reviewing the DOE and NSF funding plans to assess their impact on the optimal execution of the objectives of the U.S. LHC Program;
- monitoring developments in the LHC Program and its related activities at CERN;
- reporting to senior NSF and DOE officials on major developments in, and external events affecting, the U.S. LHC Program; and
- identifying and forwarding issues to the U.S. Co-Chair of the Co-operation Committee and to other DOE and NSF officials as appropriate.

In addition to the joint oversight functions described above, the JOG shall identify and resolve those issues that cannot be resolved at lower levels of the management structure. Those issues that cannot be resolved at the JOG level will be referred to individuals within the NSF and DOE as are appropriate to the issue at hand. The JOG shall also perform such other activities as it deems appropriate and within its programmatic responsibilities.

The JOG is co-chaired by the Director of the DOE Division of High Energy Physics and the Director of the NSF Division of Physics. They report, respectively, to the Associate Director for High Energy and Nuclear Physics at the DOE and the Assistant Director for Mathematical and Physical Sciences at NSF. Either Co-Chair may delegate authority within the agency. In the event of such delegation, the other Co-Chair shall be formally notified in writing.

Membership in the JOG is by mutual agreement of the Co-Chairs and shall be limited to Federal employees and Intergovernmental Personnel Act (IPA) appointees. While meetings of the JOG may be limited to the Co-Chairs, they will typically include the U.S. LHC Program Manager, the Associate U.S. LHC Program Manager, the U.S. LHC Project Manager, appropriate staff from DOE's Office of High Energy and Nuclear Physics and NSF's Division of Physics, and appropriate university and laboratory leadership involved in the execution of the U.S. LHC Program.

The JOG will meet at least semi-annually. In the event that the JOG cannot meet, the duties of the JOG can be discharged by the mutual agreement of both Co-Chairs. Those agenda items for JOG meetings that require separate agency review will be identified approximately one month prior to the JOG meeting date.

6. U.S. LHC Program – Day-to-Day Management

Program management activities are considered to be those which would normally be carried out by NSF and DOE program divisions separately in preparing and defending budget requests within the agencies, to the Executive Branch, and before the Congress; in the allocation of funds within the government, to universities or to national laboratories; and in oversight of the activities funded. Through implementation of this MoU, the NSF and DOE agree to coordinate their LHC related programmatic activities.

The U.S. LHC Construction Project consists of those day-to-day activities specifically required for the U.S. participating universities and national laboratories to execute the construction and delivery of the scientific and technical components ("deliverables") agreed to by the DOE, NSF, and CERN (See Protocols in Appendices B and C.). The U.S. LHC Research Program consists of those activities related to active participation in the operation of the detectors and subsequent

analysis and publication of the physics results from the experiments. Collectively, the U.S. LHC Construction Project and the U.S. LHC Research Program constitute the U.S. LHC Program. The NSF and DOE have chosen to treat these activities as a single overall program, subject to the normal review and oversight procedures of each agency for its respective components.

6.1 Management Structure

The lines of authority and responsibilities for the management of the U.S. LHC Projects are described in the U.S. LHC Project Execution Plan (PEP). The PEP covers the management structure from the JOG through all subsidiary programs and projects within U.S. LHC Accelerator, U.S. ATLAS, and U.S. CMS. The management of all projects within the U.S. LHC Construction Project and Research Program are described by appropriate Project Management Plans (PMP), which are incorporated as appendices to the PEP.

6.2 Program/Project Offices and Staffing

The U.S. LHC Program Office and the U.S. LHC Project Office are established to carry out the management functions set forth in the PEP. These offices are staffed by Federal employees or IPA appointees assigned by the DOE and NSF. As the DOE has been designated lead agency for the U.S. LHC Program, the U.S. LHC Program Manager and U.S. LHC Project Manager, who respectively head the program and project offices, will generally be DOE employees. The Associate U.S. LHC Program Manager will generally be an NSF employee.

The U.S. LHC Program Office has the overall responsibility for day-to-day program management of the U.S. LHC Program as described in the PEP. In this capacity, it reports directly to the JOG and acts as its executive arm. The office is jointly responsible with the U.S. LHC Project Office for preparation and maintenance of the PEP, and interfaces with the DOE Division of High Energy Physics and the NSF Division of Physics, which are the respective agency offices charged with responsibility to oversee the U.S. LHC Program. The Program Manager and Associate Program Manager are responsible for the coordination between the agencies of the joint oversight activities described in this MoU and the PEP. In particular, the Program Office will arrange for appropriate agency clearances of the PEP, PMPs, and other documents as may be required, as well as the accomplishment of project reviews as charged by

the JOG or as deemed necessary for effective program management. These reviews will be held at least annually.

The U.S. LHC Project Office is responsible for day-to-day oversight of the U.S. LHC Projects as described in the PEP. In this capacity, the U.S. LHC Project Manager reports to the U.S. LHC Program Manager, and routinely interfaces with the Project Managers for each of the U.S. LHC Projects. These managers represent the contractors and grantees to DOE and NSF. These contractors and grantees have direct responsibility to design, fabricate, and provide to CERN the goods and services agreed in the International Agreement and Protocols, and to fulfill the U.S. commitments in the LHC Research Program. The Project Office is responsible, in collaboration with the individual project managers, for preparing and maintaining the PMPs for each of the U.S. LHC Projects.

7. DOE-NSF Coordination

There are programmatic activities normally carried out independently by the NSF and DOE program offices that will be coordinated by the U.S. LHC Program Office so as to more effectively represent the U.S. LHC Program. They include:

- interactions with Congress in response to official inquiries, testimony, or discussion;
- initiatives in education of direct relevance to the U.S. participation on the LHC;
- public outreach activities focussed on U.S. participation in the LHC; and
- release of public information.

8. Approval, Amendments, and Terminations

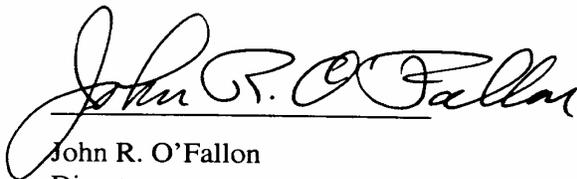
This MoU is effective upon signature by both the Director, Office of Science, U.S. DOE, and the Assistant Director for Mathematical and Physical Sciences, NSF. It supersedes the MoU of June, 1998, and remains in effect for the term specified in the International Agreement.

This MoU may be amended by written agreement between DOE and NSF.

