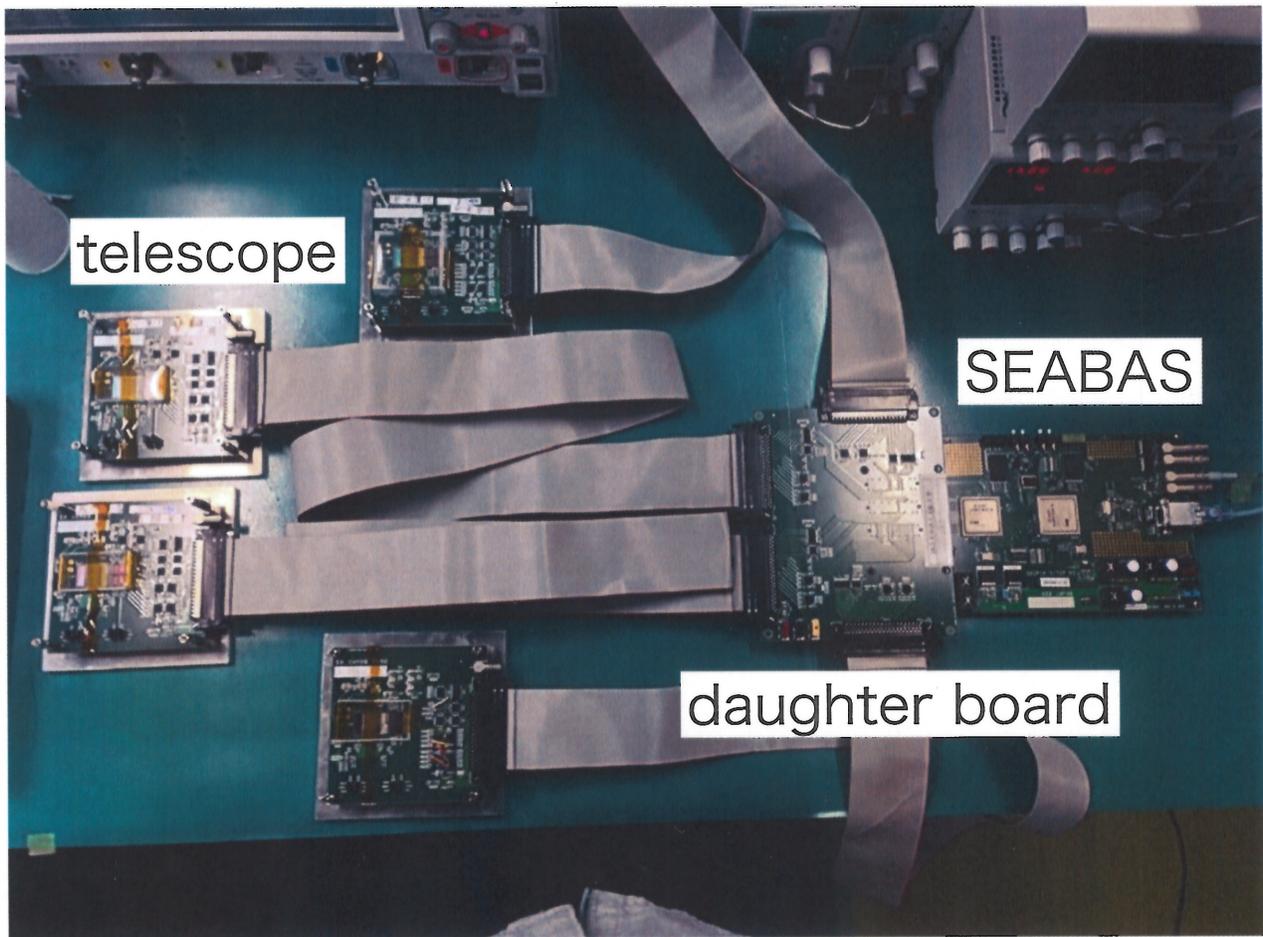


**TECHNICAL SCOPE OF WORK  
FOR THE 2015 FERMILAB TEST BEAM FACILITY PROGRAM**

**T-1068**

**The Beam Test for the SVX4 Telescope**



November 12, 2015

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    6.2 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. .... 11

