Fermilab Directorate

MEMORANDUM OF UNDERSTANDING
FOR THE 2005 MESON TEST BEAM PROGRAM

T953

University of Iowa Čerenkov Light Test

September, 2005

INTRODUCTION

This Memorandum of Understanding requests beam time at Fermilab during the Winter 2005-2006 Meson Test Run to measure the signal size from various configurations of Čerenkov light generators and phototubes.

The University of Iowa has pioneered in application of Čerenkov radiation for high-energy detectors. One of the results of this effort is the huge forward calorimeter for CMS (at the LHC) with a half million quartz fibers in iron. The laboratory plans to use this expertise to develop a variety of detectors making use of Čerenkov light and phototubes as the active elements in calorimeters for high-energy particles. There are three immediate applications related to forward angle calorimeters in CMS; ZDC, CASTOR, and the HE upgrade.

The University of Iowa will make the detailed design for the Zero Degree Calorimeter. The proposed design uses tungsten plates interleaved with sheets of quartz fibers. In the EM part the plates are perpendicular to the beam, in the rear hadronic part they are at an angle of 45^{o}. Because of the limited cross sectional area of the plates, there will be considerable leakage of shower particles out of the four sides. We plan to measure this leakage and compare the results with simulations. The leakage will be measured by placing a polished aluminum tank, 4 in wide, 20 in long and 8 in deep on top of absorber material made of blocks of tantalum and copper. The fluid in the tank, that generates the Čerenkov light, could be water; but ethylene glycol (antifreeze, but without the added color) would be better. Being non-polar, it is not corrosive like water, and it has a higher index of refraction, l.42 vs. 1.33. The larger index of refraction would result in more Čerenkov light and better coupling to the PMT.

The University of Iowa has been asked to design the light guides for CASTOR that take the light from the quartz plates, in which the light is produced, and carry it to the PMTs. These plates, interleaved with tungsten plates, are oriented at 45^{o}.

The University of Iowa has been asked to consider methods for replacing the scintillators in the HE hadronic calorimeter with quartz plates, which will not be harmed by the high radiation levels expected with the proposed LHC upgrade in luminosity. The success of this project depends on finding an extremely effective way to couple the Čerenkov light into wave-length shifting fibers.

These various configurations can all be simulated to some degree, but it is essential that the simulations be accompanied by laboratory tests. In most cases 120 GeV protons will be adequate, but in some cases there will also need to be tests using 8 and/or 16 GeV electrons.

For all of the tests, the setup will be small, at most only a few cubic feet. There will be no gas supply or complicated mechanical devices. The active devices will be a few PMTs.

The overall project will consist of a number of short, simple experiments, each lasting from one to three days. The MTB is an excellent facility for such tests.

This is a memorandum of understanding between FNAL and the U of Iowa research group. This memorandum is intended solely for the purpose of providing a work allocation for FNAL and the U of Iowa. It reflects an arrangement that is currently satisfactory to the parties involved. It is recognized, however, that changing circumstances of the evolving research program will necessitate revisions. The parties agree to negotiate amendments to this memorandum to reflect such revisions.

I. PERSONNEL AND INSTITUTIONS:

Spokesman and
physicist in charge of beam tests: Edwin Norbeck, University of Iowa

Fermilab liaison: Erik Ramberg

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

1.1 Present at FermiLab: David Northacker

1.2 University of Iowa: E. Norbeck, Y. Onel, J. E. Olson, U. Akgun

II. EXPERIMENTAL AREA, BEAMS AND SCHEDULE CONSIDERATIONS

2.1 LOCATION

2.1.1 The experiment is to take place in the MTest beam line and located in the area designated MT6-B3. In addition, the main control room to the west of the MTest line will be used to house electronics (one NIM bin, one CAMAC, our computer, and scope), and provide a small amount of work space (for 3 people). If at the time of an experiment MT6-B3 is not available, the experiment will be located in MT6-B1 with the possibility of locating the electronics in the alcove control room.

2.2 BEAM

2.2.1 The tests will use slow resonantly-extracted, Main Injector proton beam focused onto the MTest target. The tests require a beam of untagged, charged protons of the maximum energy available, 120 GeV.

2.1.2 Intensity: In the range of 1-10 KHz in an area of a square cm or so. With the current beam line design this is expected to require up to 2 x 10^{11} primary protons per second. It needs to be able to be steered into the middle of a 6 in diameter circle.

2.1.3 The tests may also require electrons of 8 or 16 GeV, with intensities of several hundred per spill.

2.3 SETUP

The setup will be on a machinist's table with castors. The table, and everything on it, can be set up outside of the radiation area. An hour or so will be required to move the table into the radiation area and connect the signal and HV cables to the PMTs. The table, with everything connected, will be located next to the beam line so that it will not interfere with beam going further downstream. The table will be moved in front of the beam just before the beam is expected. Moving the table in or out of the beam line should require only a few minutes.

2.4 SCHEDULE

The setup phase will require a few hours of beam to look at signals on the scope and make suitable adjustments to electronics and the data-taking program. If something needs to be rebuilt we will want to go away and come back another day. When everything is working properly, an hour or two of beam will provide ample data for a single configuration. A typical run will consist of a series of data-taking runs followed by short controlled accesses to modify the configuration.