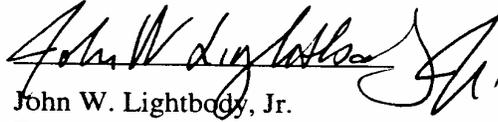
Either the DOE or the NSF may terminate this MoU by at least a ninety (90) day advanced written notice to the other, or by the agreement in writing of both parties.

Original signed 15th day of June 1998

Executed this 13th day of December, 1999

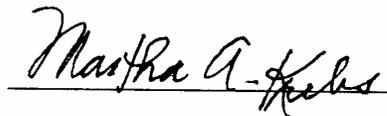


John R. O'Fallon
Director
Division of High Energy Physics
U.S. Department of Energy

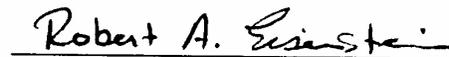


John W. Lightbody, Jr.
Executive Officer
Division of Physics
U.S. National Science Foundation

Approved:



Martha A. Krebs
Director
Office of Science
U.S. Department of Energy



Robert A. Eisenstein
Assistant Director for
Mathematical and Physical Sciences
U.S. National Science Foundation

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.

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 for Particle Physics.

CERN Council - The governing body of CERN, made up of representatives of all Member States.

CERN-U.S. Co-operation Committee- A committee established by the International Co-operation Agreement of December 1997 between CERN and the DOE and NSF concerning Scientific and Technical Co-operation on Large Hadron Collider Activities. The charge to the Committee is to monitor and facilitate activities undertaken under the agreement, with particular emphasis on matters relating to areas of involvement of U.S. contractors and grantees. The CERN Co-Chair is the CERN Director General. The U.S. Co-Chair is the Associate Director for High Energy and Nuclear Physics of the Office of Science in the DOE. The NSF is represented on the Committee by the Assistant Director for Mathematical and Physical Sciences.

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 an energy of up to 7 trillion electron volts. 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 Activities - The LHC project, the exploitation of the LHC accelerator and the LHC experiments and supporting research and development, and other LHC-related activities. International Agreement, Article I, 1.6)

LHC Program - The program for carrying out LHC Activities.

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)

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.

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 Operations and Maintenance Project - U.S. participation in the acquisition of data during LHC operations and maintenance of the LHC detectors following commissioning. The Project is an element of the U.S. LHC Research Program. It has two components, U.S. ATLAS and U.S. CMS.

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 Projects - The U.S. LHC Construction Project and the U.S. LHC Research Program are comprised by a number of well-defined sub-projects, e.g., U.S. LHC Accelerator, is under the U.S. LHC Construction Project. The collection of these sub-projects is referred to collectively as U.S. LHC Projects.

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.

U.S. LHC Software and Computing Project - Development and operation of the computing and networking facilities and development of the software required for effective U.S. participation in the LHC Research Program. The Project is an element of the U.S. LHC Research Program. It has two components, U.S. ATLAS and U.S. CMS.

Appendices

Appendix A: The International Cooperation Agreement

Appendix B: The Accelerator Protocol

Appendix C: The Detector Protocol

Appendix A

International Co-operation Agreement

of

December 8, 1997

INTERNATIONAL CO-OPERATION AGREEMENT

between

**THE EUROPEAN ORGANIZATION FOR NUCLEAR
RESEARCH (CERN)**

and

**THE DEPARTMENT OF ENERGY
OF THE UNITED STATES OF AMERICA**

and

**THE NATIONAL SCIENCE FOUNDATION
OF THE UNITED STATES OF AMERICA**

concerning

**SCIENTIFIC AND TECHNICAL CO-OPERATION
ON LARGE HADRON COLLIDER ACTIVITIES**

1997

The European Organization for Nuclear Research, hereinafter referred to as "CERN", represented by the President of Council, and the Director-General,

on the one hand,

and

the United States Department of Energy (DOE) and the United States National Science Foundation (NSF),

on the other hand,

CONSIDERING

that on 16 December 1994, the CERN Council approved the Large Hadron Collider (LHC) Project as described in Annex I, and also provided for the possibility for non-Member States to participate in it (CERN/2075);

that CERN has confirmed the overriding priority and the vital importance of the LHC for the long-term future of the laboratory;

that international collaboration provides an effective way for the optimal utilization of resources for and by CERN, DOE and NSF;

that progress in high-energy physics contributes to advances in other sciences and the results of high-energy physics research are available to all fields of science;

that, in common with the major particle physics laboratories in the United States and in other regions, CERN follows the open access policy specified in the "International Committee for Future Accelerator Guidelines on the Interregional Utilization of High Energy Physics Accelerator Facilities" adopted in 1980;

that future large accelerators and other scientific facilities are expected to be constructed, operated and supported multinationally and may be located in any participating nation;

that the U.S. contribution to the construction of the LHC represents an important step forward in international scientific collaboration, and in the expectation that the U.S. example in high energy physics accelerator construction will be followed by inter-regional contributions to future important scientific construction projects of mutual interest to the U.S. and CERN Member States;

DESIRING TO

advance the understanding of the nature of matter and energy through the LHC Experiments;

maintain the research momentum in the field of high-energy physics established over the past decades;

HAVING REGARD TO

the substantial scientific progress that has been made over the past decades through physics research facilities in Europe and the United States;

the long history and close relationship existing between the European and U.S. High-Energy Physics communities and their wish to promote and strengthen the spirit of inter-regional and global co-operation in this field;

the strong interest expressed by U.S. physicists in the LHC project and in the construction of some parts of this project, as well as the large number of U.S. institutions engaged in the experiments to be performed at the LHC accelerator; the mutual benefit which CERN, DOE and NSF will derive from U.S. participation in this unique project, and in particular from shortening the duration of the LHC accelerator construction to which U.S. participation will contribute;

the fact that experiments with the LHC accelerator will be performed by international collaborations acting on the basis of Memoranda of Understanding;

ALSO CONSIDERING

that CERN is an Intergovernmental Organization established by the Convention signed in Paris on 1 July 1953, revised on 17 January 1971;

that accordingly, the Organization enjoys international status in its Host State Switzerland, in accordance with the Agreement signed on 11 June 1955 by CERN and the Swiss Confederation, as well as in its Host State France, in accordance with the Agreement signed on 13 September 1965 by CERN and the French Republic, and revised on 16 June 1972;

HAVE AGREED AS FOLLOWS:

Article I Definitions

The following definitions pertain to this Agreement.

