



NLC News -

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NLC News Director's Corner

David L. Burke

Rocky Mountain High, Colorado. U.S. physicists and many of our international colleagues gathered in Snowmass, Colorado (elevation 8400 ft, 2800 m) last month, as we have done periodically over the past twenty years, to work and discuss present and future directions for particle physics. Most of the goals set forth at the previous Snowmass workshop in 1996 have been accomplished - the B-factories at SLAC and KEK have produced spectacular first results, operations of the Main Injector for the Tevatron have begun at Fermilab, and construction of the LHC at CERN is underway.

Planning the future in particle physics requires a long-range and growingly international view, and on center stage this time around were visions of the world in particle physics as it might appear over the first decades of the 21st century. A TeV-scale electron-positron linear collider figured prominently in that view. As summarized by DPF and Snowmass 2001 Chair Chris Quigg in his closing remarks, "At Snowmass 2001, a widespread feeling has emerged that the world community should move urgently to construct a TeV-scale linear collider as an international project."

It has been a successful summer, and the NLC Collaboration has worked hard. No less than 9 of the 27 Snowmass working groups were co-chaired by NLC people. The Collaboration met with the Machine Advisory Committee in May, submitted 42 papers and 9 major talks at the Particle Accelerator Conference in Chicago in June, <http://pac2001.aps.anl.gov/>, and all the while continued to make essential progress in R&D to support the design of the collider.

The high energy physics community has decided that an electron-positron linear collider able to study the TeV energy scale concurrent with the LHC is the next major facility needed in high energy physics. There are two candidates for this collider - the NLC/JLC X-Band machine, and the superconducting TESLA machine. Many things will take place in the coming year, including compilation of technical information about these two options. We will keep a strong focus on what we need to do - completion of the development and demonstration of X-Band rf technology for the TeV energy scale. More on this in the next edition of NLC News.

NLC Collaboration Meeting 2001

Ted Lavine, SLAC

The NLC Collaboration Winter Meeting was held at Fermilab from February 27 to March 2, 2001. The purposes of the meeting were: to review the NLC 2001 baseline design and options, and review and discuss key issues in the design and development of the X-band collider and its components; to review the present status of NLC R&D, and discuss near-term Collaboration goals and plans; and to establish a Collaboration vision of R&D and design needed to be ready to begin construction of the collider. Attendees benefitted from the sequential presentation and discussion of the entire NLC R&D program. The transparencies shown are available on the web at <http://www-project.slac.stanford.edu/lc/local/Reviews/Feb2001Rev/Agenda.htm>. The meeting allowed NLC collaborators from different institutions to communicate and share ideas with one another.

Day 1 of the meeting was devoted to introduction, summary of the recently revised machine configuration, and overview of the X-band R&D program. Project Director David Burke (SLAC), summarized the R&D project status. Two major technical issues pace the program - the X-band accelerating gradient limitations and the development of the components for high power production and handling. He emphasized the need to focus the long-range vision of the Collaboration on these two issues in order to present at Snowmass a coherent picture of the X-band collider and the R&D plan required to settle key technical issues.

Nan Phinney (SLAC) summarized the new machine configuration. She reported that choices had been made to broaden the energy expandability, reduce cost, and reflect desires expressed by the high-energy physics community. The 2001 configuration is a snapshot of an evolving model. X-band accelerating gradients of 50 MV/m (effective, or 70 MV/m at zero current) are assumed. The new configuration still features 250-GeV beams. However, it incorporates longer tunnel lengths, sufficient to accommodate two 500-GeV linacs, reducing the cost and increasing the feasibility of a future upgrade to 1 TeV center of mass (or greater, if the accelerating gradient can be increased). The number of klystrons has been cut in half, and the klystron pulse length has been doubled, to 3 ms. The individual linac structures have been

reduced in length from 180 cm to 90 cm, and doubled in number, in order to reduce the microwave group velocity that has been observed to cause damage preferentially at the upstream end of the structures (where it is greatest).

The new configuration features 120-Hz collisions at either of two interaction regions (IRs) for extended periods of time (not alternating pulses). Both IRs shall be capable of exploiting the 250-GeV beams. One IR shall be upgradable, potentially for beam energies greater than 500 GeV because the high-energy beam lines are straight (the "big bend" has been removed); the other IR is optimized for lower-energy e^+e^- and $g-g$ collisions at 40 mrad crossing angle. The philosophy is to explore and understand the costs and trade-offs of a configuration that is less costly than (but still compatible with) interleaved-pulse operation, and to focus on the common features of a California site and an Illinois site. Other issues under consideration include: staging the start-up of experimental collisions of 125-GeV beams significantly before 250-GeV beam energy is available, and simultaneous operation of both IRs at different collision energies, which may require separate 2500-m beam lines from the linac to each IR. Open issues include extensive use of permanent-magnet quads, and centralized versus remote injector complexes for the electrons and positrons.

The status of conventional facility planning was reviewed by Vic Kuchler, J. Sims, L. Hammond (Fermilab), John Cogan, Javier Sevilla and Clay Corvin (SLAC). To illustrate the effects of different geological conditions and construction methods and develop an optimized combination of construction options, Cogan discussed seven representative sites in the San Joaquin and Sacramento Valleys that support the overall scale of machine layout requirements. Sims did the same for a site centered at Fermilab and another Illinois site further west.

