Fermilab

Directorate

MEMORANDUM OF UNDERSTANDING

FOR THE 2010 FERMILAB TEST BEAM FACILITY PROGRAM

T-1008

SuperB Muon Detector Prototype

November 15, 2010

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INTRODUCTION

This is a memorandum of understanding between the Fermi National Accelerator Laboratory (Fermilab) and the experimenters of INFN Ferrara and INFN Padova who have committed to participate in beam tests to be carried out during the 2010 Fermilab Test Beam Facility program.

The memorandum is intended solely 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 memorandum to reflect such required adjustments. Actual contractual obligations will be set forth in separate documents.

Description of Detector and Tests:

The test objective is to optimize the muon identification in an experiment at a Super B Factory. To accomplish this, experimenters will study the muon identification capability of a detector with different iron configurations at different beam energies.

The detector is a full scale prototype, composed of a stack of iron tiles. The segmentation of the iron allows the study of different configurations. Between the tiles, one or two extruded scintillator slabs can be inserted to test two different readout options; a Binary Readout and a Time Readout. In the Binary Readout option the two coordinates are given by the two orthogonal scintillator bars, and the spatial resolution is driven by the bar width. In the Time Readout option one coordinate is determined by the scintillator position and the other by the arrival time of the signal read with a TDC.

1. Personnel and Institutions:

Co-Spokespersons and physicists in charge: Gianluigi Cibinetto, Mario Posocco

Fermilab Liaison: Aria Soha

The group members at present are:

	Institution	Collaborator	Country
1.1	INFN Ferrara	Mirco Andreotti	Italy
		Wander Baldini	
		Roberto Calabrese	
		Gianluigi Cibinetto	
		Angelo Cotta Ramusino	
		Eleonora Luppi	
		Matteo Manzali	
		Roberto Malagutti	
		Mauro Munerato	
		Luca Tomassetti	
1.2	INFN Padova	Massimo Benettoni	Italy
		Flavio Dal Corso	
		Enrico Feltresi	
		Nicola Gagliardi	
		Mario Posocco	
		Roberto Stroili	

2. EXPERIMENTAL AREA, BEAMS AND SCHEDULE CONSIDERATIONS:

2.1. LOCATION

2.1.1. BEAMLINE

The experiment is to take place in the MTest beamline and will be situated in the MT6.2 enclosure. The apparatus is expected to be located in the C area. To obtain the very lowest beam energies the experimenters may wish to utilize the tertiary beamline in this enclosure, in which case the detector may be moved horizontally over a few feet during the course of the tests.

2.1.2. ADDITIONAL

Some space in the Meson Detector Building high-bay is needed for storing the detector (approximately 57"H x 67"L x 40"W) between it's arrival at Fermilab from Italy and its installation in the beam area.

2.2. BEAM

2.2.1. BEAM TYPES AND INTENSITIES

Energy of beam: 1 - 5 GeV
Particles: muons and pions
Intensity: 0.1k – 1k particles/spill
Beam spot size: about 10cm^2

The experimenters will need at least 1000 mu/pi per spill for 4, and 5 and maybe 6 GeV momentum particles. The lower momentums would be appreciated, but not crucial to the completion of the experiment. This request is unique as the experimenters are asking for momentum tagged muons at low momentum, rather than just "straight-thrus". The bulk of this effort falls on the PPD FTBF Group to provide Cherenkov and TOF for particle identification. It is likely the beam tuning will require inserting lead in the beam to reduce electrons. A remote lead piece for this purpose exists, and all parties are agreeable on its use. It's also likely that if FTBF is successful in tagging, it will require Accelerator Division to push the intensity limits. A best effort to meet the above requirements will be made.

2.2.2. BEAM SHARING

Due to the size and density of the detector sharing would most likely not be possible. The beam parameters are such that other users would most likely not be interested in sharing.

2.3. EXPERIMENTAL CONDITIONS

2.3.1. APPARATUS

The detector is a full scale prototype composed of a stack of iron tiles with a total depth of 92 cm; its segmentation allows the study of different configurations. The gaps, with an area of

60x60 cm^2, are filled with extruded scintillator slabs equipped with WLS fibers and read out by Silicon Pixellated Photon Detectors in Geiger mode.

The prototype is equipped with two kinds of scintillator bars with 1 and 2 cm thickness, respectively. In the first case the gap is filled with one layer of scintillators, in the second it is filled with two orthogonal layers. The scintillator bar width is 4 cm and the fibers are placed in 3 holes or grooves. The bars were extruded by the FNAL-NICADD facility.