- 1.1 Parties to the Agreement. CERN on the one side; DOE and NSF, the U.S. funding agencies, on the other side, together "the U.S. Party".
- 1.2 The LHC accelerator. A collider with two counter-rotating proton beams, each with an energy of up to 7 trillion electron volts, which collide at four intersection points and is fed by an existing chain of proton synchrotrons.
- 1.3 The LHC experiments. The two large experiments ATLAS (A Toroidal LHC ApparatuS) and CMS (Compact Muon Solenoid) that are being built by the ATLAS and CMS international Collaborations.
- 1.4 Collaborations. International groups responsible for building each detector. They include CERN personnel, teams from institutions in CERN Member States and other non-Member States as well as contractors and grantees of DOE and NSF.

- 1.5 The 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.
- 1.6 LHC activities. The LHC project, the exploitation of the LHC accelerator, the LHC experiments and supporting research and development, and other LHC-related activities.
- 1.7 LHC Board. A co-ordinating body to be established by the Director-General of CERN, which will bring together representatives of organizations outside CERN that are involved in the construction of the LHC accelerator, and CERN staff, in order to exchange information and monitor work progress.
- 1.8 The CERN Council. The governing body of CERN made up of representatives of all Member States.
- 1.9 Observer in Council. A special non-voting status for States which are not members of CERN, which is unilaterally granted by CERN's Council to an individual State, allowing its accredited representatives to attend open Council sessions.
- 1.10 Committee of Council. A subsidiary consultative body of the CERN Council which, in collaboration with the Management of the Laboratory, prepares the meetings and decisions of the Council and monitors the policies of CERN.
- 1.11 U.S. participants. DOE and NSF, and their contractors and grantees participating in activities under this Agreement.
- 1.12 CERN personnel. As defined in CERN's Staff Rules and Regulations.
- 1.13 Memoranda of Understanding (MOU). Agreements or arrangements between institutions participating in the LHC experiments and CERN, describing the responsibilities of all participants in these experiments. (The primary responsibilities and funding obligations of DOE and NSF are set forth in this Agreement and in Protocols to this Agreement.)
- 1.14 Implementing Arrangements. Agreements or arrangements between CERN and U.S. institutions participating in the LHC accelerator, setting forth the responsibilities of the participants.

Article II Purpose

The purpose of this Agreement is to provide the Parties with a framework for scientific and technical co-operation relating to LHC activities, to help bring the LHC accelerator and the LHC experiments (detectors) into being as early as possible, and to utilize them in advancing the understanding of matter at the high energy frontier.

Article III Scope of the Co-operation

The co-operation shall include the following fields of activity:

- 3.1 construction and commissioning of the LHC accelerator; and
- 3.2 construction and participation in the LHC ATLAS and CMS experiments.

Article IV Forms of Co-operation

- 4.1 The co-operation shall take the following forms:
 - a) research and development related to accelerators and detectors;
 - b) procurement of specialized materials, equipment or software;
 - c) design and fabrication of equipment and components for use in the LHC activities;
 - d) visits by scientists, engineers and other experts to participate in assembly and commissioning activities, and to conduct research and development;
 - e) exchange of scientific and technical information, and personnel;
 - f) seminars and other meetings; and
 - g) exchanges and loans of equipment, instruments and materials.
- 4.2 The co-operation shall extend to such other forms as mutually agreed.

Article V Implementation

Co-operation under this Agreement shall be implemented pursuant to this Agreement and two Protocols which shall form an integral part of this Agreement. The Protocols to be concluded are the following:

- 5.1 An Accelerator Protocol concerning the participation of DOE and its contractors in the construction of the LHC accelerator, which will be signed by CERN and DOE.
- 5.2 An Experiments Protocol concerning the involvement of U.S. participants in the LHC experiments, which will be signed by CERN on one side and by DOE and NSF on the other side.

Article VI Involvement of U.S. Participants

Under conditions to be defined in the Protocols referred to in Article V above, the U.S. participants shall enjoy the following rights in connection with their involvement in the LHC project:

- 6.1 CERN shall supply U.S. participants with the information necessary to allow and facilitate their involvement in the co-operation.
- 6.2 U.S. scientific institutions shall have the right to participate in the LHC experiments, at the level reflected in the Experiments Protocol and in the Memoranda of Understanding that cover or will cover the ATLAS and CMS Collaborations, under conditions described in the CERN document "General Conditions for Experiments Performed at CERN", dated 25 April 1989, and such other documents, in effect at the time of

the conclusion of this Agreement, that pertain to CERN's relationship to the ATLAS and CMS Collaborations.

Article VII
Involvement of U.S. Party

- 7.1 The United States, represented by the U.S. Party, shall become an Observer at the CERN Council. As an Observer to the Council, the U.S. Party will receive the same information as Delegates to the CERN Council concerning progress of the LHC project, including regular reports from the Science Policy Committee, and reports from the Director General based on recommendations from the Machine Advisory Committee and the LHC Committee. This will allow the U.S. Party to closely monitor the progress of the LHC activities and participate in all major decisions which will impact the U.S. contributions.
- 7.2 The U.S. Party shall also be invited to discuss with the CERN Committee of Council once a year and whenever major LHC policy issues are under discussion.
- 7.3 Should any condition arise which calls into question the attainment of the design specifications of the LHC as listed in Annex I, CERN will promptly notify the U.S. Party and will invite the U.S. Party to discuss the situation with the CERN Committee of Council at the earliest opportunity. A meeting of the U.S.-CERN Co-operation Committee, which will be established in accordance with Article XV, will also be called to discuss the situation if requested by either Party.
- 7.4 The U.S. Party shall be a full member of the ATLAS and CMS Resource Review Boards.
- 7.5 DOE shall be invited to appoint a member of the LHC Board when that body is created.

Article VIII
U.S. Financial Participation

Subject to the availability of appropriated funds, the financial contributions of the U.S. Party to the LHC activities over a period of approximately ten years will consist of:

- 8.1 goods and services in an amount budgeted at and not to exceed \$200 million (which includes contingency) from DOE for the LHC accelerator construction as described in the Accelerator Protocol, it being understood that any increase in funding requirements for the LHC accelerator shall be the responsibility of CERN; and
- 8.2 goods and services budgeted at and not to exceed \$250 million (which includes contingency) from DOE, and goods and services budgeted at and not to exceed the National Science Board authorized amount of \$81 million (which includes contingency) from NSF, for the LHC experiments as described in the Experiments Protocol.

