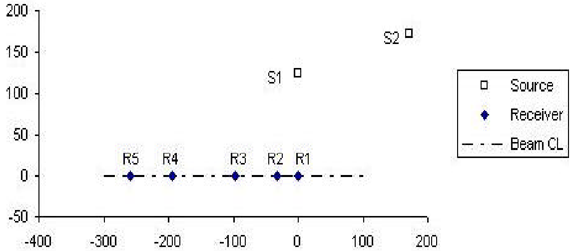

Figure 2 - Relative Locations of sources and receptors (scale in feet)

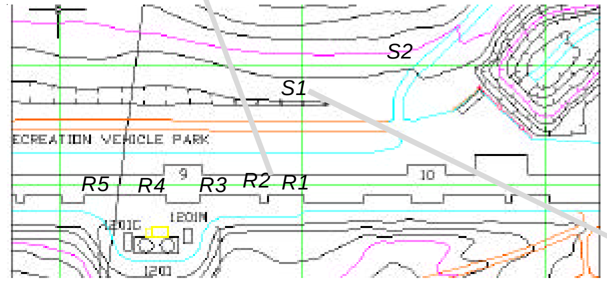

Figure 3 - Layout plan of Sectors 9 and 10 at SLAC

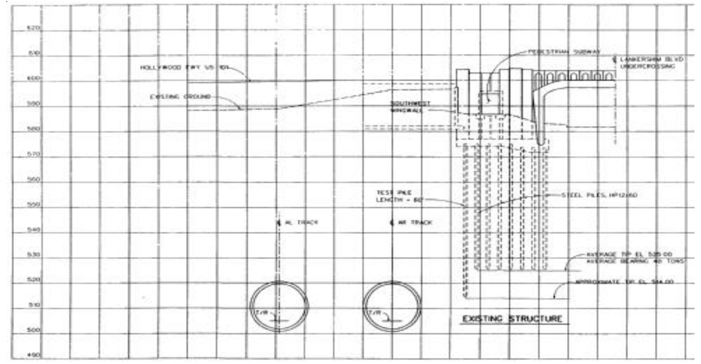

Figure 4 - Typical Cross Section of the MTA Tunnels

Figure 5- Vibration test measurements in progress in MTA tunnel

Linear Collider Collaboration Notes

http://www-project.slac.stanford.edu/lc/ilc/TechNotes/LCCNotes/lcc_notes_index_htm

LCC-0019, "FEATHER: A fast intrapulse feedback system for the JLC," Nicolas Delerue, KEK, June 2003.

II. Other Publications

Papers Presented at PAC03

EFFECTS OF DYNAMIC MISALIGNMENTS AND FEEDBACK PERFORMANCE ON LUMINOSITY STABILITY IN LINEAR COLLIDERS, A. Seryi, L. Hendrickson, T. O. Raubenheimer, P. Tenenbaum, M. Woodley
SLAC, Stanford, USA
D. Schulte
CERN, Geneva, Switzerland

COMPARISON OF THE TESLA, NLC AND CLIC BEAM-COLLIMATION SYSTEM PERFORMANCE, A.Drozhdin, G.Blair, L.Keller, W.Kozanecki, T.Markiewicz, T.Maruyama, N.Mokhov, O.Napoly, T. Raubenheimer, D.Schulte, A.Seryi, P.Tenenbaum, N.Walker, M.Woodley, F.Zimmermann, authors are from DESY, Germany; DSM/DAPNIA, CEA-Saclay, France; CERN, Switzerland; FNAL, USA; SLAC, USA; Royal Holloway College, UK.

A RECIPE FOR LINEAR COLLIDER FINAL FOCUS SYSTEM DESIGN, Andrei Seryi, Mark Woodley, Pantaleo Raimondi, SLAC.

LONG TERM STABILITY STUDY AT FNAL AND SLAC USING BINP DEVELOPED HYDROSTATIC LEVEL SYSTEM, A.Seryi, R.Ruland, SLAC, USA;V.Shiltsev, J.Lach, D.Plant, FNAL, USA; A.Chupyra, A.Erokhin, M.Kondaurov, A.Medvedko, V.Parkhomchuk, E.Shubin, S.Singatulin, BINP, Novosibirsk, Russia; A.Kuznetsov, Novosibirsk State University, Russia.