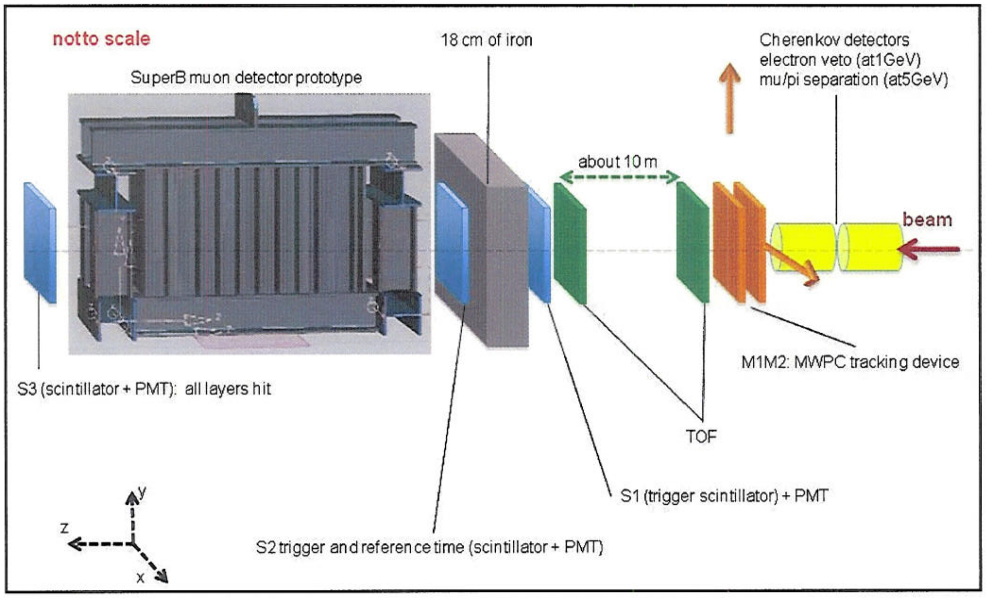
With these two scintillator layouts the experimenters can study two different readout options; a Binary Readout and a Time Readout. In the Binary Readout option the two coordinates are given by the two orthogonal scintillator bars, and the spatial resolution is driven by the bar width. In the Time Readout option one coordinate is determined by the scintillator position and the other by the arrival time of the signal read with a TDC.

For Binary Readout the experimenters will use the 1.2 mm diameter Kuraray WLS fibers, while for the Time Readout the experimenters will test Saint Gobain fibers with 1.2 mm and 1.0 mm diameters. The fibers are 4 m long in order to simulate the actual final length in the SuperB experiment. The fibers are read on one side for Binary readout and on both sides for Time readout. The fibers are contained in an aluminum box measuring 140 cm x 60 cm x 3 cm.

The photodetectors are SiPM fabricated by FBK-IRST. They are arrays of 3 devices each with a sensitive area of 1.4x1.4 cm^2.

The mechanical structure has an overall length of 1.5 m, a width of 1.0 m (1.6 m taking into account the scintillator plane boxes) and a height of 0.8 m. The total weight is 4.0 tons. During movements it is strengthened by steel rods which are removed when the detector is on the test spot. A standalone support aligns the detector with the beam trajectory.

An iron absorber block, 18 cm x 30 cm x 30 cm, will be placed in front of the detector to simulate the set-up of the actual Super-B experiment.



2.3.2. Electronics Needs

Each scintillator plane is assembled in a light-tightened box which also contains fibers, photodetectors and fiber-SiPM coupling PCB's. Signals from PCB's are wired to a custom-made crate with size comparable to the standard VME crate for amplification, discrimination and Binary readout. Discriminated signals from time readout modules are then routed to a standard VME crate equipped with two TDC's for the time measurements. Binary and TDC data are sent separately to the DAQ system via TCP/IP connection, therefore a network connection between the experimental hall and the counting room is necessary.

DAQ system consists of a dedicated PC that operates as RUN control and Online monitor. The PC is equipped with Linus-CERN operating system and the DAQ application is C++ based.

2.3.3. Description of Tests

The main objective is to study the muon identification capability with different iron configurations. In order to change configurations a limited number of accesses are needed. Tests are performed with different beam energies, as listed above. To obtain the very lowest beam energies the experimenters may wish to utilize the tertiary beamline in this enclosure.

2.4. Schedule

The two scintillator layout options will be tested at the same time by equipping some gaps with the first one and some with the second one. With this set-up the tests can be accomplished in a 7 day time slot (Dec 1 – Dec 7) with the week before available for installation and beamless tests.

The experiment may return at a later date to explore momentum below 1GeV with the tertiary beamline.