X-band Structures

The progress of research on X-band gradient limitations was presented by David Burke, Chris Adolphsen, John Cornuelle, Marc Ross, and Darryl Sprehn (all from SLAC who described testing and decision strategies being pursued to isolate and identify the causes of the gradient limitation first observed last year.

Burke described the organization of the R&D effort, and the parameter space of options being investigated. Adolphsen

described the effort to identify the causes of rf breakdown and structure damage that limit the accelerating gradient achievable in the X-band structures. He described a series of experiments underway to discriminate between the effects of structure length, group velocity, manufacturing processes, conditioning and operational history. To date, the full gradient (70 MV/m, unloaded) has been obtained without damage in a shortened traveling wave structure (DS2S) with group velocity, v , in the range from 0.03-0.05c (reduced relative to the range 0.03-0.12c in previous damped-detuned structures). Trip rates were reduced to nearly acceptable levels with conditioning time. The choice of structures addresses optimizations of v and the traveling-wave structure length. The next two test structures (with 20 and 105 cells, and v up to 0.05c) were installed in NLCTA during the Collaboration meeting for testing in March-April. Another two structures to be tested in April-May each will have 53 cells, but one will have a range of v 's between 0.01-0.03c, while the other will have v 's between 0.03-0.05c. For comparison with the zero- v limit, a pair of standing-wave p-mode structures is being prepared for testing.

Cornuelle discussed differences between high-gradient manufacturing techniques for DC, superconducting rf, and warm X-band structures, and explained the rationale behind new surface preparations that are being applied in the current round of X-band high gradient studies described in the previous paragraph. The new preparations include wet hydrogen firing, extended vacuum exhaust cycles (16 days at 650 C vs 5 days at 450 C), more particulate-free handling practices, and *in-situ* bakeout at 220 C. In general, these new preparations were chosen because they incorporate good practice, low risk, and easy implementation. The operational conditioning protocol has been modified to reduce breakdown-induced surface damage.

Ross described the significant improvements to the NLCTA, made over the past year, that enabled round-the-clock automated testing of high gradient structures and revealed breakdown-induced damage occurring at the highest gradients. New diagnostic probes have been developed to monitor transients in reflected microwave power, gas pressure, and acoustic, optical and X-ray emissions from high-gradient test structures.

Sprehn described SLAC's ongoing program of high-gradient studies using single, demountable cavities in an isolated vacuum chamber (the "window-tron"). The practical relationships between processing, breakdown, and damage in single cells with minimal stored energy are being assessed.

Next, Tor Raubenheimer, Zenghai Li, Juwen Wang (all SLAC) and Tug Arkan (Fermilab) reported on different aspects of

the status and new plans for X-band structure design and fabrication.

Raubenheimer presented the tolerances required on the rf structures which would limit emittance blowup to 20% through the Main Linacs. Conservative sources of emittance dilution include dispersion, wake fields, betatron coupling, and other sources that are expected to dominate over gas scattering and synchrotron radiation. To accommodate the emittance budget, the long-range wakes need to be controlled by a cell-to-cell tolerance of about 10 mm (depending on damping), and the short-range wakes in a 0.9-m structure need to be controlled by an overall straightness of 15 mm.

Li presented microwave design procedures, some numerical tools and a range of options for structure parameter sets including reduced group velocity and length. One recent design is based on a structure 0.9 m in length with group velocities between 0.02-0.03c, and 150-degree phase advance. A single girder module with six of these rf structures mounted on it requires 87 MW per structure to achieve an unloaded gradient of 69 MV/m.

Wang reported that the short-term, top-priority activity for SLAC is to provide test structures for the high-gradient tests, and in the longer term provide additional designs including new coupler designs.

Arkan reported results of Fermilab's first five test braze joints on X-band copper parts, along with plans to continue the tests. He also reported on the first Fermilab X-band rf measurements of single cells and short stacks, as well as rf plunger measurements on the 20 disks that will, it is hoped, become part of Fermilab's first X-band structure. He described the equipment anticipated for FY02 to provide for mechanical QC of disks and the organization of space in the Industrial Building presently allocated for structure fabrication, and a proposal for a new building in which to make complete beam-line units. Tours of the Industrial Building added an appropriate sense of reality and scale to the presentation.

X-band Power

On Day 2 the configuration and R&D for the Main Linac Rf System were reviewed. Separate presentations addressed the status of the klystrons (Sprehn), low-level rf timing and control (M. Ross and S. Smith, SLAC), DLDS and its high-power microwave components (Tantawi, SLAC). Ralph Pasquinelli (Fermilab) described the plan to fabricate from SLAC drawings and test a two-mode DLDS waveguide assembly at Fermilab within a year. Ray Larsen (SLAC) reviewed the status of induction modulator development and, given the limited resources, emphasized the need for collaboration-wide team efforts on low-level rf systems, modulator

controls, main controls, instruments and data acquisition.

