Fermilab

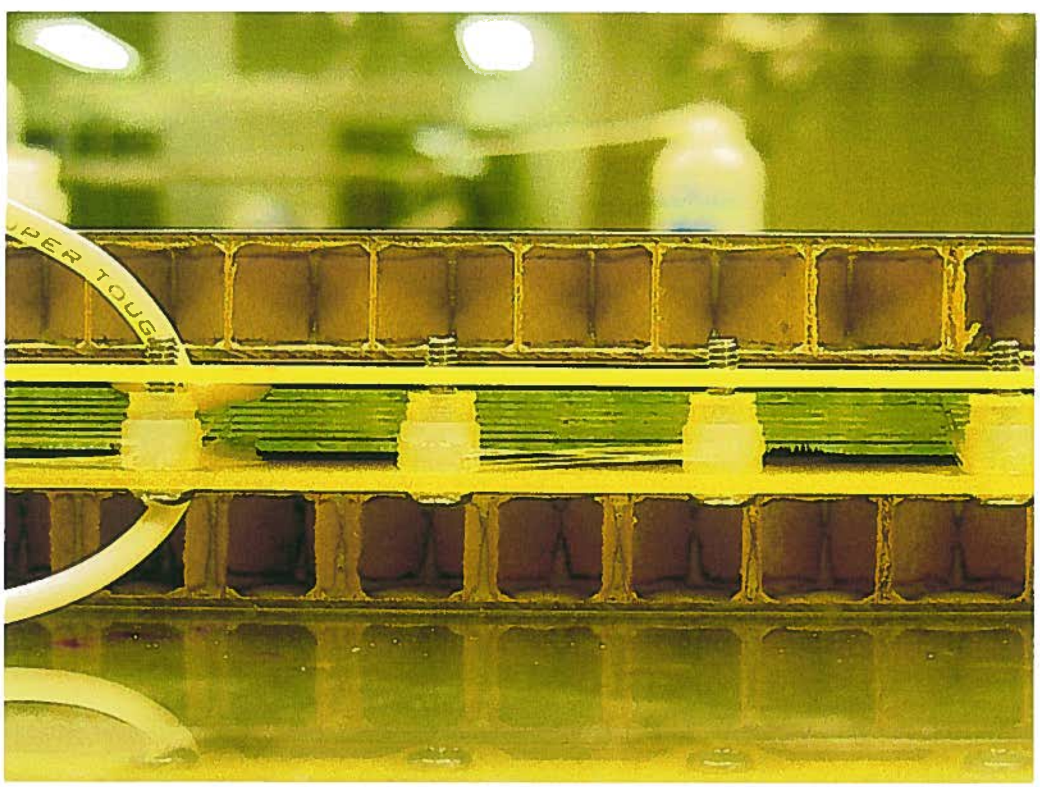
Directorate

TECHNICAL SCOPE OF WORK
FOR THE 2014 FERMILAB TEST BEAM FACILITY PROGRAM

T-1048

PHENIX Fast TOF

January 15, 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 PHENIX Fast TOF group who have committed to participate in beam tests to be carried out during the FY2014 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:

Good particle identification is an important goal for the sPHENIX/ePHENIX detector upgrades. The ability to study the dependency of different observables on particle flavor has been and is expected to be an important part of the physics programs for the RHIC-II and the future eRHIC era at Brookhaven National Lab. One possible way to provide good particle identification out to the momenta needed is to use a very fast time-of-flight detector, one capable of up to 10 picosecond timing resolution. The experimenters intend to test two approaches to achieving this timing resolution, one using a Multi-Channel-Plate-PMT (MCP-PMT), and another using a multigap Resistive Plate Chamber (mRPC).

The MCP-PMT the experimenters intend to test is a Photonis 85012-XP. This MCP-PMT has been modified to have a fused silica window, which improves the transmittance for UV light. It has an anode readout plane consisting of 8x8 pads, where each pad has a size of 6 x 6 mm^2. In front of the MCP-PMT window are 6×6 mm square and 2 cm long fused silica radiators, that generates Cerenkov light with the passage of a charged particle. The MCP-PMT is biased to 1.5 -2.0 kV by a Belkin NIM High Voltage Supply (or equivalent). The MCP-PMT has been tested with a laser to have a 50 ps transit time spread for an individual photoelectron at a bias of 1.7 kV. The MCP-PMTs are read out using fast waveform digitizers sampling at ~5 GHz.

