

EXHIBIT B

Cooperative Agreement No.
PHY 9722537

Between
NATIONAL SCIENCE FOUNDATION
Arlington, VA 22230
and
COLUMBIA UNIVERSITY
New York, NY 10027

TITLE: Construction of the U.S. ATLAS Detector
at the LHC

Program Manager/PI: William J. Willis

AMOUNT: \$60,800,000

EFFECTIVE DATE: 1 January 1999

EXPIRATION DATE: 31 December 2003

AUTHORITY: This Agreement is awarded pursuant to the authority of the National Science Foundation Act of 1950 (42 U.S.C. 1861 et. seq.).

This Agreement is entered into between the United States of America, hereinafter called the Government; represented by the National Science Foundation, hereinafter called the Foundation or NSF; and Columbia University, hereinafter called the Awardee.

NSF Program Officer: Marvin Goldberg (703) 306-1894 (phone)
(703) 306-0566 (fax)
email: mgoldber@nsf.gov

NSF Grants and Agreements Official: Mavis J. Sinkular (703) 306-1213 (phone)
(703) 306-0275 (fax)
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Please have an authorized official of your institution execute this Agreement and return three (3) signed copies within ten (10) working days to the NSF Grants and Agreements Official.

The United States of America



(Signature)

Aaron R. Asrael

(Typed Name)

Grants and Agreements Officer

(Title)

1/26/99

(Date)

National Science Foundation

Acceptance



(Signature)

Beth H. Israel
Executive Director
Office of Projects and Grants

(Typed Name)

(Title)

2/2/99

(Date)

Columbia University

Table of Contents

- I. Introduction
- II. Statement of Purpose
- III. Period of Performance
- IV. Statement of Work and Awardee Responsibilities
- V. NSF Responsibilities
- VI. Funding and Funding Schedule
 - A. Funding
 - B. Funding Schedule
- VII. Reporting Requirements
- VIII. Key Personnel
- IX. Other Conditions
 - A. Equipment
 - B. Subaward Approval
- X. General Conditions
- XI. Order of Precedence

I. INTRODUCTION

- A. The ATLAS Project is a complex collaborative experiment that is internationally funded. It involves the European Organization for Nuclear Research (CERN) which has undertaken construction of a new high energy physics research facility, the Large Hadron Collider (LHC) at its laboratory site outside Geneva, Switzerland. The facility will include the LHC accelerator and two very large detectors: ATLAS (A Toroidal LHC Apparatus) and CMS (Compact Muon Solenoid). The ATLAS detector will be a large general-purpose detector used to detect and measure the results of very high energy proton-proton collisions at the LHC accelerator. (The CMS Project is not included in this Cooperative Agreement.)
- B. The U.S. responsibilities for the design and fabrication of equipment for the U.S. ATLAS detector are referred to as the U.S. ATLAS Project. The project is a collaborative effort carried out by numerous institutions and laboratories. (See Section II of this Agreement for details.)
- C. The Department of Energy (DOE) and NSF responsibilities for the U.S. LHC Construction Program, which includes the U.S. ATLAS Project, are specified in the documents listed below. These documents govern the overall project and are listed in order of precedence.
1. The International Cooperation Agreement Concerning Scientific and Technical Cooperation on Large Hadron Collider Activities, dated 8 December 1997, defines the U.S. responsibilities common to all parts of the LHC Construction Program.
 2. The Experiments Protocol Concerning Scientific and Technical Cooperation on Large Hadron Collider ATLAS and CMS Detectors, dated 19 December 1997, describes DOE and NSF responsibilities to the detector projects.
 3. The Accelerator Protocol, dated 19 December 1997, includes only DOE responsibilities for the U.S. participation in the LHC accelerator.
 4. Responsibilities of the Joint Oversight Group (JOG) are outlined in the "Memorandum of Understanding between the U.S. Department of Energy and the U.S. National Science Foundation on U.S. Participation in the Large Hadron Collider Project at the European Organization for Nuclear Research", dated 15 June 1998. The JOG, consisting of the Director of the DOE Division of High Energy Physics and the Division Director (or designee) of the NSF Division of Physics, has been established to coordinate DOE and NSF policies and procedures, and to establish programmatic guidance and direction.
 5. The U.S. Large Hadron Collider Construction Program (U.S. LHC Project) Project Execution Plan covers the management structure from the JOG through the U.S. ATLAS, U.S. CMS, and U.S. LHC Accelerator projects. The specified management arrangements for these projects are described in their individual Project Management Plans that are an integral part of the U.S. LHC Project Execution Plan.