Calendar of Upcoming Events Conferences and Workshops of Interest

US Particle Accelerator School, 16-27 June 2003, UC Santa Barbara. NOTE: special two-week course on Physics and Technology of Linear Collider Facilities, N. Walker, A. Seryi, P. Tenenbaum, A. Wolski principal lecturers.

Cornell Linear Collider Workshop, July 13-16, 2003 Cornell University, Ithaca, NY.

International Conference on High Energy Physics (HEP2003), July 17 - 23, 2003 Aachen, Germany, http://eps2003.physik.rwth-aachen.de/.

Lepton/Photon 2003, August 11-16, 2003, Fermi National Accelerator Laboratory, Batavia, Illinois, http://conferences.fnal.gov/lp2003/.

30th Advanced ICFA Beam Dynamics Workshop on High Luminsoity e+e- Collisions, October 13-16, 2003, Stanford, CA. http://www-conf.slac.stanford.edu/icfa03/

IEEE Nuclear Science Symposium and Medical Imaging Conference (NSS/MIC 2003) October 19-24, 2003, Portland, Oregon, USA. http://www.nss-mic.org/.

NLC News

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Linear Collider Detector Simulations

Norman Graf

The global consensus that a linear collider should be the next major high-energy physics project arose from a long and dedicated series of physics studies. In order to exploit fully the physics potential of a future linear collider, the detectors must be optimized to yield the highest possible resolutions and efficiencies along with the lowest achievable systematic effects, all within budget. This short article provides an introduction to the ongoing efforts to design the detectors for the next linear collider.

The desired program ranges from high precision measurements to discovery searches and the operating point spans a wide range of center-of-mass energies (from M_Zc^2 to 1 TeV and beyond). The implications of such a project for the detector design are many and varied and the detector must be fully simulated before a final design can be selected. Some of the major detector performance requirements are:

Track momentum and angular resolution: Momentum resolution capable of reconstructing the recoil-mass to di-muons in Higgsstrahlung with resolution better than the beam-energy spread.

Vertex resolution: High efficiency and purity in jet flavor tagging to identify b, c, and light quarks.

Calorimetry: Two-jet mass resolution comparable to the natural widths of the W and Z bosons for an unambiguous identification of the final states.

Hermeticity: High precision determination of the missing energy in events to measure neutrinos and search for non-interacting non-Standard Model particles.

Machine Environment: Immunity to backgrounds, sensitivity to the beam bunch time structure.

The North American linear collider physics and detector community has until recently used a small set of generic, "straw man" detector designs to investigate the overall detector requirements and capabilities. This was sufficient to make the physics case for the machine, but much more work is now needed to specify an affordable detector that can actually be proposed and built. An essential part of that effort is the detector response and performance simulation.

Modern software and software methodologies, along with faster and more affordable computing hardware, allow much more simulation work to be undertaken before a detector design is finalized. In the past, detectors have often been patched together from disparate subdetector elements without sufficient regard given to the integrated design or to how the events will be reconstructed and the physics content extracted. We are developing a flexible, object-oriented software framework to enable beginning-to-end simulation of the complete chain of events from beam-beam interactions, through physics event generation, detector response, event reconstruction and final physics analysis. To optimize the detector design, we are studying performance as a function of basic detector parameters such as the tracker radius, calorimeter segmentation, solenoidal magnetic field strength, etc. The goal is to characterize the detector performance as a function of these basic parameters and determine the dependencies, or ''slopes.'' We will then fully simulate one particular design in complete detail and use it as a pivot point from which to extrapolate. We aim thereby to be able to gain a complete and systematic understanding of a specific detector, while maintaining the flexibility to understand the cost and performance ramifications of modifications to this design.

