FERMILAB-PROPOSAL 0959

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Fermilab

Directorate

MEMORANDUM OF UNDERSTANDING FOR THE 2006 MESON TEST BEAM PROGRAM

T-959

Microparticle Shielding Assessment

October 10, 2006

INTRODUCTION

This is a memorandum of understanding between the Fermi National Accelerator Laboratory and experimenters from Georgia Institute of Technology and the University of Kentucky who have committed to participate in beam tests to be carried out during the 2006-2007 MTBF program. The memorandum is intended solely for the purpose of providing a budget estimate and a work allocation 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 negotiate amendments to this memorandum which will reflect such required adjustments.

The tests involve determination of the shielding effectiveness of boron nanoparticle and microparticle shielding materials. This work is being funded by NASA and in a joint partnership between the University of Kentucky and Georgia Institute of Technology. Polyethylene based boron nanoparticle and microparticle shielding materials have been fabricated by the University of Kentucky, Materials Science division. These materials are to be experimentally tested in a high energy particle beam. The tests will start late in the calendar year 2006. These tests will be used in part to finalize the shielding effectiveness tests of this novel shielding material.

I. PERSONNEL AND INSTITUTIONS:

Spokesman and physicist in charge of beam tests: Nolan Hertel, Georgia Tech

Fermilab liaison: Erik Ramberg

The group members at present and others interested in the testbeam are:

1.1 Georgia Tech: Eric Burgett, Kimberly Burns, Rebecca Howell, Dwayne Blaylock, Heather Hubble, Christina LoBracco

1.2 University of Kentucky: Eric Grulke, Courtney Harrison

II. EXPERIMENTAL AREA, BEAMS AND SCHEDULE CONSIDERATIONS

2.1 LOCATION

2.1.1 The experiment is to take place in the Meson beam lines, in an area that can receive high intensity protons. The experimenters need approximately 1 cubic meter and will provide all necessary positioning equipment. In addition, the experimenters require a location to set up data acquisition equipment that can be manned continuously.

2.1.2 The experimenters will need a 1 cubic meter area inside the beam line for electronics and will utilize patch panels available or provide adequate test leads for the electronics needed. Most of the data acquisition electronics will be housed in the control space and utilize a NIM bin as well as several laptops.

2.1.3 Additional work space will be needed in the control space, equivalent to at most two 6'x3' tables. This space will be used for computing and general work space.

2.2 BEAM

2.2.1 BEAM TYPES: The tests will use slow resonantly-extracted, Main Injector proton beam focused onto the test apparatus. The test requires a beam of charged protons at a maximum energy of 120 GeV. The test requires as large a beam spot as can be made, up to approximately a 6 cm x 6 cm. Lower energy beams for comparison studies are helpful to this program of measurements.

2.2.2 BEAM EXTRACTION: We expect to run in the SY120 extraction mode where beam is delivered during a 12 hour period during the day.

2.2.3 BEAM INTENSITY: High intensity is a necessity in this experiment. Fluxes on the order of 7×10^{10} protons per measurement point or greater are needed. Approximately 200-300 measurement points are envisioned.

2.2.4 BEAM SHARING: If the measurement takes place in another beamline other than MTest, then beam can be split to that facility as well, as long as the flux indicated above is received.

2.2.5 RUNNING TIME: Beam time needed will be approximately 5 days. Several days of this will be setup time.

2.3 SETUP

2.3.1 The experimental setup will consist of an acrylic tank filled with tissue equivalent liquid or deionized water. In addition to the tank, an X-Y positioning table will be used to move a Tissue Equivalent Proportional Counter (TEPC) through the water block, as well as the material to be tested. The material to be tested will consist of contained ground polyethylene, ground polyethylene with 5 weight percent boron nitride microparticles, polyethylene with 5 weight percent boron nitride nanoparticles, polyethylene with 5 weight percent boron carbide microparticles, and known calibration thicknesses of aluminum metal. These particles are molded into solid blocks approximately 7x5x0.5 cm^3 and these blocks will be stacked in various configurations. These components will be shipped to the users and carried on site by hand.