3. Responsibilities by Institution – Non Fermilab

3.1. INFN Ferrara:

- 3 crates VME
- 2 PC's
- 1 oscilloscope LeCroy Mod. Mxi204
- 3 modules TDC VME Mod. Caen 1190A
- 1 module ADC VME Mod. Caen V792
- 2 Low Voltage Power supply for SiPM and MPPC (custom made)
- 1 Pulser Lecroy
- 2 Voltage transformers (220V > 110V)
- 12 SuperB muon detector modules

3.2. INFN Padova:

- 1 iron structure of the prototype
- 140lbs. C4F8O bottles (for Cerenkov detector)

4. Responsibilities by Institution – Fermilab

4.1. Fermilab Accelerator Division:

4.1.1. Use of MTest beamline 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. Scalers and beam counter signals should be made available in the counting house.

4.1.4. Reasonable access to the equipment in the MTest beamline.

4.1.5. Connection to beams control 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).

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 antiproton stacking rate and the neutrino flux 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 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. [0.5 person weeks]

4.2.2. Set up and maintenance of the Time of Flight system. [0.5 person weeks]

4.2.3. Set up and maintenance of the MWPC tracking system (2 stations). [0.5 person weeks]

4.2.4. Set up and maintenance of 3 scintillator counters with PMTs. [0.25 person weeks]

4.2.5. Set up and maintenance of the Cherenkov particle ID system. In order to reject the huge amount of electrons in the beam at such low momentum, one Cherenkov detector will be operated as electron veto. The other Cherenkov counter will be filled with C4F8O gas to give muon/pion separation for particles with momentum starting from about 2.2 GeV. Muon/pion identification below 2.2 GeV will be handled by means of a time of flight device with few ps resolution over a lever arm of 10 meters. The setup of PID devices is responsibility of the Fermilab Particle Physics Division while the C4F8O gas will be purchased by the user institutions. [0.5 person weeks]

4.2.6. Support only for FTBF DAQ systems as needed.

4.2.7. Crane Operation for installation. [1 person weeks]

4.3. Fermilab Computing Division

4.3.1. Internet access should be continuously available in the counting house.

4.3.2. See Appendix II for summary of PREP equipment pool needs.

4.4. Fermilab ES&H Section

4.4.1. Assistance with safety reviews.

4.4.2. Provide all necessary safety training.

5. Summary of Costs

Source of Funds [$K]	Equipment	Operating	Personnel (person-weeks)
Particle Physics Division	$0K	$0 K	3.75
Accelerator Division	0	0	0.5
Computing Division	0	0	0
Totals Fermilab	$0 K	$0K	4.25
Totals Non-Fermilab			

6. Special Considerations

6.1. The responsibilities of the Spokespersons 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 Spokespersons agree 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 Spokespersons 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 spokespersons will ensure 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 Spokespersons 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 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.

6.8. At the completion of the experiment:

6.8.1. The Spokespersons are 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 Spokespersons 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 unless removal requires facilities and personnel not able to be supplied by them, such a rigging, crane operation, etc.

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

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

SIGNATURES:

