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Fermilab

Directorate

MEMORANDUM OF UNDERSTANDING FOR THE 2007 MESON TEST BEAM PROGRAM

T976

CsI Gaussian Shaper Electronics and Detector Test

October 10, 2007

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INTRODUCTION

This is a memorandum of understanding between the Fermi National Accelerator Laboratory and experimenters from University of Chicago, KEK, Kyoto University, and Osaka University, who have committed to participate in beam tests to be carried out during the 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 a small calorimeter consisting of a 4x4 array of 16 undoped CsI crystals (aka KTeV CsI crystals). Each of these crystals is 5cm (W) x 5cm (H) x 50cm (L) (27 radiation length). The focus of the test is to validate a new electronics technique to measure both charge (ADC) and time (TDC) simultaneously. The raw CsI pulse will be shaped by a front end 10-pole Gaussian filter, then digitized with 125 MHz FADC with FPGA/VME readout. From simulations and cosmic ray tests, the timing resolution is ~ 100 psec, but needs to be validated by high energy particle beam measurement.

JPARC experiment E14, an approved experiment to measure the rate of $K_L \rightarrow \pi^0 \nu \nu$ plans to use the new technique for all its detector elements including ~3000 channels of KTeV CsI crystals. With the anticipated time resolution, it is possible to perhaps determine the momentum of the measured photon. When a photon (~few tens of MeV to GeV) strikes the CsI array, few tens of blocks will have deposited energy. The times of arrival of the blocks, therefore the longitudinal distances of shower development can be measured with resolution of ~3cm (corresponding to the 100 psec time resolution). Therefore, the direction of the photon perhaps can be determined by these time distributions.

The tests will take place in December 2007. This test is limited by the number of electronic channels; pending results of this test, larger array of CsI test may be needed.

I. PERSONNEL AND INSTITUTIONS:

Physicist in charge of beam tests: Yau W. Wah, University of Chicago.

Fermilab liaisons: Erik Ramberg
Doug Jensen

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

1.2 Osaka University: Taku Yamanaka
1.3 National Taiwan University: Yee Bob Hsiung, Yu-Cheng Tung
1.3 Kyoto University: Tadashi Nomura
1.4 KEK: Takeshi Komatsubara
1.5 University of Chicago: Mircea Bogdan, Jiasen Ma, Yi Zheng, Yau W. Wah

II. EXPERIMENTAL AREA, BEAMS AND SCHEDULE CONSIDERATIONS

2.1 LOCATION

2.1.1 The experiment is to take place in the MTEST beam line, in the MT6-2A area.

2.1.2 The following items will be needed in the beam area:

- 1 19-inch rack for electronics (to house two NIM and one VME crates)
- Dry nitrogen supply
- The upstream motion table, which is capable of holding the 200 lb detector assembly.
- Space in the beam line for a beam telescope, to be located in front of the motion table.

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

2.2 BEAM: The tests will use the slow resonantly-extracted, Main Injector proton beam focused onto the downstream MTest target. The experimenters will need mostly low energy (1-8 GeV) electron beam. Low intensity beams (50 – 1000 Hz onto the 1 x 1 cm^2 trigger counters) will be ideal.

2.2.2 BEAM SHARING: Most likely the experimenters could run parasitically downstream of some other test during most of the setup and debugging time if other tests require low rates. Because of limited manpower the experimenters cannot run continuously. Alternating with other users is possible.

2.2.3 RUNNING TIME: The experimenters estimate the need for several 8 hour periods of running time to explore the phase space of experimental conditions (various HV and threshold settings) with rates of the order of 100 Hz/cm^2. Measurements with low momentum electrons (1 – 8 GeV/c) are needed. The experimenters will likely require about 10 days of beam time.

2.3 SETUP: The experimental setup consists of two parts: a) a calorimeter stack (see Figure 1) with the 16 CsI crystals. Each crystal is 5cm x 5cm x 50cm. The stack will be placed inside a light tight box with dry nitrogen feed. The dimension of the box is 75cm x 75cm x 100cm. The total weight of the setup will not exceed 200 lbs. The stack is to be located on top of a scanning table; and b) a beam telescope consisting of 2 scintillation counters, fixed in space and located in of the stack.

