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Fermilab

Directorate

MEMORANDUM OF UNDERSTANDING FOR THE 2007 MESON TEST BEAM PROGRAM

T-971

Tests of LHCb Silicon Detectors

December 3, 2007

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1. INTRODUCTION

This Memorandum of Understanding applies to the use of the FNAL Meson Test Beam Facility to study the performance of several LHCb silicon vertex detectors. The tests will be carried out as a collaborative effort of CERN, Glasgow, Liverpool, and Syracuse Universities.

The Vertex Locator (VELO) of the LHCb detector uses short silicon strips in a unique geometry that features strips at constant radial distance from the beam line and strips at almost constant azimuthal angle. The Silicon detectors in use at LHCb are implemented with n strips on n substrates. Prototype replacement sensors, however, have been produced using n strips on p substrates. The new processing scheme offers the prospect of producing significantly lower cost detectors for future projects and possibly better performance especially of irradiated sensors.

The experimenters wish to compare the performance of the n-on-n and n-on-p detectors for irradiated and non-irradiated sensors. To do so, the experimenters plan to use the pixel telescope being constructed in the MTest facility. In particular, the experimenters are planning to study the efficiency of the irradiated and unirradiated devices and the spatial resolution as a function of the track incident angle. They vary over the sensor area due to the unusual geometry. The experimenters will also change the incident angle of the beam by moving the sensors, to investigate how the resolution varies with angle. Besides VELO sensors, some n-on-p sensors are available from the RD50 collaboration at CERN. Many physicists participating in this test beam are members of RD50.

This memorandum is intended solely for the purpose of providing a work allocation for Fermi National Accelerator Laboratory and the participating universities and institutions. It reflects an arrangement that is currently satisfactory to the parties involved. It is recognized, however, that changing circumstances of the evolving research program may necessitate revisions. The parties agree to negotiate amendments to this memorandum to reflect such revisions.

2. PERSONNEL AND INSTITUTIONS

PI and Group Leader: Marina Artuso (Syracuse University)
Lead Experimenter in charge of beam test: Marina Artuso (Syracuse University)
Deputy Experimenter in charge: Raymond Mountain (Syracuse University)
Fermilab liasion: Erik Ramberg (FNAL)

The members of the group which will take part to the installation, data taking activity and dismantling at Fermilab are:

Marina Artuso (Syracuse University)
Sheldon Stone (Syracuse University)
Gwaenelle Lefeuvre (Syracuse University)
Raymond Mountain (Syracuse University)
Jianchun Wang (Syracuse University)
Themis Bowcock (Liverpool University)
Gianluigi Casse (Liverpool University)
Tony Affolder(Liverpool University)
Chris Parkes (Glasgow University)
Tomasz Szumlak (Glasgow University)
Lars Ecklund (Glasgow University)
Paula Collins (CERN)

3. EXPERIMENTAL AREA, BEAMS AND SCHEDULE CONSIDERATIONS

3.1 LOCATION

3.1.1 The tests will take place in MT6-A1.

3.1.2 Lab space shall be provided for pre-testing the detectors and making repairs as necessary. This shall include two ~30"x72" work surfaces in a low dust environment equipped with ESD-safe surfaces and grounding and lights.

3.1.3 Office space including two desks and network connectivity will be provided for the duration of T-971.

3.2 BEAM

3.2.1 Type of Beam Needed: 120 GeV proton beam

3.2.2 Intensity Needed: 10-100k particles/ (4s spill)
Beam Size Needed: ~ 10 cm^2

3.3 EXPERIMENTAL CONDITIONS

3.3.1 Provision will be made for the devices under test (including the largest VELO sensors) to be rotated with respect to the beam direction.

3.3.2 The pixel telescope upgrade for the beam line is required. The experimenters can offer some manpower help in commissioning the telescope.

3.3.3 The test environment shall be humidity-controlled, preferably with the test devices in a dry nitrogen atmosphere.

3.3.4 There shall be refrigeration capability so that the detectors can be operated at -10° C, the operating temperature at LHCb. The LHCb modules dissipate approximately 20W each. Given the construction of the hybrids a cooling capacity of ~50W at –30C (temperature of the cooling interface) should be foreseen.

3.3.5 The experimenters will provide all the computers needed for DAQ and data analysis and disks for data storage.

3.3.6 Fermilab will provide 250 Gbytes of space on a managed disk server that the experimenters will use for short-term backup of test beam data.