Plans for rf systems integration tests were presented. Karen Fant (SLAC) described two X-band high-power tests at SLAC—the first test will use two pairs of 50-MW NLCTA klystrons (with SLED-II pulse compression) to energize microwave components at 800 MW; the second test should integrate a full eight-pack of NLC klystrons to energize one of the four feeds of a prototype delay-line distribution system (DLDS). Paul Czarapata (Fermilab) enunciated the goals of exploring and refining the DLDS concept with a full-scale Engineering Test Facility at Fermilab.

Participants in a two-hour afternoon panel discussion moderated by Steve Holmes (Fermilab), shared individual visions of the minimal Main Linac R&D required to gain sufficient confidence for project authorization and/or construction. The discussion focused on the relationship of the ETF to other linear collider test facilities, and on the relative merits of two different approaches to engineering tests: sustained testing of NLC-like components under NLC-like conditions versus an integrated system test of a beam-line module consisting of klystrons, modulators, DLDS, and structures. Choices were discussed, with regard to integrated system testing, as to how many structures or klystrons comprised a beam line module sufficient for an engineering test, whether the components under test should be industrially produced, and the need and/or desirability of a beam as a test-probe. Interest was expressed in using the ETF as part of a broad research program on high-gradient acceleration that would permit Fermilab scientists to develop their own institutional opinion of many aspects of X-band accelerator technology. Holmes brought the discussion to closure, observing that discussion and debate would go on for quite some time, and that there was no need to settle all the issues that day.

Injectors and IR's

On Day 3 summaries were given of configuration and R&D issues for the injectors (positron and polarized electron sources, damping rings, low-frequency accelerator and compressor systems), beam delivery and interaction regions.

Andrei Seryi (SLAC) described the latest developments in the beam delivery and final-focus design; octupoles are now used to reduce the amplitude of the beam halo. While the potential of octupole doublets to compress the beam halo has been recognized for many years, this is the first fully successful implementation of same in a final-focus design. Peter Tenenbaum (SLAC) described the design of the post-linac collimation system, which is immediately upstream of the final focus. Dmitry Onoprienko presented experimental results from the measurements of

collimator geometric wakefields. Jeff Gronberg (Livermore) described work on the g-g collision option.

The meeting paused on Thursday afternoon for Fermilab's regularly scheduled "Line Drive" Colloquium which consisted that day of a double header of seminars: Tom Markiewicz (SLAC) spoke on "Interactions Region Issues at a Linear Collider," concluding that many of the IR issues and solutions for linear colliders are common to both NLC and TESLA. (Video is available at <http://vmsstreamer1.fnal.gov/Lectures/LineDrive/Markiewicz/index.htm>.) The next hour, Chris Adolphsen (SLAC) spoke about "Power to the Beams at NLC and TESLA." He summarized NLC's and TESLA's proposed acceleration systems, and concluded that both were viable technologies for a 500-GeV collider. The upgrade path for NLC is via increasing linac length. For TESLA, it is via increasing gradient. (Video is available at <http://vmsstreamer1.fnal.gov/Lectures/LineDrive/Adolphsen/index.htm>.)

Alignment, Magnets and Evaluation

Day 4 consisted of presentation and discussion of topics affecting multiple areas of the NLC machines: ground motion, beam-based alignment and feedback, and development of cost-saving permanent magnet (PM) alternatives to electromagnets.

Andrei Seryi summarized the status of ground motion measurements and potential vibration stabilization strategies, observing that, for a linear collider to work, ground motion resulting from natural and man-made sources (both at the lab and due to more remote influences of human culture, such as trucks on roadways) must be tolerable, or it must be remediated by active measures. Possible stabilization feedbacks were described by Joe Frisch (SLAC) and Glen White (Oxford). Frisch described R&D applying inertial sensors and actuators to stabilize the final-focus magnets with respect to bedrock. White described his progress developing simulations of intra-pulsetrain feedback algorithms that seem capable of recovering significant luminosity losses by adjusting beam position, bunch by bunch. Peter Tenenbaum gave a progress report on techniques to minimize emittance dilutions from misalignments of quadrupoles and RF structures in the Main Linac.

Jim Volk (Fermilab) described the prototyping of adjustable-strength PM quads at Fermilab, and plans for precise control of the magnetic center shifts (required for beam-based alignment). Fermilab is building and testing a series of R&D versions of PM quads with different types of mechanical tuners for adjusting magnetic focusing strength. At the time of the meeting, center-shift stability of 30-100 mm over the tuning range had been achieved. Since the meeting, newer versions are approaching center-shift

stability better than 10 mm, and are beginning to demand improvement of Fermilab's magnetic measurement capabilities. An electromagnetic quad prototype for the Main Linac, built and tested last year at SLAC, had center-shift stability better than 1 mm; but the R&D emphasis, now, is on developing a cost-saving PM alternative (sans DC power supplies, cables, and cooling water). Cherrill Spencer (SLAC) described progress establishing which of the NLC's approximately 5600 beam line magnets can utilize PM technology.

