Fermilab

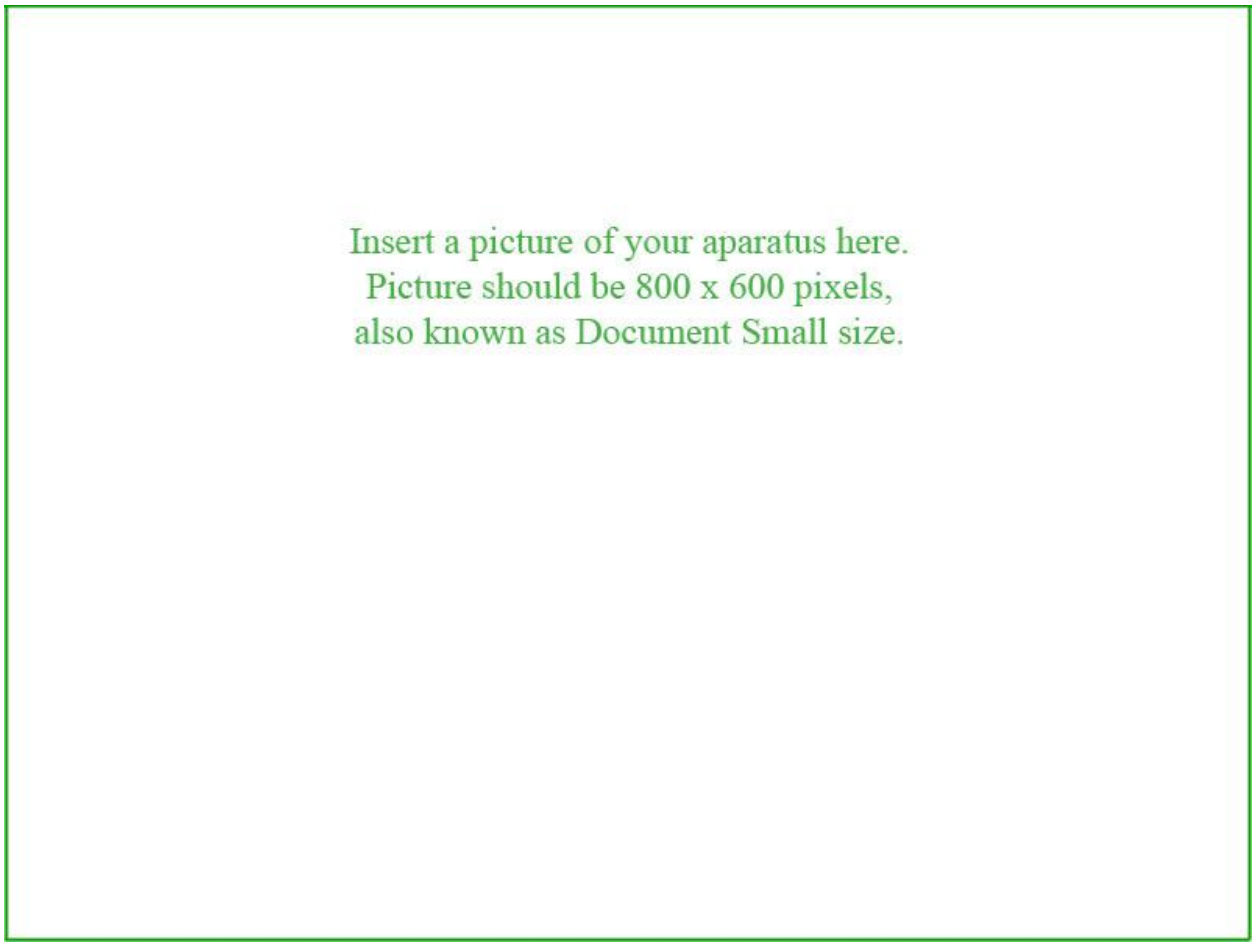
Directorate

TECHNICAL SCOPE OF WORK
FOR THE 2015 FERMILAB MTA DETECTOR IRRADIATION PROGRAM

T-1050

CDRD High Rate Data Links Program

March 20, 2014



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INTRODUCTION

This is a technical scope of work (TSW) between the Fermi National Accelerator Laboratory (Fermilab) and the experimenters of University of Minnesota, Fermilab, Argonne National Laboratory (ANL), Ohio State University (OSU) and Southern Methodist University (SMU) who have committed to participate in beam tests to be carried out during the 2013 - 2014 Fermilab Test Beam Facility program.