The second technology, using mRPC, consists of anywhere from 6 to 24 flat plates of float glass in a gas volume, separated by 150-250 microns, and held at high voltages of up to 15 kV. The gases used are R134A, isobutane, and SF6, in a 95/4.5/0.5% mixture. When a charge particle passes through the gas gaps, they lose energy through ionization loss and generate small avalanches of electrons. The avalanches induce signals on cathodes placed on either side of the outer gaps. The cathodes are read out on both ends differentially through a custom preamp and digitized with fast waveform digitizers. The mRPC is expected to achieve about 15 ps timing resolution, which can be compared to the MCP-PMT where resolutions below 10 ps could be expected. However, the mRPC is an order of magnitude cheaper than the MCP-PMT, and therefore is highly advantageous whenever cost is a concern.

The goals for this test beam experiment are to verify the timing performance of the two types of time-of-flight detector prototypes. Included in this test is the performance of the electronics, which are also state of the art and requires verification. The performance would be studied under a variety of conditions: varying HV bias, varying gas mixtures, and varying incident particle angles. A secondary goal would be to provide hadron identification for the sPHENIX HCAL test beam experiment. To achieve these goals, the experimenters propose to run parasitically with the sPHENIX HCAL test beam experiment, and follow their schedule. The experimenters anticipate spending the first two weeks on set up, particularly the gas system, and the final two weeks with beam tests.

I. PERSONNEL AND INSTITUTIONS:

Spokesperson: Eric Mannel

Lead Experimenter in charge of beam tests: Mickey Chiu

Fermilab Experiment Liaison Officer: Aria Soha

The group members at present are:

	Institution	Country	Collaborator	Rank/Position	Other Commitments
1.1	Brookhaven National Laboratory	USA	Mickey Chiu	Scientist	PHENIX
			Eric Mannel	Scientist	PHENIX
			Sean Stoll	Physics Associate	PHENIX
			Don Lynch	Engineer	PHENIX
			Steve Boose	Engineer	PHENIX
			Dave Northacker	Technician	PHENIX
1.2	Howard University	USA	Marcus Alfred	Professor	PHENIX
			James Lindesay	Professor	
1.3	University of Tsukuba	Japan	Tatsuya Chujo	Professor	PHENIX, Alice
			Motoi Inaba	Professor	
			Toshihiro Nonaka	Student	
			Wataru Sato	Student	
			Ikumi Sakatani	Student	
			Masahiro Hirano	Student	
1.4	UIUC	USA	Ihnjea Choi	Post-doc	PHENIX

II. EXPERIMENTAL AREA, BEAMS AND SCHEDULE CONSIDERATIONS:

2.1 LOCATION

2.1.1 The beam test(s) will take place in location: MT6.2, as shown in Appendix I.

2.2 BEAM

2.2.1 BEAM TYPES AND INTENSITIES

Energy of beam: 8-60 GeV
Particles: Pions/muons/protons
Intensity: 10k – 100k particles/ 4 sec spill
Beam spot size: about 1cm^2

2.2.2 BEAM SHARING

The experimenters expect to run parasitically with T-1044.

The total Radiation Length of the detectors including the gas boxes is ~44%, and is dominated by the walls of the four gas boxes (2 aluminum and 2 steel). Since we are running parasitically, we expect to take the detectors out of the beam-line when running with electron beams to avoid disturbing the calorimeter tests. For running with hadron beams, there should not be much of an interference since the nuclear interaction length is fairly small, 8%.

2.2.3 RUNNING TIME

The experimenters expect to run parasitically with T-1044. After initial setup, the experimenters expect minimal access to the detector to modify the positioning of the detectors with access coordinated with T-1044.

See section 2.3.3 for total run time and long-term schedule.

2.3 Experimental Conditions

2.3.1 Area Infrastructure

There will be two identical sets of two prototypes of each detector type, one from Tsukuba and one from BNL. They will be placed in the beam-line on the supplied tables 2C and 2B. They will be separated along the beam-line, with one prototype in the hut in front of the electromagnetic calorimeter, using table 2C, and the other upstream on table 2B. The uni-strut will allow for easy change of the horizontal and vertical position, as well as the angle of incidence, relative to the beam.

The MCP-PMT's are small prototypes consisting of 6" by 6" square tubes, housed in a 8.5" diameter cylindrical can which holds the fused silica Cerenkov radiators, and with a bias supplied by a standard SHV connector.