The final session was devoted to evaluation of the cost and scheduling of a future, NLC construction project. John Cornuelle summarized the evolution of the cost (without escalation, contingency, or detectors) from \$5.1 billion (in 1999) to \$3.7 billion (in 2000). The cost analysis for 2001 is not yet complete, but appears to be in the range from \$3.5 - 4 billion without escalation, contingency or detectors. The new cost will include increases for full-length 500-GeV linac tunnels, the addition of low-energy bypass lines for reduced-energy collisions, and the second IR. It will reflect considerable reductions due to using permanent magnets, cutting the klystron population in half, and reducing the beam-delivery length. And it will reflect the potential increases due to doubling of the klystron average power and the number of X-band structures (while halving the structure length to overcome breakdown-induced damage). Ted Lavine (SLAC) described the evolution of an execution model as a step toward demonstrating the feasibility of a project timeline, budget and resource profiles, and to provide benchmarks for the production rates required for klystrons, structures and other components.

David Burke closed-out the meeting. He acknowledged that a wide range of individual perspectives had been voiced and cited collaboration-wide agreement on several points: the Engineering Test Facility (ETF) is needed and its contemplated scale and cost are appropriate to support construction of the NLC; demonstration of an integrated power system and structures at full-spec gradient are needed to construct the ETF; we are still looking for new ideas and fertile directions to explore; and the R&D goals for Snowmass this summer are on target.

Conventional Facilities - General Update

Vic Kuchler

The Conventional Facilities Group, both at SLAC and Fermilab, has currently been working hard to prepare for both the Machine Advisory Committee (MAC) Review and Snowmass 2001. While these specific tasks are keeping us busy, they also fold nicely into the overall goals we have set for FY01. In general there were two basic goals for the year. The first was to review the Conventional Facilities (CF) process as a whole with regard to the consistency of documentation. The second was to iterate design solutions for both a California and an Illinois site based on the 2001 Machine Configuration and supported by further consultant studies.

Up until this year, the SLAC and Fermilab groups have been producing designs, drawings and estimates that were based on the same criteria, but in formats that reflected the somewhat independent nature of the efforts to date. The work produced was well done, but meaningful comparisons were difficult to make. This was especially apparent when trying to understand cost differences between the California and Illinois design solutions. This year a concerted effort has been made to formalize the CF documentation at all levels.

On the cost-estimating side, a common WBS dictionary has been established that identifies common elements that are applicable to any site location as well as those elements that are particular to a specific site solution. This work will be then reflected in the updated cost estimates that will be generated in an Excel spreadsheet format. Each line item will be noted even if a particular element is not applicable to a specific site. In this way, we believe it will be easier to make meaningful comparisons between different design options. It will also provide a framework in which some level of configuration management can be reasonably accomplished.

On the drawing side, the group has settled on AutoCAD as the standard drawing software. All drawings are currently being produced in AutoCAD. In addition to finding common software, a drawing format and a set of AutoCAD standards have been developed. These standards identify such things as line weights, scales, text and dimensioning conventions and other details that will produce drawings that are consistent in appearance regardless of who (or how many) produced them. At the end of this year, the CF Group will have a single set of drawings and cost estimate documentation that describes the work done for both the California and Illinois sites.

The second major goal was to iterate design solutions for sites in California and Illinois. The California effort is centering in areas ad-

jacent (loosely speaking) to site 135. Sites have been identified to the North and South of the 135 site and have been designated 127 and 145. A tunneling option for these sites will be explored. For Illinois the N/S solution will be reviewed with one of the major investigations being the feasibility of constructing the tunnels in a rock strata that would be only approximately 100-150 feet deep. All of these designs will be incorporating the current NLC 2001 configuration data, adjusted as needed to each specific solution. With regard to the NLC 2001 configuration, I would like to especially acknowledge the help of Marc Ross and John Sheppard. Their personal interaction with the CF Group and many of the other physicists and technical folks has provided us with a better understanding of the machine configuration and its components. Just as important, they were able to convey our questions and suggestions in a way that resulted in positive progress for us. The CF Group will continue to engage in these very important interactions to provide the best possible solutions as issues arise.

As I stated above, there are several consultant studies also planned to support this effort. We have received this year, the final version of a Mechanical Cooling Study that was primarily for the California area, but has a lot of good information that can also be applied to an Illinois site. A Geology Study for California sites is currently underway which will also evaluate some aspects of the Illinois sites and a Footprint Study for the Illinois N/S site ready to begin. We are also pursuing an Electrical Study that will initially focus on California, but will eventually incorporate Illinois sites as well. We have also made good progress to establish an Underground Advisory Board, which proved to be a very successful resource on the Fermilab NuMI project. This board will start with two members and be expanded to four in the coming year. Their purpose is to help us define, coordinate and interpret the various inputs regarding underground construction for the various sites and provide a well-balanced and complete effort in these areas. In all cases, the consultant studies will be coordinated to provide a complete and unbiased information set for the eventual final site selection process.

All of the work described above will be related to the MAC at the upcoming review in May. In addition, the CF contribution to the Snowmass NLC Document rounds out the immediate tasks at hand. In the longer term, the CF Group will continue to follow the direction identified in the overall NLC R&D Plan.