III. RESPONSIBILITIES BY INSTITUTION - NON FERMILAB

3.1 The detectors and electronics will be brought from the U of Iowa.

3.2 If ethylene glycol is to be used as a radiating material, then U. of Iowa will ensure that a spill control structure (e.g. a drip pan) will be installed and that proper disposal of the glycol will be made at the end of the test.

IV. RESPONSIBILITIES BY INSTITUTION - FERMILAB

4.1 **Fermilab Accelerator Division:**

4.1.1 Use of MTest 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 The test beam energy and beam line elements will be under the control of the BD Operations Department Main Control Room (MCR).

4.1.5 Position and focus of the beam on the experimental devices under test will be under control of MCR. Control of secondary devices that provide these functions may be delegated to the experimenters as long as it does not violate the Shielding Assessment or provide potential for significant equipment damage.

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 the neutrino program by more than 5% globally, with the details of scheduling to be worked out between the experimenters and the Office of Program Planning.

4.1.S Summary of Beam Division costs:

Type of Funds	Equipment	Operating	Personnel (person-weeks)
Total new items	$0.0K	$0K	0.0

4.2 Fermilab Particle Physics Division

4.2.1 The test-beam efforts in this MOU will make use of the Meson Test Beam Facility. Requirements for the beam and user facilities are given in Section 2. The Fermilab Particle Physics Division will be responsible for coordinating overall activities in the MTest beam-line, including use of the user beam-line controls, readout of the beam-line detectors, and MTest gateway computer. (.2 person weeks)

4.2.2 We require one NIM bin and one CAMAC crate for the experiment.

4.2.3 We will need assistance in developing a beam trigger scintillator, using components already in existence at the test beam facility.

4.2.S Summary of Particle Physics Division costs:

Type of Funds	Equipment	Operating	Personnel (person-weeks)
Total new items	$0K	$0K	.2

4.3 Fermilab Computing Division

4.3.1 U of Iowa will supply all computer equipment.

4.4 Fermilab ES&H Section

4.4.1 We will require assistance with safety reviews.

V. SUMMARY OF COSTS

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

VI. SPECIAL CONSIDERATIONS

6.1 The responsibilities of the spokesman of the U of Iowa group and the procedures to be followed by experimenters are found in the Fermilab publication "Procedures for Experimenters" (http://www.fnal.gov/directorate/documents/index.html).. 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 a Partial Operational Readiness Clearance document in conjunction with the standing Particle Physics Division committee. The spokesman of the Iowa group 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 spokesman of the Iowa group will ensure that at least one person is present at the Meson Test Beam Facility whenever beam is delivered 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 ES&H 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 spokesman of the Iowa group 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 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 The Iowa group 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 At the completion of the experiment:

6.8.1 The spokesman of the Iowa group 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 spokesman of the Iowa group will be required to furnish, in writing, an explanation for any non-return.

6.8.2 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.

6.8.3 The experimenters will assist the Fermilab Divisions and Sections with the disposition of any articles left in the offices they occupied, including computer printout and magnetic tapes.

6.8.4 An experimenter will report on the test beam effort at a Fermilab All Experimenters Meeting.

SIGNATURES:

E Norbeck

Edwin Norbeck, University of Iowa — 9/ 28/ 2005

Jim Strait, Particle Physics Division — / / 2005

Roger Dixon, Accelerator Division — / / 2005

Robert Tschirhart, Computing Division — / / 2005

William Griffing, ES&H Section — / / 2005

Hugh Montgomery, Associate Director, Fermilab — / /2005

Steven Holmes, Associate Director, Fermilab — / /2005

APPENDIX I – U OF IOWA PPAC TEST **– EQUIPMENT POOL NEEDS**

PREP Equipment Pool and MTBF items needed for Fermilab test beam on the first day of setup:

Quantity	Description
1	NIM crate, with cooling fans
1	CAMAC crate and power supply
2	Scintillators to locate the beam
3	PMT's
12	iron bricks 2x4x8 inches

APPENDIX II - 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 (1500V at 1.0mA max) (for PMTs)		
	Bubble chamber		exposed equipment over 50 V		
Pressure Vessels		**Flammable Gases or Liquids**			
	inside diameter	Type:			
	operating pressure	Flow rate:			
	window material	Capacity:			
	window thickness	**Radioactive Sources**			
Vacuum Vessels			permanent installation	**Target Materials**	
	inside diameter		temporary use		Beryllium (Be)
	operating pressure	Type:			Lithium (Li)
	window material	Strength:			Mercury (Hg)
	window thickness	**Hazardous Chemicals**			Lead (Pb)
Lasers			Cyanide plating materials	X	Tungsten (W)
	Permanent installation		Scintillation Oil		Uranium (U)
	Temporary installation		PCBs	**X**	Other : **Iron (Fe), Ta Cu**
	Calibration		Methane	**Mechanical Structures**	
	Alignment		TMAE		Lifting devices
type:			TEA		Motion controllers
Wattage:			photographic developers		scaffolding/elevated platforms
class:			Other: Activated Water?		Others