**INTRODUCTION**

This is a technical scope of work (TSW) between the Fermi National Accelerator Laboratory (Fermilab) and the experimenters of KEK and Osaka University who have committed to participate in beam tests to be carried out during the 2016 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:*

The purpose of this experiment is to study the silicon strip detector consisting of the silicon strip sensors and SVX4 readout ASIC's, called SVX4 telescope. This detector is used as the reference detector to measure the charged particle trajectory so that it provides the particle incident position at the other detector under test (DUT).

The sensor is p-in-n single sided with 256 readout strips whose pitch is  $50\mu\text{m}$ , while the SVX4 has 128 readout channels. Two SVX4 ASIC's are used for each sensor. The single SVX4 telescope has two sensors aligned with 90 degree rotation so that it provides two-dimensional position information, and hence consists of two sensors and four SVX4's. The SVX4 is capable of charge amplification, local storage of the hit information, and on-chip digitization.

At the beam test for the other devices, typically two SVX4 telescopes are located upstream of the DUT, and the other two are downstream. Therefore four SVX4 telescopes are read out simultaneously and synchronized. Such data acquisition (DAQ) system is established using the SEABAS readout board via the daughter board. The SEABAS is composed from basically two FPGA's. One is to control the SVX4, and the second to establish TCP/IP network connection and communicate with a DAQ PC.

The experimenter's group is developing the silicon pixel/strip detectors for the ATLAS upgrade. In this R&D program, the prototype detector needs to be tested by the beam tests. The SVX4 telescope has been developed mainly for this test program. Since the typical size of pixel or strip pitch of the DUT is  $50\mu\text{m}$ , the SVX4 telescope is required to have the position resolution closer to  $5\mu\text{m}$  to map the efficiency inside each pixel or between the two strips of DUT. One of the scopes of the proposed beam test is, therefore, to measure the position resolution of the SVX4 telescope by using multiple devices and by the cross reference. The understanding of the position resolution is needed when it is used as the reference detector for the other DUT.

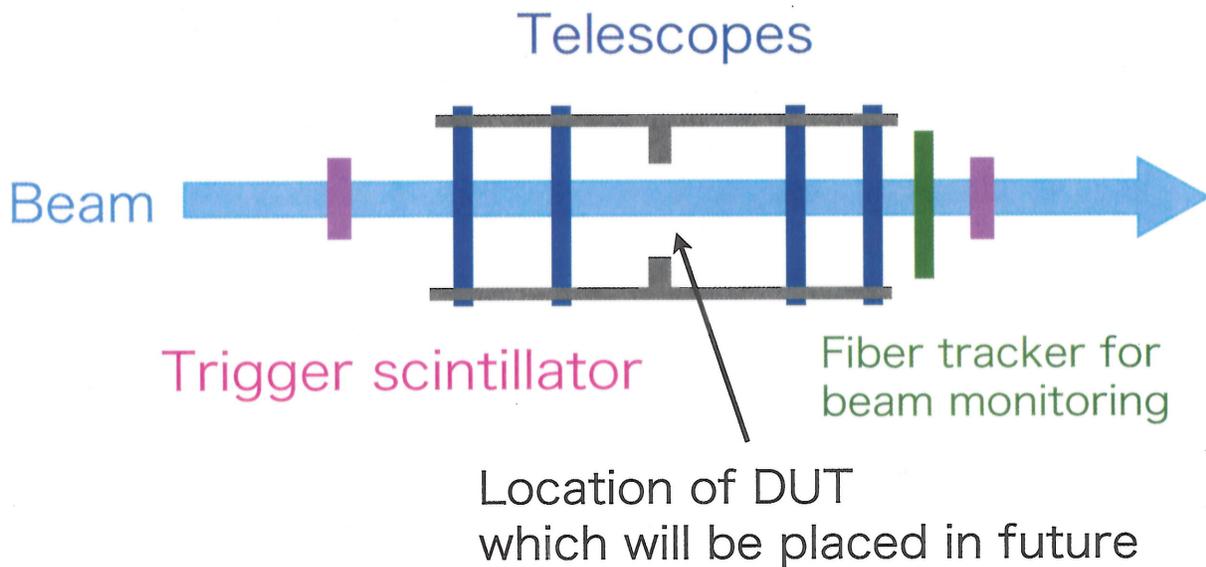
The other important goal is to measure the charge collection efficiency of the SVX4 telescope. Of particular importance is to understand the charge sharing between the two strips. The collected charge as a function of the distance from each strip will be used as a lookup table when the SVX4 telescope will be used as the reference detector for the other detector, which is crucial to improve the position resolution by making use of the charge information of each strip. This allows the SVX4 telescope to have resolution better than  $10\mu\text{m}$  although the strip pitch is  $50\mu\text{m}$ .

