Memorandum of Understanding

between

The University of Texas - Austin

and

Fermi National Accelerator Laboratory

for the

MINOS Experiment

FY2002-2005

For WBS 1.1.1 Primary Proton Beamline
Version 0.0

I. Preamble

This memorandum describes an understanding between the University of Texas at Austin and the Fermi National Accelerator Laboratory (Fermilab) in the design, construction and installation of the Neutrinos at the Main Injector (NuMI) beamline facility to be used by Experiment E875. This experiment, the Main Injector Neutrino Oscillation Search (MINOS), and the NuMI facility, is described in detail elsewhere. Fermilab has overall responsibility for the NuMI/MINOS project. The organization, leadership, and operating procedures of the NuMI/MINOS Project are described in the NuMI Project Management Plan. The Plan will be updated as necessary and will constitute the main policy basis for managing the NuMI Beamline efforts.

This Memorandum of Understanding is made between the University of Texas (UT) - Austin and the NuMI Project Management at Fermilab. This document represents an understanding between Fermilab and the participating scientists at UT-Austin concerning their anticipated long-term contributions and responsibilities in connection with the design and construction of the NuMI beamline. It is understood that the anticipated contributions of UT-Austin may later be modified or that additional responsibilities may be added to those described here. 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 NuMI beamline design and construction program.

Periodic amendments to this Memorandum of Understanding (Statement of Work) will detail the contributions of UT-Austin 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).

The NuMI project must focus an intense 400 kW beam of 120 GeV protons extracted from the Fermilab Main Injector accelerator onto the NuMI production target. The beamline is designed to receive protons which are fast-extracted into 8.6 microsecond bursts of 4E13 protons per pulse with a momentum spread of <0.003 and emittance of $<40\pi$ mm-rad. This extracted beam is bent downward by 150 mR to descend rapidly through acquifer regions beneath the FNAL site, then bent upward by 100 mR to achieve the final steering onto the NuMI target.

To ensure proper steering of the intense proton beam through the NuMI delivery channel, as well as monitor the quality of the beam from the Main Injector and through the NuMI optics, a series of profile monitors must be developed. These monitors will likely be based on the phenomenon of secondary electron emission from metallic foils or wires placed temporarily in the proton beam. Segmentation of these foils or wires will provide lateral profile information about the proton beam which will be used to determine beam quality. The University of Texas at Austin will develop these detectors for the NuMI project.

II. Responsibilities

1. Activities

The following tasks will be performed as part of this memorandum of understanding.

1) Identify foil/wire materials for the Secondary Emission Monitors (SEM's) which can withstand the intense radiation dose of approximately 1E20 per square centimeter from the NuMI beam. These materials must possess secondary electron emission properties which will not age significantly in the NuMI beam.

2) Evaluate a suitable geometry of either foils or thin wires which will withstand heating from the NuMI beam and simultaneously not pose a significant hazard from interactions of the beam in the foil/wire material. These interactions must be minimized to reduce scattering/loss of the beam below ground.

3) Develop a prototype SEM for testing at the Fermilab Booster or MiniBooNE extracted beamline which will be exposed to 5E12 to 2E13 protons per second. This prototype must compare geometries as well as chamber materials, and will be installed in 2003.

4) Design a SEM for NuMI which can be baked out and operated at 1E-8 Torr and be exposed to 1E9 Rad/yr as will be anticipated near the NuMI target. The SEM should be retractable from the beamline without placing significant material in the beam, so that beam operations need not be halted for instrumentation insertion/removal. The accuracy of the SEM placement in the beam should be 50 micrometers.

5) Construct 12 SEM's to be installed in the NuMI beamline.

6) Develop a design for SEM insertion consistent with Fermilab's existing instrumentation controls system and positioning readback system.

7) Develop a readout path, cables, consistent with Fermilab's existing Segmented Wire Ionization Chamber (SWIC) readout electronics used throughout Fermilab.

8) Online software will be written to read out and track changes in monitoring chamber parameters during the NuMI run. This software will be written to integrate into the NuMI run control software framework and will be available prior to commissioning of the beamline, as the monitoring system is important for checks of the alignment and commissioning.

2. Personnel

The present contact person for WBS 1.1.1 activities at UT-Austin is Sacha E. Kopp. The task managers for WBS 1.1.1 are Drs. Sam Childress and Craig Moore, both of Fermilab. The following members of UT-Austin will participate in the Primary Beam Profile Monitoring System activities. Physicist effort is provided by UT-Austin; a fraction of the technical staff's effort is paid from NuMI project funds as shown in the table below.

