



# NLC News -

February 2001  
Volume 2 Number 2

## Program Director's Corner:

David L. Burke

The NLC Collaboration prepares to meet this month at Fermilab, against the backdrop of an active and successful HEP program worldwide. Electron-positron storage rings at SLAC and KEK, already the highest luminosity colliders in the world, are beginning major physics runs with the ambitious goal to triple the data rate, and with the BaBar and Belle collaborations aiming to zero-in on minute differences in the interactions of b-quarks and their antiparticle partners. The Tevatron at Fermilab will continue as the world's leader on the energy frontier, with upgraded CDF and D0 detectors looking to bag the Higgs and maybe a SUSY particle or two.

The broader community of high-energy physics has begun to look toward the 20-30 year horizon that extends beyond the lifetimes of the PEP II, KEK-B and Tevatron colliders. Preparations are underway in the U.S. for discussions at Snowmass this summer<sup>1</sup>, and a newly formed DOE/NSF HEPAP subpanel will provide a formal voice for the community<sup>2</sup>. The NLC Collaboration will play a major role in this deliberation. Review with the DOE, and consultation with the MAC are scheduled for this spring, and the Collaboration is preparing for the Snowmass 2001 Workshop.

On the international scene, installation of the LHC is beginning at CERN, and the TESLA Collaboration will release its Technical Design Report for a 500 GeV superconducting linear collider at DESY next month. A recent session of ICFA reactivated and enlarged the ILC-TRC committee chaired by Greg Loew (SLAC)<sup>3</sup>. This committee brings uniformity to the language of linear collider design and technology, and provides a repository for comparative information. This is a first step in setting-up comparison between the leading options for the next generation linear collider.

The world is getting down to the *business* of building a linear collider.

## New IR Region Design

Tom Markiewicz

Over the last year, the NLC beam delivery system has been extensively redesigned to reduce the cost and expand the breadth of the physics program. There are now two

asymmetric Interaction Points (IP), one optimized for high energy and one for lower energy. The low energy IP is designed to provide the highest luminosity for physics in the energy range from 90 to 500 GeV while the high energy IP has an initial energy range of 250 GeV to 1 TeV. Because the high energy IP has minimal bending and the new final focus optics is more compact, it is capable of being upgraded to multi-TeV if the necessary main linac rf system is developed in the future. The new final focus (FF) can support 3-5 TeV collisions in a length of about 700 meters instead of the several kilometers required for the traditional design.

The ZDR-era NLC site layout (Figure 1) had two symmetric interaction regions, both optimized for 0.5-1.5 TeV. In this scheme, the electron and positron linacs were co-linear and each was followed by a roughly co-linear 2.5 km long collimation system. To generate the 20 mrad crossing angle necessary to avoid parasitic collisions between bunches in the train, each beamline then passed through a 10 mrad 'Big Bend' followed by a 2.5 km long final focus. The length of the system was determined primarily by the need to limit synchrotron radiation (SR) induced emittance growth which scales as  $E^6$ . To keep SR growth below a design value of 5%, both the Big Bend and the bends intrinsic to the FF chromatic correction scheme had to be long and weak enough to accommodate the maximum beam energy (750 GeV). In this configuration, the IPs were separated transversely by ~44 m and longitudinally by ~280 m and beam could be brought to only one IP at a time.

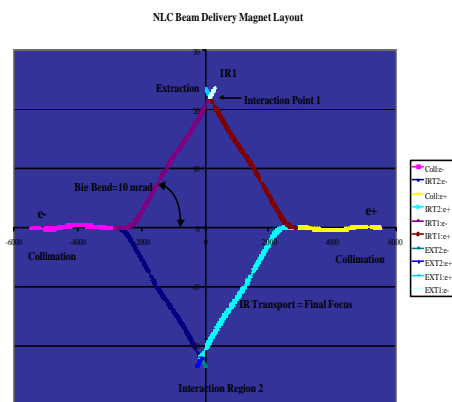


Figure 1

The new asymmetric NLC layout was driven by the interest of the physics community in a facility that could be the basis of a long-range program reaching ever higher energies while at the same time being capable of a high precision measurement at the  $Z^0$  mass (92 GeV). Expanding the high-energy reach was

made possible by a new FF design where chromaticity is corrected locally at the final doublet. This reduces the number of bends required to produce the required dispersion so that while  $E^6$  scaling still holds, an ~300 m long FF would now handle 750 GeV beams and ~750 m of FF would suffice to handle beams up to 2.5 TeV. In the new layout, the high energy IP has a 750 m FF and minimal bending to allow a multi-TeV upgrade. The 10-mrad Big Bend has been eliminated and the linacs each rotated by 10 mrad to provide the 20 mrad crossing angle.

