

***Memorandum of Understanding***

between

The University of Michigan

and

U.S. ATLAS Collaboration  
Project Management  
at Brookhaven National Laboratory

for WBS 1.5 Muon System

April 6, 1998

**1. *Introduction***

This Memorandum of Understanding describes the collaboration by members of the University of Michigan in the ATLAS Project in the United States. The purpose of this collaboration is the design, fabrication, operation and scientific exploitation of the ATLAS Detector. The detector is described in the ATLAS Technical Proposal, December 15, 1994, the Technical Design Reports, and subsequent technical documents elaborating that design. The contribution of the U.S. ATLAS Collaboration to the ATLAS Detector Project was first described in the U.S. ATLAS Proposal, September 1996 and in the U.S. ATLAS Project Management Plan (PMP), U.S. ATLAS Document 97-7.

It is understood that successful collaboration in construction and operation of the ATLAS detector requires implementation of a clear management plan for ATLAS. In the U.S., the U.S. ATLAS Project Management Plan is the basis for meeting this requirement and is accepted as part of this memorandum. The U.S. ATLAS project management infrastructure (U.S. ATLAS Project Office) resides at Brookhaven National Laboratory, and the responsibility for U.S. ATLAS project management resides in the U.S. ATLAS Project Manager (PM), reporting to the BNL Associate Director for High Energy and Nuclear Physics and to the Joint Oversight Group of the DOE and NSF. This work is in accord with the Memorandum of Understanding for the construction of the ATLAS Experiment between CERN and the Institutions/Funding Agencies of the ATLAS collaboration which is under the International Cooperation Agreement between CERN and the U.S. Department of Energy and the U.S. National Science Foundation concerning Scientific and Technical cooperation on Large Hadron Collider Activities (1997) and the Experiments protocol.

This Memorandum of Understanding describes the anticipated funding from the DOE and/or NSF, together with the long-term contributions of the University of Michigan to the design, construction and operation of the ATLAS Detector. It is understood that the anticipated contributions of the University of Michigan may later be modified or that additional responsibilities may be added to those described here.

An annual Statement of Work will detail the contributions of the University of Michigan as the detector construction proceeds and will contain the specific activities, deliverables and funding required. The normal period of performance will be the U.S. fiscal year (October 1-September 30). It is understood that shortfalls in funding will result in reduced deliverables.

This Memorandum of Understanding is made between the University of Michigan and U.S. ATLAS Project Manager (PM). It does not constitute a legal contractual obligation on the part of either of the parties. It reflects an arrangement that is currently satisfactory to the parties involved. The parties agree to negotiate amendments to this memorandum as required to meet the evolving requirements of the ATLAS research and development and detector construction program.

## **2. Personnel**

### 2.1. List of Scientific Personnel

Participating scientists committed to ATLAS over the full project period are expected to be:

Name	ATLAS Fraction	Other Research Commitments/Comments
Homer Neal	80%	D0
Jay Chapman	60%	CDF Muon Trigger/DoE Project Director
Jianming Qian	35%	D0 Preshower Detector Development
Greg Tarle	33%	HEAT/MACRO
Myron Campbell	40%	CDF Trigger and TDC
Robert Ball	40%	Electronics/Computing

### 2.2. Institutional Collaboration Board Representative

Homer Neal is the representative of the University of Michigan on the U.S. ATLAS Institutional Board.

### 2.3. List of Technical Personnel

Participating technical staff members foreseen to participate over the full project period are:

### Engineers

Name	ATLAS Fraction	Source of Support
John Mann	50%	DoE Base Grant

### Designers

Name	ATLAS Fraction	Source of Support
Ed Diehl	100%	DoE/University/ATLAS

### Technicians

Name	ATLAS Fraction	Source of Support
Helmut Schick	80%	DoE/ATLAS

#### 2.4. Other Key Personnel

The Environment, Safety and Health officer for the University of responsible for overseeing the compliance with applicable ES&H policies associated with ATLAS participation by this institution is John Vidolich of the University of Michigan. The Quality Assurance officer for the University of Michigan currently responsible for QA compliance of tasks performed by this institution is Ed Diehl of the University of Michigan.

