Neutrino Division	# Technical Scope of Work		
Document Identifier: MicroBooNE DocDB # ***6241***	*Institute Document Ref:*	*Created: 7/24/2016* *Last Modified:* 8/16/2016	*Rev. No.:* *4*

MicroBooNE Cosmic Ray Tagger
Side and Top Installation

7/24/2016

Prepared by:
Martin Auger and Roxanne Guenette

History of Changes

Date	Version	Changes/Comments	Authors
7/24/2016	1		RG, MA
8/11/2016	2		AS, JZ
8/16/2016	3		RG, MA, MW
8/16/2016	4		SZ, BF

I. INTRODUCTION

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

This document 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 addend this document 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 is composed of two layers of scintillator with the light directed to SiPMs by wavelength shifting fibers. This system is intended to record location and timing when charged particles pass through the scintillator with precise timing resolution. This will augment the existing Physics capabilities of the MicroBooNE experiment and allow the experimenters 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.

The first stage of this installation was the installation of the bottom CRT system, described in a separate TSW. The side and top structure design and engineering, and side panel installations form the second stage of the CRT system described here. The testing and electrical installation have been and will be detailed in additional documents.

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

- Labor and expertise for installation.
- Technical support to help with moving the equipment on site.
- Engineering help with the design of the support structure and lifting procedure.
- Material to build the mechanical support structure.

II. Personnel and Institutions:

The conveners of the MicroBooNE cosmic-ray tagger system are Roxanne Guenette, professor, Oxford, and Martin Auger, postdoc, Bern.

The installation managers are David Martinez, postdoc, IIT and Martin Auger, postdoc, University of BERN.

MicroBooNE Technical Coordinator, is Joseph Zennamo, coordinating activities along with MicroBooNE Run Coordinator, Matt Bass.

Aria Soha is coordinating the installation effort for all the Fermilab-related tasks (mechanical installation design and construction, panel handling and installation, reviews).

Technical Task Overseer: John Voirin, FNAL – PPD
Lead Mechanical Engineer: CM Lee, FNAL – PPD
Expert Electronics Engineer: Linda Bagby, FNAL – PPD
MicroBooNE CRT Mechanical Installation Committee Chair: Barry Norris, FNAL – ND

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	
Yale	Elena Gramellini	Graduate student	
	Rui An	Graduate student	
IIT	David Martinez	Postdoc	
	Bryce Littlejohn	Professor	
	Matt Bass	Postdoc	
Oxford	Roxanne Guenette	Professor	
	Roberto Soleti	Graduate student	

III. EXPERIMENTAL AREA, BEAMS AND SCHEDULE CONSIDERATIONS:

III.1. LOCATION

III.1.1. The support structure will be prefabricated in Lab F.

III.1.2. The modules and support structures will need to be prepped for installation in LArTF at ground level.

III.1.3. The actual side modules, along with support structure, will sit on either side of the MicroBooNE cryostat. Possibly supported by the platform I-beams.

III.1.4. The actual top modules will be supported by a structure possibly connected to the platform in LArTF.

III.1.5. Before installation, the side panels will need to be stored at D0 Assembly Building.