Conventional Facility Vibration Studies

Fred Asiri

All around us are material objects of many kinds, and it is quite difficult to move without shaking some of them more or less. If we walk about on the floor, it quivers a little under the fall of our feet; if we put down a cup on the table, we cannot avoid giving a small vibration to the table and the cup. If an animal walks in the forest, it must often shake the leaves or the twigs or the grass, and unless it walks softly with padded feet it shakes the ground. The motions may be very minute, far too small to see, but they are there nevertheless. William Bragg (1933).

The task is to design, build and operate a facility with a footprint of about 30 km long and one km wide including several buildings, each size of a football field. It will take several hundred mega watts of electricity to energize motion of one kind or another to keep it in operation. It requires putting in motion a few hundred thousand gallons of water per minute to keep it at desirable operating temperature. Nevertheless, it must be stable within a nanometer range at the most critical region (Interaction Point). See figure below to get a perspective for range of natural and man-made vibration:

This article presents an overview of a technical approach to estimate the vibration in the critical regions of the NLC conventional facility, at the preconceptual stage. These estimations will help in preparing a reasonable/practical vibration requirement for future siting and design of NLC. For this effort, we turn to the wealth of vibration and ground motion studies that took place at SLAC over several decades; we learn from experience and knowledge gained in siting, design and construction of the most recent projects with an ambitious vibration criteria.

An overview of the Laser Interferometer Gravitational-Wave Observatory (LIGO) conventional facility vibration mitigation approach was presented at Snowmass, 2001. For the complete presentation materials see part one of,

<http://www-user.slac.stanford.edu/asiri/Snowmass%202001/>

The major thrust of this study is to estimate vibration at the top of the technical foundation for each critical region. The "technical foundation" denotes the floor on which the support for the sensitive equipment is mounted. In general, two sources are considered to have the potential to excite the technical foundation: far-field sources, which are produced external to the facility, and near-field sources, which are within the facility. Far-

field excitation is in the form of ground motion due to natural and cultural sources, and near-field excitation is associated with compressors, HVAC equipment, pumps, fan, transformer, coolant flow, etc. The excitation of the technical foundation caused by these sources is influenced primarily by the transmission path and properties of the soil. Because of the inhomogeneity of these media, the transmission mechanisms are very complicated. Predictive calculations can therefore only be viewed as approximations. By means of in situ measurements, the reliability of such results can be improved. However, these measurements should be performed in a proper manner in order to obtain conclusive results.

Determination of vibration at the technical foundations must ultimately rest with the Architect /Engineer firm. Since this will not happen in near future, a procedure illustrated in flow-diagram format is proposed for the preconceptual study. See Ref. 1, for details.

Six representative sites, four in north California and two in Illinois have been chosen for purpose of this study. Geological study at a reconnaissance level of these locations is completed. As result of these studies, soil material information (classification) for each site is identified. This information will help in estimating the approximate range of shear velocities for each layer. To estimate ground noise due to cultural and natural sources, we turn for guidance to an international standard for the design, installation and operation of the worldwide network of seismographs. The table in Ref. 2 from that report provides recommended minimum distances from sources of disturbance to seismograph stations for short-period (~1 Hz) seismographs. These data provide a method for evaluating the relative importance of noise sources for these locations.

