Neutrino Division	# Technical Scope of Work		
Document Identifier: *DocDB #*	*Institute Document Ref:*	*Created: 7/3/2016* *Last Modified:*	*Rev. No.:* *1*

MicroBooNE Cosmic Ray Tagger Test Stand

6/30/2016

Prepared by:
Joseph Zennamo, David Martinez and David Lorca

History of Changes

Date	Version	Changes/Comments	Authors
7/3	1		JZ,DM, DL

I. INTRODUCTION

This is a technical scope of work between the Fermi National Accelerator Laboratory (Fermilab) and the MicroBooNE Collaboration, who have committed to testing these scintillator panels, provided by the University of Bern, and build the racks necessary to power and readout the system. These panels will allow us to tag cosmic ray particles that are passing through the MicroBooNE cryostat.

The memorandum is intended solely for the purpose of recording expectations for budget estimates and work allocations for Fermilab, the funding agencies and the participating institutions. It reflects an arrangement that currently is satisfactory to the parties; however, it is recognized and anticipated that changing circumstances of the evolving research program will necessitate revisions. The parties agree to modify this memorandum to reflect such required adjustments. Actual contractual obligations will be set forth in separate documents.

I.1. DESCRIPTION OF COSMIC RAY TAGGER SYSTEM:

This cosmic ray tagger system will be composed of two layers of scintillator where the light is directed to a pair of SiPM readout devices by two wavelength shift fibers. This system is intended to record location and timing of when charged particles pass through the scintillator with precise timing resolution. This will augment the existing MicroBooNE liquid argon time projection chamber and allow for us to tag activity as cosmic induced. This will reduce cosmic backgrounds and allow for the use of precise timing of cosmic particles as a calibration source.

These panels are constructed at the University of Bern and shipped to Fermilab. We intend to unpack the panels and test them. Once tested these panels will be stored at the test stand before they are moved to LArTF for installation. In addition we intend to build the production racks in this space and receive pORC before moving them to LArTF for installation. The procedure for the installation of these panels will be documented in additional TSWs.

For the installation proposed here, the experimenters are requesting the following support from Fermilab:

- Technical support to help with moving the equipment to the test stand.
- Space to host the test stand.
- Space to store the panels pre- and post-testing.
- Resources to transport the panels from the test stand to LArTF for installation.
- Electrical requirements to power the production racks for pORC.

II. PERSONNEL AND INSTITUTIONS:

The physicists in charge of the testing will be Roxanne Guenette, professor, Oxford, and Martin Auger, postdoc, Bern, with David Martinez, postdoc, IIT, acting as test stand manager. Joseph Zennamo, MicroBooNE Technical Coordinator, is coordinating activities along with Linda Bagby.

The group members on this project at present are:

Institution	Collaborator	Rank/Position	Other Commitments
	Martin Auger	Postdoc	
Bern	David Lorca	Postdoc	
	Michele Weber	Professor	
U. Chicago	Joseph Zennamo	Postdoc	
Fermilab	Linda Bagby	Staff	
Yale	Elena Gramellini	Graduate student	
	Rui An	Graduate student	
IIT	David Martinez	Postdoc	
	Bryce Littlejohn	Professor	
Oxford	Roxanne Guenette	Professor	

III. EXPERIMENTAL AREA AND SCHEDULE CONSIDERATIONS:

III.1. LOCATION

III.1.1. The panels will be received in the DAB highbay, where they will be moved into the pit. They can be stored either in the sidewalk area or on the pit floor. The area in question is shown in Fig. 1.

III.1.2. The test stand will be staged on the sidewalk, where we will also build the production rack.

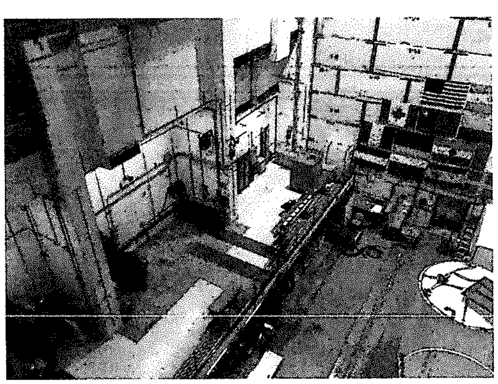

Figure 1: Location of test stand, DAB pit sidewalk. The pit floor will act as additional storage space for the tested panel shipments

III.2. Experimental Conditions

III.2.1. Area Infrastructure

The proposed location of the test stand is shown if Figure 1.