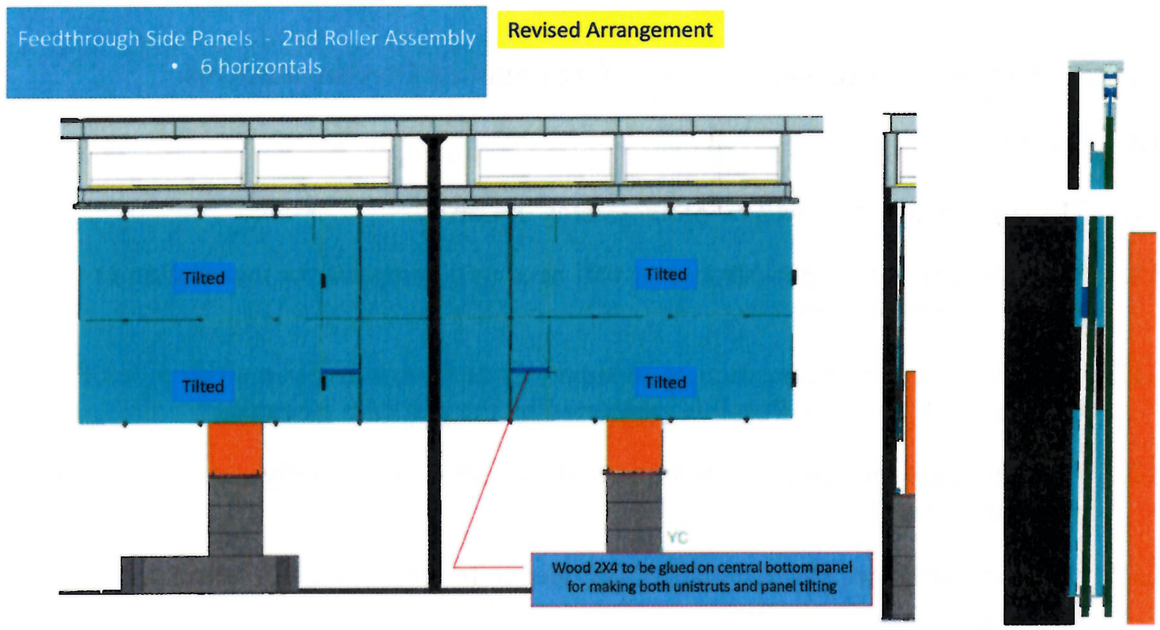
III.2. EXPERIMENTAL CONDITIONS

III.2.1. AREA INFRASTRUCTURE

The proposed location of the CRT system side panels are shown if Fig. 1 and Fig. 2.

The experiment will need help manipulating this structure in LArTF, specifically:

- Help with prepping and installation of the support structure.
  - Installation of panels will require coordination with the collaboration to allow for cable installation and testing
- Use of crane and riggers for moving and positioning the scintillator panels and support structure.
- Rigging and lifting the support structure into place.



F10058593

Figure 1: Schematic of a possible installation of the MicroBooNE CRT "feed through-side" panels. This is a duel-layered structure; see side view to the right.