The proposed study is only possible at the facility which can provide high momentum hadron (or muon) beam with high intensity because of the required position resolution in the measurement. Our goal is to achieve the position resolution better than  $5\mu\text{m}$ . The reduction of multiple scattering with high momentum beam is crucial. For example, assuming the 10cm separation between the two detectors, the multiple scattering of  $1.6\mu\text{m}$  is expected for 100 GeV proton, given the fact that the single telescope uses two silicon sensors with each thickness of  $320\mu\text{m}$ . In addition, the mapping of efficiency or charge collection for the small detector such as

SVX4 needs high intensity beam. Note that the pitch strip is only  $50\mu\text{m}$ . It is hopeless to obtain the efficiency map by cosmic rays.

The test setup is shown in the figure below. The main parts of the setup are the four SVX4's. They are sandwiched with two scintillators providing the trigger. The other device placed downstream of the SVX4 telescopes is the fiber tracker consisting of the scintillating fibers and MPPC for its light readout. It will work as the beam position monitor. The use of this fiber tracker is optional, and is not yet decided as of writing this document.

In summary the experimenters propose the beam test of the SVX4, where the position resolution measurement and the efficiency mapping will be conducted.



1. PERSONNEL AND INSTITUTIONS:

Spokesperson: Kazunori Hanagaki (KEK/Osaka University)

Lead Experimenter in charge of beam tests: Kazuki Yajima (Osaka University)

Fermilab Experiment Liaison Officer: Mandy Rominsky

The group members at present are:

	<u>Institution</u>	<u>Country</u>	<u>User</u>	<u>Rank/Position</u>	<u>Other Commitments</u>
1.1	Osaka University	Japan	Kazuki Yajima	Student	ATLAS
			Yoko Yamauchi	Student	ATLAS
			Toshihiro Imasaka	Student	ATLAS
1.2	KEK/Osaka U.	Japan	Kazunori Hanagaki	Professor	ATLAS
1.3	KEK	Japan	Yoichi Ikegami	Assistant Professor	ATLAS
			Yoshiji Yasu	Engineer	No specific experiment

## U. EXPERIMENTAL AREA, BEAMS AND SCHEDULE CONSIDERATIONS:

### 2.1 LOCATION

2.1.1 The beam test(s) will take place in MT6.2, as shown in Appendix I. As the size of the whole setup is small, the location can be flexible as long as the network bandwidth is enough. In addition, the whole setup is thin, allowing to run in parallel with the other test setup as long as the beam momentum is high enough.

2.1.2 List additional space needed:

Work space for the experimenters to control and tune the test setup, and to take data.

### 2.2 BEAM

#### 2.2.1 BEAM TYPES AND INTENSITIES

Energy of beam: 120 GeV

Particles: protons

Intensity: 10k – 40k particles/ 4 sec spill

Beam spot size: about  $1\text{cm}^2$  or smaller

Pions with momentum greater than 10 GeV are also acceptable.