2.3.2 A table or similar object is required in the beamline to support the acrylic tank and X-Y positioner, and a location for the materials to be tested. The beam can be located 9 inches or more above the table or support surface. We expect to have less than 300 pounds of material in less than 1 meter length.

2.3.3 Electric power for electronics both in the beam area and in the counting house is required.

2.3.4 The experimenters will utilize a very small quantity of methane based TE gas. The flow rate will be 6 cubic centimeters per minute at pressures of 1 psi above atmospheric. This flow will be shut off when the detector is not in use to limit the amount of gas released. This flow rate poses no threat of creating a flammable gas atmosphere or an oxygen deficient atmosphere. A lecture bottle will be used to contain the gas. If necessary a vent line can be established. The bottle will be secured in an appropriate fashion at all times.

2.3.5 An ethernet connection is required for data transmission offsite from a computer which will use ssh to transfer files to and from computers located at Georgia Tech. If there is a firewall issue, the data can be transferred in sequential transfers between networks.

2.3.6 Access is required to the beam area periodically for installation and cabling and switching the materials to be tested. It is expected that AD and PPD will help coordinate this access.

2.3.7 Georgia Tech will supply at least one DAQ computer.

2.3.8 We will need assistance on how to use the accelerator beam readouts.

2.3.9 We require a record of accelerator information on beam intensity for each spill of beam on our detector.

2.4 SCHEDULE

2.4.1 The experimenters plan to do this test in calander year 2006, with the exact schedule depending on beam availability. We require several hours at a low beam rate to look at signals on the scope and make suitable adjustments to electronics and the data-taking program. When everything is working properly, approximately 40 hours of beam at 7E10 protons/minute will provide ample data.

III. RESPONSIBILITIES BY INSTITUTION - NON FERMILAB

([] denotes replacement cost of existing hardware.)

3.1	TEPC (1)	[$3k]
3.1.1	X-Y positioner table (1)	[$3k]
3.1.2	High Voltage supplies	[$3k]
3.1.3	Pulse generator w/ adj rate	[$2k]
3.1.4	3PC's,monitors	[$6k]
3.1.5	Electrometers	[$6k]
3.1.6	Asst. lemo cables, voltmeters, tools, toolbox	[$4k]
3.2.7	Test materials (Univ. Kentucky)	[$5k]
	Total existing items	[$33K]

IV. RESPONSIBILITIES BY INSTITUTION - FERMILAB

([] Denotes replacement cost of existing hardware.)

4.1 FERMILAB ACCELERATOR DIVISION:

4.1.1 Use of Meson beam.

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 Reasonable access to our equipment in the test beam.

4.1.4 Assistance in setting up the equipment in the beamline so as to assure that no disturbance is made to other beamline equipment.

4.1.5 The test beam energy and beam line elements will be under the control of the AD Operations Department Main Control Room (MCR).

4.1.6 The integrated effect of running this and other SY120 beams will not reduce the antiproton stacking rate or protons on target for neutrino production by more than 5% globally, with the details of scheduling to be worked out between the experimenters and the Office of Program Planning.

4.2 FERMILAB PARTICLE PHYSICS DIVISION

4.2.1 The test-beam efforts in this MOU will make use of the upstream areas of the Meson beamlines. Requirements for the beam and user facilities are given in Section 2. General assistance in setting up the experiment and interfacing with the Accelerator Division is required. [0.2 person weeks]

4.3 FERMILAB COMPUTING DIVISION

4.3.1 Ethernet should be available in the counting house.

4.3.2 Connection to beams control console and remote logging (ACNET) should be made available in the counting house.

4.4 FERMILAB ES&H SECTION

4.4.1 Assistance with initial safety reviews.

4.4.2 If available, the loan of radioactive source (preferably Cs^{137}, 0.1mCi) for the first day after setup in the test beam.

4.4.3 Radiological surveys of the equipment and water after the test is done. Analysis of exposed TE liquid by the Activation Analysis Lab will be accomplished and disposal of this liquid will be performed by Fermilab.