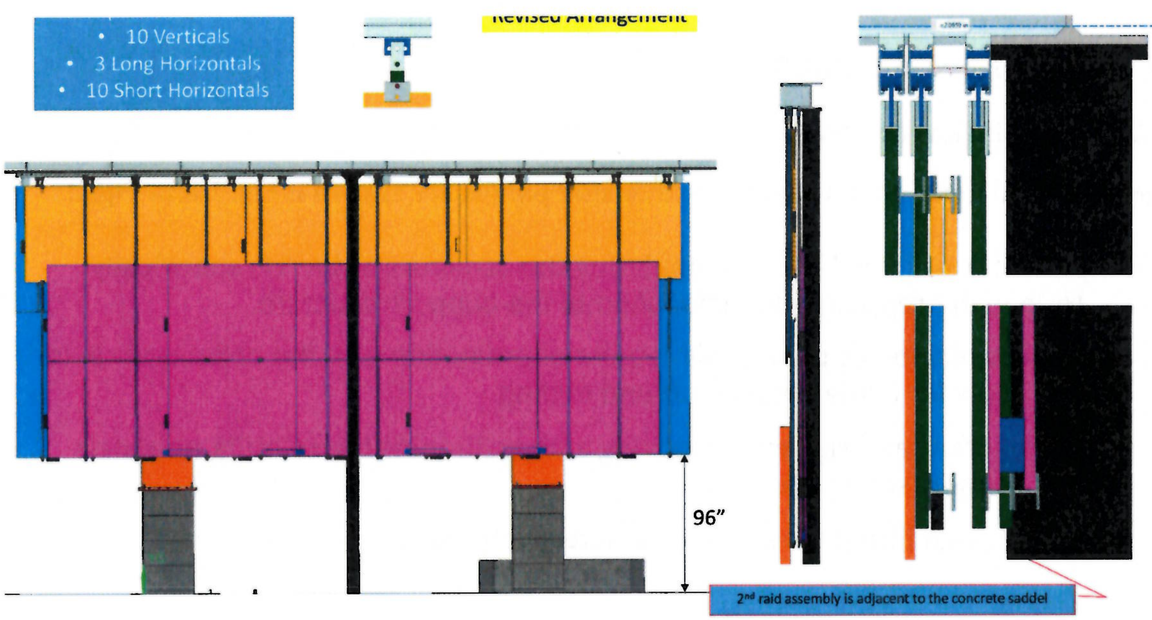


Figure 2: Schematic of a possible installation of the MicroBooNE CRT "pipe-side" panels. This is a three-layered structure; see side view to the right.

I.1.2. Description of CRT Installation

The first stage is the installation of the side panels is the installation of the support structure. One concept for supporting the CRT panels is shown in Figure 5. This involves suspending a panel assembly from a set of commercial unistrut rollers that are rated to bare the weight of the load, shown in Fig. 5.

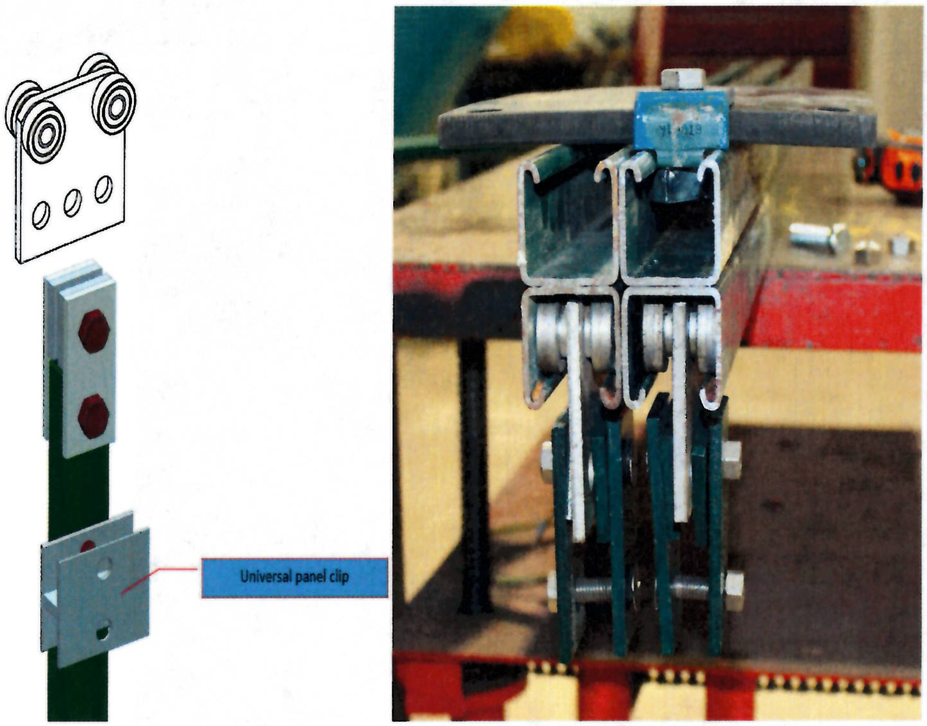


FIG 5: Schematic of the support structure for the side panel installation on both sides of the MicroBooNE cryostat.