**Article IX
Personnel**

- 9.1 CERN and the U.S. participants shall each be responsible for their own personnel, in particular as far as salaries, allowances, social insurance coverage and travel costs are concerned.
- 9.2 CERN, on the territory of its Host States, and the U.S. participants, on the territory of the United States, shall assist each other in dealing with personnel issues as appropriate when necessary for the implementation of this Agreement.
- 9.3 The Parties shall use their best efforts to ensure that their personnel, including personnel of the U.S. participants, when working under this Agreement, shall conform to the rules for conduct and safety in force in the institution where the work is performed, and shall be placed under the institution's authority in this respect.

**Article X
Equipment**

- 10.1 The U.S. participants shall remain the owners of the equipment which they supply under the Agreement and the Protocols thereto, unless the ownership thereof has been transferred to CERN.
- 10.2 The U.S. Party shall use its best efforts to ensure that all equipment which the U.S. participants agree to supply shall conform to the safety standards in force at CERN at the time of delivery to CERN.
- 10.3 The LHC accelerator materials and equipment, supplied to CERN under the Agreement, shall remain at CERN's disposal until the full completion of all experiments at the LHC, unless otherwise agreed by the Parties.
- 10.4 The delivery of LHC accelerator materials and equipment to CERN shall be carried out in accordance with a procedure to be agreed between the Parties. After the completion and commissioning of the LHC accelerator, CERN shall be responsible for its operation and maintenance.
- 10.5 Operations and maintenance responsibilities for the equipment and components delivered for the detectors will be defined in MOUs.

**Article XI
Principle of Free Circulation**

Each Party shall use its best efforts to facilitate, in accordance with applicable laws and regulations, the movement of persons, the importation and exportation of materials, equipment and other goods and the transfer of currencies which may be necessary for the implementation of this Agreement.

Article XII
Liability for Damages

In the event that damages are incurred in the course of, or arising out of, the execution of this Agreement and its Protocols, the Parties shall consult on appropriate methods of settlement.

Article XIII
Intellectual Property

The Parties shall notify each other, in a timely fashion, of any inventions or copyright works resulting from this Agreement. Rights to such intellectual property shall be granted in accordance with the following guidelines.

- 13.1 For intellectual property created during research activities designated by the Parties as joint research, DOE and NSF shall be entitled to obtain all rights and interests in the territory of the United States and CERN shall be entitled to obtain rights and interests in the territories of the CERN Member States. Rights and interests in other countries will be determined by mutual agreement. In determining rights and interests in other countries, the Parties shall consider the relative contributions of the Parties, the benefits of exclusive or non-exclusive licensing by territory or for field of use, requirements imposed by the Parties' domestic laws and other factors deemed appropriate. A Party wishing to take out patents or otherwise protect inventions, developments, expertise or software resulting from the joint research, shall first consult with the other Party in order to agree on the legislation applying to the use and exploitation of such intellectual property.
- 13.2 If research is not specifically designated as joint research, rights to intellectual property arising from the research will be granted in accordance with the policies of the institute conducting the research.
- 13.3 Each Party shall assure that the other Party is granted a non-exclusive, irrevocable, royalty-free license for the use of such intellectual property arising under this Agreement.

Article XIV
Fiscal and Customs Exemptions

Each Party shall make its best efforts to exempt or limit from taxation and customs duties the equipment referred to in Article X above.

Article XV
Co-operation Committee

- 15.1 In order to monitor and facilitate the activities undertaken within the framework of this Agreement, a U.S.-CERN Co-operation Committee, hereinafter referred to as "the Committee", shall be established.
- 15.2 The Committee shall consist of representatives appointed by each Party. Two co-chairmen shall also be selected, one by CERN and one by the U.S. Party.

- 15.3 The Co-operation Committee shall meet annually, or more frequently as deemed appropriate, and shall monitor the LHC activities, with particular emphasis on matters related to areas of involvement of U.S. contractors and grantees.

**Article XVI
Amendments**

The Parties may amend this Agreement by written consent.

**Article XVII
Governing Law**

This Agreement shall be governed by international law.

**Article XVIII
Disputes**

- 18.1 The Parties shall consult with each other on any dispute arising out of the interpretation or implementation of this Agreement and its Protocols. The Parties shall use their best efforts to settle disputes promptly through consultation.
- 18.2 If any issue not settled through such consultations still needs to be resolved, the Parties may, if both agree, submit the issue to a mutually acceptable form of dispute resolution such as conciliation or mediation. If agreed by the Parties, this could include submission to an international arbitration tribunal, if appropriate.

**Article XIX
Duration**

- 19.1 This Agreement shall enter into force upon signature by the Parties. It shall remain in force for a period of twenty (20) years and thereafter be automatically renewed for a one year period on each anniversary date of the Agreement unless terminated pursuant to section 19.2 below.
- 19.2 Either Party may terminate this Agreement, its Protocols and any related document at any time, subject to one year's written notice of termination and to a consultation between the Parties with a view to reaching an equitable settlement for both Parties.

Done in Washington, on December 8, 1997, in duplicate copies, in the English and French languages, both versions being equally authentic.

FOR THE EUROPEAN
ORGANIZATION FOR NUCLEAR
RESEARCH (CERN):



Luciano Maiani
President of the CERN Council

FOR THE DEPARTMENT OF
ENERGY OF THE UNITED STATES
OF AMERICA:

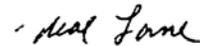


Federico Peña
Secretary of Energy

FOR THE NATIONAL SCIENCE
FOUNDATION OF THE UNITED
STATES OF AMERICA:



Christopher H. Llewellyn Smith
Director-General of CERN



Neal Lane
Director, National Science
Foundation

ANNEX I

THE LARGE HADRON COLLIDER

CERN - the European Laboratory for Particle Physics - is one of the world's leading scientific research laboratories. An early European joint venture, CERN was founded in 1954 by the Conseil Européen pour la Recherche Nucléaire (whence the acronym) and straddles the French-Swiss border west of the city of Geneva. CERN's nineteen member States - Austria, Belgium, the Czech Republic, Denmark, Hungary, Germany, France, Finland, Greece, Italy, the Netherlands, Norway, Poland, Portugal, Slovakia, Spain, Sweden, Switzerland, the United Kingdom - provide the budget (937.6 million Swiss francs in 1996) in proportion to their national revenues.

CERN's business is pure research - studying Nature's tiniest building blocks, the fundamental particles, to find out how our world and the Universe work. The energy densities reached in head-on collisions of particles accelerated in CERN's machines approach those which may have prevailed immediately after the 'Big Bang', and are sufficient to create the elementary particles which populated the early universe. Detectors, built around the collision points, record the brief existence of these particles, re-enacting moments in the evolution of the early universe.