The Tsukuba mRPC's are housed in gas chambers, which is made of aluminum and is approximately 50x38x20 cm^3, while the BNL gas boxes are stainless steel cylinders of 10" diameter and 20" height. The total weight of each prototype will not exceed 20 kg. The chambers each have one inlet and one outlet, as well as a gas-tight feed-through for the HV and signals. A CAEN A1526 supply housed in a CAEN SY4527 mainframe supplies the HV bias.

The mRPC detectors use a gas mixture of R134A/Isobutane/SF6 in a 95%/4.5%/0.5% ratio, with a total flow rate for the system of ~ 400 ccm during operation. A gas mixing system will be located in the gas mixing area with supply and return lines running between the mixing area and the gas enclosure. The full gas mixing system design is still in progress but is anticipated to be similar to the one used for the DHCal (T-970) gas mixing system.

The experiment will make use of the FTBF Downstream Cherenkov, and two MWPC stations.

2.3.2 Electronics Needs

The readout for these high performance TOF prototypes requires fast waveform digitizing. The experimenters are using a variety of electronics in order to test and compare their performance: the CAEN DT5742 waveform digitizer, the DRS4 evaluation board, and CAMAC based TDCs and ADCs. The mRPC also uses the PHENIX TOF.W preamp as well as Wenteq preamps, and custom preamps designed at Tsukuba.

No PREP electronics are requested.

2.3.3 Description of Tests

The detectors from Tsukuba will be shipped to FNAL in early January 2014, and the BNL detectors will be shipped in the last week of January. From January 13, 2014 to Feb 11, 2014, Dave Northacker will begin working on setting up the gas mixing system. From January 27, the experimenters will arrive and begin to commission detector and electronics.

From Feb 11, 2014 to Feb 25, 2014 the experimenters will collect data parasitically with experiment T-1044

2.4 Schedule

The experimenters are requesting to run parasitically with T-1044 during the period of Feb 5, 2014 to Feb 25, 2014. The first week will be used to install and commission the detectors, and the following 2 weeks will be used for data taking. All data taking will be done parasitic to T-1044 operations with any accesses coordinated with them.

III. RESPONSIBILITIES BY INSTITUTION – NON FERMILAB

3.1 NAME OF INSTITUTION:

- Brookhaven National Laboratory;
    - MRPC and MCP-PMT Detector: $50K
    - Readout and DAQ Electronics: $50K
    - Installation and commissioning of detectors
    - Staffing of data taking shifts
    - Data Analysis
- Howard University
    - Installation and commissioning of detectors
    - Staffing of data taking shifts
    - Data Analysis
- Tsukuba University
    - MRPC and MCP-PMT Detector: $50K
    - Readout and DAQ Electronics: $50K
    - Installation and commissioning of detectors
    - Staffing of data taking shifts
    - Data Analysis

IV. Responsibilities by Institution – Fermilab

4.1 Fermilab Accelerator Division:

4.1.1 Use of MTest beam line 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 Scalars and beam counter readouts will be made available via ACNET in the MTest control room.
4.1.4 Reasonable access to the equipment in the MTest beam line.
4.1.5 Connection to beams console and remote logging (ACNET) should be made available.
4.1.6 The test beam energy and beam line elements will be under the control of the AD Operations Department Main Control Room (MCR). [0.5 FTE/week]
4.1.7 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.
4.1.8 The integrated effect of running this and other SY120 beams will not reduce the neutrino flux by more than an amount set by the office of Program Planning, 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 TSW will make use of the Fermilab Test Beam Facility. Requirements for the beam and user facilities are given in Section II. 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 FTBF computers. [6.5 FTE/Week]
4.2.2 Setup and maintenance of MPWCs
4.2.3 Setup and maintenance of Downstream Cherenkov
4.2.4 Conduct a NEPA review of the experiment.
4.2.5 Provide day-to-day ESH&Q support/oversight/review of work and documents as necessary.
4.2.6 Provide safety training as necessary, with assistance from the ESH&Q Section.
4.2.7 Update/create ITNA's for users on the experiment.
4.2.8 Initiate the ESH&Q Operational Readiness Clearance Review and any other required safety reviews.