### **3. *Design, Prototype, Production and Installation Responsibilities***

#### 3.1. Design, Prototype and Production Responsibilities

##### 3.1.1 *Deliverables*

The University of Michigan will carry out the following list of detector design, prototype, fabrication, and installation tasks:

### MDT Chambers WBS 1.5.1

WBS (L5)	Item
1.5.1.1.3	MDT Chamber Assembly
1.5.1.2.1	Tube Assembly Station
1.5.1.2.2	Tube Test Station
1.5.1.2.3	Chamber Assembly Station
1.5.1.2.4	Chamber Test Station
1.5.1.2.5	Handling/Transport Fixture
1.5.1.2.6	General Equipment
1.5.1.3.3	MDT Prototypes
1.5.1.4.X	MDT Drift Tubes (EEL2, EML3, EML4, EML5, EMS5)
1.5.1.5.3	Checkout at CERN

The University of Michigan will provide a design for the MDT Tube Assembly Station, develop a prototype and certify it. The endplug to be used is the base line endplug developed at the University of Pavia who will define the procurement procedure and delivery schedule.

The University of Michigan will build one Chamber 0 of type to be specified and 80 production chambers (16 each of type EEL2, EML3, EML4, EML5, and EMS5). The University of Michigan will test the completed chambers, ship the production chambers to CERN and install them on the detector. ATLAS will supply the drift tube endplugs and the BMC will provide the on-chamber alignment components. The drift tube material will be procured jointly with other ATLAS institutions.

### MDT Electronics WBS 1.5.3.1 & 1.5.3.2

WBS (L5)	Item
1.5.3.1	MDT Electronics
1.5.3.1.1	On Chamber Electronics Design
1.5.3.1.2	Readout Architecture
1.5.3.1.4	Test Station Design
1.5.3.2	Electronics for Prototypes
1.5.3.3.1	On Chamber Electronics Production
1.5.6.2.3	DAQ Readout

The University of Michigan, in collaboration with the BMC and the barrel muon groups will provide components of the front-end electronics in accord with the agreed upon design of the Muon system. The University of Michigan, in collaboration with CERN electronics group, will develop TDC testing facilities and coordinate the assembly and testing of the prototype front-end electronics to the level of 10K channels.

Total project funds (base cost without contingency) required from DOE is approximately \$2,798,000 (see MOU Report from ACCESS in Appendix I).

### 3.1.2 *Installation and Commissioning*

The University of Michigan will participate in the installation and commissioning of the MDT chambers and front-end electronics associated with those chambers.

### 3.2. Coordination and Reporting

The U.S. ATLAS Subsystem Manager for the Muon Subsystem is Venetios Polychronakos of Brookhaven National Laboratory. The institutional contact person for Muon activities at the University of Michigan is Homer Neal. The task managers for activities carried out at the University of Michigan are as follows:

Name	WBS and Task
Ed Diehl	1.5.2 MDT Supports
Greg Tarle	1.5.1 MDT Chamber Assembly
Jay Chapman	1.5.3.1 MDT electronics
Ed Diehl	1.5.1 MDT tube assembly

The progress of the design, fabrication, and testing of these components will be reported by the above-named institutional contact person on a monthly basis, by WBS element to L5 in detail, to the U.S. ATLAS Subsystem Manager, who in turn will report subsystem progress to the U.S. ATLAS PM. All status reports will be assembled and made public to the U.S. ATLAS collaboration.

Technical reporting to ATLAS project management will be coordinated by the U.S. ATLAS Subsystem Management Coordinator. Financial reporting by L5 WBS element will be made to the U.S. ATLAS Project Office. Financial reporting to ATLAS will be made by the U.S. ATLAS PM.

### 3.3. Collaboration with Other Groups and Institutions

Design, construction and installation related to the Muon subsystem will be carried out in close communication and collaboration with other groups working on Muon subsystem.

WBS / Task	Collaboration Group	Responsibility with University of Michigan
1.5	BNL	Forward Muon System
1.5.1	U of Washington	MDT Chambers
1.5.1	BMC	MDT Chambers
1.5.6	MPI, Munich	Forward Alignment System
1.5.6	NIKHEF, Amsterdam	Forward Alignment System
1.5.6	SACLAY, Paris	Forward Alignment System
1.5.x.1	BMC	MDT Electronics
1.5.3.x.1.2	KEK	Mezzanine Cards
1.5.3.x.1.2	BMC	Mezzanine Cards
1.5.3.x.1.2	NIKHEF, Amsterdam	NIMROD DAQ Readout Units

## **4. *Contribution of Effort, Services and Facilities***

### 4.1. Effort

Subject to adequate base program funding by DOE, the University of Michigan will provide support for the scientific and technical personnel as indicated in section 2.

### 4.2. Services

The services of the University of Michigan Purchasing, Expediting, and Receiving Departments and the Administrative Staff will be available to the ATLAS project to the degree required to carry out the responsibilities of the University of Michigan.