#### 2.2.2 BEAM SHARING

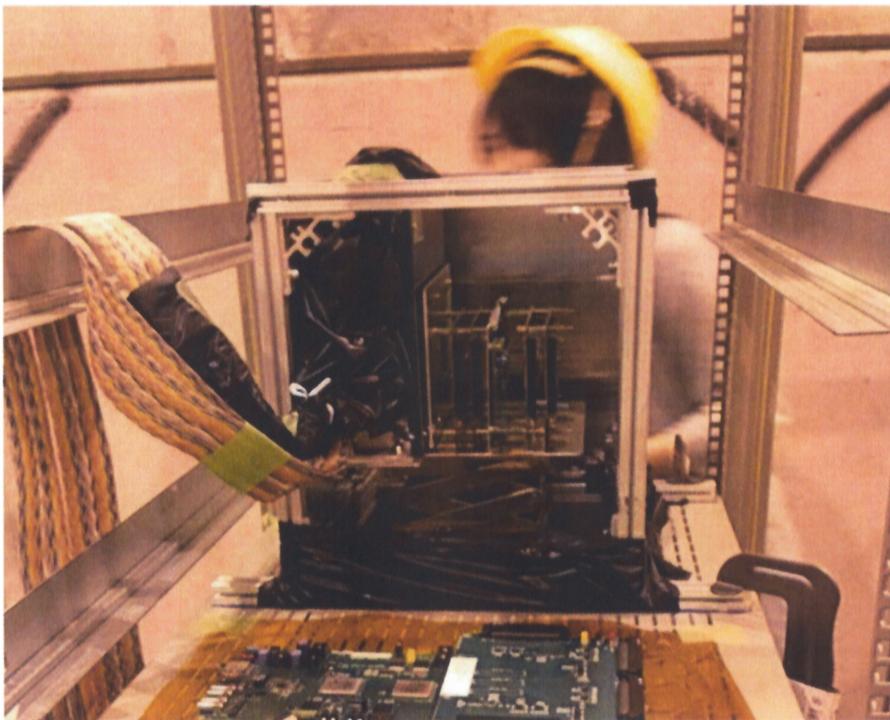
There can be thin or gas detector upstream of the experimenter's setup. There can be any detector downstream of the setup.

The total radiation length is 6.0% (without the fiber tracker). There are 8 silicon sensors with the thickness of  $320\mu\text{m}$ , resulting in 3.2% in radiation length. There are 2 plastic scintillators, resulting in 2.8% in radiation length. The usage of the fiber tracker adds up 2mm thick scintillation fibers, which is 0.6% radiation length.

### 2.3 EXPERIMENTAL CONDITIONS

#### 2.3.1 AREA INFRASTRUCTURE

The whole setup can be placed on the 19 inch rack as shown in the picture below.



The movable table is needed. The remote controlled one is preferred.

Air is needed to cool down the SVX4 telescopes. The flow rate is not yet determined. The telescope doesn't have the cooling loop. Rather the gas flow into the telescope soaks out to the atmosphere.

### 2.3.2 ELECTRONICS AND COMPUTING NEEDS

See Appendix II for summary of PREP equipment pool needs.

The DAQ computer is directly connected to the SEABAS readout board, and is controlled remotely by the experimenter's PC. The experimenters need a private network for this work. Here the private means that the connection between the beamline where the DAQ computer locates and the experimental control room or elec-hat.

The experimenters also need a global network access for their PC's to check emails and so on.

### 2.3.3 DESCRIPTION OF TESTS

A General Run Plan:

1<sup>st</sup> day: The experimenters pick up and receive the items which would be sent from Osaka University to Fermilab. The infrastructure such as the private network will be set up.

2<sup>nd</sup> day: The network access and the DAQ computer will be set up. The SVX4 telescopes will be powered up and should be confirmed to be working.

3<sup>rd</sup> day: The SVX4 telescopes and the trigger scintillators will be installed to the test area. Some tuning, including the calibration runs, are anticipated.