As early as 1977, during preparatory discussions for building the Large Electron Positron collider (LEP) at the European Laboratory for Particle Physics (CERN), it was clear that excavating the LEP tunnel would make more economic sense if it could be reused for a successor machine. Thus, while LEP was being designed and built in the early '80s, groups at CERN were busy looking at the longer term future. After many years of work on the technical aspects and physics requirements of such a machine, their dreams came to fruition in December 1994 when CERN's governing body, the CERN Council, voted to approve the construction of the Large Hadron Collider (LHC).

The LHC will be built from high powered superconducting magnets each 15 meters long. These magnets will hold counter-rotating beams of protons on a steady course around the ring as superconducting accelerating cavities "kick" them almost to the speed of light at energies up to the design energy specification of 7 TeV¹ per beam, and the design luminosity² specification of 10³⁴ cm⁻²-sec⁻¹, both higher than have ever before been reached in such accelerators. When these proton beams collide, at fixed crossing points, their combined energy of motion of 14 TeV will produce an intense micro-fireball which will shoot out hundreds of new particles. These flashes of energy will probe the interactions between the tiny quark constituents hidden deep inside the colliding protons and reveal how nature works at the most fundamental levels.

Since the mid-1980s the number of scientists from all over the world using CERN's facilities has increased enormously. Currently more than 6500 users, over half of the planet's experimental high-energy physicists, carry out fundamental research at CERN. This user community, coming from all parts of the world, is living proof that CERN welcomes inter-regional collaboration which benefits all and boosts the progress of science. The LHC, the only machine capable of addressing problems way beyond today's frontiers of high energy physics, offers a unique opportunity for extending world wide

¹ A TeV, or tera electron volt, is a unit of energy used by particle physicists.

² Luminosity is a measure of the collision rate in the colliding beams in units of cm⁻²-sec⁻¹. At 7 TeV and at a luminosity of 10³⁴, the interaction rate will be the order of one billion (10⁹) collisions per second.

collaboration. The door is open for non-Member States to become partners in the final design, construction, and exploitation of the LHC machine and its experiments. Such a 'globalization' of the LHC project would establish a precedent for future megascience projects, not only in particle physics but also in other fields. The foundation of CERN in the post-war years set a precedent in uniting the nations of Europe to carry out high quality research. The LHC now offers the exciting opportunity of establishing a model for future world-wide collaboration in 'Big Science'.

Appendix B

Experiments Protocol

of

December 19, 1997

**INTERNATIONAL CO-OPERATION AGREEMENT
CONCERNING
SCIENTIFIC AND TECHNICAL CO-OPERATION
ON LARGE HADRON COLLIDER ACTIVITIES**

EXPERIMENTS PROTOCOL

between

**THE EUROPEAN ORGANIZATION FOR NUCLEAR RESEARCH
(CERN)**

and

**THE DEPARTMENT OF ENERGY
OF THE UNITED STATES OF AMERICA**

and

**THE NATIONAL SCIENCE FOUNDATION
OF THE UNITED STATES OF AMERICA**

concerning

**SCIENTIFIC AND TECHNICAL CO-OPERATION
ON THE LARGE HADRON COLLIDER
ATLAS AND CMS DETECTORS**

1997

The European Organization for Nuclear Research, hereinafter referred to as "CERN" and represented by its Director-General,

and on the one hand,

the United States Department of Energy (DOE), and the United States National Science Foundation (NSF), hereinafter referred together as the "U.S. Party"

on the other hand,

CONSIDERING

that a key component of the scientific and technical co-operation between CERN and the U.S. Party on the Large Hadron Collider (LHC) program is the participation of scientists from U.S. universities and national laboratories in the design, fabrication and operation of the two major detector facilities, ATLAS and CMS, each of which is to be built and exploited by a large international collaboration of scientists from both CERN Member States and Non-Member States;

that the participation of U.S. groups of scientists in the LHC experiments is to benefit the U.S. High Energy Physics program by giving U.S. scientists unique opportunities to work at the "energy frontier" of elementary particle physics, and by involving U.S. scientists in the construction of technologically advanced detectors;

that at the same time the participation of U.S. scientists benefits the CERN program by providing intellectual and financial resources that allow substantial improvement in the capabilities of the detectors, and therefore a greatly enhanced research program;

that this Protocol is pursuant to the International Co-operation Agreement Concerning Scientific and Technical Co-operation on Large Hadron Collider Activities of December 8, 1997, which provides, in its Article V "Implementation", for involvement of U.S. participants in the LHC experiments under an Experiments Protocol;

that groups of scientists from various institutions from CERN Member and Non-Member States have come together, with the approval of their Governments, to form the CMS detector Collaboration and the ATLAS detector Collaboration, and that each detector Collaboration prescribes its own rules and regulations for the management of the Collaboration; and

that CERN provides oversight to each Collaboration through CERN staff members in key management positions in each Collaboration, and through hosting of, and chairing, the Resources Review Boards, composed of officials responsible to their governments for the funding of the ATLAS and CMS Collaborations;

HAVE AGREED AS FOLLOWS:

Article I
Purpose of the Experiments Protocol

This Protocol defines the framework under which DOE and NSF, the U.S. funding agencies, and their contractors and grantees, collectively the U.S. participants, will participate in the detector Collaborations.

Article II
**Participation by U.S. Groups of Scientists
in the ATLAS and CMS Detector Collaborations**

Each Collaboration will have a process, defined by a Memorandum of Understanding, for admitting participating institutions which will apply equally to both CERN Member States and non-Member States. Contractors and grantees of DOE and NSF representing universities and DOE laboratories will be entitled to participate in the ATLAS and CMS detector Collaborations as provided under Memoranda of Understanding.

Article III
Organization of U.S. LHC Detector Collaborations

The U.S. participants in the LHC Collaborations shall operate in the framework of the overall Collaborations of which they are an integral part. Each U.S. LHC detector Collaboration shall have a spokesperson and its own Project Management Plan which will describe the U.S. organization and distribution of management responsibilities. These spokespersons will represent the U.S. Collaborations before the U.S. Party, and be responsible to the ATLAS and CMS Collaborations for U.S. technical and budget-planning activities.

Article IV
Resources Review Boards

The Resources Review Boards for the ATLAS and CMS detectors, composed of representatives of each participating funding agency and chaired by the CERN Director of Research, shall monitor and oversee resource-related matters. The U.S. Party shall be a full member of these Resources Review Boards.