### 4.3. Facilities and Equipment

The following University of Michigan facilities and equipment will be made available to the ATLAS project to the degree necessary to carry out the design and fabrication responsibilities of the group. Machine Shop, clean rooms, high bay area in the machine shop of the physics building that has access to the loading dock. In addition, for electronics development the High Energy Physics Electronics Shop, CAD systems, and electronics instrumentation will be made available. These facilities will be available to the end of the construction period 2005.

### 4.4. Operating Costs

The University of Michigan, subject to adequate base program funding from DOE, will support the normal research operating expenses (such as physicists' salaries, travel

expenses, miscellaneous supplies, administrative support, etc.) of the University of Michigan group working on the ATLAS project. These normal operating expenses are not considered as part of the ATLAS detector cost estimate. The reference ATLAS costs are expected to be derived from additional supplemental funding.

## **5. Administration**

### 5.1. Method of Funding Transfers and Purchasing

The expenditures by University of Michigan are to be covered by funds provided by DOE, upon the allocation decision of the U.S. ATLAS PM. Funds to cover work described in this document will be provided directly to the University of Michigan by DOE.

### 5.2. Procurement Authorization

Major procurements (currently \$100k) must have the written authorization of the U.S. ATLAS PM. Items purchased as ATLAS Common Project items must be explicitly authorized by the U.S. ATLAS PM and approved by the ATLAS Resource Review Board, regardless of the cost.

The list of such procurements by the University of Michigan are:

Granite table for chamber assembly. (\$100K)

### 5.3. Reporting to U.S. ATLAS Project Management

All reporting to ATLAS project management will be in accordance with the procedures defined in U.S. ATLAS Project Management Plan.

The University of Michigan will report all ATLAS related expenditures, labor charges, and travel together with associated technical progress in each item of work by Work Breakdown Structure (WBS) category (Level 5) on a monthly basis to the U.S. ATLAS Project Office the expenditure of U.S. ATLAS Project funds related to detector fabrication, including labor charges and travel.

#### 5.4. Component Ownership

All equipment items bought or fabricated using DOE or NSF funds will be properly marked as the property of DOE or NSF. Any other equipment furnished by the University of Michigan as part of the detector will remain University of Michigan property. In either case, the equipment will remain part of the ATLAS detector until it is dismantled or the detector element in question is replaced.

### **6. *General Considerations***

#### 6.1. Safety and Engineering Practices

The experimenters from the University of Michigan agree to familiarize themselves with DOE and NSF safety policies and to adhere to them. All detector components must be designed, fabricated, installed and operated in conformity with the University of Michigan, DOE, NSF, and CERN safety policies and practices as well as University of Michigan, DOE, NSF, and CERN engineering standards. Copies of the necessary standards will be provided by the U.S. ATLAS Project Office. All engineering, design, quality assurance, safety, and other activities shall be in compliance with ISO standards. All major components will undergo appropriate design, safety, and engineering reviews with oversight by the U.S. ATLAS Project Office.

#### 6.2. Operations

The University of Michigan agrees to maintain, to the best of its ability, equipment provided for the ATLAS detector as long as the University of Michigan is a member of the ATLAS collaboration.

### **7. *Schedules and Milestones***

The University of Michigan will make every effort to carry out their institutional responsibilities consistent with the schedule for the fabrication of the ATLAS detector. These schedules may have to be changed as the project progresses. Changes that affect the University of Michigan will be noted in Amendments to this Memorandum.

## 7.1. Design, Fabrication and Installation Milestones

The key milestones relevant to the University of Michigan are listed here:

Key Milestones	Baseline Date	Current Date
WBS 1.5.1		
Decision on Central Locator	10-98	10-98
Tube Assembly Station Complete	1-99	1-99
Prototype Chamber Assembly Station Complete	4-99	4-99
Finish chamber 0	6-99	6-99
Approval of Production Start	11-99	11-99
Start MDT production line	1-00	1-00
Fabrication of Chambers Complete	9-03	9-03
Installation of Chambers Complete	12-04	12-04
WBS 1.5.3		
Test Readout Prototype for Module 0	12-98	12-98
Readout Architecture Design	12-98	12-98
Test Station Design with "ATLAS" Electronics	9-99	9-99
Electronics for Prototypes with "ATLAS" Electronics	1-00	1-00
On Chamber Electronics Production Complete	5-04	5-04
WBS 1.5.6		
DAQ Readout for Test Station	3-00	3-00