Name	Position	% paid by NuMI project	% FTE on NuMI			
			FY02	FY03	FY04	FY05
Sacha Kopp	Physicist	0	50	50	50	50
Tom Osiecki	Physicist	0	50	100	100	100
Virginia Kruemke	Sec'y/Purchasing	0	20	20	20	20
Marek Proga*	Technician	50	0	50	50	50
UT Physics Machine Shop	Machinists (15)	0	100	200	200	0
John England	Engineer	0	0	10	10	0

*Already working on MINOS NuMI Beam Monitoring (WBS 1.1.5). Listed is only his WBS 1.1.1 contribution.

3. Deliverables

UT-Austin will deliver the following.

Item	Associated WBS#	Quantity
Prototype SEM Box	1.1.1	1
Profile SEM Detectors	1.1.1	12
Vacuum and electronic readout for above	1.1.1	12
installation of all the above in NuMI beamline	1.1.1	-

The group will report on all studies and activities for the NuMI monthly report, at regular NuMI project meetings, and at MINOS collaboration meetings. Engineering drawings and other designed items along with written descriptions of their specifications, intended method of operation and test procedures and results will be made available to the collaboration at the time of their completion. All work will be performed on the schedule shown in the NuMI Cost and Schedule Plan.

4. Transportation

Unless specifically indicated otherwise here, items produced by UT-Austin for use in the NuMI beamline or its subsystems shall be transported by the providing institution to the agreed upon point of delivery. UT-Austin shall be responsible for safe transport of all items to these delivery points.

5. Institutional Contribution of Services and Equipment

1) Services
The services of the UT-Austin Purchasing, Expediting, and Receiving Departments and the Administration Staff will be available to the NuMI project to the degree required to carry out the fabrication responsibilities of UT-Austin.

2) Facilities and Equipment
The following UT-Austin facilities and equipment will be made available to the NuMI project to the degree necessary to carry out the design and fabrication responsibilities of the group:

a) 400 sqft. clean room (UT-HEP labs)
b) 1500 sqft electronics labs (UT-HEP labs)
c) 5000 sqft of laboratory space (UT-HEP labs)
d) UT Physics Department Machine Shop
e) UT Physics Department Electronics Design Shop

3) Operating Costs
UT-Austin, subject to adequate funding from DOE or NSF, will support the normal research operating expenses (such as physicists' salaries, physicist travel expenses, miscellaneous supplies, administrative support, etc.) of the UT-Austin group working on the NuMI project. These normal operating expenses are not considered as part of the NuMI beamline cost estimate.

6. Fermilab Resources Required

1) Fermilab will make available beam for studies of SEM chamber aging effects.

2) The NuMI Project will deliver 12 SWIC electronics racks and interfaces to the Arcnet Fermilab network, each capable of reading 96 channels.

3) The NuMI Project will install all necessary infrastructure for the 1.1.1 beam profile monitoring system, such as electric power, air circulation, temperature control, and cable trays, as part of its civil outfitting contract for the NuMI tunnels and halls.

4) The NuMI Project will supply specifications for the NuMI tunnels and halls, including temperature and humidity conditions, degree and conditions of access to the detector alcoves, and an integrated installation schedule for the beamline which designates when WBS 1.1.1 instrumentation installation may occur.

7. Coordination and Reporting

The progress of the design, fabrication, and testing of these components will be reported by UT-Austin to the above-named task managers by WBS element, to the NuMI Level 2 Manager, who in turn will report subsystem progress to the NuMI Project Manager.

III. Cost and Funding

1. Tasks and Costs

UT-Austin will carry out the following list of detector design, procurement, and fabrication tasks:

WBS	Task	Cost est with burdens
1.1.1	SEM Prototyping, Development	$50
1.1.1	SEM Construction	$200

Total funding required from Fermilab is approximately $250K. The total cost includes all university overheads (0% on M&CS, 22.5% on off-campus labor, and 50% on on-campus labor). The cost does not include the 1.5% Fermilab pass-through overhead rate. All costs are in FY02 dollars.

2. Method of Funding Transfer and Purchasing

Fermilab shall commit funds to the UT-Austin based on the Fermilab budget allocated to the NuMI Project for the duration of the NuMI construction. The NuMI Project Manager has the final authority over such expenditures as well as the obligation to monitor and control costs related to the project. The NuMI Project Manager may redirect funds in the event of funding shortages, project delays, or cost overruns. UT-Austin shall make every effort to minimize the cost of the items procured under the terms of this memorandum insofar as it is consistent with the technical requirements of the project.