The TSW is intended primarily 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 scope of work to reflect such required adjustments. Actual contractual obligations will be set forth in separate documents.

This TSW fulfills Article 1 (facilities and scope of work) of the User Agreements signed (or still to be signed) by an authorized representative of each institution collaborating on this experiment.

Description of Detector and Tests:

Irradiation of components for high bandwidth optical communication systems. The experimenters plan to conduct radiation tolerance testing on several different components of ultra-high bandwidth data links. All components are small with surface densities less than 1 gm/cm^2. The following category of tests are foreseen:

1) Measurement of the effect of total ionizing dose (TID) with hadrons at levels up to 1 MGy for ASICs made with silicon and standard semiconductor impurities.
2) Measurement of the effect of TID of thin films of Barium Strontium Titanate deposited on fused silica substrates to levels of 1 MGy and total fluxes of up to 10^{15} protons/cm^2.
3) Measurement of Single Event Upsets (SEU) rate under irradiation of semiconductor components.
4) Measurements of darkening effects (i.e. loss of transparency) in optical components

Category 1) tests are done with an *in situ* readout of the components. This will be accomplished by having the component under study attached to a simple, and usually disposable, driver board that is placed approximately 1 m from the beam. This driver board is connected with copper cables and fiber optics to a readout and control system that is to be located in an accessible room for continuous monitoring of the component under test.

Category 2) tests are performed where it is sufficient to place the material in the beam and remove it once the irradiation is complete.

Category 3) tests require a beam with a flux as low as 100 Gy/hr. This corresponds approximately to a proton flux of 10^{11} protons/hour or 10^7 protons per second. Ideally the flux should be continuous.

I. PERSONNEL AND INSTITUTIONS:

Spokesperson: Roger Rusack

Fermilab Experiment Liaison Officer: Aria Soha

The group members at present are:

Institution	Country	Collaborator	Rank/Position	Other Commitments
The University of Minnesota	USA	Roger Rusack	Professor	CMS
		A. Finkel	Grad Student	CMS
		T. Norbert	Grad Student	CMS
Fermilab	USA	Alan Prosser	Engineer	CMS
OSU	USA	K.K. Gan	Professor	ATLAS
SMU	USA	Jingbo Ye	Professor	ATLAS
Argonne	USA	David Underwood	Scientist	

II. EXPERIMENTAL AREA, BEAMS AND SCHEDULE CONSIDERATIONS:

2.1 LOCATION

2.1.1 The beam test(s) will take place in the experimental hall of the MTA.

2.2 BEAM

2.2.1 BEAM TYPES AND INTENSITIES

Energy of beam: 400 MeV
Particles: H- ions
Beam spot size: 1 cm^2
Required Fluences: From 10^{13} to 10^{15} particles/cm^2

The purpose of this test is to irradiate components to evaluate their use in a high radiation environment. The flux of particles needs to be known with a precision of 1%.

2.2.2 BEAM SHARING

Beam sharing is feasible. If the material is downstream then it is only a question of access. Upstream the experimenters would be affected if the material was significant.

Radiation Length of all material in the beam

2.2.3 RUNNING TIME

Access will be required to change out materials. See section 3.3.3 for total run time and long-term schedule.

2.3 EXPERIMENTAL CONDITIONS

2.3.1 AREA INFRASTRUCTURE

The experimenters will need radiation monitoring and after irradiation storage of radioactive material as it cools down.

The experimenters will also need beam flux measurements by material activation methods.