4.3 Fermilab Scientific Computing Division

4.3.1 Internet access should be continuously available in the MTest control room.

4.4 Fermilab ESH&Q Section

4.4.1 Assistance with safety reviews.

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

V. SUMMARY OF COSTS

Source of Funds [$K]	Materials & Services	Labor (FTE/week)
Accelerator Division	0	0.5
Particle Physics Division	0.0	6.5
Scientific Computing Division	0	0
ESH&Q Section	0	0.2
Totals Fermilab	$0.0K	7.2
Totals Non-Fermilab	$200K	22

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 is present at the Fermilab 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 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 listed in Appendix II. 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 as 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:

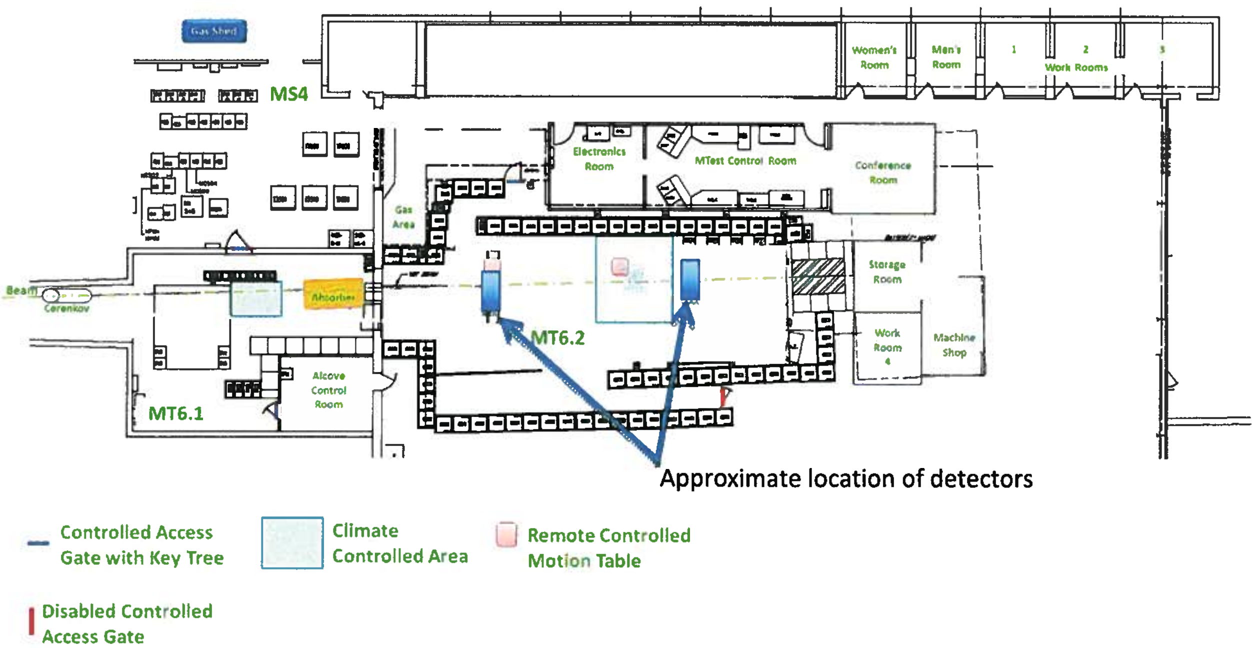
____ / / 2014

Eric J. Mannel, Experiment Spokesperson

APPENDIX I: MT6 AREA LAYOUT

The detectors will be located in the MT6.2 area as indicated in the drawing below.

MTEST AREAS



The 2C table is re-located to downstream of the hut.

APPENDIX II: EQUIPMENT NEEDS

Provided by experimenters:

The experimenters will provide all detectors, associated readout electronics, power supplies and cables required for the test beam setup.

Equipment Pool and PPD items needed for Fermilab test beam, on the first day of setup.

PPD FTBF:

Quantity	Description
2	MWPC Stations
1	Downstream Cerenkov Counter
2	Motion tables (2B, and 2C)

APPENDIX III: - 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:	R134A/Isobutane/SF6 95%/4.5%/0.5%	Type:			Cyanide plating materials	List hazardous/toxic materials planned for use in a beam line or an experimental enclosure:
Flow rate:	400 ccm	Flow rate:			Hydrofluoric Acid	
Capacity:	640L	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:		X	High Voltage (50V)		Lifting Devices	
MFR Class:			Exposed Equipment over 50 V		Motion Controllers	
		X	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:

1 /24/2014

Michael Lindgren, Particle Physics Division, Fermilab

1/29/

1 /24/2014

Sergei Nagaitsev, Accelerator Division, Fermilab

1 /24/2014

Robert Roser, Scientific Computing Division, Fermilab

Martha Michels

1 /24/2014

Martha Michels, ESH&Q Section, Fermilab

1 /28/2014

Greg Bock, Associate Director for Research, Fermilab

1 /31 /2014

Stuart Henderson, Associate Director for Accelerators, Fermilab