

**TEST REQUEST**

**Title:** LC – Beam 1 **Date:** June 11, 2004  
Linear Collider - BPM-based energy spectrometer 2

**Spokesman:** Mike Hildreth **Address:** University of Notre Dame

**Telephone:** 574-631-6458  
**e-Mail:** mikeh@omega.hep.nd.edu

**Purpose of Test:** see attachment

**Description of Test Apparatus:**

**Beam Requirements:**

**Momentum:**

**Particles:**

**Rep. Rate:**

**$\Delta p/p$ :**

**Space requirements (include sketch):**

**Special power requirements:**

**Duration of test and shift utilization:** 1 week

**Desired calendar dates:** June 2005

-----  
Test Beam Coordinator \_\_\_\_\_ Date: \_\_\_\_\_

Radiation Physicist \_\_\_\_\_ Date: \_\_\_\_\_

Chairman, SOC \_\_\_\_\_ Date: \_\_\_\_\_

Area Manager \_\_\_\_\_ Date: \_\_\_\_\_

Accelerator Dept. Physicist \_\_\_\_\_ Date: \_\_\_\_\_

-----  
**Program Coordinator**

Action: Approve/Disapprove/Defer Signature \_\_\_\_\_ Date: \_\_\_\_\_

Remarks:

# SLAC Test Beam Request

Title: LC-BEAM1  
Spokesman: Mike Hildreth

Date: June 14, 2004  
Address: University of Notre Dame  
Telephone: 574-631-6458  
Email: mikeh@omega.hep.nd.edu

## Introduction:

At the Linear Collider (LC), beam energy measurements with an accuracy of (100-200) parts per million are needed for the determination of particle masses, including  $m_{top}$  and  $m_{Higgs}$ . Energy measurements both upstream and downstream of the collision point are foreseen by two different techniques to provide redundancy and reliability of the results. Upstream, a beam position monitor-based spectrometer is envisioned to measure the deflection of the beam through a dipole field. Downstream of the IP, an SLC-style spectrometer is planned to detect stripes of synchrotron radiation (SR) produced as the beam passes through a string of dipole magnets. This test beam request is part of the work described in a recent UCLC Proposal,[1] and is part of a program of beam tests being proposed in End Station A.[2,3]

## Purpose of Test:

We wish to demonstrate the mechanical and electrical stability of a prototype BPM-based Energy Spectrometer for use at a future Linear Collider (LC). This test would use the End Station A (ESA) beamline whose capabilities are particularly well matched to the studies we would like to make, given that we can produce single or multi-bunch pulses with nearly arbitrary energy spread and/or beam halo. The initial configuration will include 4 BPMs and 1 WireArray on a single girder. Installing these devices in ESA will allow us to determine parameters beyond the single-device resolution such as susceptibility to backgrounds, beam tails, beam tilt and other environmental effects not accessible or reproducible at other facilities. The overall goal for system stability in the face of these adverse effects is ~50 nm over approximately a one hour time scale, a level of electronic and mechanical stability consistent with the expected requirement of 100 nm position stability for an actual energy measurement. We envision this as the first in a series of tests which will culminate in a prototype spectrometer insertion for a LC. In addition to the stability tests, multi-bunch running will allow an exploration of the time resolution of the BPMs. Position resolution along a bunch train can also be explored. (Depending on availability, alternate BPM cavity designs may be explored.)

## Description of Test Apparatus:

The test apparatus will include a single 5 meter "girder" on which 4 RF BPMs and 1 Wire Array are mounted. See Figure 1, below. BPMs at the beginning and end of the girder define the beam trajectory, and two BPMs mounted on the same mechanical stage are used as the test BPMs to monitor resolution and position drifts. The internal pair on the same mount will allow a separation of mechanical and

electrical effects. The adjacent WireArray will also assist in separating mechanical and electrical effects. (Two additional WireArrays adjacent to BPMs1 and 4 will also be installed if the necessary resources are available. The three WireArrays would allow for measurements of drifts in the mechanical bowing of the support girder. There is one existing WireArray that can be used, but two additional ones would have to be fabricated for a full complement of three. We are also investigating possibilities for a stretched wire or laser interferometer system to monitor the mechanical stability of the support girder.) The 6-axis moveable stage will also allow us to gauge the effects of beam tilts on the BPM measurements by observing any measurement bias as a function of overall BPM rotation. We also plan temperature sensors along the girder to study the temperature sensitivity of mechanical motion and electronics drifts.

The specific location of the girder in the End Station is not critical. A possible configuration of beamline components is shown below in Figure 2.