Article V
Memoranda of Understanding (MOUs)

- 5.1 For the period of 1996-1997, each Collaboration has concluded an Interim Memorandum of Understanding (IMOU) that assigns responsibilities to all participating institutions, including those from the United States, for research and development (R&D), engineering design, and prototyping during the 1996-1997 period.
- 5.2 The final responsibilities for the construction of the ATLAS and CMS detectors will be specified in Memoranda of Understanding, one per experiment, with the concurrence of the Resources Review Boards. Subsystem Technical Design Reports on the scientific and technical aspects of the detectors will be submitted by the Collaborations to CERN

for approval and will be the bases for the commitments listed in the MOU.

- 5.3 Each MOU shall cover the actual construction of its detector and its installation in the underground experimental area, and shall include the distribution of tasks and other responsibilities for all participating institutions, including those from the United States, as well as the organizational, managerial, and financial guidelines to be followed by each Collaboration.

**Article VI
Responsibilities of U.S. Participants
in the ATLAS and CMS Collaborations**

- 6.1 The U.S. participants will have responsibilities for R&D, engineering design, prototyping, fabrication, and normal maintenance and operation of detector systems and components as agreed to and described in the IMOUs, and the MOUs and their addenda.
- 6.2 The U.S. participants will provide specified equipment to be built by or under the supervision of U.S. institutions. They will also contribute, in whole or in part, items of a largely industrial nature considered as part of common projects which are the responsibility of the overall Collaboration ("Common Projects"). Such items will be funded directly or indirectly by all participants in the Collaborations, in accordance with the provisions of the IMOUs and MOUs, and will be subject to the approval of the Resources Review Boards.
- 6.3 Requirements for cash or cash-equivalent contributions from U.S. participants in the ATLAS and CMS Collaborations, including contributions to Common Projects, will be specified in the IMOUs and MOUs. Responsibility for such contributions will be in conformance with Article VII below, and will be limited to the amounts stated in the IMOUs and MOUs, except by mutual agreement among CERN, the Collaborations, and the U.S. Party.

**Article VII
Funding of the U.S. Participation in ATLAS and CMS**

- 7.1 To enable the U.S. participants to meet their responsibilities during the detector research, development and construction phases, DOE will provide total funding budgeted at and not to exceed \$250,000,000 (which includes contingency) to the U.S. ATLAS and CMS Collaborations, and NSF will provide funding not to exceed the National Science Board authorized amount of \$81,000,000 (which includes contingency) to the combined U.S. ATLAS and CMS Collaborations. The sum of DOE and NSF funding is to be split approximately equally between the two detectors. This funding will be subject to the availability of appropriated funds. DOE and NSF will each be responsible for its own funding commitment.
- 7.2 The application of these funds to pay for detector system costs will follow standard DOE and NSF accounting practices.

- 7.3 Detector system cost estimates presented to and reviewed by CERN utilize CERN accounting policies and practices. The U.S. Party will assume no responsibility with respect to the validity of such cost estimates.
- 7.4 These funds shall only be used for those U.S. responsibilities identified in Article VI and the associated MOUs.

**Article VIII
Responsibilities of CERN**

- 8.1 The general obligations of CERN as host laboratory, and of the participating institutions are laid down in the document "General Conditions for Experiments Performed at CERN" (April 1989), which is considered a part of this Protocol. The Financial Guidelines for LHC Collaborations (CERN/FC/3796, dated August 30, 1995) is also considered a part of this Protocol.
- 8.2 It is understood that the design, fabrication, and operation of the detectors will be managed by the ATLAS and CMS Collaborations, respectively, with CERN having oversight responsibility and providing continuous monitoring through CERN's Research Board and its LHC Committee. The Research Board is responsible for CERN's entire experimental research program and is chaired by the Director General, whereas the LHC Committee reviews for the Research Board the technical progress of the LHC experiments.
- 8.3 The Technical Co-ordinators of the ATLAS and CMS Collaborations shall be CERN staff members, and shall have overall responsibility for technical aspects of detector construction. Their responsibilities shall include integration of the subdetectors, safety, infrastructure at CERN, surface and experimental areas, services, installation, machine interface, and test beams.
- 8.4 Similarly, the Resource Co-ordinators of the ATLAS and CMS Collaborations shall be CERN staff members and shall have the responsibility for monitoring the financial aspects of the detector projects, including budget and manpower planning and the MOUs, as well as the responsibility for the financial aspects of the Common Projects and associated Common Funds.
- 8.5 CERN shall have the responsibility to approve the appointments of the Technical and Resource Co-ordinators, and to ensure that they have the staff and engineering support required to carry out their responsibilities. It will be CERN's overall responsibility to ensure, as best as it can, that there is a satisfactory match between the available resources (including funding and manpower) and the approved detector projects. CERN, through the Resource and Technical Co-ordinators, will have oversight responsibility for Common Projects and Common Funds.

**Article IX
CERN Support for U.S. Scientists**

CERN will provide U.S. scientists participating in the LHC program the same level of facility support that it normally provides to all its visiting scientists.

**Article X
Potential Detector Upgrades**

Should the ATLAS and/or CMS Collaborations seek to improve and upgrade their detectors some time in the future, such upgrades will be the subjects of new MOUs, or addenda to existing MOUs, to be negotiated within the Collaborations. The access of U.S. contractors and grantees to participation in the Collaborations will be extended to participation in the upgraded detectors on the same basis as described in Article II of this Protocol.

**Article XI
Protocol Duration**

This Protocol shall enter into force upon signature, and remain in force for twenty (20) years from the date of signature, followed by automatic renewal on a year-by-year basis, provided the International Co-operation Agreement remains in force.

**Article XII
Amendment Procedure**

The Parties may amend this Protocol by written consent.

**Article XIII
Final Provisions**

This Experiments Protocol shall form an integral part of the International Co-operation Agreement.

Done in Geneva on December 19, 1997.