The experiment will need:

- Help moving the panels to this location.
- Space to store the panels.
- Power to operate the racks for a pORC review.

III.2.2. Description of Shipped Panels and Testing

Each batch is shipped in large boxes containing many panels on an A-frame. The maximum shipping box dimensions are 5 m x 2 m x 0.75 m, with a typical weight of ~2000 kg (2.2 tons), depending of the module configuration.

The last shipment of module consisting of 3 crates is estimated arrival in the end of July or beginning of August.

Bern has sent a total of 8 crates. Two of which are completely or partially empty because the panels have been moved to LArTF for installation. In the worst-case scenario, if all the crates are placed together, then 80 m^2 of floor space will be needed.

All crates will be leaving DAB in the second half of August when all the side panels get installed. ~~One panel will be kept as excess at the DAB test stand.~~ GZ

Testing setup will consist of a single server rack and table, with a large space available for storage of module stacks on their shipping palettes. This storage will not hinder the passage through any emergency exit or aisle in the work platform. FEBs will be attached to individual or multiple modules and connected to a server and power supply in the server rack while tests are run on that module. Standard 120V AC power is needed for the power supply and computers, and is readily available in this location.

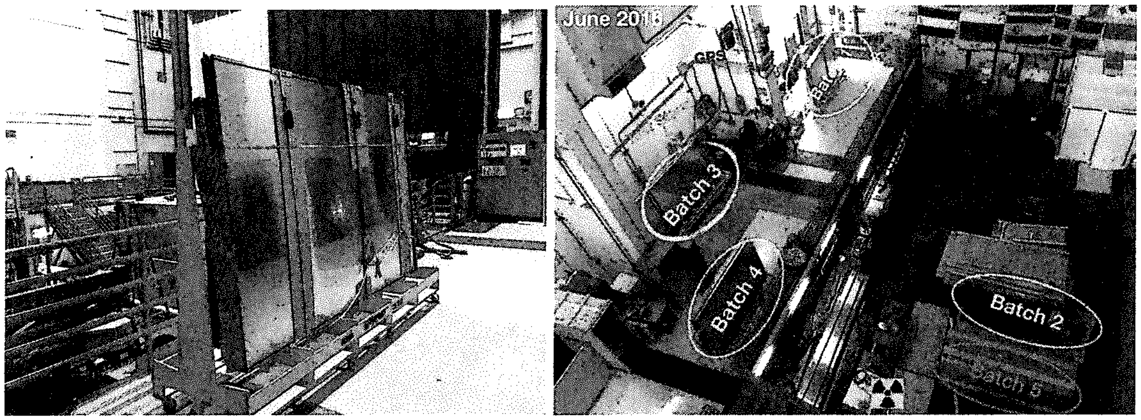

FIG 2: Left: One batch of modules. Right: All the batches of modules present at DAB including radioactive source box location.

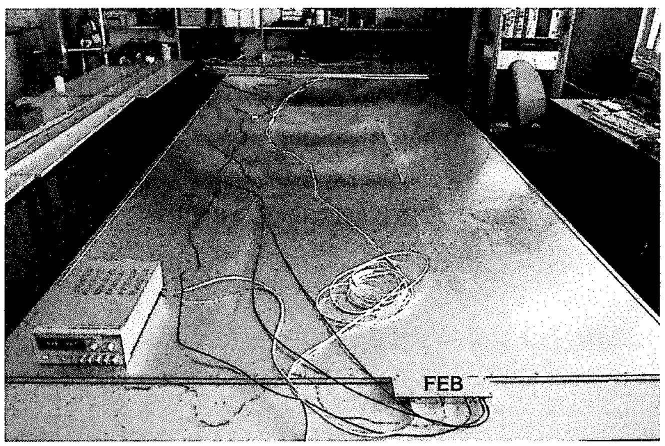

FIG 3: Prototype cosmic tagger module with FEB connected.