- D. Funding for the U.S. ATLAS Project is being provided by both the DOE and the NSF. This Cooperative Agreement addresses only the NSF-funded U.S. ATLAS activities undertaken by Columbia University.

II. STATEMENT OF PURPOSE

- A. Columbia University (also referred to as the Awardee) will assume primary oversight responsibility for managing the NSF funding allocated to the U.S. institutions collaborating on the design and fabrication of ATLAS components. A complete listing of U.S. ATLAS institutions with their responsibilities is included in the U.S. ATLAS Project Management Plan approved by the DOE/NSF Joint Oversight Group in March 1998. (See Section IV. of this Agreement for details.) Unless NSF reserves specific responsibility, by Special Condition or General Condition, for coordinating or integrating the project's activities with other activities, or sharing responsibility for certain aspects of the project, all such responsibilities remain with the Awardee.
- B. Columbia University accepts the overall supervision, financial and reporting oversight responsibilities for the NSF-funded portion of the U.S. ATLAS construction project. The Foundation expects the Awardee and its lead Principal Investigator to be responsible for fulfilling the terms of this Agreement, in accordance with their proposal, and administering the project in accordance with the Project Management Plan. In case of the departure of the Project Manager, PI, or Deputy Project Manager from the University, the Awardee, in consultation with NSF, will find a suitable replacement. Written approval from the NSF Grants and Agreements Officer must be secured before the change is implemented.
- C. The Foundation has a major responsibility for providing Columbia University with financial support, general oversight, and monitoring to help assure effective performance and administration.

III. PERIOD OF PERFORMANCE

The period of performance of this Agreement shall begin 1 January 1999, and is initially approved for the period ending 31 December 2003.

IV. STATEMENT OF WORK AND AWARDEE RESPONSIBILITIES

- A. Columbia University will assume primary financial oversight responsibility for expenditures and procurements to acquire those components and subsystems of the ATLAS detector for which the U.S. groups supported by the NSF have assumed responsibility. Each subsystem is described in the ATLAS Technical Proposal to the CERN Laboratory (CERN/LHCC/94-43, LHCC/P2, dated 15 December 1994) and in Technical Design Reports for each of the ATLAS subsystems.

- B. A detailed list of the components of the ATLAS detector for which U.S. ATLAS groups assume responsibility is given in the U.S. ATLAS Project Management Plan (U.S. ATLAS 98-06), dated 13 March 1998, and approved by the DOE and the NSF. This Management plan also addresses the U.S. ATLAS Project Manager's programmatic coordination and management responsibilities for the U.S. ATLAS.
- C. Collaborating U.S. institutions currently included under this Agreement, in order to accomplish the tasks outlined in proposal PHY-9722537 by Columbia University to the NSF, are:
- The University of Chicago;
 - Hampton University;
 - Michigan State University;
 - The State University of New York at Stony Brook (also DOE supported);
 - Northern Illinois University;
 - The University of Rochester; and
 - The University of Washington.
- D. Columbia University may issue subcontracts to these or other collaborating universities. These subcontracts shall be in accord with the requirements of Section IX.B of this document.
- E. The work plan of the U.S. ATLAS collaboration to build the ATLAS detector is contained in the proposal of Columbia University to the NSF (proposal number PHY-9722537; dated 7 November 1996), in which the specific involvement of the NSF-supported U.S. groups in the individual components of the ATLAS detector is indicated. This document (NSF proposal PHY-9722537) shall be regarded as definitive in determining specific initial responsibilities of the U.S. NSF-supported groups.
- F. This project will be administered in accordance with the U.S. ATLAS Project Management Plan (U.S. ATLAS 98-06) dated 13 March 1998.

V. NSF RESPONSIBILITIES

- A. For the NSF-funded portion of the project, NSF shall make decisions and take actions such as providing approvals, as necessary and appropriate, that are required under the Special or General Conditions of this Agreement.
- B. NSF technical involvement will include:
1. Performance of work under this Agreement shall be subject to the general oversight and monitoring of the NSF Program Officer. This NSF involvement may include, but is not limited to:
 - a. performance oversight through merit review;

- b. participation in resolution of technical, managerial, and scheduling concerns;
 - c. technical guidance/advice especially with regard to the integration and coordination with other activities; and
 - d. review and, where required by this Agreement, approval of technical reports and information to be delivered by the Awardee.
2. NSF technical involvement must be consistent with the general statement of work as stated in this Agreement. The Program Officer does not have the authority to and may not:
- a. request additional work outside the general scope of this Agreement;
 - b. issue instructions which constitute a change as defined in Article 8, "Significant Project Changes," of the General Conditions;
 - c. cause an increase or decrease in the estimated cost or time required for performance under this Agreement; or
 - d. change any of the expressed terms and conditions of this Agreement.
3. If, in the opinion of the Awardee, any instructions or requests issued by the NSF Program Officer are within one of the categories as defined in (a.) through (d.) in the above paragraph, the Awardee shall not proceed but shall notify the NSF Grants and Agreements Officer and shall request, if appropriate, modification of this Agreement in accordance with Article 42, "Changes--Limitation of Funds," of the Cooperative Agreement General Conditions.
4. All NSF approvals required by this Agreement must be made in writing by the Grants and Agreements Officer unless otherwise specified.