# U.S. ATLAS MOU Summary

**Funding** All  
**Institutions** U. of Michigan

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<b>WBS Number</b>	<b>Description</b>	<b>Base Cost Proj.</b>	<b>Total Mat. (k\$)</b>	<b>Mat. Proj. (k\$)</b>	<b>Mat. Base + Inf.</b>	<b>Labor Proj.</b>	<b>Labor Proj (FTE)</b>	<b>Labor Base + Inf. (FTE)</b>
<b>1.5</b>	<b>MDT Chambers</b>	2798	1555	1555	0	1243	33.1	2.9
<b>1.5.1</b>	<b>MDT Chambers</b>	2638	1532	1532	0	1106	29.6	1.9
<b>1.5.1.1</b>	<b>Mech. Design &amp;</b>	88	12	12	0	75	1.4	0.0
<b>1.5.1.1.3</b>	<b>MDT Chambers</b>	88	12	12	0	75	1.4	0.0
<b>1.5.1.1.3.5</b>	<b>UM MDT Chambers</b>	88	12	12	0	75	1.4	0.0
<b>1.5.1.2</b>	<b>Tooling</b>	576	469	469	0	107	2.2	0.0
<b>1.5.1.2.1</b>	<b>Tube Assy Station</b>	66	38	38	0	28	0.7	0.0
<b>1.5.1.2.1.3</b>	<b>UM Tube Assy Station</b>	66	38	38	0	28	0.7	0.0
<b>1.5.1.2.2</b>	<b>Tube Test Station</b>	79	63	63	0	16	0.3	0.0
<b>1.5.1.2.2.3</b>	<b>UM Tube Test Station</b>	79	63	63	0	16	0.3	0.0
<b>1.5.1.2.3</b>	<b>Chamber Assy Station</b>	293	230	230	0	63	1.2	0.0
<b>1.5.1.2.3.3</b>	<b>UM Chamber Assy Station</b>	293	230	230	0	63	1.2	0.0
<b>1.5.1.2.4</b>	<b>Chamber Test Station</b>	72	72	72	0	0	0.0	0.0
<b>1.5.1.2.4.3</b>	<b>UM Chamber Test Station</b>	72	72	72	0	0	0.0	0.0

<b>WBS Number</b>	<b>Description</b>	<b>Base Cost Proj.</b>	<b>Total Mat. (k\$)</b>	<b>Mat. Proj. (k\$)</b>	<b>Mat. Base + Inf.</b>	<b>Labor Proj.</b>	<b>Labor Proj (FTE)</b>	<b>Labor Base + Inf. (FTE)</b>
1.5.1.2.5	Handling/Transport Fix.	26	26	26	0	0	0.0	0.0
1.5.1.2.5.3	UM Handling/Trans. Fix.	26	26	26	0	0	0.0	0.0
1.5.1.2.6	General Equipment	41	41	41	0	0	0.0	0.0
1.5.1.2.6.3	UM General Equipment	41	41	41	0	0	0.0	0.0
1.5.1.3	MDT Prototypes	71	32	32	0	40	1.1	0.0
1.5.1.3.3	UM MDT Prototypes	71	32	32	0	40	1.1	0.0
1.5.1.4	MDT Construction	1811	986	986	0	825	24.0	1.4
1.5.1.4.1	MDT Drift Tubes	834	544	544	0	290	9.9	1.4
1.5.1.4.1.3	UM Tube Production	834	544	544	0	290	9.9	1.4
1.5.1.4.2	MDT Chamber Assembly	976	441	441	0	535	14.1	0.0
1.5.1.4.2.8	EEL2	202	87	87	0	114	3.0	0.0
1.5.1.4.2.15	EML3	191	87	87	0	104	2.7	0.0
1.5.1.4.2.16	EML4	191	87	87	0	104	2.7	0.0
1.5.1.4.2.17	EML5	203	93	93	0	110	2.9	0.0
1.5.1.4.2.20	EMS5	191	87	87	0	104	2.7	0.0
1.5.1.5	Installation @ CERN	92	33	33	0	59	1.0	0.5
1.5.1.5.3	Checkout	92	33	33	0	59	1.0	0.5
1.5.3	MDT Electronics	160	23	23	0	138	3.5	1.0
1.5.3.1	Electronics Design	160	23	23	0	138	3.5	1.0
1.5.3.1.2	Readout Architecture	160	23	23	0	138	3.5	1.0
1.5.3.1.2.2	Off-chamber Architecture	160	23	23	0	138	3.5	1.0