Server rack will be populated with production rack infrastructure and electronic components. This infrastructure consists of production MicroBooNE rack protection, slow control, temperature and smoke sensors and 208-3phase AC distribution systems, as well as commercial units including a network switch, a NIM crate and modules and fan pack, a server, and a Wiener 512 DC power supply. This setup will require 208-3phase power, which will need to be run via an extension from an existing 208-3phase outlet on DAB's high bay level.

III.2.2.1. Testing

Testing will be carried on as follows:

- **Initial Setup:** Connect one FEB to one module, and verify proper readout to test stand computers and operation of the FEB-module pair.

- **FEB Tests:** Connect all FEBs to the previously tested module, and verify proper operation of and signal processing in all FEBs.

- **Module Tests:** Connect FEBs to multiple stacked modules and perform simultaneous readout of modules to determine scintillator strip's trigger rate, muon detection rate, and light collection levels along each strip's length. Record rates and efficiency and identify problematic strips.

- **Position Reconstruction Verification**: Utilize a weak μCi-level radioactive gamma source to verify proper position reconstruction.

- **CRT production rack pORC**: perform pORC of production rack to allow unattended operation and streamlining of the CRT ORC process at LArTF.

- **Slow Control Testing**: Verify readout of slow control information from the production rack rack's slow control chassis and Wiener power supply. Test automated storage of slow control data in MicroBooNE's slow control database.

For the CRT production rack pORC we will include the following items in a single rack:

1) Five 1U single Intel Xeon E5 2620-v4 2.1 GHz 8 core server node with a total power consumption of 3.5 kW.
2) One 24 Network switch with power consumption of 700 W.
3) One smoke sensor with power consumption of 30 W.
4) One slow control box with power consumption of 15 W.
5) One 2U Dual Intel Xeon E5 2620-v4 2.1 GHz storage rack server with power consumption of 440 W.
6) One slide out 1U rack mount monitor/keyboard with power consumption of 13.6 W.
7) One AC switch box with power consumption negligible.

The total power consumption for the production rack will be around 4.7 kW.

III.3. SCHEDULE

Testing is currently underway with three more shipment of modules currently enroute (expected to arrive July 21). All modules will be moved for installation during the first 5 weeks of the summer shutdown.

IV. RESPONSIBILITIES BY INSTITUTION – NON FERMILAB

- Cosmic Tagger Modules (Bern University)

- Cosmic Tagger Front-end electronics (Bern University)

- Commercial electronics: Server (MicroBooNE collaboration)

- Operational organization, including reviews, operation reports, and interactions with MicroBooNE collaboration (Bern, IIT, Oxford, U. Chicago, Yale)
- Labor for running test stand (All)
- Analysis of test stand data (All)

V. RESPONSIBILITIES BY INSTITUTION – FERMILAB

V.1. FERMILAB PARTICLE PHYSICS DIVISION:

- PPD technical support in moving modules into appropriate test stand locations (DAB overhead crane supported by neutrino division).
- PPD engineers for safety review.
- Space to store the modules after testing and before installation.

V.2. FERMILAB NEUTRINO DIVISION

- Rack infrastructure: rack protection and slow control systems, AC distribution, network switch, temperature sensors and fan packs.
- AC, DC, network and signal cabling for testing.
- Custom and commercial electronics: reference signal distribution box, HV power supply, and servers.

V.3. FERMILAB SCIENTIFIC COMPUTING DIVISION

- Internet access in DAB at the test stand location.
- NIM crate and logic modules for testing.

V.4. FERMILAB ESH&Q SECTION

- Assistance with safety reviews.
- Provide safety training for experimenters, as necessary. Assistance with the radiation work and radiation source training for the experimenters.
- Radioactive Co-60 source for testing.

VI. Summary of Costs

Item	Required Funds (k$)	Labor [Person-weeks] PPD	Labor [Person-weeks] ND	Labor [Person-weeks] Collab
	ND			
RPC Chasis	1.0		1.0	1.0
Servers	8.0		1.0	1.0
Electronic Material	1.0		1.0	1.0
Crane Operation		1.5		
Total	10.0	1.5	3.0	3.0

For the 1.5 FTE weeks of PPD labor is coming from neutrino division with budget code 40SBN.CM.OPS.