Physics events are generated using legacy toolkits such as Pythia, Herwig and Isajet or modern generators such as Whizard or Pandora. These generators have all been interfaced to code, which accounts for the beam- and bremsstrahlung appropriate to the accelerator under consideration. Machine backgrounds are generated by such programs as GuineaPig or Cain and can be overlaid onto signal events in arbitrary combinations. The detector response to such events is fully simulated using the Geant4 toolkit. The detectorgeometries are specified at run-time through an XML formatted plain text file, allowing configurations to be changed quite easily. The detector response is output in a generic format that enables segmentation and resolution studies to be conducted after the full simulation. Tracker hit positions can be smeared and merged according to different detector specifications without having to rerun the events. Similarly, the effects of calorimeter segmentation can be studied by ganging groups of readout cells. The reconstruction programs are based on abstract interfaces, allowing different algorithms to be plugged in and directly compared. Arbitrary levels of detector noise and inefficiencies
can be modeled by adding or removing random hits. The event reconstruction begins with pattern recognition in the tracking detectors, associating hits to tracks and fitting them. Clusters are formed from nearby hits in the calorimeters. These are then either associated with found tracks or attributed to neutral particle showers. Final reconstruction and analysis takes this further by associating particles into jets, identifying jet quark flavors, assigning quarks to their progenitors, identifying and quantifying the physics processes responsible for the event, etc. A full suite of tools for such reconstruction and subsequent analysis is available in both Java and C++. Any deficiencies in the detector capabilities uncovered as a result of these analyses need to then be fed back to the detector designers, and the loop repeated.

Although the detectors will represent a small portion of the cost of the linear collider program, it would be incorrect to assume that cost is therefore not an issue. Although compromising the detector performance prematurely due to cost considerations would be a mistake, the eventual price tag should be kept in mind throughout the design process. Fortunately, spreadsheet programs such as Excel allow fairly sophisticated costing analyses to be quickly and systematically undertaken. Detector element costs can be studied as functions of various parameters such as calorimeter inner radius, magnetic field strength, etc. Combined with the performance ''slopes'' discussed previously, the tradeoffs between performance and cost can be quickly and systematically investigated.

It is only after a series of such iterations and refinements that we will end up with a detector design that we believe will be capable of fully exploiting the physics opportuniies provided by the next linear collider.

The physics potential of the next linear collider is impressive and presents both an opportunity and a challenge to detector designers. Efforts are intensifying to move beyond generic detectors and develop a fully specified detector design. Stay tuned for updates.

Updating the Machine Detector Interface

Thomas W. Markiewicz

There have been a number of changes over the past year to the layout and concept of the machine detector interface. This note briefly summarizes the current design and points to issues that still need to be resolved.

Final Doublet Configuration:
Through Snowmass 2001 we have maintained both a so-called long final doublet configuration (QD0/QF0 @ 3.6 m/5.1 m) that can handle 1 TeV c.o.m. as well as a configuration with a shorter (2.2 m/2.0 m) final doublet optimized for 500 GeV c.o.m. As the physics scope definition of the LC has been clarified, we have concentrated exclusively on the short 500 GeV version. One practical outcome of this decision was the construction of a mechanical prototype of an IR girder, used to investigate the vibration properties of an extended magnet-shaped object, based on the anticipated masses and moments of the short final doublet only. When the machine is upgraded to 1 TeV, the doublet will need to be replaced, and its more difficult mechanical properties studied.

Final Doublet Magnet Technology Baseline:
It is perhaps better known in the community that we are changing the baseline magnet technology from permanent magnets to superconducting magnets. The physics requirements seem to require relatively frequent changes in beam energy over large ranges that are inconsistent with current schemes for adjustable permanent magnet quadrupoles. Brookhaven National Laboratory has developed a technology to wind and restrain SC magnet cable that will allow magnets to be built that are just as compact as those made from rare earth cobalt permanent magnet material. The BNL group is making prototype windings and will study the internal mechanical rigidity of these SC magnets. The BD design group is optimistic that this effort will continue successfully, and has adopted the BNL SC magnets as the baseline.

Detector Access and Support of the Final Focusing Quadrupole:
The working hypothesis for the LC detectors is that they are composed of a central barrel section and doors that move along the axis of the barrel to provide access to either end for maintenance. Additionally, if only one door is opened and the remainder of the detector slid the other way, enough space is available to extract the entire 5.4 m long TPC. The inboard tip of the 2.2 m long QD0 quad is 3.51 m from the IP. In the case of the large detector, the outside face of the door is 6.69 m from the IP, and the door opens to 10.4 m. This provides 3.7 m of access per side or 5.6 m between the barrel yoke (z=4.8 m) and endcap ECAL (z=3.0 m) when the detector is arranged to enable TPC extraction. Our current quad support model has the magnet mounted on active vibration-damping supports within a 40 cm diameter cantilevered tube. To minimize the length of the cantilever, we now suppose that the door will be blocked by a moveable platform that will be the base of the cantilevered tube. In this case, pictured in Figure 1, the unsupported length of the cantilevered tube is 3.2 m. Were one to insist on unfettered door-openings, the corresponding unsupported length would be 3.7 m longer, or 6.9 m. The mechanical prototype IR grideris sized for the 3.2 m cantilever.