FOR THE EUROPEAN
ORGANIZATION FOR NUCLEAR
RESEARCH (CERN):



Christopher Llewellyn Smith
Director-General

FOR THE DEPARTMENT OF
ENERGY OF THE UNITED STATES
OF AMERICA:



Martha A. Krebs
Director, Office of Energy Research

FOR THE NATIONAL SCIENCE
FOUNDATION OF THE UNITED
STATES OF AMERICA:



Robert A. Eisenstein
Assistant Director for Mathematical
and Physical Sciences

Appendix C

Accelerator Protocol

of

December 19, 1997

**INTERNATIONAL CO-OPERATION AGREEMENT
CONCERNING
SCIENTIFIC AND TECHNICAL CO-OPERATION
ON LARGE HADRON COLLIDER ACTIVITIES**

ACCELERATOR PROTOCOL

between

**THE EUROPEAN ORGANIZATION FOR NUCLEAR RESEARCH
(CERN)**

and

**THE DEPARTMENT OF ENERGY
OF THE UNITED STATES OF AMERICA**

1997

The European Organization for Nuclear Research, hereinafter referred to as "CERN" and represented by its Director-General,

and

The United States Department of Energy (DOE),

CONSIDERING

That the International Co-operation Agreement concerning Scientific and Technical Co-Operation on Large Hadron Collider Activities provides, in Article V "Implementation", for the participation of the DOE in the construction of the Large Hadron Collider (LHC) accelerator, details of which are to be concluded in the form of an Accelerator Protocol;

HAVE AGREED AS FOLLOWS:

Article I Purpose of the Accelerator Protocol

The purpose of this Protocol is to describe the nature and the implementation measures of the DOE's contribution, through its national laboratories and other contractors, in the construction of the LHC Accelerator.

Article II Scope of DOE's Contribution to the Accelerator

- 2.1 Subject to the availability of appropriated funds, DOE's total contribution to the LHC Accelerator under section 2.2 below will total an amount budgeted at and not to exceed \$200 million (which includes contingency), in accordance with standard DOE accounting practices, over the duration of this Protocol.
- 2.2 DOE's contribution, through its laboratories and other contractors, will consist of:
 - collaborating with CERN in the design of the Interaction Regions and their integration into the LHC accelerator, and related research and development;
 - providing equipment, specialized material, components and software to CERN, according to the provisions of Article III below; and
 - providing CERN with agreed-upon products manufactured in the United States that are procured according to the provisions of Article IV below.
- 2.3 These funds, which include contingency, shall only be used for those activities identified in Article II, Section 2.2 above, and the associated Implementing Arrangement.

Article III
Items provided by U.S. National Laboratories

- 3.1 Of the \$200 million specified in section 2.1, an estimated \$110 million worth of mutually agreed goods and services from national laboratories, according to standard accounting practices of the DOE, will be provided to CERN. These goods and services will focus primarily on the Interaction Regions and their integration into the LHC accelerator.
- 3.2 Implementing Arrangement(s) between CERN and the U.S. Laboratory Collaboration, as described in Article V below, will: specify the equipment; detail the technical specifications, schedules and acceptance procedures; and specify other activities of U.S. laboratories in support of the construction of the LHC.
- 3.3 Such Implementing Arrangement(s) shall also define the procedures for modifications to the technical specifications. Before implementation, modifications to the technical specifications or schedule will be submitted for approval to the DOE- and CERN-designated Project Managers indicated in Article V below.
- 3.4 CERN shall be notified by the DOE-designated Project Manager in advance about acceptance tests concerning the equipment to be delivered to CERN under this Protocol. CERN will have the right to send a representative to witness the tests.

Article IV
Procurement from Industry

- 4.1 Of the \$200 million referenced in section 2.1, CERN will specify the use of \$90 million for procuring from U.S. industrial firms, as defined in section 4.3 below, mutually agreed upon supplies and items required to construct the LHC Accelerator, including superconducting cable for approximately \$20 million, and items such as superconducting alloys, niobium barriers and polyimide insulating material, for the remainder.
- 4.2 The Director General of CERN (or his designee) and the DOE Director of High Energy Physics (or his designee) shall be responsible for implementing section 4.1. Based on a list of supplies and items required to construct the LHC Accelerator, they will reach agreements in writing on which such supplies and items may be procured from U.S. industrial firms, and the portion of U.S. funds to be allocated for each agreed upon procurement. These agreements shall be consistent with the annual funding limitations resulting from the U.S. budget process, and the procedures set forth above shall be applied until expenditures for such agreed upon items total \$90 million.
- 4.3 For purposes of this Protocol, a "U.S. industrial firm" is defined as one which will supply, for each agreed upon procurement, U.S. domestic end-products as defined in the Buy American Act and implementing regulations.
- 4.4 For those mutually agreed upon supplies and items as set forth in sections 4.1 and 4.2 above, CERN shall solicit responses from U.S. industrial firms, among others. In this regard, CERN shall be responsible for the conduct of the overall procurement process, and utilize its standard procurement and selection procedures. These

solicitations shall require US industrial firms to supply to CERN the information necessary for qualification under section 4.3.

- 4.5 For those U.S. industrial firms selected by CERN for contract award, CERN will enter into appropriate contractual arrangements and shall be responsible for all negotiation and administrative functions associated with these awards including, but not limited to, compliance with delivery schedules, technical oversight, inspections, change orders, and contract termination.
- 4.6 With respect to payment for such procurements awarded to a U.S. industrial firm by CERN, DOE will enter into a separate, written understanding with CERN specifying payment provisions and such additional details as may be necessary to implement fully the process specified in this Article.
- 4.7 Unless otherwise agreed in writing between DOE and CERN, ownership of all supplies and items purchased in conjunction with this Article shall be vested in CERN.

Article V Management Structure

- 5.1 For the purpose of implementing this Protocol, the Brookhaven National Laboratory, the Fermi National Accelerator Laboratory, and the Ernest Orlando Lawrence Berkeley National Laboratory shall form a U.S. Laboratory Collaboration, headed by the DOE-designated Project Manager indicated in section 5.2 below. The U.S. Laboratory Collaboration will have a Project Management Plan, prepared in consultation with CERN, which will describe the organization and distribution of management and other responsibilities among these laboratories for the U.S. effort in support of the LHC accelerator project.
- 5.2 DOE and CERN shall each designate a Project Manager to ensure the effective co-ordination and performance of all technical, financial and procurement activities related to the implementation of this Protocol.
- 5.3 Each Party's Project Manager shall make reports to the Co-operation Committee which is identified in Article XV of the International Co-operation Agreement.

Article VI Amendment Procedure

DOE and CERN may amend this Protocol by written consent.

Article VII Duration

This Protocol shall enter into force upon signature by CERN and DOE, and shall remain in force for a period of ten (10) years from that date, provided the International Co-operation Agreement remains in force.

**Article VIII
Final Provisions**

This Accelerator Protocol shall form an integral part of the International Co-
operation Agreement.

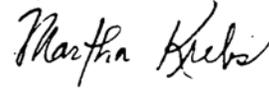
Done in Geneva on December 19, 1997.