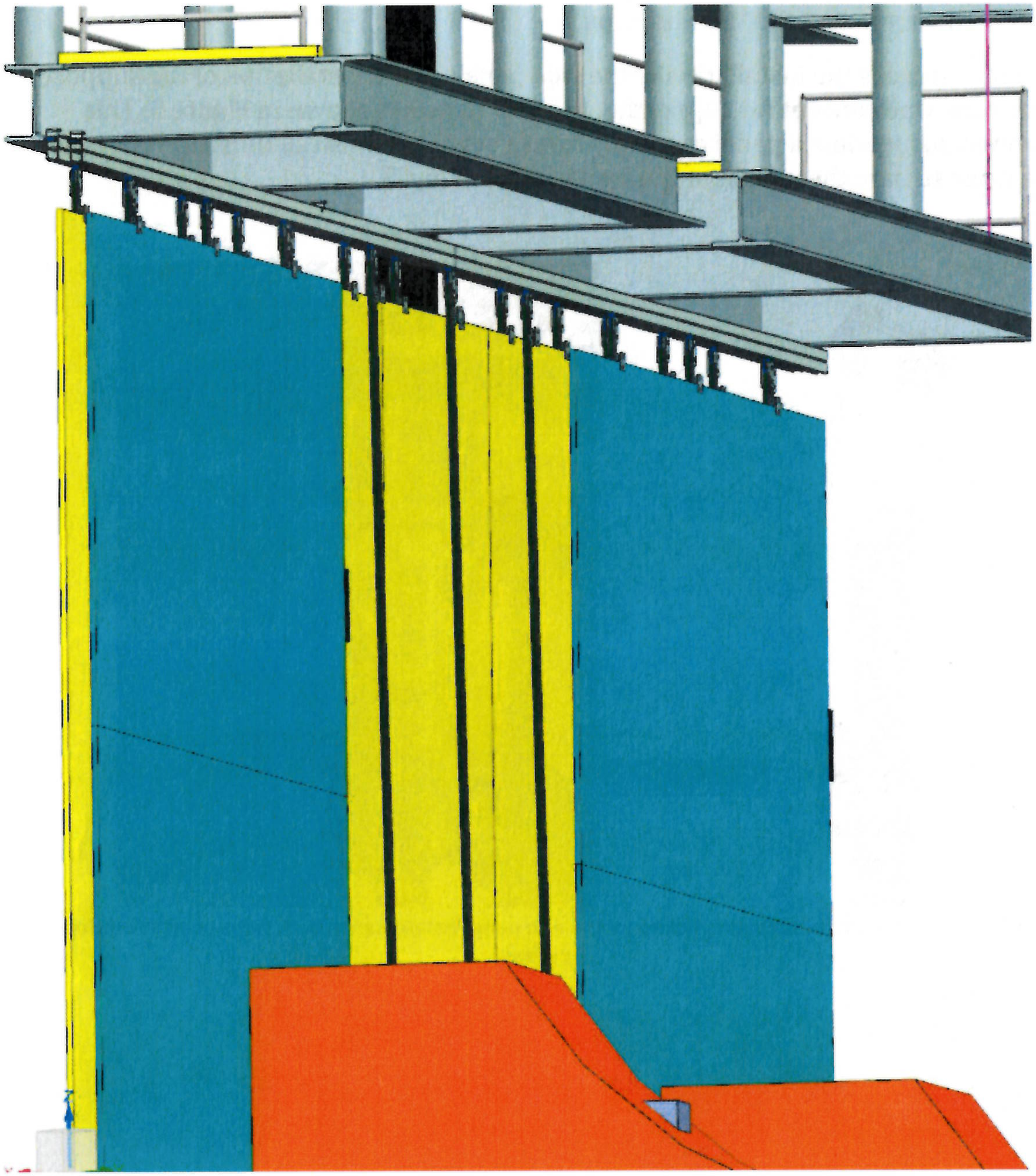


FIG 6: Schematic of the support structure for the side panel installation on the sides of the MicroBooNE cryostat with cryogenic with pipes and feedthroughs.

The panels will be lowered in the pit using the building crane and a rigging system. This rigging will be composed of a commercial vacuum-lifting fixture that holds the panels and can be rotated to accommodate installation orientation.

