NLC News

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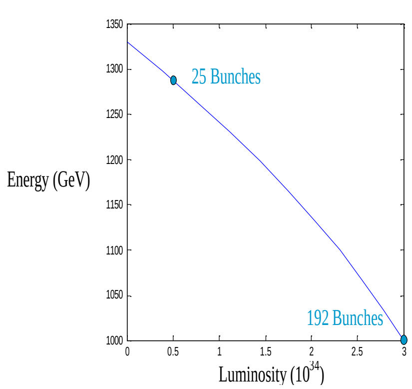
Director's Corner

David L. Burke

There is growing determination to speed up globalization of the linear collider project. The goal to understand particle physics at the TeV energy scale requires that the linear collider and the LHC be able to reinforce and guide each other, just as similar colliders have done in the past. It is recognized that the linear collider and the LHC must have a substantial period of concurrent operation. An international choice of collider technology will significantly enhance the probability that a linear collider will be built in time. This is compelling reason to establish the X-Band technology soon.

The research teams working on the X-Band rf must advance demonstration of a suitable technology, and must do it with no substantial increase in resources. For this reason, the NLC and JLC collaborations have joined to bring forward a baseline that uses the SLED-II option for pulse compression. This baseline, similar to one first described in the ZDR in 1996 and used since in the NLCTA, is on schedule to be demonstrated in 2003 as Phase 1 of the 8-Pack. While less efficient than the DLDS baseline it replaces, it is a more conservative choice that will do well. Operation of the NLCTA (with loaded gradients of 25 MV/m) has already demonstrated its suitability for use at 500 GeV cms, and with the improved components presently in production, this technology could support physics studies well above 1 TeV cms. (See figure.)



The increasing urgency for a technology choice for a linear collider was apparent at the recent meeting at CERN of the International Committee for Future Accelerators (ICFA) [http://www.fnal.gov/directorate/icfa/icfa_45thmtg.html20020301/ipr2002-03-01.html]. The International Linear Collider Technical Review Committee (ILC-TRC) [NLC News, Vol. 2, Nos. 4-8, August 2001] has begun to reach important preliminary conclusions. Greg Loew (ILC-TRC Chair) summarized these at ICFA:

? By the end of 2003, we hopefully should know if TESLA can reach 800 GeV at 35 MV/m.

? By the end of 2003, we hopefully should know if JLC/NLC can meet its main linac [1 TeV] RF system specifications.

We are focused on meeting the metrics for JLC/NLC first-level feasibility (so-called R1 measures by the ILC-TRC): (i) demonstration of baseline SLED-II power output, and (ii) demonstration of the necessary acceleration gradient.

Our plans for 2003 were the theme of the most recent review by the NLC Machine Advisory Committee and the Collaboration meeting that followed. These were both important and very productive working sessions, and are the subjects of the articles in this issue of NLC News.

Note from the NLC R&D Machine Advisory Committee

Satoshi Ozaki, Chairman

The NLC R&D Machine Advisory Committee (NLC MAC) was organized in the spring of 2000, just after the first DOE Lehman Review of the NLC Project, and its first meeting was held in May 2000 at Fermilab. Since then, we have been meeting almost every six months to review the progress and plan of the NLC R&D activities, and to offer advice to the NLC R&D Collaboration and its management. The sixth meeting of the Committee took place on November 6-8, 2002 in the brand new Research Office Building at SLAC. The regular members of the Committee are Daniel Boussard, CERN; Jean-Pierre Delahaye, CERN; Jean Delayen, TJNAF; Don Hartill, Cornell; Lowell Klaisner, SLAC; Gus Kugler, LLNL; Katsunobu Oide, KEK; Satoshi Ozaki, BNL; Stephen Peggs, BNL; James Rosenzweig, UCLA; James Strait, Fermilab; Nobu Toge, KEK; Ferdinand Willeke, DESY; and John Galayda, SLAC; they provide expertise in all areas of the NLC R&D. The Committee enjoyed having Eric Colby and Uli Wienands participate in this meeting and cover the missing expertise of four members of the committee who could not join this meeting.

Looking back at the last three years, the NLC MAC was initiated when an intensive effort was being made to further reduce the collider construction cost estimate as recommended by the Lehman Review Committee and the damage to the accelerating structure from the high power rf was uncovered both at SLAC and CERN. During the three years since then, the NLC Collaboration made very significant progress in dealing with these issues, and I, on behalf of the MAC Committee, praise the accomplishments the collaboration made during these years. Another pleasant observation I made is that there has been significant collaboration between SLAC and KEK that is working well, and that the NLC collaboration with principal participation of LLNL, Fermilab, LBNL, and SLAC, and most recently BNL has grown and is working together to resolve many challenging problems.