FOR THE EUROPEAN
ORGANIZATION FOR NUCLEAR
RESEARCH (CERN):



C. H. Llewellyn Smith
Director-General

FOR THE DEPARTMENT OF
ENERGY OF THE UNITED STATES
OF AMERICA:



Martha A. Krebs
Director, Office of Energy Research

CONCURRENCE:

SC-223	SC-223	SC-221	SC-22	NSF	NSF
TEToohig	JRitchie	PKWilliams	JO'Fallon	MGoldberg	
	JLightbody				
10/ /99	10/ /99	10/ /99	10/ /99	10/ /99	10/ /99

Appendix 1.B

U.S. LHC Governing Documentation and Key Personnel

Appendix 1B Table 1- U.S. LHC Governing Documentation²

Responsible Parties	Document	Date (original;revised)	Location
<i>DOE NSF-CERN Cooperation</i>			
DOE/NSF/CERN	International Cooperation Agreement	12/8/97	PEP-1.A/A
DOE/NSF/CERN	Experiments Protocol	12/19/97	PEP-1.A/B
DOE/CERN	Accelerator Protocol	12/19/97	PEP-1.A/C
<i>U.S. LHC Joint Oversight Group</i>			
DOE/NSF	MOU on Participation in the LHC (joint oversight)	8/98; rev. 12/99	PEP-1.A
DOE/NSF/CERN	Endorsement of Detector Deliverables (letter to Foa)	10/19/98	U.S. LHC Project files
DOE/NSF/U.S. CMS-ATLAS-	U.S. LHC Project Execution Plan	12/1/98; rev 10/02	Base Doc.
<i>U.S. LHC Accelerator Project</i>			
DOE//U.S. LHC Accelerator	U.S. LHC Accelerator Project Management Plan	10/98	PEP-2.A
DOE/CERN	Understanding Concerning Payments	12/19/97	PEP-2.A/Annex I.
U.S. LHC Accelerator/CERN	Implementing Arrangement for the Accelerator	7/20/98; rev 5/02	PEP-2.A/Annex II
DOE/Fermilab	U.S. LHC Accelerator Lead Laboratory Agreement	7/22/98	U.S. LHC Project files
<i>U.S. ATLAS Project</i>			
DOE/NSF/U.S. ATLAS	U.S. ATLAS Project Management Plan	3/13/98; rev.11/99; rev. 12/02	PEP-2.B
U.S. ATLAS/CERN	U.S. ATLAS List of Deliverables (letter to Foa)	4/23/98	PEP-2.B/1
ATLAS/CERN	ATLAS MOU	4/28/98	U.S. LHC Project files
DOE/NSF/BNL	U.S. ATLAS Host Laboratory Letter	4/21/97	U.S. LHC Project files
<i>U.S. CMS Project</i>			
DOE/NSF/U.S. CMS	U.S. CMS Project Management Plan	12/1/98; rev. 12/02	PEP-2.C
U.S. CMS/CERN	U.S. CMS list of Deliverables (letter to Foa)	8/18/98	PEP-2.C/1
CMS/CERN	CMS MOU	4/29/98	U.S. LHC Project files
DOE/NSF/Fermilab	U.S. CMS Host Laboratory Letter	11/30/97	U.S. LHC Project files
CMS	Guidelines for the management of the CMS Project	9/21/98	U.S. CMS Project files
U.S. CMS	U.S. CMS Constitution	9/13/96	U.S. CMS Project files
CMS	CMS Constitution	3/21/97	U.S. CMS Project files

² Governing documentation is compiled as appendices in the Project Execution Plan (PEP) or kept in appropriate project files, as indicated.

Appendix 1B Table 2- Key U.S. LHC Offices and Groups¹

Position	Authority	Designee (Current/Prior)	Affiliation	Authorization
<i>U.S. CERN Co-operation Committee</i>				
U.S. Co-Chair	DOE/NSF	Peter Rosen	DOE/HNEP SC-20	
CERN Co-Chair	CERN	Luciano Maiani	CERN/DG	
<i>U.S. LHC Joint Oversight Group</i>				
DOE Co-Chair	DOE/NSF	John O'Fallon	DOE/HEP SC-22	6/15/98
NSF Co-Chair	DOE/NSF	John Lightbody	NSF/Physics	6/15/98
<i>U.S. LHC Program Office</i>				
U.S. LHC Program Manager	DOE/NSF	Moishe Pripstein/A. Byon-Wagner/T. Toohig	DOE/HEP SC-22	12/1/98
U.S. LHC Associate Program Manager	DOE/NSF	Marvin Goldberg	NSF/Physics	12/1/98
U.S. LHC Deputy Associate Program Manager	NSF	Jim Whitmore/Alex Firestone	NSF/Physics	
U.S. LHC Accelerator Associate Program Manager	DOE	Bruce Strauss	DOE/SC-224	2/27/98
<i>U.S. LHC Project Office</i>				
U.S. LHC Project Manager	DOE/NSF	Jim Yeck	DOE/CH/FAO	12/1/98
U.S. LHC Deputy Project Manager	DOE/NSF	Pepin Carolan	DOE/CH/FAO	
<i>U.S. LHC Accelerator Office</i>				
U.S. LHC Accelerator Lead Laboratory Authority	DOE/Fermilab	Mike Witherell/John Peoples	Fermilab	7/22/98
U.S. LHC Accelerator Project Manager	DOE/Fermilab	Jim Strait	Fermilab	2/12/97
<i>U.S. ATLAS Project</i>				
U.S. ATLAS Host Laboratory Authority	DOE/NSF/BNL	Peter Paul/Jack Marburger	BNL	3/2/98
U.S. ATLAS Host Laboratory Oversight	BNL	Tom Kirk	BNL	3/2/98
U.S. ATLAS Project Manager	DOE/NSF/BNL	Bill Willis	Columbia Univ.	
U.S. ATLAS Deputy Project Manager	BNL	Howard Gordon	BNL	
U.S. ATLAS NSF Funds Administrator	NSF	Jeremy Dodd	Columbia Univ.	
U.S. ATLAS Institutional Board Convener	U.S. ATLAS	Jim Siegrist	LBNL	
<i>U.S. CMS Project</i>				
U.S. CMS Host Laboratory Authority	DOE/NSF/Fermilab	Mike Witherell/John Peoples	Fermilab	10/30/97
U.S. CMS Host Laboratory Oversight	Fermilab	Ken Stanfield	Fermilab	
U.S. CMS Project Manager	DOE/NSF/Fermilab	Dan Green	Fermilab	2/25/98
U.S. CMS NSF Funds Administrator	NSF	Steve Reucroft	Northeastern Univ.	
U.S. CMS Collaboration Spokesperson	U.S. CMS	Harvey Newman	Caltech	

¹ Authorization documents are kept in appropriate U.S. LHC project files.