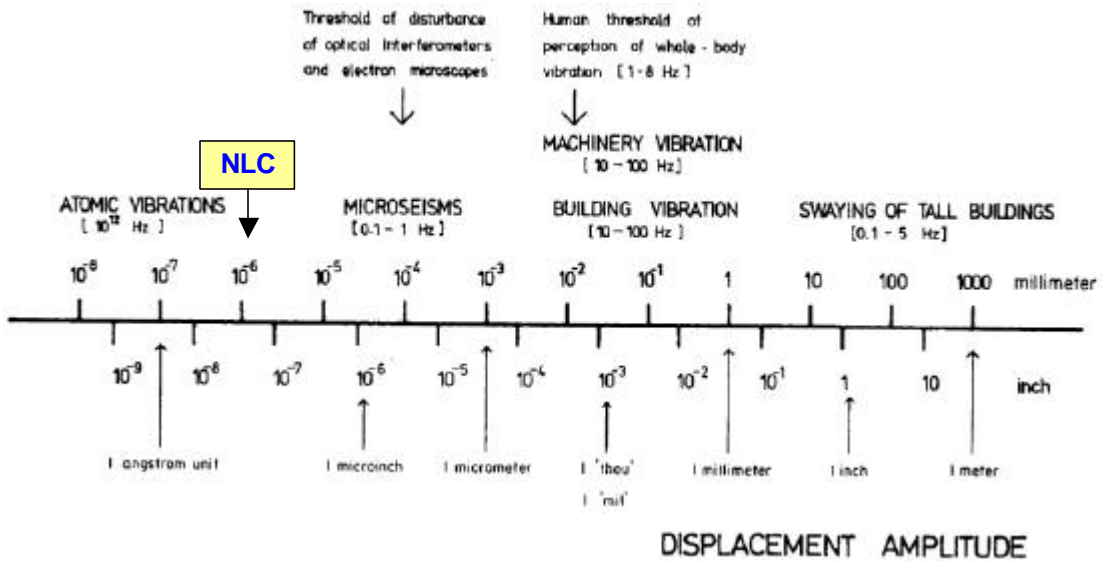
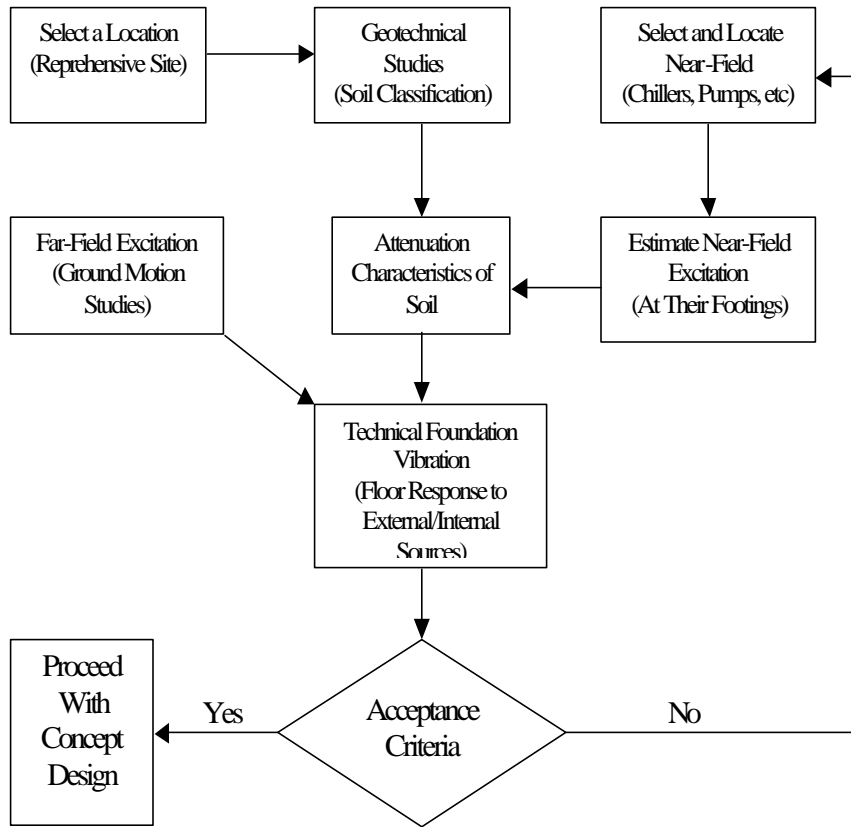
The near-field sources can be considered to be within our control. Thus, their contribution to the excitation of the technical foundation can be minimized and controlled by proper design and specification. As a first attempt to estimate their vibration contribution, the following technical approach is proposed:

- Identify, classify and characterize vibration sensitive regions, such as interaction region one (IR1), IR2, etc.
- Identify and characterize major vibration sources. Major vibration sources will be mounted on a similar spring-isolated skid.
- Locate vibration sources about 300 feet or as far as practical or economically feasible from the closest vibration sensitive region. If land is not available, then locate them as far

as land permits (as may be the case in Illinois).

- Analyze transmission paths use available soil attenuation data from LIGO and NIF, to estimate excitation each technical foundation caused by near-field sources.
- Tabulate results in a spreadsheet format.

For a complete overview of NLC conventional facility vibration mitigation approach see part two of the Snowmass presentation: <http://www-user.slac.stanford.edu/asiri/Snowmass%202001/>



RECOMMENDED DISTANCES TO NOISE SOURCES

Source of Disturbances	†	Seismometer on Hard Massive Rock, Granite, Quartzite, etc.			Seismometer on Hard Clay, Hardpan, etc.		
		A	B	C	A	B	C
		km			km		
1. Oceans:							
a. with coastal mountain systems as Pacific North and South America		300	50	1	300	50	1
b. with broad central and coastal plains as eastern North and South America		1000	200	10	1000	200	20
2. Inland seas, bays, and large lakes; Great Lakes	a	150	25	1	150	25	1
	b	500	100	5	500	100	5
3. High waterfalls, cataracts or excessive flow over large dams, e.g. Niagara, Grand Coulee Dam	c	40	10	5	50	15	5
	d	60	15	5	100	25	10
4. Transcontinental oil or gas pipelines	c	20	10	5	30	15	5
	d	100	30	10	100	30	10
5. Small lakes	c	20	10	1	20	10	1
	d	50	15	1	50	15	5
6. Reciprocating power plant machinery, rockcrushers, heavy machinery, etc.	c	15	3	1	20	5	2
	d	25	5	1	40	15	3
7. Low waterfalls, rapids of a large river, intermittent flow over large dams	c	5	2	0	15	5	1
	d	15	3	1	25	8	2
8. Railways, if frequent operation	c	6	3	1	10	5	1
	d	15	5	1	20	10	1
9. Airports and airways with heavy traffic		6	3	1	6	3	1
		meters					
10. Non-reciprocating power plant machinery, balanced industrial machinery	c	2000	500	100	10	4	1
	d	4000	1000	200	15	6	1
		meters					
11. Busy highway, nearly continuous traffic or mechanized farm area		1000	300	100	6000	1000	500
12. Graded country roads, high buildings		300	200	50	2000	1000	500
13. Low buildings and high trees, wind charger for seismograph batteries if coupled to ground		100	30	10	300	100	50
14. High fence, low trees, large rocks, high bushes		50	25	5	100	50	10
15. Wind charger for seismograph batteries if decoupled from ground		30	15	5	60	30	10

Source: Manual of Seismological Observatory Practice, Table 2.1 "Recommended minimal distances from sources of disturbance to seismograph station—short-period seismographs."