4.4.4 Training of all respective members of the team.

V. SUMMARY OF COSTS

Source of Funds [$K]	**Equipment**	**Operating**	**Personnel** (person-weeks)
Particle Physics Division	$0.0K	$0K	0.2
Accelerator Division	0	0	0
Computing Division	0	0	0
Totals Fermilab	$0.0K	0	0.2
Totals Non-Fermilab	[$33K]		

VI. SPECIAL CONSIDERATIONS

6.1 The responsibilities of the Microparticle Shielding Spokesperson and procedures to be followed by experimenters are found in the Fermilab publication "Procedures for Experimenters" (PFX) (http://www.fnal.gov/directorate/documents/). The Physicist in charge agrees to those responsibilities and to follow the described procedures.

6.2 To carry out the experiment a number of Environmental, Safety and Health (ES&H) reviews are necessary. This includes creating an Operational Readiness Clearance document in conjunction with the standing Particle Physics Division committee. The Microparticle Shielding research group 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 Microparticle Shielding Spokesperson will ensure that at least two people are present at the Meson Test Beam Facility whenever beam is delivered and that these people are 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 ES&H section.

6.5 All items in the Fermilab Policy on Computing will be followed by experimenters. (http://security.fnal.gov/Policies/Fermilab%20Policy%20on%20Computing.htm)

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

6.7 Each institution will be responsible for maintaining and repairing both the electronics and the computing hardware supplied by them for the experiment. Any items for which the experiment requests that Fermilab performs maintenance and repair should appear explicitly in this agreement.

6.8 If the experiment brings to Fermilab on-line data acquisition or data communications equipment to be integrated with Fermilab owned equipment, early consultation with the Computing Division is advised.

6.9 At the completion of the experiment:

6.9.1 The Microparticle Shielding 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 Microparticle Shielding Spokesperson will be required to furnish, in writing, an explanation for any non-return.

6.9.2 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 ES&H requirements, including those related to transportation. All the expenses and personnel for the removal will be borne by the experimenters.

6.9.3 The experimenters will assist the Fermilab Divisions and Sections with the disposition of any articles left in the offices they occupied

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

SIGNATURES:

Nolan Hertel, Georgia Institute of Technology — 10/21/2006

Jim Strait, Particle Physics Division — 10/10/2006

Roger Dixon, Accelerator Division — 10/18/2006

Robert Tschirhart, Computing Division — 10/16/2006

William Griffing, ES&H Section — 10/10/2006

Hugh Montgomery, Associate Director, Fermilab — 10/20/2006

Stephen Holmes, Associate Director, Fermilab — 10/22/2006

APPENDIX I - Hazard Identification Checklist

Items for which there is anticipated need have been checked

Cryogenics		Electrical Equipment		Hazardous/Toxic Materials	
	Beam line magnets		Cryo/Electrical devices		List hazardous/toxic materials
	Analysis magnets		capacitor banks		planned for use in a beam line or experimental enclosure:
	Target	X	high voltage		
	Bubble chamber		exposed equipment over 50 V		
Pressure Vessels		**Flammable Gases or Liquids**			
	inside diameter	Type:	Methane based TE		
	operating pressure	Flow rate:	6 cc/min		
	window material	Capacity:	Lecture bottle		
	window thickness	**Radioactive Sources**			
Vacuum Vessels			permanent installation	**Target Materials**	
	inside diameter	X	temporary use		Beryllium (Be)
	operating pressure	Type:	**Cs-137**		Lithium (Li)
	window material	Strength:	**0.5 mCi**		Mercury (Hg)
	window thickness	**Hazardous Chemicals**			Lead (Pb)
Lasers			Cyanide plating materials		Tungsten (W)
	Permanent installation		Scintillation Oil		Uranium (U)
X	Temporary installation		PCBs	X	Other : **Polyethylene, BN, B4C**
	Calibration		Methane	**Mechanical Structures**	
X	Alignment		TMAE		Lifting devices
type:	Dewalt Rotary Laser		TEA	X	Motion controllers
Wattage:	<.05 mW		photographic developers		scaffolding/elevated platforms
class:	IIIa	X	Other: Activated Water?		Others