The second IP is optimized for high luminosity at lower energies than the first IP. Figure 2 shows the luminosity as a function of energy for a FF design optimized for 1 TeV. The luminosity falls linearly with decreasing energy because the emittance undergoes less adiabatic damping. At energies below ~250 GeV, the beta function of the system must be adjusted to keep the beam size within the aperture of the vacuum system and the luminosity falls as  $E^2$ . As can be seen, making a FF that will work over more than about a factor of four is difficult. After discussions with the community, it was agreed to design the beam transport and FF for the second IP to allow a maximum energy of ~500 GeV. To avoid unwanted emittance growth as the beam passes through unpowered RF structures, the lower energy beam would be picked off and diverted into a bypass line at the 45, 125, and 250 GeV energy points. The bypass line then rejoins the main linac beam line immediately in front of the collimation system.

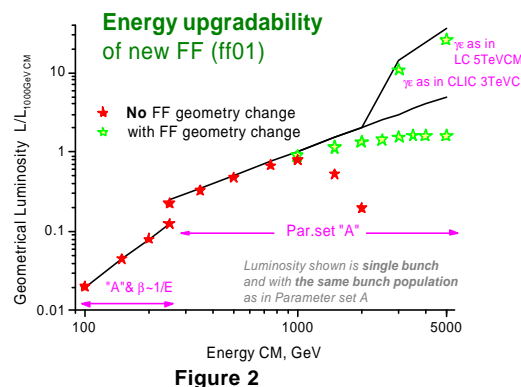


Figure 2

Figure 3 shows the basic layout of the new configuration. The Big Bend to the second IP is 25 mrad and located after the collimation system in order to minimize overall length and allow the same collimation system to be used to deliver beam to either IP, an initial cost savings. The crossing angle at the second IP has been chosen as 30 mrad, slightly larger than the 20 mrad at IP1 in recognition of the possibility that the IP may

<sup>1</sup> See, <http://snowmass2001.org/>.

<sup>2</sup> See, <http://www.pha.jhu.edu/groups/hep/panel/>.

<sup>3</sup> See, <http://www.slac.stanford.edu/xorg/ilc-trc/ilctrchome.html>.

someday be used for gamma-gamma collisions, which require a larger clear space to extract the more highly disrupted beam. The IPs are offset by a modest 25 m transversely and longitudinally by some hundreds of meters (440 m in Figure 3) to provide a measure of vibration isolation between the halls. This layout minimizes the amount of bending required to achieve a given crossing angle that may possibly allow a higher maximum energy at IP2. The initial configuration provides for 'sequential' operation where beam is delivered to only one IP at a time but could later be upgraded to allow both detectors to operate simultaneously with interleaved pulses. If different energies were desired at the two IPs, a second independent collimation system would be required which could share the same tunnel.

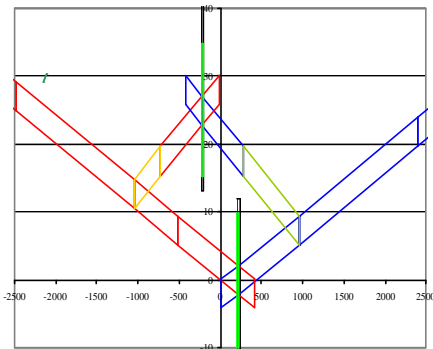


Figure 3

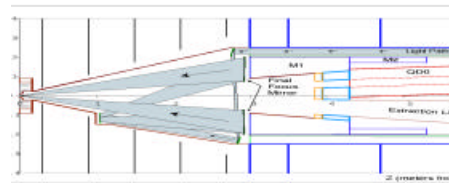
**Overview of NLC R&D at LLNL: Part II**  
Karl van Bibber

State-of-the-art thermomechanical engineering, metallurgy and materials modeling at LLNL have been brought to bear on the thorny problem of the high-power positron production target. Positrons are produced by crashing a high-energy beam of electrons in a thick high-Z radiator, capturing the shower of low-energy positrons out the back end, and damping and accelerating them. The old SLC design target consisted of a thick water-cooled tungsten-rhenium disk, about the size of a hockey puck, moved in a trolling pattern to spread out the beam power absorbed by the target, about 4 kilowatts. The conundrum is that after the end of SLC operations, the target showed evidence of severe damage, possibly having skirted catastrophic failure; yet the NLC target design will have to produce a factor of 10 more positrons, while absorbing a factor of 6 more beam power. Werner Stein and Ann Sunwoo, in collaboration with the SLAC positron target group have been conducting a retrospective study of the old (now radioactive) SLC target, including both destructive and non-destructive evaluation at Los Alamos, and comprehensive modeling studies. The key question is whether any simple extension of the thermal target design can be found to work with confidence in the more challenging NLC regime, or whether one needs to resort to alternative concepts or workarounds (e.g., dividing the beam among

several targets in parallel, a 'Gatling gun' approach).