†Notes:

a. as in 1a

b. as in 1b

c. Source and seismometer on widely different formations, or that mountain ranges or alluvial valleys intervene.

d. Source and seismometer on same formation and with no intervening alluvial valleys or mountain range.

A: Gain for 1 Hz 200,000 or more; B: Gain 50,000 to 150,000; C: Less than 25,000

International Linear Collider Technical Review Committee Reconvenes

At its last February meeting held at DESY, ICFA decided to ask that Greg Loew reconvene the International Linear Collider Technical Review Committee and prepare a second report. Greg has since selected a four-member steering committee, consisting of Reinhard Brinkmann, DESY; Gilbert Guignard, CERN; Tor Raubenheimer, SLAC; and Kaoru Yokoya, KEK, to assist him with this project. The full group met for the first time at the recent Snowmass meeting. A proposal was developed, presented and approved at the July 27 ICFA meeting held in Rome. In addition to the Steering Committee, two Working Groups will be formed, one to evaluate Technology, RF Power, and Energy Performance under the leadership of Daniel Boussard, recently retired from CERN, the other a Luminosity Performance Group under Gerry Dugan of Cornell. The Committee has an ambitious schedule, with a plan to have a first draft of its report by June 2002 and the final report hopefully complete by October 2002. Their next major meeting to have a first review of the Working Group reports will be in early February at SLAC in conjunction with the LC02 meeting.

Transitions

Two significant personnel changes have taken place in the NLC Collaboration. First, Karen Fant, a SLAC mechanical engineer with the primary responsibility for overseeing the mechanical design, fabrication, and installation of DLDS components in the NLCTA has been appointed head of the Mechanical Fabrication department under Lowell Klaisner. Karen will oversee the work of about 70 engineers and technicians. Her loss to NLC will be large but we wish her every success in her challenging new position. NLC will certainly call on her department for assistance with increasing frequency as our R&D program proceeds.

Then, John Corlett, the head of the NLC Collaboration at LBNL, has handed over the reins to Alan Jackson of the Accelerator and Fusion Division. John goes off to become project manager of the new FEL Light Source. We wish him well in this role. Your NLC Newsletter editor will especially miss John's humor and his always timely cooperation. We welcome Alan, a member of HEPAP and xxxx to lead the Berkeley work on damping rings.

New Damping Rings Lattices

John Corlett

To accommodate changes in beam parameters, and to further develop accelerator physics studies, the damping rings designs have been substantially renovated in recent months. Andy Wolski (LBNL), has developed lattices for both the main damping rings and the positron pre-damping ring. Design work has included options to allow operation at 180 Hz, studies of chromatic properties, dynamic aperture, effects of errors, emittance coupling, and orbit correction schemes. RF cavities, injection and extraction hardware, damping wiggler, and circumference adjustment chicane have been included. The design parameters of damping time and extracted emittance appear achievable with reasonable errors and systems specifications. While this is work in progress, interested readers may keep up to date with developments by accessing Andy's website at: <http://awolski.lbl.gov/>.

Structures Update

Chris Adolphsen

As has been reported in past newsletters, there is an aggressive R&D program underway to develop X-band accelerator structures that reliably meet the NLC unloaded gradient goal of 70 MV/m. This program involves the concerted efforts of a number of departments at SLAC and the ongoing collaborative efforts with the KEK JLC group on structure development (LLNL is also involved in providing diamond-turned cells). The high gradient testing for this program continues at NLCTA where currently two sets of structures are being processed.

One of these sets consists of two structures built as part of a series to compare performance dependence on group velocity and length. They are designated T53VG3 and T53VG5, which denotes that they are traveling wave ('T'), 53 cm long and have an initial group velocity ('VG') of 3% c and 5% c. In comparison, the NLC structure design during the past several years was 180 cm long with 12% c initial group velocity. From tests thus far, it appears that the lower group velocity allows for higher gradients without significant breakdown-related damage. The current test is to compare the performance of structures of different group velocity but the same length, thus eliminating length as a factor.

The processing of these structures began in late May and has proceeded much more rapidly than any earlier ones. For example, when initially processing to 72 MV/m with 240 ns pulses, the T53VG5 structure had a breakdown rate about 1/3 of that of the previous 5% c structure (T105VG5). Both this structure set and the previous one had been prepared using a procedure that includes 'wet' and 'dry' H₂ firing at 950 °C, a two-week vacuum bake at 650 °C, and a one-week in-situ bake at 220 °C. However, the cells of the latest structures, which were machined using conventional methods, were etched deeper during cleaning (few microns compared to sub-microns) than the diamond-turned cells in the earlier structures. The gas load during the bake procedures was clearly lower in the recent structures, which may be related to this difference. Future tests will be aimed in part at isolating the factors contributing to the improvement.