2.4 COMPUTING: The experimenters will supply their own DAQ computer. Ethernet connection (with capability of using SSH) will be required for data transmission offsite (and downloading of updated versions of firmware from outside institutes).

III. RESPONSIBILITIES BY INSTITUTION - NON FERMILAB

University of Chicago will provide all the below listed equipment ([] denotes replacement cost of existing hardware.)

3.1	16 CsI crystals ($2k each)	[$32k]
3.2	16 channels front end/FADC/FPGA on 1 VME 6U card	[$12k]
3.3	Digital scope	[$10k]
3.4	2 PCs	[$ 5k]
3.5	VME crate with custom cards and a VME-PCI bridge	[$20k]
3.6	Cables, voltmeters, tools, toolbox, etc…	[$ 2k]
	Total existing items	[$81K]

IV. RESPONSIBILITIES BY INSTITUTION - FERMILAB

4.1 **Fermilab Accelerator Division:**

4.1.1 Use of MTest beam according to Section 2 above.

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 A scaler or beam counter signal should be made available in the counting house.

4.1.4 Reasonable access to the experimental equipment in the test beam.

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

4.1.6 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.

4.1.7 The integrated effect of running this and other SY120 beams will not reduce the antiproton stacking rate 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 testbeam 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 installation of test equipment, use of the user beam-line controls, readout of the beam-line detectors, and MTest gateway computer. (0.2 person-weeks)

4.2.2 The electronics group of PPD will stuff 5 already existing LVDS->ECL boards for this test. ($.5K, 2 person-weeks)

4.3 Fermilab Computing Division

4.3.1 Ethernet and printer should be available in the counting house.

4.3.2 In conjunction with the Accelerator Division, 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 safety reviews.

4.4.2 Loan of radioactive source (preferably Sr^{90}, 0.1mCi) for the duration of the test beam.

V. SUMMARY OF COSTS

Source of Funds [$K]	Equipment	Operating	Personnel (person-weeks)
Particle Physics Division	$0.5K	$0K	2.2
Accelerator Division	0	0	0
Computing Division	0	0	0
Totals Fermilab	$0.5K	0	2.2
Totals Non-Fermilab	[$81K]		

VI. SPECIAL CONSIDERATIONS

6.1 The responsibilities of the spokesman of the research group and 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 an Operational Readiness Clearance document in conjunction with the standing Particle Physics Division committee. The spokesman of the research group will follow those procedures in a timely manner, as well as any other requirements put forth by the division's safety officer and follow all procedures in the PPD Operating Manual.

6.3 The spokesman of the research 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 research 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 research 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 research 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 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.

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

SIGNATURES:

Yau W. Wah, University of Chicago 10/10/ 2007

Greg Bock, Particle Physics Division 11/ 13/ 2007

Roger Dixon, Accelerator Division 11/15/ 2007

Victoria White, Computing Division 11/21/ 2007

William Griffing, ES&H Section 11/15/ 2007

Hugh Montgomery, Associate Director, Fermilab 11/28/2007

Stephen Holmes, Associate Director, Fermilab 11/27/2007

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	X	exposed equipment over 50 V		
Pressure Vessels		**Flammable Gases or Liquids**			
	inside diameter	Type:	Isobutane (5% of a non-flammable mixture)		
	operating pressure	Flow rate:			
	window material	Capacity:			
	window thickness	**Radioactive Sources**			
Vacuum Vessels			permanent installation	**Target Materials**	
	inside diameter	X	temporary use		Beryllium (Be)
	operating pressure	Type:	**Sr90**		Lithium (Li)
	window material	Strength:	**5 mCi**		Mercury (Hg)
	window thickness	**Hazardous Chemicals**			Lead (Pb)
Lasers			Cyanide plating materials		Tungsten (W)
	Permanent installation		Scintillation Oil		Uranium (U)
	Temporary installation		PCBs		Other :
	Calibration		Methane	**Mechanical Structures**	
	Alignment		TMAE		Lifting devices
type:			TEA	X	Motion controllers
Wattage:			photographic developers		scaffolding/elevated platforms
class:			Other: Activated Water?		Others