3.4 ELECTRONICS:

The system is read out through a custom DAQ system. An interface board will be used to route the data to an online computer connected to a Fermilab server via internet. The readout boards will be located near the detector in the hut. The detector themselves are run at up to ~300 V. No exposed HV parts will be present.

3.5 SCHEDULE:

The time schedule is primarily dictated by the availability of the new pixel telescope in the test beam. As this is expected to be completed in the spring of 2008, the experimenters would envisage running their tests at that time. The experimenters are willing to arrive earlier than that to help commission the facility pixel telescope.

The experimenters envisage a 3 weeks running time divided into three approximately equal phases:

1. Setup and synchronization, where the devices under test are put into the text box at the nominal "normal to the beam" position, and the operating conditions are optimized and synchronization with scintillator trigger and pixel telescope is implemented.
2. Data taking with VELO modules: it is envisaged to take data at 6 angles and different VELO positions to investigate resolution and efficiency at various bias voltages for the full detector acceptance.
3. Setup and test of RD50 strip detectors at a few beam angles.

4. RESPONSIBILITIES BY INSTITUTION - NON FERMILAB

The personnel from Syracuse, Glasgow, Liverpool and CERN will set up equipment on the beam line under the Fermilab Particle Physics Division guidance and supervision, provide the DAQ and slow control systems, provide test beam coordination and funding for its personnel during the beam test.

5 RESPONSIBILITIES BY INSTITUTION - FERMILAB

5.1 FERMILAB ACCELERATOR DIVISION:

5.1.1 Use of MTest beam as outlined in Section 3.

5.1.2 Maintenance of all existing standard beam line elements (SWICs, loss monitors, etc) instrumentation, controls, clock distribution, and power supplies.

5.1.3 Reasonable access to the experimenters' equipment in the test beam.

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

5.1.5 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 will be delegated to the experimenters as long as it does not violate the Shielding Assessment or provide potential for significant equipment damage.

5.2 FERMILAB PARTICLE PHYSICS DIVISION

5.2.1 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.

5.2.2 PPD will maintain scintillation counters that are part of the Meson Test Beam Facility.

5.2.3 PPD will provide on-call LINUX DAQ computing support during normal working hours.

5.2.4 PPD will commission and maintain the Meson Test Beam Facility pixel telescope and assist in coordinating it with the experimenters DAQ.

5.2.5 PPD personnel will modify the "pixel box" to allow it to be used for VELO testing as detailed in 3.3. It is estimated that 3 weeks of engineering will be required to design the required cooling systems including isolation of cold and warm sections of the pixel box. Approximately one week of designer effort and 4 weeks of technician time will be required for modifications to accommodate the VELO sensors. The M&S cost associated with the modifications and the cooling system is estimated to be $20k.

5.2.6 PPD will provide office and lab space as detailed in 3.1.

5.3 FERMILAB COMPUTING DIVISION

5.3.1 Ethernet and printer will be available in the counting house.

5.3.2 Connection to beams control console and remote logging (ACNET) should be made available in the counting house.

5.3.3 CD will provide access to 250 Gb data storage on a centrally backed-up server for the duration of the beam test.

5.4 FERMILAB ES&H SECTION

Assistance with safety reviews.

6 SUMMARY OF COSTS

Source of Funds [$K]	**Equipment**	**Operating**	**Personnel** (person-weeks)
Particle Physics Division	$0k	$20k	8.5
Accelerator Division	0	0	0.5
Computing Division	0	0	0.1
Totals Fermilab	0k	$20k	9.1
Totals Non-Fermilab	[$50k]		

7 SPECIAL CONSIDERATIONS

7.1 The responsibilities of the PI of the Syracuse 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.

7.2 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 PI of the Syracuse group will follow those procedures in a timely manner, as well as any other requirements put forth by the division's safety officer.

7.3 The PI of the Syracuse 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.

7.4 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.

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

7.6 The PI of the Syracuse 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.

7.7 The SYRACUSE 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.

7.8 At the completion of the experiment:

7.8.1 The PI of the SYRACUSE 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 PI of the SYRACUSE group will be required to furnish, in writing, an explanation for any non-return.

7.8.2 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.

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

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

SIGNATURES

Marina Artuso 12/4/2007
Marina Artuso, SYRACUSE

12/5/2007
Greg Bock, Particle Physics Division

12/20/2007
Roger Dixon, Accelerator Division

1/2/2008
Victoria White, Computing Division

12/18/2007
William Griffing, ES&H Section

1/12/2008
Hugh Montgomery, Associate Director, Fermilab

1/10/2008
Stephen Holmes, Associate Director, Fermilab

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		high voltage		
	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	X	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		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