IR Hall Size, a pressing question:
The length of the IR hall along the beam line has been chosen to allow there to be 1.2 m of access around the back of the 3.2 m long “feet” that keep the door upright, when the door is in its open position. The IR hall half-length is then 10.4+3.2+1.2=14.8 m. The IR hall is thus 2 x (14.8-6.7) = 16.2 m wider than it has to be were it minimally sized to fit the detector with its door closed. As some of the sites being considered for the collider would require excavating the IR halls from a mountainside, one needs to think carefully as to the cost implications of the detector access model.

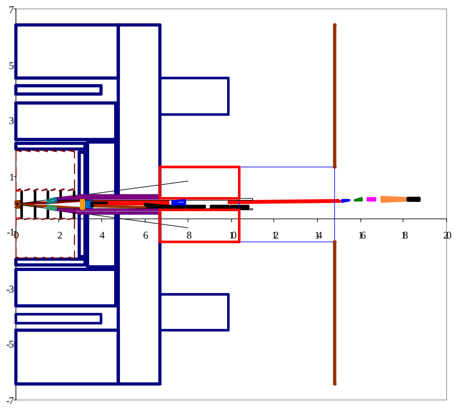

Figure 1: Footprint of the Large Detector in its IR Hall. When the detector doors are closed, the doors extend to 6.7m; when open they extend to 10.4m. The pit is sized at 14.8m to allow space for the feet supporting the door.

Forward Masking, The LD Detector:
Figure 2 shows the current concept of the beamline masking, forward tracking and forward calorimeters for the Large Detector. The changes relative to previous design are as follows: the cylindrical tungsten mask that protects the calorimeter from beam interactions in the vacuum pipe of QD0 has been moved to outside the support tube, thickened to 10 cm and is assumed to be mechanically part of the detector, traveling with the door when it opens. The remaining conic section of the mask, with its instrumented tip, now extends to 1.5 m from the IP, 1.65 m from the front face of the Pair-Luminosity Monitor. In the previous design the cone tip to Pair-LuMon overhang was chosen to be only 60 cm, to minimize weight under the assumption that the support tube would also hold the mask. However, it is now understood that the detector must support the weight of all the masking and the Pair-LuMon when the vibration reducing systems supporting the final quad are active. Without the constraint of keeping the mask short to minimize weight, it is possible to provide more protection for the detector’s central tracking systems. In Figure 2 the support tube extends from 17-20 cm in radius and extends to 1.99 m. When the detector door is open, the support tube holds the trapped inner part of the conic mask and Pair-Lumon by remotely releasable devices (pneumatic wedges have been suggested). When the detector door is closed, the concept calls for the load of the mask and Pair-LuMon to be transferred to the cylindrical tungsten mask of the detector by remotely activated devices that reach through a sufficient number of access holes in the support tube between 1.99 and 3.51 m. The next round of simulations of IP-generated backgrounds and synchrotron radiation will use this new mask design.

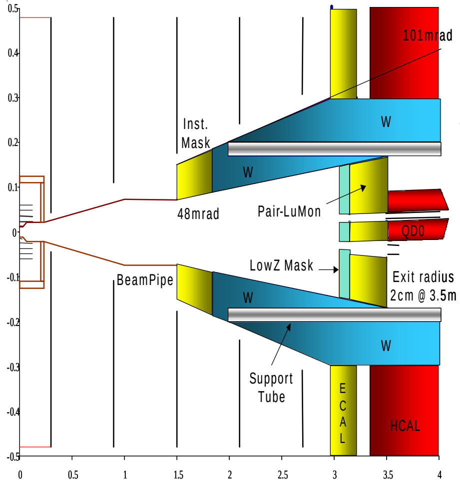

Figure 2: Beamline masking, forward tracking and forward calorimeters for the Large Detector.