2.3.2 ELECTRONICS AND COMPUTING NEEDS

The electronics are all custom (for example, consisting of micro-TCA crates) and small custom cards to be placed close to the beam. Experimenters will submit electrical diagrams of these custom electronics to the OCR Chair two weeks prior to the ORC inspection.

All components and readout systems are provided by the experiment.

No PREP Electronics are requested.

2.3.3 DESCRIPTION OF TESTS

The experimenters will conduct radiation qualification measurements on several different components to evaluate the effect of radiation on device. In particular, the experimenters are interested in single event upsets and lattice damage in silicon. More details on the tests to be carried out for individual groups are listed here:

University of Minnesota:

Tests: TID and Displacement damage. Tests will be carried out with devices operating and monitored.

Material (Item 1): Commercial lithium niobate optical modulator

Dimensions (Item 1): ~65 mm x 7 mm x 5 mm (estimated from Thor Labs modulator data sheet)

Material (Item 2): Barium Strontium Titanate waveguides

Dimensions (Item 2): 20 mm x 10 mm x 0.1 mm

Required fluences: 1 x 10^{13} protons/cm^2 to 1 x 10^{15} protons/cm^2

Material (Item 3) Silicon Carbide Avalanche photodiodes and Shottky diodes.

Required fluences 1 x 10^{13} protons/cm^2 to 1 x 10^{15} protons/cm^2

Material (Item 4) Nano crystalline amorphous silicon wafers mounted on glass substrates.

Argonne National Laboratory:

Tests: TID, Displacement Damage, Single Event Effects (SEE). All tests are to be carried out with devices operating and monitored.

Material: Silicon photonics optical modulator

Dimensions: 5 mm x 5 mm

Other factors: Dose rate to be limited to10 kRad/hr.

Southern Methodist University and Fermilab:

Tests: TID, SEU (electronics), Displacement damage (optics)

Materials: Optical transmitter assemblies, laser driver ASICs, and passive optical components. Electronics components and assemblies will be operated and monitored.

Largest dimensions: ~20 mm x 20 mm (transmitter assemblies)

Required fluences: > 1 x 10^{13} protons/cm^2

Ohio State University:

Tests: TID, Displacement damage, SEE. Tests will be carried out with devices operating and monitored.

Material : Laser Driver ASICs.

Dimensions: 5 mm x 5 mm

Required fluences: From 8.6 x 10^{13} protons/cm^2 to 2.5 x 10^{15} protons/cm^2

2.4 SCHEDULE

The experimenters will be ready to begin tests in 2013 when beam is available. Different components can be irradiated over the course of about 1 year. The exact timetable will be determined by the availability of the components. The time required for irradiation is expected to be minimal (< 1 hour).

III. RESPONSIBILITIES BY INSTITUTION – NON FERMILAB

This is a collaboration of several institutions who are working on the development of a new generation of high speed data links. Each institution will bring their own items for testing and remove them as soon as transportation is permitted. They will be each responsible for the individual components for testing and the data collection and storage.

Source of Funds [$K]	Materials & Services	Labor (person-weeks)
Argonne (experimenter)		???
Minnesota (experimenter)		???
Ohio State (experimenter)		???
Southern Methodist (experimenter)		???

IV. RESPONSIBILITIES BY INSTITUTION – FERMILAB

4.1 FERMILAB ACCELERATOR DIVISION:

4.1.1 Use of MTA beamline as outlined in Section II.

4.1.2 Maintenance of all existing standard beam line elements (SWICs, loss monitors, etc) instrumentation, controls, clock distribution, and power supplies.

4.1.3 Scalers and beam counter readouts will be made available via ACNET in the MTA control room.

4.1.4 Reasonable access to the equipment in the MTA beamline.

4.1.5 Connection to beams console and remote logging (ACNET) should be made available.

4.1.6 Conduct a NEPA review of the experiment.

4.1.7 Provide day-to-day ESH&Q support/oversight/review of work and documents as necessary.

4.1.8 Provide safety training as necessary, with assistance from the ESH&Q Section.

4.2 ACCELERATOR PHYSCIS CENTER

4.2.1 Position and focus of the beam on the experimental devices under test will be under control of the MTA group within the APC.