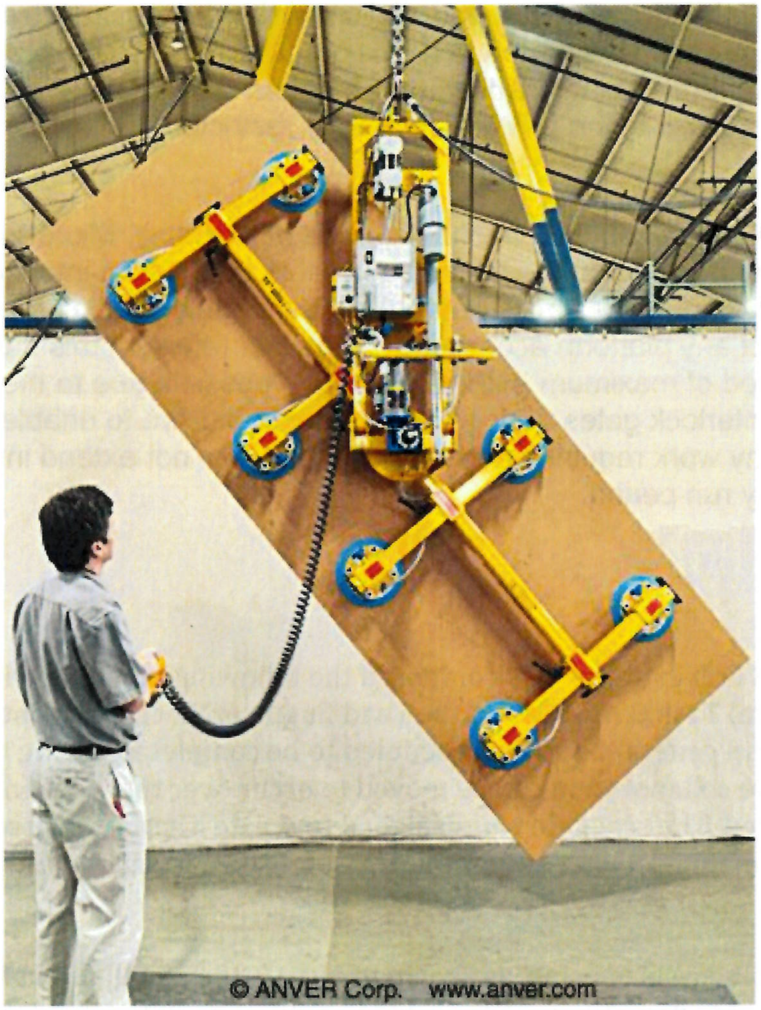


Fig. 7 Lifting vacuum jig that will be used to move the panels.

The vacuum-lifting fixture has been ordered and is expected to arrive before August 17th. An engineering analysis and practice sessions will be completed upon arrival and before the fixture is deployed to LArTF.

The top panels will not be arriving at the laboratory until November 2016 but the support structure for them can be installed during the shutdown so that the panels can be installed once they arrive. These panels will be supported by a structure to be designed by Fermilab engineering.

I.1.1. Schedule Concerns

The installation of the CRT system support structure has been scheduled to be completed over the summer shutdown. This is because access to the platform creates DAQ instabilities leading to downtime and loss of POT for the experiment. For this reason, access to the platform is heavily restricted during nominal beam data-taking.

After the BNB shutdown but before NuMI comes back online, MicroBooNE will have the opportunity to run at the highest allowable BNB beam intensity, so the collaboration will want to maximize data-taking during this special period and hence will restrict any platform access that could interfere with this data-taking. This unique period of maximum BNB rate is made possible due to the installation of a set of new interlock gates during the summer shutdown to enable this. It is important that any work requiring access to the platform not extend into this special BNB-only run period.

I.3. Schedule

The MicroBooNE Collaboration has composed the following schedule with input from the Technical Task Overseer and the Lead Engineer. Each task contains built in contingency and in general tasks are scheduled to be completed during the day, but other work by the collaboration can be moved to occur over the weekends or evening if required. The schedule was designed to create a serial work schedule to keep track of changing detector conditions for debugging, if issues arise.