Forward Masking, The SD Detector:
Figure 3 shows the current concept of the beamline masking, forward tracking and forward calorimeters for the Silicon Detector. The IP-QD0 distance is the same as for the LD design, as is the mask and detector layout concept. Sor SD, the tip of the instrumented Si/W mask is also about 1.5 m from the IP, 1.65 m from the face of the Pair-LuMon. The radial thickness of the cylindrical W mask is currently drawn as 2 cm as it is assumed that the deeper location of th QD0 within the detector (ECAL door at 1.85 m) will ease the shielding required. The perforated support tube is extended from QD0 at 3.51 m to 1.85 m so that, in the manner described for LD, the weight of the W mask, instrumented mask, and Pair-LuMon can be transferred from the tube to the detector and vice versa.

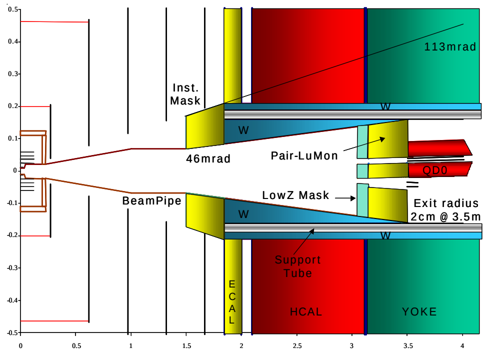

Figure 3: Beamline masking, forward tracking and forward calorimeters for the Silicon Detector.

Ground Motion R&D Program

Fred Asiri

It is well understood that the NLC will be placed in a tunnel, either at great depth (in bedrock) or at lesser depth (like SLAC’s SLC). A parallel tunnel would be used to provide space for support systems, such as RF generating equipment, electrical power, mechanical equipment, and so forth (Figure 1). To achieve the desired luminosity of the NLC, the focusing components on the main linac must be kept at a few nanometers and a few hertz. A large variety of vibrations can affect these components. Vibrations could arise primarily from three sources: (1) activities at the ground surface; (2) activities and operation of equipment in the adjoining tunnel; and (3) ambient conditions other than those already named, including sources at great distance and background seismic activity. The characterization of these sources and their transmission paths, as well as their effects on main Linac components is part of an ongoing ground motion and vibration R&D program at NLC [F. Asiri et al., PAC 2003, “Study of Near-Field Vibration Sources for the NLC Linac Components”].

Key to estimating the effects of vibration at the invert of the Beam tunnel from the above sources is the transmissibility of vibration in the ground. To achieve this goal, two vibration measurement studies have been initiated in order to characterize the vibration transmissibility in geology similar to that at representative NLC California sites. The first one was carried out along Linac Sectors 9 and 10 at SLAC. This field measurement study was intended to provide data associated with surface-to-tunnel-floor transmission of vibrations for tunnels at shallow depth. The figures below show the location of measurements. For the complete report refer to (http:/www-project.slac.standford.edu/lc/ilc/TechNotes/ LCNotes/PDF/LCC-0115.pdf).

Figure 1-Schematic cross section of the NLC Support and the Beam Tunnels

The second vibration measurement study was carried out in the Red Line tunnels near the Universal City Station in Los Angeles, to establish the vibration characteristics for tunnels at greater depth. This measurement program was intended to provide data associated with three concerns:

1. Transmission of vibration from the surface to the tunnel floor,
2. Vibration transmission from a parallel tunnel at the same depth as the tunnel; and
3. Vibration transmission along the length of a tunnel.

The testing was done during the nonrevenue portion of the early morning from May 11 thru May 14, 2003, from 01:30 AM to 03:30 AM. The area allocated for the test was from Hollywood/Vine to Universal City, about 800 feet east of Universal Station. The cross section (Figure 1) shows the location of the tunnels in which measurements took place. Tunnels are about 90 feet below the surface and are separated by a distance of about 20 feet. Right above the tunnel is corner of Lankershim and Ventura Boulevards which were used for the instrumented drop weight source. Also shown is the location of Hollywood (101) Freeway. The photograph was taken during the testing along the tunnel. The weight (100 kg) drop source was mounted on the rail vehicle, and a typical measurement set-up consisting of seismometer and Geophone are shown in the picture. The draft report of the testing data and analysis has just been received. Early indication is that there are very useful results. These results will be used to assess potential impacts of internal and external vibration sources on the operation of main Linac focusing components. For highlights of the preliminary results refer to: (http://www-user.slac.stanford.edu/asiri/Vibration Related/)