At the NLCTA, the structures are powered from a common source in a configuration intended to produce equal gradients in them. However, an in-line load used in this setup has a lower attenuation than desired, resulting in a 6% higher gradient in the lower group velocity structure. Thus far, the structures have run for 600 hours without any measurable damage (i.e., no discernible change in their net phase advance). With 240 ns pulses, T53VG3 has been

processed to 86 MV/m and T53VG5 to 81 MV/m: they have also been run at 70 MV/m and 66 MV/m, respectively, with 400 ns pulses, the NLC design value. After 30 hours of operation with the longer pulse length, the breakdown rate was 2-3 per hour in each structure, which is about five times larger than acceptable for the NLC. This rate is dominated by breakdowns in the coupler cell. To reduce these events, an input coupler with lower fields and higher impedance has been designed. It will be used in one of the structures in the next round of testing.

The results so far from the low group velocity structures are encouraging. However, their average cell iris radius is too small to meet NLC short-range wakefield requirements. To increase the iris size while maintaining low group velocity, a higher phase advance per cell (150° instead of 120°) will be used. Also, long-range wakefield suppression will need to be added, which should be fairly straightforward given the decade-long experience gained in developing such techniques for the 180-cm structures. Tests of structures with the higher cell phase advance will begin early next year.

Another approach being explored for achieving higher gradients is to use short standing wave structures, which require much lower peak power than traveling wave structures currently being studied. For testing, pairs of such structures are made so they can be configured to direct the power that naturally reflects from them to a load. The first pair produced for this study are 15 cell, 20 cm long, and operate in pi-mode. They have run for over 500 hours at the NLCTA where a gradient of 82 MV/m was achieved with a 100 ns flatpout pulse and a gradient of 74 MV/m was achieved with a 270 flatpout pulse, the NLC bunch train length. With the wider pulse, the breakdown rate was about 1 per hour in each structure when the gradient was lowered to 55 MV/m, the NLC loaded gradient (unlike the traveling wave structures, the standing wave structures would not need to operate above the NLC loaded gradient). The breakdown in these structures appears to occur mainly in the input coupler cells. Frequency shifts of 300 kHz and 500 kHz have been measured for the two structures, indicating that the breakdown is likely causing damage. In a few months, a similar pair of structures will be tested that have been tuned to have a lower field in the coupler region. Other improvements are planned in future tests, so it is still early in the development of these structures to access their viability for the NLC.

Recent Linear Collider Publications

If you would like an NLC-related paper listed, please send information to amlarsen@slac.stanford.edu

I. Linear Collider Collaboration Notes

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

LCC-0058 "SLAC EDX/Auger of Cornell Nb Breakdown Test Plate B2," R. E. Kirby and F. Marcelja, G. R. WERNER, April 2001.

LCC-0059 "Interaction Region RF Shield Issues," Gennady Stupakov and Tor Raubenheimer, April 2001.

LCC-0060 "Guide to LIBXSIF, A Library for Parsing the Extended Standard Input Format of Accelerator Beamlines," P. Tenenbaum, April 2001.

LCC-0061 "Lattice Description for NLC Main Damping Rings at 120 Hz," A. Wolski, April 2001.

LCC-0062 "Symplectic Integrators for Nonlinear Wiggler Fields," A. Wolski, April 2001.

LCC-0063, "Varying alpha/lambda in NLC Structures - BNS Damping and Emittance Growth," G. Stupakov and Z. Li, May 2001.

LCC-0064, "A Coupling Correction Scheme for the NLC Main Damping Rings," A. Wolski, June 2001.

LCC-0065, "NLC Positron Target Heating," D.C. Schultz, Y. K. Batygin, V.K. Bharadwaj, J.C. Sheppard, June 2001.

LCC-0066, "A New Structure for the NLC Positron Predamping Ring Lattice," A. Wolski, June 2001.

LCC-0067, "High-Pressure Water-Rinse Cleaning of Copper," R. E. Kirby, E. L. Garwin and F. Marcelja, June 2001.

LCC-0068, "Radial Particle Distribution on Two DDS2 Cells," E. L. Garwin and F. Marcelja, June 2001.

LCC-0069, "Coupled Bunch Instabilities in the NLC Damped Rings," S. De Santis, May 2001.

LCC-0070, "Design Studies of Positron Collection for the NLC," Y. K. Batygin, V. K. Bharadwaj, D.C. Schultz, J.C. Sheppard, August 2001.

Calendar of Upcoming Events

Conferences of Interest

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

NLC Machine Advisory Committee, Oct. 24 - 26, 2001 at LBNL..

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

NLC/JLC International Study Groups, KEK, Nov. 12 - 16, Tsukuba, Japan.

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

LC02, 9th International Workshop on Linear Accelerators, CA, February 4 - 8, 2002, at SLAC.

8th European Particle Accelerator Conference, June 3-7, 2002, Paris, France.