The old wags at the Lab often quip that the acronym LLNL really stands for 'Lasers, Lasers, Nothing but Lasers', and so no R&D campaign would be complete without at least one technology-expanding high-power laser system. Fortunately for the NLC there is the gamma-gamma collider, or 'photon collider'. Conceived in 1981 by Ginzberg, Kotkin, Serbo and Telnov, the central idea is to Compton-backscatter short pulse laser light – bunches of about 1 Joule in 1 picosecond – from the converging electron beams, only a few millimeters before the interaction point. Nearly every electron will upshift a one electron-volt laser photon to a gamma ray of nearly the full energy of the beam electron, thus producing collisions of real photons with center-of-mass energy and luminosity comparable to that for electron-positron collisions. The original GKST paper was truly visionary, preceding by several years the development of chirped-pulse amplification lasers (1985), which made terawatt lasers feasible. But peak power alone is not enough, as the NLC pulse format requires a very high average power as well, around 10 kW, about a factor of a hundred higher than any existing short-pulse laser. However, there are now promising developments for high-efficiency direct diode-pumped lasers, a spin-off from the inertial fusion program, and a credible architecture now exists for the NLC. We have been developing a pre-conceptual design for a complete photon collider for several years, including both the laser and the transport and focusing optics within the highly constrained vacuum beam pipe of the detector, and an intense effort is being mounted this year to complete the design by Snowmass. Under the direction of Jeff Gronberg, the team consists of laser and optics experts (Jim Early, Ray Beach, Steve Payne, Camille Bibeau, Lynn Seppala, Steve Boege, Scott Lerner), engineering (Ken Skulina), physicists (Dave Asner, Tony Hill, Solomon Obolu), and accelerator physics support from SLAC. Should a high-luminosity photon collider be proven feasible, it would open up truly fantastic physics, complementary to  $e^+e^-$ . For example, a precise measurement of the production of the Higgs boson could indirectly reveal the existence of new charged particles of arbitrarily high mass, even far beyond the energy reach of any accelerator man will ever build.

The Figure shows the gamma-gamma interaction region with the mirrors and light path for the lasers



Each of the LLNL program elements will be described in more detail in forthcoming issues of NLC News.

**FLASH ~ SPECIAL !!!**

**U.S. Particle Accelerator School announces 2001 Prizes:** The USPAS prizes honor individuals by recognizing their outstanding achievements over the full range of accelerator physics and technology.

The 2001 winners are **Tor Raubenheimer** "for the development of emittance control techniques for high-performance electron-positron linear collider and storage rings, and for his leadership role in the development of a second-generation linear collider," and **Dieter Mohl** "for outstanding contributions to stochastic and electron cooling and to counteracting intensity limitations in accelerators, and for his impact on the conception, design and operation of low-energy storage rings for ions and antiprotons."

Tor is the NLC Deputy for Accelerator Physics and a member of the SLAC faculty.

**Congratulations, Tor!**

A special recognition award goes to Martin Reiser "in recognition and appreciation of a lifetime of outstanding accomplishment in research, education and community leadership in accelerator technologies and the physics of beams.

**Recent Linear Collider Publications**

If you would like an NLC-related paper listed, please send information to [amlarsen@slac.stanford.edu](mailto:amlarsen@slac.stanford.edu)

**I. Linear Collider Collaboration Notes**

[http://www-project.slac.stanford.edu/lc/ilc/TechNotes/LCCNotes/lcc\\_notes\\_index.htm](http://www-project.slac.stanford.edu/lc/ilc/TechNotes/LCCNotes/lcc_notes_index.htm)

**LCC-0054**, "Test Beams and Polarized Fixed Target Beams at the NLC," Lewis Keller, Rainer Pitthan, Sayed Rokni, Kathleen A. Thompson, Yury Kolomensky, 01/01.

**LCC-0055**, "Improved Dynamics in the 180 Hz Damping Rings," Andrzej Wolski, 02/01.

**Calendar of Upcoming Events**

*Collaboration Meetings*  
? Feb. 27 – March 2, 2001, Collaboration Meeting, FNAL.

? May 16 – 18, 2001, NLC MAC Meeting, LBNL.

*Conferences of Interest*  
? HEACC01, March 26 - 30, 2001 Tsukuba, Japan, <http://conference.kek.jp/heacc2001/>

? 2001 Particle Accelerator Conference, Chicago, IL, June 17-22, 2001, <http://pac2001.aps.anl.gov/>.

? 2001 Asian Particle Accelerator Conference, Beijing, China, Sep. 17 – 21, 2001, <http://apac01.ihep.a.c.cn>.

? 2001 Nuclear Science Symposium, San Diego, CA, Nov. 4 – 6, 2001. Abstract deadline, April 20, 2001, <http://www.nss-mic.org/>.

? ICALEPCS 2001, San Jose, CA, Nov. 27 – 30, 2001, Abstract deadline April 20, 2001, <http://icalepcs2001.slac.stanford.edu>.