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In Appendix I, we summarize the properties of diamond and, for comparison, those of silicon.

The most distinctive feature of diamond is its large band gap, 5.5 eV. This large band gap along with the associated large cohesive energy are responsible for much of the radiation hardness of diamond. The large band gap also makes diamond an excellent electrical insulator. As a result, a large electric field can be applied without producing significant leakage current. Thus, there is no need for a reverse biased pn-junction and the diamond detector functions much like a "solid-state" ionization chamber. Diamond has two additional properties that are favorable compared to silicon. Its smaller dielectric constant yields a smaller detector capacitance and, thereby, better noise performance of the associated frontend electronics. In addition, even though diamond is an electrical insulator, it is an excellent thermal conductor with a thermal conductivity exceeding that of copper by a factor of five. A common problem with large strip detector systems is the management of the thermal load generated by the large number of electronic channels used in the detector readout. The handling of this thermal load would be simplified if the detectors were constructed from diamond.

Diamond appears ideal in many respects but it does have a limitation: the large band gap which produces many of its outstanding properties limits the signal size to at most half that of silicon for a given detector thickness in radiation lengths. This may be partially compensated by lower front-end electronic noise due to diamond's nearly non-existent leakage current and, for strip detectors, diamond's lower capacitive load.

In the figure below, we show the basic principle behind the use of diamond as a charged particle detector. Several hundred volts ($\sim 1\text{V}/\mu\text{m}$) is applied across a layer of diamond a few hundred microns thick.

PERSONNEL AND INSTITUTIONS:

Physicist in charge of beam tests: Steven Worm, Rutgers Univ.

Fermilab liaison: Erik Ramberg

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

1.1 Rutgers University: J. Doroshenko, T. Koeth, L. Parera, S. Schnetzer, R. Stone, S. Worm

Other commitments:

CDF: S. Worm

CMS: J. Doroshenko, L. Parera, S. Schnetzer, R. Stone, S. Worm

HiRes: L. Parera, S. Schnetzer

1.2 Purdue University: D. Bortoletto, I. Shipsey, G. Bolla, J. Lee, K. Arndt, A. Roy, S. Son.

Other commitments:

CDF and CMS: D. Bortoletto, G. Bolla, A. Roy

CLEO and CMS: I. Shipsey, J. Lee, K. Arndt

II. EXPERIMENTAL AREA, BEAMS AND SCHEDULE CONSIDERATIONS

1. LOCATION

1.1. The experiment is to take place in the MTEST beam line and located in the area designated MT6-A2. In addition, the alcove control room to the east of the MTEST line will be used to house electronics (up to two 19" racks of electronics)

1.2. Additional work space will be needed in this control room, equivalent to at most two 6'x3' tables. This space will be used for computing and general work space.

2. BEAM

2. The tests will use slow resonantly-extracted, Main Injector proton beam focused onto the MTest target. The tests require a beam of untagged, charged particles of energy approximately 80 GeV.
3. Intensity: Variable, in the range of 1-10 KHz in an area of 1 square cm. With the current beam line design this is expected to require up to 2×10^{10} primary protons per second.
4. We can make good use of the planned initial beam to MTEST. Currently this is envisioned to be a 1 sec spill per 60 sec supercycle. We are modifying our DAQ to take advantage of this scenario.
5. We anticipate some parasitic running during the test beams outlined in T927 (BTev pixel test beam, located at MT6-A1). We would like to be informed of any accesses.

3. SETUP

2. At least one full day of access to the experimental area will be needed to set up the pixel test stand. This includes not only the silicon telescope planes and mechanical apparatus, but also the cable work.
3. At least one additional day will be needed to install and debug the DAQ and NIM logic associated with the trigger. This would require only sporadic access.
4. Cabling to the counting room is significant. We have allowed one day of setup time. An outline of our cable needs between counting house and MT6-A2 include:
 - o Strip sensors (3 cond. for power, 20 cond. ribbon, 6 RG58 BNC coax)
 - o Pixel sensors (3 cond. for power, 60 cond. ribbon, 16 RG58 BNC coax)
 - o Trigger scintillators (5 RG59 SHV for voltage, 38 RG58 BNC coax)
 - o Power, Ethernet, DAQ interconnection cables (in counting house)

4. SCHEDULE

2. We are requesting a few days of setup time followed by three weeks of regular data taking. Each run will consist of a few hours of measurements, and we will take data with about 12 devices and possibly at several angles of incidence to the beam for each. Upon changing to a new device under test or a new angle of incidence, access to the experimental area will be needed.