**Beam Requirements:**

Momentum: 25 GeV

Particles:  $10^{10}$  single bunch;  $(1-5) \times 10^{11}$  in 60-300ns train

Rep. Rate: 10 Hz

$\Delta p/p$ : <1%

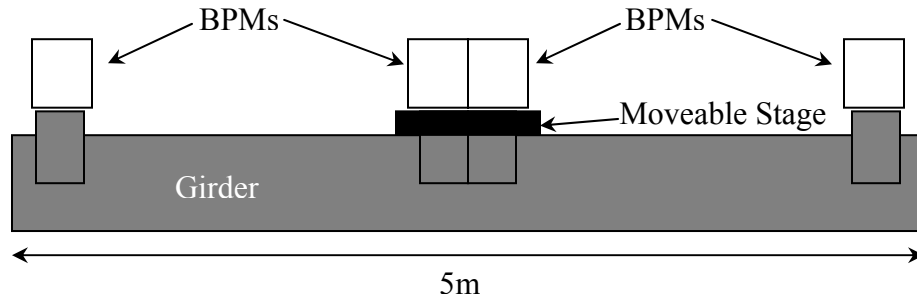


Figure 1. Sketch of the BPM girder and BPM locations.

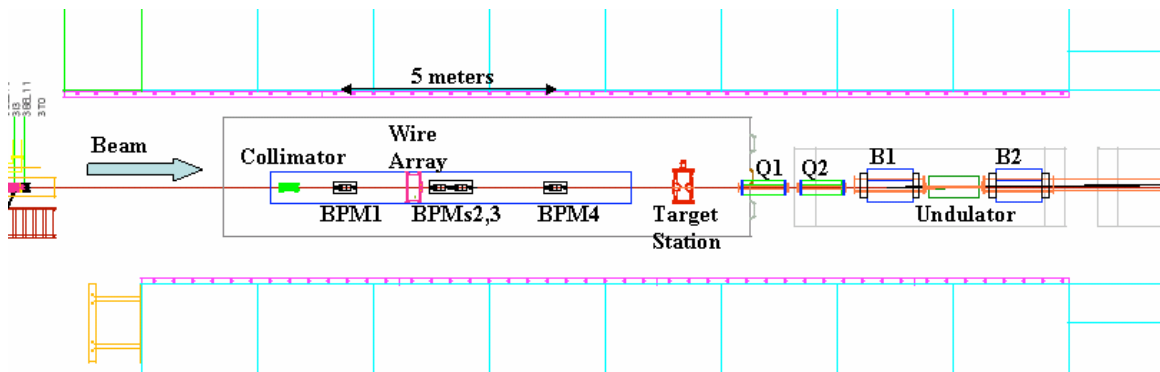


Figure 2. Proposed setup of BPM girder in End Station A

**Space Requirements:**

5 meters for girder insertion

**Special Power Requirements:**

None

**Other Requirements:**

Neslab chiller for BPM coolant water

12 high-quality RF cables, about 100' in length

**SLAC Responsibilities and Other Requests to SLAC:**

- i) 5-meter girder
- ii) alignment
- iii) DAQ infrastructure
- iv) 4 Linac-style 0.8" diameter cavity rf BPMs
- v) 0.75" protection collimator for BPMs
- vi) cabling
- vii) utilities

Concerning the BPMs, we request to use 3 BPMs currently installed on a 2-meter girder in ASSET that were used for the recent E-158 experiment. Then we need one additional BPM, possibly available from the end of Sector 5 or Sector 6.

**Collaborators and responsibilities:**

1. University of Notre Dame (Mike Hildreth)
  - analysis and monitoring of girder mechanical stability
2. UC Berkeley (Yury Kolomensky)
  - BPM signal processing
  - analysis and monitoring of BPM electronic stability
3. UC London, UK (David Miller, Stewart Boogert, Matthew Wing)
  - 6-axis mover, including support, readout and controls
4. University of Cambridge, UK (David Ward, Mark Thomson)
  - monitoring and analysis of mechanical stability
5. SLAC (Ray Arnold, Carsten Hast, Mike Woods)

**Duration of test and shift utilization:**

1 week: 2 days checkout. 2 days single bunch tests. 3 days tests with long train.

**Desired calendar dates:** June 2005

## **References**

1. University Program of Accelerator and Detector Research for the Linear Collider (vol. II), December 2003;  
[http://www.hep.uiuc.edu/LCRD/pdf\\_docs/LCRD\\_UCLC\\_Big\\_Doc/](http://www.hep.uiuc.edu/LCRD/pdf_docs/LCRD_UCLC_Big_Doc/)  
See UCLC Proposal 3.5 in this document, *A Demonstration of the Electronic and Mechanical Stability of a BPM-based Energy Spectrometer for an Electron-Positron Linear Collider*.
2. *Beam Instrumentation Tests for the Linear Collider using the SLAC A-Line and End Station A*, SLAC-LOI-2003.2. October 2003;  
<http://www.slac.stanford.edu/grp/rd/epac/LOI/LOI-2003.2.pdf>.
3. *Beam Instrumentation Tests for the Linear Collider using the SLAC A-Line and End Station A. Update on SLAC LOI-2003.2*. IPBI-TN-2004.2, May 2004.  
<http://www.slac.stanford.edu/xorg/lcd/ipbi/notes/LC-LEP%20update.pdf>