4<sup>th</sup> to 6<sup>th</sup> day: Data taking. 12 hours of beam per day is requested. (10am to 10pm is preferred.) The frequent access will be anticipated to change some detector parameters which cannot be modified remotely. The frequency of the access will be once every a few hours or so if there are no troubles. On the other hand, when the startup, unexpected access may be needed.

## 2.4 SCHEDULE

The testing of the SVX4 telescope will be finished with the currently proposed beam test. However, the similar beam test will be proposed where the SVX4 telescope will be used as the reference detector on the DUT. Such beam test will be proposed with the frequency approximately once a year.

## **III. RESPONSIBILITIES BY INSTITUTION – NON FERMILAB**

### 3.1 OSAKA UNIVERSITY:

- SVX4 telescopes
- SEABAS DAQ board and the daughter board
- DAQ PC
- DC LV Power supplies if the facility cannot provide enough
- Fiber tracker
- Source meters
- Switching hub

## **IV. RESPONSIBILITIES BY INSTITUTION – FERMILAB**

### **4.1 FERMILAB ACCELERATOR DIVISION:**

- 4.1.1 Use of MTest beamline as outlined in Section II. [0.25 FTE/week]
- 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 MTest control room.
- 4.1.4 Reasonable access to the equipment in the MTest beamline.
- 4.1.5 Connection to ACNET console and remote logging 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). [0.25 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 PPD DDOD Test Beam Group 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 [Be sure to include Infrastructure and Instrumentation needs specified in section 2.3.1]
- 4.2.3 [Be sure to include Crane/Forklift needs specified in section 2.3.1]
- 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.
- 4.3.2 See Appendix II for summary of PREP equipment pool needs.
- 4.3.3 [Be sure to include Network/computing needs specified in section 2.3.2] [0.2 FTE]

### **4.4 FERMILAB ESH&Q SECTION**

- 4.4.1 Assistance with safety reviews.

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- 4.4.2 [Loan of radioactive source (specify sources) for (specify duration).]
- 4.4.3 Provide safety training, with assistance from PPD, as necessary for experimenters. [0.2 FTE]

**V. SUMMARY OF COSTS**

<b>Source of Funds [SK]</b>	<b>Materials &amp; Services</b>	<b>Labor (person-weeks)</b>
Accelerator Division	0	0.5
Particle Physics Division	0.0	0.5
Scientific Computing Division	0	0
ESH&Q Section	0	0.2
Totals Fermilab	\$0.0K	1.2
Totals Non-Fermilab	[specify from Section III]	4

## 6.1 GENERAL CONSIDERATIONS

**6.2 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](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.**

6.3 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.

6.4 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.

6.5 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.

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

6.7 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.

6.8 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.

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

6.10 The co-spokespersons are the official contact and are responsible for forwarding all pertinent information to the rest of the group, arranging for their training, and requesting ORC or any other necessary approvals for the experiment to run.

6.11 The co-spokesperson should ensure the appropriate people (which might be everyone on the experiment) sign up for the test beam emailing list.

6.12 The spokesperson, or designee, will generate a one-page summary of the experiment's use of the Test Beam facility during the fiscal year, to be included in the annual Test Beam Report Fermilab submits to the DOE.

*At the completion of the experiment:*

6.13 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.

- 6.14 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.

SIGNATURES:



A handwritten signature in black ink, appearing to read 'K. Hanagaki', written over a horizontal line.