VII. MILESTONES

1. 5 batches of modules shipped from Bern arrived safety at Fermilab.
2. Successfully test all the modules readout into the 5 batches.
3. Radioactive source testing using Co-60 have shown no broken fibers inside the modules.
4. Light leak testing successfully carried on all the modules into the 5 batches. Modules with light leaks found were patched and no light leaks present.
5. Successfully testing of all the necessary frontend boards (FEBs) to instrument all the modules. Furthermore all their input/output connectors were tested.
6. Perform a pORC of production rack to allow unattended operation and streamlining of the CRT ORC process at LArTF.

VIII. SPECIAL CONSIDERATIONS

1. The responsibilities of the Spokesperson and the procedures to be followed by experimenters are found in the Fermilab publication "Procedures for Researchers". The Spokesperson agrees to those responsibilities and to follow the described procedures.

2. To carry out the work a number of Environmental, Safety and Health (ES&H) maybe required. This includes creating any necessary Operational Readiness Clearance documents. The Technical Coordinator will follow those procedures in a timely manner, as well as any other requirements put forth by the Division's Safety Officer.

3. All regulations concerning radioactive sources will be followed. No radioactive sources will be carried onto the site or moved without the approval of the Fermilab ES&H section.

4. All items in the Fermilab Policy on Computing will be followed by the experimenters. (http://computing.fnal.gov/cd/policy/cpolicy.pdf).

5. The experimenters will be responsible for maintaining both the electronics and the computing hardware supplied by them for the experiment. Fermilab will be responsible for repair and maintenance of the Fermilab-supplied electronics. Any items for which the experiment requests that Fermilab performs maintenance and repair should appear explicitly in this agreement.

VIII. The following People have read this TSW:

________________ 8 / 30 / 2016

MicroBooNE Technical Coordinator

________________ 09 / 01 / 2016

MicroBooNE Spokesperson

________________ 9 / 02 / 2016

ESH&Q Representative

________________ 9 / 2 / 2016

Neutrino Division Representative

________________ 9 / 6 / 2016

Particle Physics Division Representative

APPENDIX I: - HAZARD IDENTIFICATION CHECKLIST

Items for which there is anticipated need have been checked. See next page for detailed descriptions of categories.

Flammable Gases or Liquids		Other Gas Emissions		Hazardous Chemicals		Other Hazardous /Toxic Materials
Type:		Type:			Cyanide plating materials	List hazardous/toxic materials planned for use in a beam line or an experimental enclosure:
Flow rate:		Flow rate:			Hydrofluoric Acid	
Capacity:		Capacity:			Methane	
Radioactive Sources		**Target Materials**			photographic developers	
	Permanent Installation		Beryllium (Be)		PolyChlorinatedBiphenyls	
X	Temporary Use		Lithium (Li)		Scintillation Oil	
Type:	Cesium-137 Wand		Mercury (Hg)		TEA	
Strength:	2 microCuries		Lead (Pb)		TMAE	
Lasers			Tungsten (W)		Other: Activated Water?	
	Permanent installation		Uranium (U)			
	Temporary installation		Other:	**Nuclear Materials**		
	Calibration	**Electrical Equipment**		Name:		
	Alignment		Cryo/Electrical devices	Weight:		
Type:			Capacitor Banks	**Mechanical Structures**		
Wattage:		X	High Voltage (50V)	X	Lifting Devices	

Class:			Exposed Equipment over 50 V		Motion Controllers	
		X	Non-commercial/Non-PREP		Scaffolding/ Elevated Platforms	
			Modified Commercial/PREP		Other:	
Vacuum Vessels		**Pressure Vessels**		**Cryogenics**		
Inside Diameter:		Inside Diameter:			Beam line magnets	
Operating Pressure:		Operating Pressure:			Analysis magnets	
Window Material:		Window Material:			Target	
Thickness:		Window Thickness:			Bubble chamber	