Purchases may be made in two ways:

a) Fermilab Purchase Orders written by the NuMI Project Manager or Level 2 Manager to UT-Austin to cover specific equipment and services items agreed upon in this document.
b) Fermilab Purchase Orders written by the NuMI Level 2 Manager to specific vendors, requesting the material to be delivered to UT-Austin.

UT-Austin, in consultation with NuMI Level 2 Manager may choose to use Fermilab purchasing services as in b) above. The choice of funding method shall be at the option of UT-Austin, provided the arrangement is satisfactory to the funding authority. Expenditures at UT-Austin covered by Fermilab purchase orders written by the NuMI Project Manager or Level2 Manager to UT-Austin will be reimbursed. Reimbursement will be based upon an invoice of actual costs incurred and submitted to the NuMI Project Office at Fermilab by UT-Austin.

UT-Austin may attempt to forward-fund some components covered in this MOU so as to accomplish the work in advance of the funding schedule. In such an event, UT-Austin and the NuMI Project manager will draft an amendment to this MOU to delineate the amount of this forward funding and a repayment schedule consistent with the NuMI TEC funding profile.

3. Procurement Authorization

Item purchases exceeding the delegated limit (currently $20k) must be authorized by the NuMI Level2 Manager. Major procurements (currently $100k) must in addition have the written authorization of the NuMI Project Manager.

4. Cost Reporting

UT-Austin will invoice Fermilab for all NuMI related expenditures and labor charges and will report associated technical progress in each item of work by Work Breakdown Structure (WBS) category (level 4) on a monthly basis through the appropriate NuMI Level2 Manager to the NuMI Project Manager. Monthly progress reports to NuMI management should include details of work carried out, and current status as required for the NuMI Monthly Report.

IV. General Consideration

1. Safety and Engineering Practices

The experimenters from UT-Austin agree to familiarize themselves with NuMI & Fermilab safety policies and to adhere to them. All detector components must be designed, fabricated, installed and operated in conformity with NuMI & Fermilab safety policies and practices as well as NuMI & Fermilab engineering standards. All major components will undergo appropriate NuMI Project design, safety, and engineering reviews.

Collaborators are reminded that they may not bring to or take from Fermilab any radioactive materials, including sealed radioactive sources or detectors which contain such sources, without appropriate prior authorization. This authorization must be given in writing, for each item, from the head of the Fermilab Environment, Safety and Health Section. All experimenters are expected to comply with the requirements of the Fermilab ES&H Manual for work and devices at Fermilab, of which the Fermilab Radiological Control Manual is a part.

2. Component Ownership

All items purchased or fabricated with funds supplied by Fermilab will remain the property of Fermilab. Such items will be properly identified with a Fermilab property tag. Any item owned by UT-Austin, which is installed as part of a NuMI beamline shall be identified by a UT-Austin property tag. Such items shall remain part of the beamline until such time as the beamline is decommissioned or the element is replaced.

3. Schedule and Milestones

UT-Austin will make every effort to carry out their institutional responsibilities consistent with the schedule shown in NuMI Cost and Schedule Plan for the fabrication of the NuMI beamline. These schedules may have to be changed as the project progresses. Changes that affect UT-Austin will be noted in Amendments to this Memorandum.

The key milestones relevant to UT-Austin are listed here:

WBS	Key Milestones	Date
1.1.1	Development of prototype SEM	Feb. 2003
1.1.1	Begin chamber construction period	June 2003
1.1.1	Installation in NuMI tunnel	July 2004

V. Approval

The following concur in the terms of this Memorandum of Understanding.
These terms will be updated as appropriate in Amendments to this Memorandum.

_____
S. Kopp – Principal Investigator at UT-Austin

_____
W. Kuenstler – Director, Office of Sponsored Projects, UT-Austin

_____
S. Childress – NuMI co-Level 3 Manager for WBS 1.1.1

_____
B. Baller – NuMI Level 2 Manager

_____
S. Wojcicki - MINOS Spokesperson

_____
G. Bock - NuMI Project Manager

_____
R. Dixon – Beams Division Head, Fermi National Accelerator Laboratory

_____
S. Holmes – Associate Director for Beams, Fermi National Accelerator Laboratory

_____
M. Witherell – Director, Fermi National Accelerator Laboratory