The experimenters are proposing, as shown in Fig. 10, the installation of side-panel support structure starting August 17th. This procedure is expected to take 4 days (as estimated by the Technical Task Overseer including contingency).

Once the support structure is in place and the vacuum jig has passed the necessary reviews the side-panels themselves would be installed and cabled up starting August 29th. This will be done in tandem with the cabling of the panels as they are installed. Further electrical installation and testing work can be performed in the night after given panels are installed.

Finally, the top panel support structure could be installed and would take an additional 8 days for the support structure starting the week of September 12th, but will move as the schedule demands. Further, the top table could be installed after data-taking starts but this will result in a loss of data to the experiment and is not preferred by the collaboration.

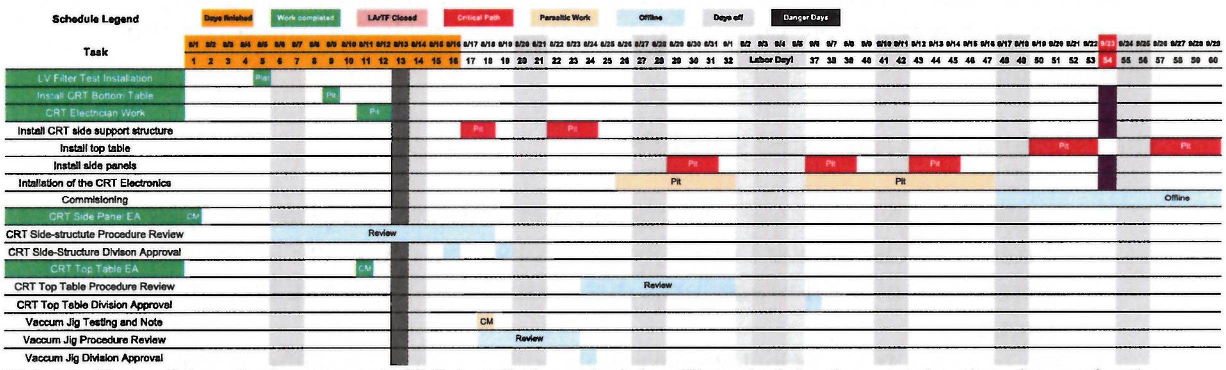


FIG 10: The collaboration's requested CRT installation schedule. The schedule also contains time frames for the expected reviews and approvals needed.

The CRT installation is the largest and most time consuming of the MicroBooNE summer upgrades, full schedule shown in Fig. 11, that are planned to take place during the accelerator shutdown. This installation represents the critical path for a successful completion of the collaboration's upgrade plans. For this reason these installations are planned to take place as the engineering analyses are completed for the subsequent installation steps.

