SLAC National Accelerator Laboratory

FACET & TEST BEAM FACILITIES PROPOSAL

Date: 10/26/13

A. EXPERIMENT TITLE: HPS Silicon Sensor Acute Beam Accident Damage Test

B. PROPOSERS & REQUESTED FACILITY:

Principal Investigator:	Per Hansson Adrian
Institution:	SLAC
Contact Information:	Phone: 2704 Email: phansson@slac.stanford.edu
Experiment Members:	Tim Nelson, Takashi Maruyama, Sho Uemura, John Jaros, Al Odian, Clive Field
Collaborating Institutions:	
Funding Source (optional)	
Facility/Facilities Requested:	NLCTA
Approximate Duration:	1 day runtime; 1 day installation (in parallel w/ other activity)

C. EXPERIMENT:

1. Science justification (one paragraph)

The Silicon Vertex Tracker (SVT) of the Heavy Photon Search apparatus at Jefferson Lab is built to track and vertex e+e- pairs originating from thin fixed target illuminated by the CW CEBAF electron beam. The unique aspect of the HPS is that in order to reach low mass sensitivity in the search the SVT has to operate with it's edge 0.5mm from the center of the beam. While the SVT has been built by radiation hard technologies and fast readout to deal with the large occupancy expected one of the remaining questions is how susceptible the silicon strip sensors are to a beam accident. With protection collimators being built, the most severe accident would be beam hitting the collimator and creating an intense radiation field on the SVT until the beam is shut down. This important beam test will show how susceptible our sensors are to damage and thus help in designing the collimator structures for the beam line at Jefferson Lab.

2. Description of experiment goals (~ 1 page):

The test consists of exposing existing silicon modules for the SVT (built and tested in a 2012 test beam , including readout and data acquisition) to large deposition of charge in the bulk of the silicon to test the module susceptibility to develop pin holes. These are shorts of the AC coupling capacitor between the strips and implants. This can happen if an excessive amount of charge is deposited in the bulk, creating an “ohmic path” between the implant and backside, which sits at high voltage for the reverse bias of the silicon. Studies from similar sensors in Atlas has shown that depending on the exact sensor design and the applied reverse bias voltage damage sensors can be more or less susceptible to this kind of damage. The specification for the breakdown of the capacitor in a non-transient situation is approximately 100V. In the physics run the nominal operating reverse bias voltage will be <200V; but the SVT may be required to operate up to 1kV increasing the chance of damage.

The goal is to deposit a similar amount of charge in a similar area as to what we expect in the beam accident scenario at Jefferson Lab. Using NLCTA we can pass this amount of radiation through the sensor in single bunches; increasing the damage factor compared to the CW beam at Jefferson Lab. In order to understand our sensors we will control the charge density on our sensor by controlling the bunch charge and the distance from the beam exit window. In addition we will use thin foils to spread out the beam even further.

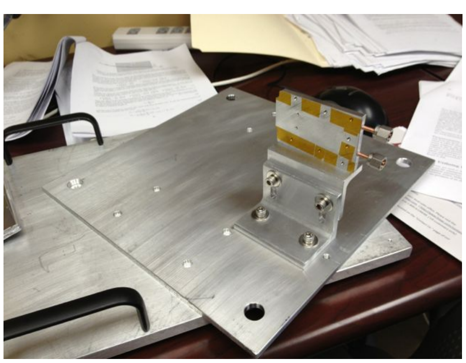
Starting from a safe level we will scan both the reverse bias voltage, bunch charge and radiator thicknesses.

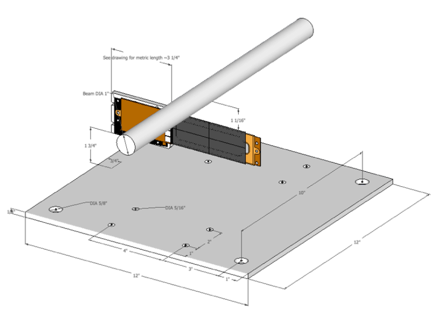
3. Beam parameters needed (assess the appropriateness of the facility requested):
   (see table below for machine parameters)
   - Bunch charge between 0.1pC and the maximum available. If measurement of the charge below 1pC is not possible this is ok; we will be active and timed in to tell if we see charge on our sensor while we ramp up bunch charge.
   - 1-10Hz range is ok.
   - Beam spot sigma of about 0.5mm or less is favorable.

D. EXPERIMENTAL APPARATUS:

Give a detailed description of the experimental apparatus, including as appropriate:

- Sketch of the planned layout with dimensions
  Support plate that will sit on the stand about 200cm downstream of the beam exit window. The silicon module height is adjustable to go completely above or below the beam.





- Description of the DAQ system coming with the experiment and what additional DAQ will be needed from SLAC
  Sensor is wirebonded to hybrid readout board. The readout board sends signals to a 5x5" PCB board that handles ADC and event handling. The data is converted to optical and sent through 6m of fibers to a Linux desktop that we will control from the control room. The hybrid board power supply, the development board power supply and HV supply will all be remotely controlled.
  Needs:
  At least 2 power outlets within ~1.5m from the area were the sensor will sit for power supplies.
  2 power outlet about 6m upstream of the sensors for the DAQ desktop.

- Other electronics components (HV supplies, scopes, etc.)
  None

- Cooling or gas supply needs
  None

- Radioactive sources
  None

- Computing infrastructure needs
  Network cable that reaches DAQ desktop in tunnel.
  IP address to allow us to connect to the DAQ desktop.
  Computer and monitor on control room on the network that we can use to connect to the DAQ desktop.

- Any other aspect which might be of importance
  Area where the sensor is should be as dark as possible since our sensor is photosensitive.

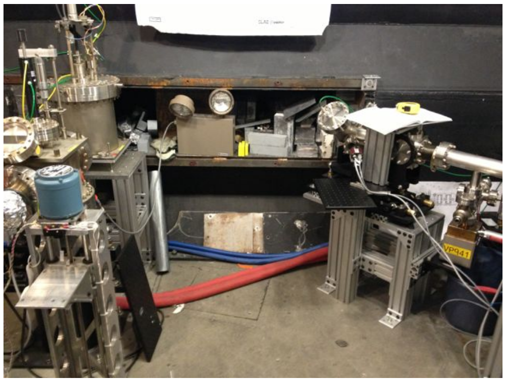
- Support needed from SLAC: riggers, technicians, DAQ systems, cooling, gas lines, etc.
  We need access to standard tools for settting up the support structure on the stand.

E. EXPERIMENT LOGISTICS:

Give details of the logistics for the experiment, including as appropriate:

- Space Requirements (include sketch):
  We will installing our support plate (right picture below) on the stand where the Faraday cup is located. The DAQ PCB board will be on the ground below the stand together with

power supplies for the sensor module and PCB board.



We propose that the desktop be located as far upstream as possible, limited to 6m from available cabling along the beamline.

- Special Requirements (cooling water, gasses, electricity, magnets, detectors, etc):
  None special except for those list in the previous section.

- Estimated installation time:
  ½ day.

- Duration of Test and Shift Utilization:
  1 day of test using a single shift.

- Desired Calendar dates:
  From Oct. 30 and onwards.

- Any other aspect of Importance:
  There was some concern about radiation environment. Our electronics on the module should be safe but the power supplies that are now only 1-2m away from the beam dump might be at larger risk.