III. RESPONSIBILITIES BY INSTITUTION - NON FERMILAB ([] denotes replacement cost of existing hardware.)

1. Diamond samples under test (\$1k each) [\$12k]
2. Mechanical translation stage, stepper motors, computer control [\$10k]
3. (All equipment and DAQ will be supplied by the Rutgers University group.)
 - 3.1. Repeater card box, repeater boards, (Vienna) ADC [\$5k]
 - 3.2. VME Crate w/ 5, 2V supplies (if item 2 in Appendix I is unavailable) [3]
 - 3.3. Silicon telescope mechanical assembly [2]
 - 3.4. Silicon telescope detector planes and holders [15]
 - 3.5. Digital scope [10]
 - 3.6. Keithley 237 Voltage/Current Source [8]
 - 3.7. Pulse generator w/ adj rate knob [2]
 - 3.8. Comp. control attenuator [1]
 - 3.9. 2 10V supplies 10A [1]
 - 3.10. 2 PC's, monitors, Ethernet and hub [3]
 - 3.11. 2 DLT drives and tapes [2]
 - 3.12. Soldering iron [1]
 - 3.13. Asst. lemo cables, voltmeters, tools, toolbox [1]

- 3.14. 60 150' BNC, SHV, lemo, and ribbon cables [2]
- 3.15. Remote positioning system (manipulators, encoders) [3]
- 3.16. CCD camera for monitoring [1]

Total existing items [\$82K]

IV. RESPONSIBILITIES BY INSTITUTION - FERMILAB

([] Denotes replacement cost of existing hardware.)

4.1 Fermilab Beams Division:

1. Use of MTest beam.
2. Maintenance of all existing standard beam line elements (SWICs, loss monitors, etc) instrumentation, controls, clock distribution, and power supplies.
3. A scaler or beam counter signal should be made available in the counting house.
4. Reasonable access to our equipment in the test beam.
5. The test beam energy and beam line elements will be under the control of the BD Operations Department Main Control Room (MCR).
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.
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.

4.1.S Summary of Beam Division costs:

Type of Funds Equipment Operating Personnel
(person-weeks)

Total new items \$0.0K \$0K 0.0

4.2 Fermilab Particle Physics Division

1. Adequate lighting for the MT6-A2 area is requested, as there is currently only indirect lighting from upstream. The estimated cost and time are given below.
- 4.2.2 Cooling water (or a chiller) and dry nitrogen (for electronics) should be provided.
- 4.2.3 The test-beam 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 use of the user beam-line controls, readout of the beam-line detectors, and MTest gateway computer.

4.2.S Summary of Particle Physics Division costs:

Type of Funds Equipment Operating Personnel
(person-weeks)

Total new items \$0.2K \$0K 0.2

4.3 Fermilab Computing Division

1. Ethernet and printers should be available in the counting house.
2. Connection to beams control console and remote logging (ACNET) should be made available in the counting house.
3. See Appendix II for summary of PREP equipment pool needs.

4.4 Fermilab ES&H Section

1. Assistance with safety reviews.
2. Loan of radioactive source (preferably Sr⁹⁰, 5mCi) for the duration of the test beam.

V. SUMMARY OF COSTS

Source of Funds [\$K] Equipment Operating Personnel
(person-weeks)

Particle Physics Division \$0.2K \$0K 0.2
Beams Division 0 0 0
Computing Division 0 0 0
Totals Fermilab \$0.2K 0 0.2

Totals Non-Fermilab [\$82K]

VI. SPECIAL CONSIDERATIONS

6.1 The responsibilities of the Diamond Detector Research Group Spokesperson and procedures to be followed by experimenters are found in the Fermilab publication "Procedures for Experimenters" (PFX). 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 a Partial Operational Readiness Clearance document in conjunction with the standing Particle Physics Division committee. The Diamond Detector Research Group 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 Diamond Detector Test Beam Spokesperson 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 experimenters.

6.6 The Diamond Detector Research Group Spokesperson will undertake to ensure that no PREP and 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 Each institution 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 If the experiment brings to Fermilab on-line data acquisition or data communications equipment to be integrated with Fermilab owned equipment, early consultation with the Computing Division is advised.

6.9 At the completion of the experiment:

6.9.1 The Diamond Detector Research Group 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 Diamond Detector Research Group Spokesperson will be required to furnish, in writing, an explanation for any non-return.

6.9.2 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.