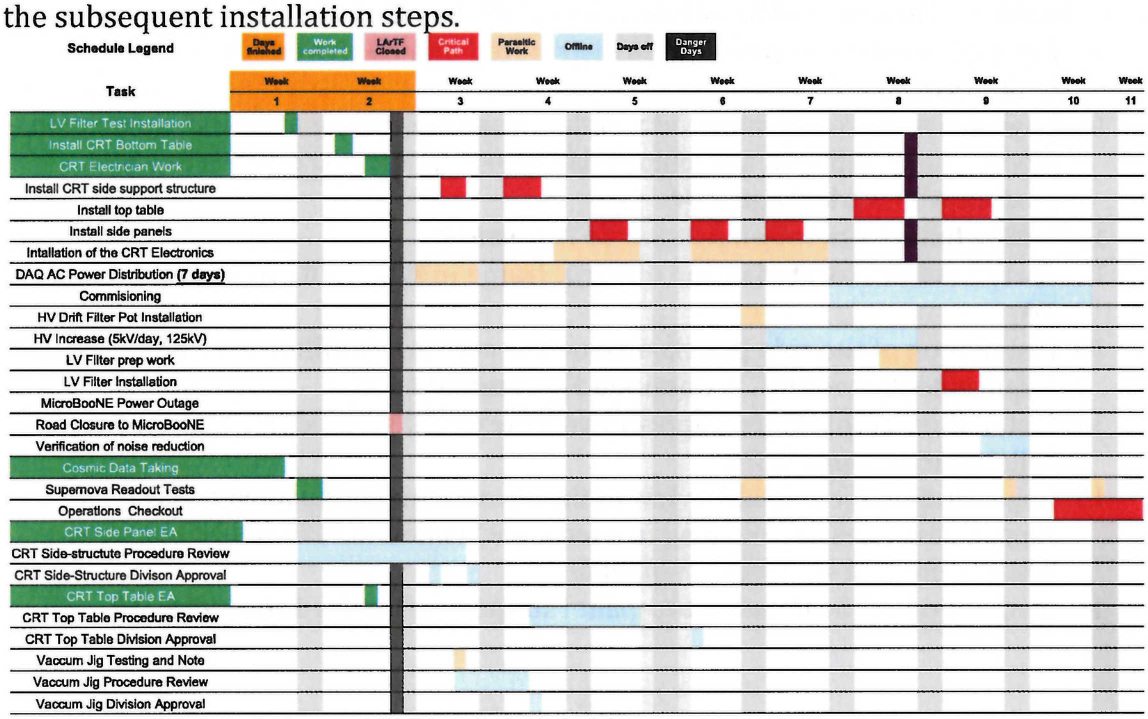


FIG 11: The collaboration's requested CRT installation schedule.

Schedule concerns include completeing the installation in time for high intensity BNB only running, before NuMI turns on, as described above. An additional concern is to avoid over-scheduling the Expert Electronics Engineer. As the schedule slides there is increased risk that her duties during the shutdown, currently fully leveraged, will overlap. We will request overtime for technical support if the schedule slips.

The collaboration's requested schedule:

1. Engineering Note for steel unistrut support structure completed. ***August 1***
2. Wrote JHA/Installation Procedure for steel support structure. ***August 8***
3. Installation of steel procedures distributed and approved by collaboration ***August 8***
4. Engineering & Technical Review of the side-structure installation process and support structures, culminating in a recommendation to PPD and ND division heads to proceed with work. ***August 16***
5. Installation of the unistrut side-panel support structure in the pit of LArTF. ***August 17***
6. Engineering notes for top-panel support completed. ***August 11***
7. Lifting fixture to arrive on site ***August 17***
8. Engineering note for the lifting fixture to put the panels on the nominal position (side of the MicroBooNE cryostat) ***August 18***
9. Installation of panel procedures distributed and approved by collaboration by ***August 16***
10. Engineering & Technical Review of the vacuum-lifting jig and panel installation process, culminating in a recommendation to PPD and ND division heads to proceed with work. ***August 24***
11. Lifting fixture operational at LArTF ***August 26***
12. Forty modules located in the unistrut frame in the pit of LArTF. ***September 14***
13. Installation of the side panels around the cryostat fulfilling the ES&H requirements and ORC is obtained ***September 16***
14. Installation of top-panel support procedures distributed and approved by collaboration ***August 24***
15. Engineering & Technical Review of the top-structure installation process and support structures, culminating in a recommendation to PPD and ND division heads to proceed with work. ***September 9***
16. Installation of the unistrut top-panel support structure ***September 19***

All final HAs and procedures will be created by the Technical Task Overseer and will be approved by the MicroBooNE CRT Mechanical Installation Committee.

IV. Responsibilities by Institution – Non Fermilab

- Cosmic Tagger Modules (Bern University)
- Operational organization, including reviews, operation reports, and interactions with MicroBooNE collaboration (Bern, IIT, Oxford, Yale, U. Chicago)
- Labor for installation (Bern, IIT, Oxford, Yale)

V. Responsibilities by Institution – Fermilab

V.1. Fermilab Particle Physics Division:

5.1.1 Technical support for the construction of the support structure.
5.1.2 Technical support for the movement and installation of support structures.
5.1.3 Technical support for the installation of the panels.
5.1.4 Engineering support for determining the installation procedure and verification of the structural side-supports, by August 2nd.
5.1.6 Engineering support for determining the installation procedure and verification of the panel installation utilizing the commercial vacuum-lifting fixture, by August 18th.