____ / / 2010

Mario Posocco, SuperB Muon Detector Prototype Co-spokesperson

____ / / 2010

Gianluigi Cibinetto, SuperB Muon Detector Prototype Co-spokesperson

____ 11 /16 / 2010

Michael Lindgren, Particle Physics Division

____ 11 /17 / 2010

Roger Dixon, Accelerator Division

____ 11 /16 / 2010

Peter Cooper, Computing Division

____ 11 /16 / 2010

Nancy Grossman, ES&H Section

____ 11 /23 / 2010

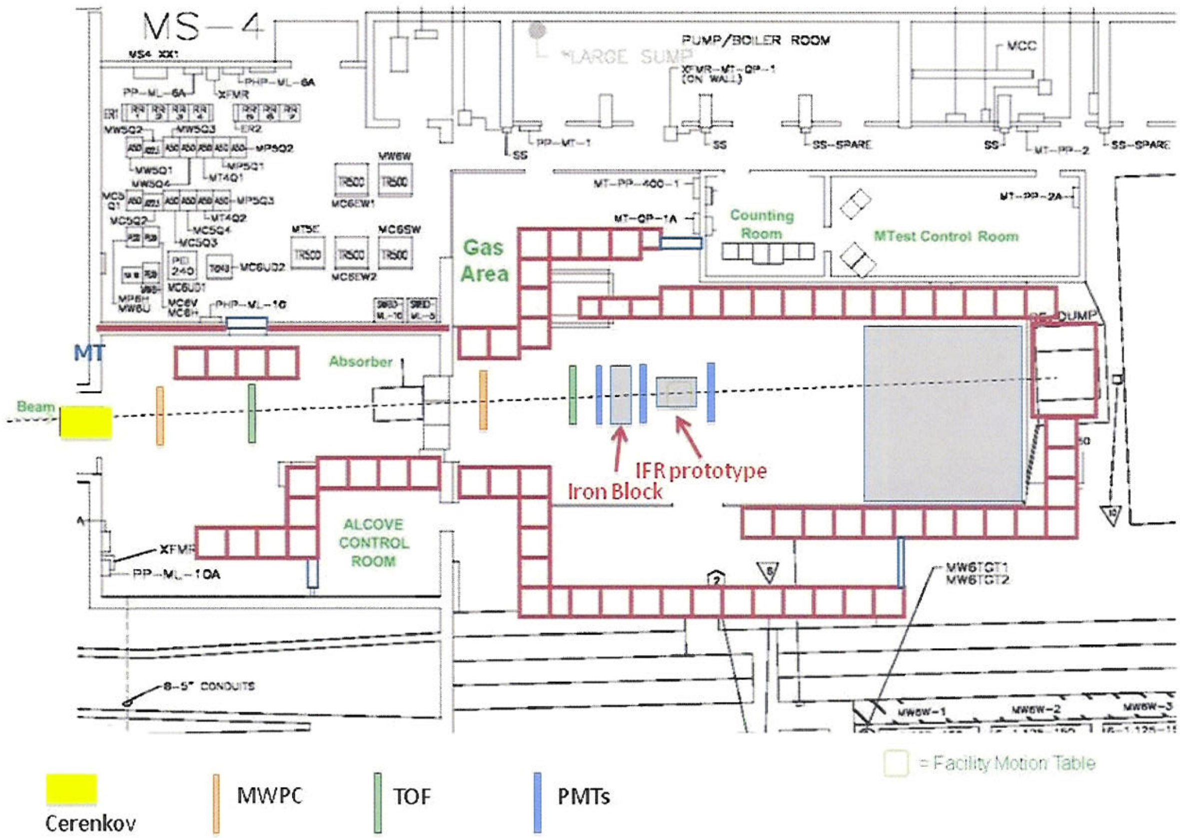
Greg Bock, Associate Director for Research, Fermilab

____ 11 / 19 / 2010

Stuart Henderson, Associate Director for Accelerators, Fermilab

APPENDIX I: MT6 AREA LAYOUT

Experiment will set up in the MT6.2-B and C areas.



Equipment in the enclosure includes:

- An aluminum box, containing the fibers for the binary readout measuring 140 cm x 60 cm x 3 cm.
- The mechanical structure has an overall length of 1.5 m, a width of 1.0 m (1.6 m taking into account the scintillator plane boxes) and a height of 0.8 m.
- An iron absorber block, 18 cm x 30 cm x 30 cm

The total weight is 4.0 tons.

APPENDIX II: EQUIPMENT NEEDS

Equipment Pool and PPD items needed from Fermilab, on the first day of setup.

Quantity	Description
PREP EQUIPMENT POOL:	
1	crate CAMAC
1	crate NIM
1	module NIM Fan Out/ Fan In Mod. LeCroy 428F (or equivalent)
1	module NIM Coincidence Unit Mod. LeCroy 465 (or equivalent)
1	module NIM NIM-ECL level translator Mod. LeCroy 4616 (or equiv.)
1	module NIM discriminator Mod. 623B (or equivalent)
1	Low Voltage power supply 0-24V
?	cables, power cords, adapters etc. (to be defined)
PPD FTBF:	
3	scintillator paddles (complete with PMTs) to be used as a trigger/time reference (possibly 12" x 12" or bigger)
1	HV power supply for the above scintillators
2	Cerenkov counters
2	MWPC Tracking stations
?	Lemo cables, various lengths (to be defined)
1	Iron absorber appr. 30 cm x 30cm x 18cm to be put before the detector
1	A suitable support table, movable if needed for installation, able to hold the detector aligned with the beam

APPENDIX III: - HAZARD IDENTIFICATION CHECKLIST

Items for which there is anticipated need have been checked.

Cryogenics		**Electrical Equipment**		**Flammable Gases or Liquids**	
	Beam line magnets		Cryo/Electrical devices	Type:	
	Analysis magnets		capacitor banks	Flow rate:	
	Target	X	high voltage	Capacity:	
	Bubble chamber		exposed equipment over 50 V	**Hazardous/Toxic Materials**	
Pressure Vessels		**Other Gas Emissions**		List hazardous/toxic materials planned for use in a beam line or experimental enclosure:	
	inside diameter	Type:	C4F8O		
	operating pressure	Flow rate:	140 lbs/week		
	window material	Capacity:	140lbs		
	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		Tungsten (W)
	Permanent installation		Scintillation Oil		Uranium (U)
	Temporary installation		PCBs	X	Other: Iron (Fe)
	Calibration		Methane	**Mechanical Structures**	
	Alignment		TMAE		Lifting devices
type:			TEA		Motion controllers - manual
Wattage:			photographic developers	X	scaffolding/elevated platforms
class:			Other: Activated Water?		Others