# 10.11 BCD Proposal: Beam Profile Monitor System

## *1. Overview*

The ILC beam profile monitor system is the collection of devices to be used to measure the transverse size of the beam throughout the complex. In the damped beam section (damping rings, bunch compressor, main linac and beam delivery) these are based on 'laserwires'. A laserwire uses a finely focused, very high power laser to sample the particle beam density in the same way that a wire scanner does. However, the operational issues surrounding a laserwire are more complex because of laser control, laser focusing, laser profile, pulsed laser timing and etc. These have been studied and are described in [1]. The laserwire has the added advantage that there is no added material inside the vacuum chamber. This reduces the risk of contaminating the nearby cryo-cavities.

The un-damped beam section of ILC, (source, injector linac, damping ring injection), will use wire scanners and related conventional profile monitors.

## *2. Baseline Configuration*

### a. Description

In the baseline configuration, there are laserwires in 1) the damping rings, 2) the ring to BC transport, 3) between the two BC stages, 4) the BC to main linac transport, 5) within the main linac (3 sets; at the 10%, 25% and 50% energy gain locations), 6) at the entrance to the beam delivery and 7) within the beam delivery, downstream of the collimation systems. The total number of laserwire systems per side is thus 9. With the exception of the damping ring laserwire, each laserwire system has 3 to 5 interaction chambers distributed along a fraction of a betatron cycle, extending perhaps 40 meters, depending on the beam optics. Each interaction chamber has a focal system for x and another for y and may have a 'u' scan direction also, for monitoring x y coupling. The damping ring only has two interaction chambers, one for a dispersion - free and one for a non-zero dispersion region. The main linac laserwires use a modified inter-module insert that allows 'warm access' to the vacuum chamber. [2] The total number of interaction chambers, for both sides of the ILC is 70. It is important to note that a single laser (a cost driver in the system) may feed many IP's through the use of an extended laser transport system. The number of lasers for the ILC laserwire system should be 12 or less (total for both sides).

The performance requirements for the laserwire profile monitors are summarized in section 10.0, Table 1. Typically, the system must provide a 10% measurement of emittance (5% beam size). The system in the damping ring and the system at the entrance to the beam delivery should be 2x better than that.

A laserwire consists of four main subsystems: 1) the laser and its control and timing system, 2) a laser transport system that carries the light from outside the accelerator enclosure to 3) the Compton interaction chamber, including its strong focusing system and 4) the scattered radiation detector. Typical subsystem parameters are listed in the references.

### b. Supporting Documentation

[1] Preliminary analysis of laserwire error (systematic and statistical) budget:
Blair note of November 1, 2005.

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[2] Answer to Snowmass Question number 29; 'Linac Diagnostic Sections', Marc Ross, September 2005. http://www.linearcollider.org/files/WGGG/DECISION%2029.doc

Design and performance of existing laserwires; an outline of laserwire RD:
Snowmass reports from Grahame Blair and Yosuke Honda.
http://alcpg2005.colorado.edu:8080/alcpg2005/program/accelerator/GG2/grahame_blair20050818043011.ppt
Yosuke Honda, et.al., Nucl.Instrum.Meth.A538:100-115,2005

Design of NLC laserwires:
J. Frisch, 2002. http://www-project.slac.stanford.edu/lc/local/systems/special_projects/Nanobeams2002/laserwire.pdf

### c. Required Research and Development

RD is required to show:

1) high resolution performance with high power lasers. In order to make precise measurements of sub-micron beams, very high power (>100MW peak) lasers with ultra-violet light must be used.

2) effective use of the 01 mode, which effectively halves the minimum beam size that can be measured

3) implementation of precision scattered particle detectors in complex accelerator systems, such as the BDS collimation region and the main linac.

4) component durability in this environment.

5) effective use of fringe-laser based monitor: 'Shintake' monitor.

## *3. Alternative lower cost Configuration*

### a. Description