4.3 FERMILAB PARTICLE PHYSICS DIVISION:

4.3.1 Update/create ITNA's for users on the experiment.

4.3.2 Initiate the ESH&Q Operational Readiness Clearance Review and any other required safety reviews. [0.2 person-weeks]

4.4 FERMILAB SCIENTIFIC COMPUTING DIVISION

4.4.1 Internet access should be continuously available in the MTA control room.

4.4.2 See Appendix II for summary of PREP equipment pool needs.

4.5 FERMILAB ESH&Q SECTION

4.5.1 Assistance with safety reviews.

4.5.2 Provide safety training, with assistance from AD, as necessary for experimenters. [0.2 person weeks]

4.5.3 The ESH&Q section will cooperate with the Accelerator Division radiation safety group to monitor activity of irradiated samples and will be responsible for allowing irradiated samples off site.

4.6 FERMILAB COLLABORATORS

V. SUMMARY OF COSTS

Source of Funds [$K]	Materials & Services	Labor (person-weeks)
Accelerator Division	0	0.5
Accelerator Physics Center	0	1.0
Particle Physics Division		
Scientific Computing Division	0	0
ESH&Q Section	0	0.5
Fermilab Collaborators		
Totals Fermilab	$0.0K	1.7
Totals Non-Fermilab		

VI. GENERAL CONSIDERATIONS

6.1 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 ensure that the experimenters all follow the described procedures.

6.2 To carry out the experiment a number of Environmental, Safety and Health (ESH&Q) reviews are necessary. This includes creating an Operational Readiness Clearance document in conjunction with the standing Particle Physics Division committee. The Spokesperson will follow those procedures in a timely manner, as well as any other requirements put forth by the Division's Safety Officer.

6.3 The Spokesperson will ensure at least one person from the experiment is present during all irradiation and cool-off periods and that this person is knowledgeable about the experiment's hazards.

6.4 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 ESH&Q section.

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

6.6 The Spokesperson will undertake to ensure that no PREP or computing equipment be transferred from the experiment to another use except with the approval of and through the mechanism provided by the Scientific Computing Division management. The Spokesperson also undertakes to ensure no modifications of PREP equipment take place without the knowledge and written consent of the Computing Sector management.

6.7 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.

At the completion of the experiment:

6.8 The Spokesperson is responsible for the return of all PREP equipment, computing equipment and non-PREP data acquisition electronics. If the return is not completed after a period of one year after the end of running the Spokesperson will be required to furnish, in writing, an explanation for any non-return.

6.9 The experimenters agree to remove their experimental equipment as the Laboratory requests them to. They agree to remove it expeditiously and in compliance with all ESH&Q requirements, including those related to transportation. All the expenses and personnel for the removal will be borne by the experimenters unless removal requires facilities and personnel not able to be supplied by them, such a rigging, crane operation, etc.

6.10 The experimenters will assist Fermilab with the disposition of any articles left in the offices they occupied.

6.11 An experimenter will be available to report on the test beam effort at a Fermilab All Experimenters' Meeting.

SIGNATURES:

_____ / / 2014
Roger Rusack, Experiment Spokesperson, University of Minnesota

_____ / / 2014
Mark Palmer, MAP Director

APPENDIX I: MTA AREA LAYOUT

[Describe where you would like to put your apparatus, or how you would like to arrange it. Including a diagram is a good idea. You may draw on the picture below, or use the power-point file on the website to create your own. See examples for ideas.]

MTA AREAS

APPENDIX II: - HAZARD IDENTIFICATION CHECKLIST

Items for which there is anticipated need *should be* checked. See next page for detailed descriptions of categories. (*There is NO need to list existing Facility infrastructure you might be using*)

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)		Lifting Devices	
MFR Class:			Exposed Equipment over 50 V		Motion Controllers	
			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	
Window Thickness:		Window Thickness:			Bubble chamber	

The following people have read this TSW:

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