VI. FUNDING and FUNDING SCHEDULE

- A. **Funding.** It is the intention of the Foundation to provide up to \$60,800,000 to support this project for a five-year period commencing 1 January 1999. For purposes of payment of costs, funds in the amount of \$16,630,000 are hereby provided to support the project for the period 1 January 1999 to 31 December 1999, as described in the proposal dated 7 November 1996.
- B. **Funding Schedule.** Contingent on the (1) the availability of funds; (2) progress in all areas identified within this Agreement and the Project Management Plan dated 13 March 1998; and (3) any special conditions of this Cooperative Agreement, NSF expects to continue support at approximately the following levels:

Fiscal Year	Proposed Effective Date	Duration (in months)	Proposed Funding Amount
2000	01/01/00 - 12/31/00	12	\$11,940,000
2001	01/01/01 - 12/31/01	12	\$12,290,000
2002	01/01/02 - 12/31/02	12	\$12,650,000
2003	01/01/03 - 12/31/03	12	\$ 7,290,000

- C. Nothing in the above terms supersedes the Foundation's rights under Article 41, "Suspensions or Termination for Convenience" of the Cooperative Agreement General Conditions (CA-1).

VII. REPORTING REQUIREMENTS

- A. Reporting requirements for the U.S. ATLAS project are documented in the U.S. LHC Project Execution Plan and in the U.S. ATLAS Project Management Plan. As described in the U.S. ATLAS Project Management Plan, the U.S. ATLAS Project Manager provides the NSF Program Official with a monthly report. This report is the principal reporting mechanism for NSF and DOE as the funding agencies. In order to meet the specific reporting needs of the NSF, these reports will include, but will not necessarily be limited to, the following:

1. Monthly Report.

- a. A Project Monthly Report will be prepared and submitted to NSF every month except December. An Annual Report will be submitted in lieu of the December Monthly Report. This report shall consist of: a summary of work accomplished during the reporting period including major scientific and technical accomplishments, an assessment of current status against scheduled status, a review of current or anticipated problem areas and corrective actions, a summary of subawardee accomplishments, and a status of actions affecting Columbia/NSF responsibilities. This report shall also include management information such as changes to personnel, financial status report and other financial information including actual or anticipated underruns or overruns, and any other action requiring NSF or other Federal Agency notification. One section of the DOE/NSF report, possibly as an appendix, will specifically address the activities supported by NSF funding.
- b. The financial information in the U.S. ATLAS Project Monthly Report will include a summary (to WBS level 2) of actual obligations versus time to WBS level 2 compared with the planned obligation profile. Schedule status will include a statement of earned value (where appropriate) to WBS level 2 and a narrative discussion of construction progress with reference to the baseline schedule. Whenever there are significant variances, information will be provided on WBS level 3.

- c. The Report will include a description of all Change Control actions for key milestones or contingency usage, and changes in the U.S. ATLAS Major Project Milestones and the annual acquisition plan that are identified in the Project Management Plan. Cost, schedule and performance goals shall include milestones for completion of and construction of the U.S. ATLAS subsystem in accordance with the U.S. ATLAS Program Management Plan (U.S. ATLAS 98-06).
2. **Annual Progress Report.** An Annual Report will be prepared and submitted by 31 December to NSF. The report will contain:
- a. A summary of overall progress, including results to date, and a comparison of actual accomplishments with proposed goals for the period; (ii) an indication of any current problems or favorable or unusual developments; (iii) a summary of work to be performed during the succeeding year; and (iv) any other pertinent information. Financial and schedule status information similar to that given in the Monthly Report will be included in the Annual Report.
 - b. A listing of any publications and reports produced by Awardee personnel supported by this award.
 - c. A listing of other funding support for Key Personnel or a statement indicating no other support. This must include the number of person-months or percentage of effort devoted to each project regardless of the source. If on academic appointment, the number of supported summer months must be shown.
 - d. A budget for the next funding year prepared on NSF Form 1030.
 - e. An estimate of funds that will be unspent on the anniversary date or a statement indicating that no residual funds are expected.
3. **Final Report.** As set forth in Article 16, "Final Report Requirements", of the General Conditions (GC-1), a final report shall be submitted.
4. **Reviews.** DOE and NSF will conduct a review at least once per year. DOE and NSF Program Managers will review project management, cost and schedule objectives; technical experts will review subsystems. These reviews will be held on mutually agreed upon dates and locations.
5. **Special Report.** The Awardee shall also submit such Special Reports as may be reasonably requested by the Foundation.
- B. The reports and plans shall be sent in the specified number of copies to the following destination:

<u>No. of Copies</u>	<u>Addressee</u>
4	NSF, Division of Physics Attention: Marvin Goldberg, Room 1015

VIII. KEY PERSONNEL

- A. An important criterion in selecting and continuing to support the project are the qualifications of the Project Manager, Principal Investigator, Deputy Project Manager, and Subsystem Managers. Any contemplated changes in these Key Personnel should be discussed with the NSF Program Officer. Written approval from the NSF Grants and Agreements Officer must be secured before change in the Project Manager, Principal Investigator, or Deputy Project Manager is implemented. Any change in the Project Manager, Principal Investigator, or Deputy Project Manager without the written prior approval of NSF may be cause for suspension or termination of the performance of work under this Agreement as specified in Article 41, "Suspension or Termination for Convenience," of the Cooperative Agreement General Conditions (CA-1).
- B. Any anticipated change in the Project Manager, Principal Investigator, Deputy Project Manager, or Subsystem Managers to be effective within the next performance year must be disclosed in the Awardee's Annual Report or renewal proposal, and a succession plan must be provided in the report/proposal.
- C. The following individuals are considered to be Key Personnel and essential to the work of the project.

Name	Title or Function	Organization
William Willis	Project Manager	Columbia University
William Willis	Principal Investigator	Columbia University
Howard Gordon	U.S. ATLAS, Deputy Project Manager	Bookhaven National Laboratory

IX. OTHER CONDITIONS

A. Equipment

1. Equipment costing in excess of \$1,000,000 must be approved in writing in advance by the NSF Program Official and the NSF Grants and Agreements Officer.
2. Title to equipment costing over \$5,000 and having a useful life of at least one (1) year acquired under this Agreement shall vest in the Awardee upon acquisition, subject to the conditions reflected in Article, 7, "Equipment", of GC-1 dated 10/98, and the provisions of OMB Circular A-110.

B. Subaward Approval

1. Involvement of collaborating institutions is integral to the effective performance of the overall project. Therefore, the responsibilities of a number of these institutions are explained within Columbia's proposal and the U.S. ATLAS Project Management Plan; the Work Breakdown Structure in the Project Management Plan assigns specific elements to the various institutions. In addition, Memoranda of Understanding between Columbia and each of the collaborating institutions formalize the participation of those parties. The Foundation authorizes the Awardee to enter into the proposed subaward arrangements with the University of Chicago, Hampton University,

Michigan State University, State University of New York at Stony Brook, Northern Illinois University, University of Rochester, and the University of Washington, and to fund such arrangements with grant funds up to the amount indicated in the approved budget. Such subaward arrangements should contain appropriate provisions consistent with the applicable grant general terms and conditions and any special conditions included in this agreement.

2. NSF recognizes that, during the performance of this project, it may be necessary to establish subaward agreements with other institutions, including those listed on page 15 of the U.S. ATLAS Project Management Plan (U.S. ATLAS 98-06). Excluding contractual arrangements identified below, all additional subcontracts or other agreements under this award involving substantive effort are subject to the approval of the NSF Grants and Agreements Officer. For purposes of this agreement, a subcontract or subaward valued in excess of \$500,000 shall be considered substantive effort. The Awardee hereby agrees to administer/monitor all subcontracts/subawards it enters into and supports with NSF funds in accordance with the applicable federal cost principles and the applicable federal administrative requirements.

subcontracts for commercially available supplies, materials, equipment, or support services

3. NSF may ratify in writing any contractual arrangements made by the Awardee. Such action shall constitute approval.

X. GENERAL CONDITIONS

The following General Conditions attached hereto shall apply to this Cooperative Agreement:

- A. Grant General Conditions, GC-1 (10/98), Articles 1 through 41.
- B. Cooperative Agreement General Conditions, CA-1 (2/98), Articles 41 through 45.

XI. ORDER OF PRECEDENCE

Any inconsistency in this Cooperative Agreement shall be resolved by giving precedence in the following order: (1) the Special Conditions, Sections I through IX of this Agreement, and (2) the General Conditions, Section X of this Agreement.