V.2. Fermilab Neutrino Division

5.2.1 Funding for the M&S of the structure for the side panels
5.2.2 Technical oversight of the installation
5.2.3 Engineering review of the installation fixtures and procedures

V.3. Fermilab ESH&Q Section

5.5.1 Assist with safety reviews.
5.5.2 Provide necessary training for experimenters.

VI. SUMMARY OF COSTS

Source of Funds	Materials & Services (For Side and Top Installation)	Planning (For the Side and Top installation) (person-weeks)	Labor for Installation (For the Side and Top structure and side panels) (person-weeks)
Neutrino Division	$6k (side structure)+ $6k (top structure)+ $16k (lifting fixture)	3 weeks for John V. + CM L. + Erik V. (1-wk EA* of side-structure, 1-wk EA* top-structure, 1-wk EA* of lifting fixture)	5 weeks for John V. + 3 Technicians
Non-Fermilab		3 weeks for 2 collaborators (Martin and David)	5 week for 6 collaborators (David and 5 more)
Totals Fermilab	$28K	9	20
Totals Non-Fermilab	$450K	6	30

* "EA" refers to "engineering analysis"

VII. MILESTONES

1. Engineering Note for steel unistrut support structure completed.
2. Wrote JHA/Installation Procedure for steel support structure.
3. Installation of steel procedures distributed and approved by collaboration
4. Engineering & Technical Review of the side-structure installation process and support structures, culminating in a recommendation to PPD and ND division heads to proceed with work.
5. Installation of the unistrut side-panel support structure in the pit of LArTF.
6. Engineering notes for top-panel support completed.
7. Lifting fixture to arrive on site
8. Engineering note for the lifting fixture to put the panels on the nominal position (side of the MicroBooNE cryostat)
9. Installation of panel procedures distributed and approved by collaboration by
10. Engineering & Technical Review of the vacuum-lifting jig and panel installation process, culminating in a recommendation to PPD and ND division heads to proceed with work.
11. Lifting fixture operational at LArTF
12. Forty modules located in the unistrut frame in the pit of LArTF.
13. Installation of the side panels around the cryostat fulfilling the ES&H requirements and ORC is obtained
14. Installation of top-panel support procedures distributed and approved by collaboration
15. Engineering & Technical Review of the top-structure installation process and support structures, culminating in a recommendation to PPD and ND division heads to proceed with work.
16. Installation of the unistrut top-panel support structure

All final HAs and procedures will be created by the Technical Task Overseer and will be approved by the MicroBooNE CRT Mechanical Installation Committee.

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": (http://www.fnal.gov/directorate/PFX/PFX.pdf). 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. The Technical Coordinator will ensure one person is available at LArTF whenever work is being performed and that this person is knowledgeable about the experiment's hazards.
4. 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.
5. All items in the Fermilab Policy on Computing will be followed by the experimenters. (http://computing.fnal.gov/cd/policy/cpolicy.pdf).
6. 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.

IX. SIGNATURES

The following People have read this TSW:

_______________________ 8/16/2016
MicroBooNE Technical Coordinator

_______________________ 8/16/2016
MicroBooNE Spokesperson

_______________________ 8/16/2016
Neutrino Division Representative

_______________________ 8/17/2016
Particle Physics Division Representative

Angela Aparicio _______________________ 8/18/2016
ESH&Q 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	
	Temporary Use		Lithium (Li)		Scintillation Oil	
Type:			Mercury (Hg)		TEA	
Strength:			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:			High Voltage (50V)	X	Lifting Devices	

Class:			Exposed Equipment over 50 V		Motion Controllers	
			Non-commercial/Non-PREP	X	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	