11 / 12 / 2015

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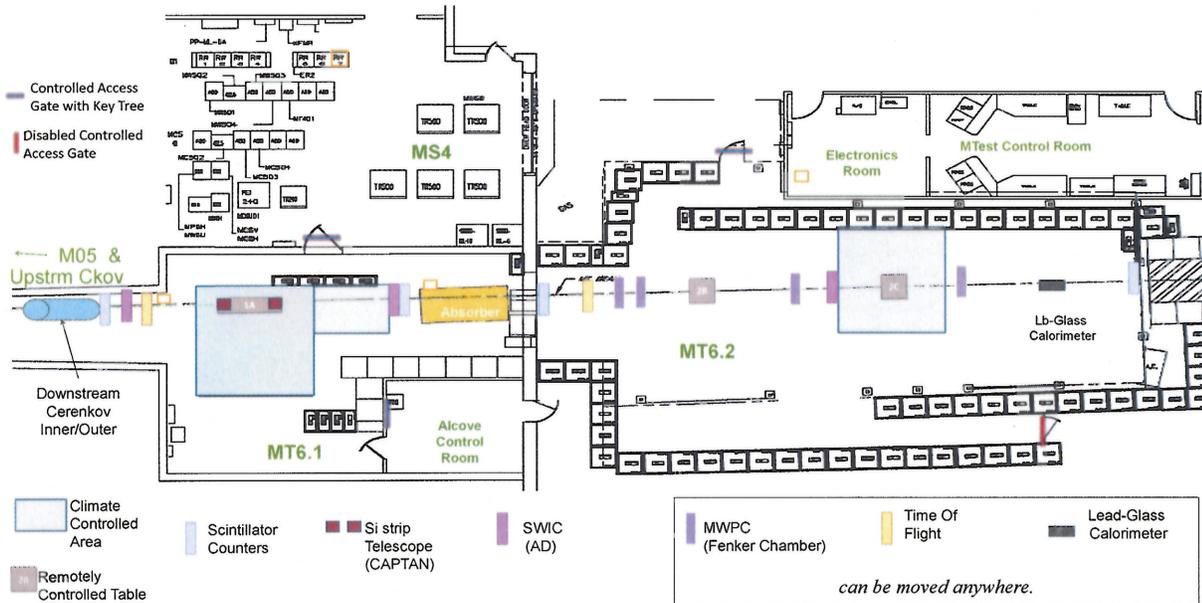
Kazunori Hanagaki, Experiment Spokesperson

If there are two spokespeople, they are called co-spokespeople and both sign the Signatures page.  
If one is spokesperson and the other is a deputy spokesperson, only the spokesperson signs.  
Please adjust Section VI accordingly.

APPENDIX I: MT6 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.]

MTEST AREAS



**APPENDIX II: EQUIPMENT NEEDS**

Provided by experimenters:

[If you wish you may include a breakdown of what is being provided by which institution, for your records.]

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

**PREP EQUIPMENT POOL:**

<u>Quantity</u>	<u>Description</u>
3	Low voltage power supply (5A)
1	NIM crate
1	NIM 8ch discriminator
2	NIM coincidence
1	NIM clock generator
1	NIM gate generator
1	NIM scaler
2	NIM fan in/out
1	19-inch rack

**PPD FTBF:**

<u>Quantity</u>	<u>Description</u>
1	Dry air
1	Motion table (possibly remote controlled)

**APPENDIX III: - HAZARD IDENTIFICATION CHECKLIST**

Items for which there is anticipated need should be checked.

See ORC Guidelines for detailed descriptions of categories.

There is **NO** need to list existing Facility infrastructure you might be using.

(Do Not list FTBF Lasers or Motion Tables, unless you are bringing them)

Flammables (Gases or Liquids)		Gasses		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		

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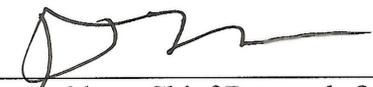
The following people have read this TSW:

  
\_\_\_\_\_  
Patty McBride, Particle Physics Division, Fermilab 11 / 18 / 2015

  
\_\_\_\_\_  
Sergei Nagaitsev, Accelerator Division, Fermilab 11 / 19 / 2015

  
\_\_\_\_\_  
Martha Michels, ESH&Q Section, Fermilab 11 / 18 / 2015

  
\_\_\_\_\_  
Robert Roser, Chief Information Officer, Fermilab 11 / 19 / 2015

  
\_\_\_\_\_  
Joe Lykken, Chief Research Officer, Fermilab 11 / 23 / 2015