The 6th meeting of MAC was opened by the Director of SLAC, Jonathan Dorfan, who announced that a decision had been made to reorient the present R&D effort and to focus on the SLED II rf power system as the baseline of the room temperature technology. This decision is based on the observation that one technology choice must be made in the 2003 time frame in order to keep physicists moving toward the next linear collider. Although how and on what basis this choice will be made has not been decided, it is imperative that the room temperature technology collaboration, i.e., the NLC and JLC group, jointly present the best workable choice that we are prepared to support. Thus the decision was reached to go with SLED II, instead of DLDS, as the demonstration technology. The rebaselining of the 8-Pack Project, Phase 1 as well as Phase 2, presented at this meeting, is the result of this decision.

The key ingredients for this X-Band rf power demonstration project are the tests of "NLC/JLC-Ready" accelerator structures in the NLCTA, and the operation of the SLED-II system at full power. Initial testing will begin with the XL series solenoid-focused klystrons. PPM klystrons from SLAC and KEK will be substituted as soon as they are ready. Continued R&D in 2004 will aim to combine the SLED-II power source with structures in the NLCTA, and prepare components of next-generation systems. The questions the Committee was asked by the R&D management, then, were:

- "Are these tests planned correctly?"

• "Are we on track to complete them in 2003?"

• "What are the greatest vulnerabilities and what can be done to further mitigate risks?"

• "Is the effort planned for this year appropriate on these future goals?"

Noting that the rebaselined R&D program presented above is in line with the recommendation by the MAC during its May meeting, and that it is also in line with the recommendation by the Loew Technical Review Committee, we endorsed this reorientation and rebaselining of the 8-Pack Project Phase 1.

Understanding the damage to the accelerating structure by the acceleration rf power and developing the design of the structure that is safe against this damage has been the key issue in the NLC R&D. We believe that the collaboration has come a long way in understanding the cause of the accelerating structure damage and found cures to the point that the 70 MV/m gradient can be sustained rather routinely with the high gradient test structure. The cause of the breakdown phenomena in the power couplers was traced to the rf heating of sharp edges and modifications to the design are being made to develop a sounder structure. There still are a number of hurdles that need to be overcome, particularly in fabricating an acceptable damped and detuned structure that will meet the NLC/JLC specification. I, however, believe that we are well within the shooting range of having the acceptable NLC/JLC accelerating structure in time.

The development of the high power X-Band rf source and distribution system is another key issue. I must say that development of the solid-state modulator by the SLAC-LLNL collaboration is novel and very significant. In many ways, this approach for the main linac modulators should result in significant savings. I know a lot of effort has gone into the development of the DLDS concepts and the design of hardware components. This is an attractive concept that may lead to some cost savings, but also carries a significant risk considering the current state of the development. Therefore, the decision was made to use the SLED II system with 1.6 msec pulse width instead. This was a good technical decision that is more realistic and achievable. While the PPM klystron development is under way at SLAC and KEK, the high power demonstration test will begin with existing XL-4 type klystrons. This I believe is also a sound decision.

The NLC R&D was not limited to these two key areas. In order to develop a comprehensive proposal for a linear collider, issues involved with the entire collider system must be addressed. They include the source for electron and positron, damping rings, accelerating structure fabrication, installation, alignment, and stability, as well as the system to deliver beams to the collision point. In order to design the entire system, the behavior of the intense low emittance beam from the electron and positron source, through damping rings and linac, and then to the interaction point must be studied in detail with simulation. Overall, we were pleased to find that good progress has been made in all other areas of the R&D activities, in spite of the strong management emphasis on the rf issues and the consequent shortage of money to cover other areas of R&D.

For example, the NLC R&D efforts at Fermilab have built-up its momentum very rapidly. They began the production of the high gradient test structure and they are now getting ready for the fabrication of the NLC/JLC ready damped and detuned structure. Their permanent magnet R&D also began to demonstrate some meaningful results.

Specifications for the NLC damping rings are very demanding, and every detail must be addressed in order to obtain satisfactory beam emittance for the high luminosity collisions. Diligent study by the LBNL group is making good headway in resolving issues one by one.

Although the current R&D work is not site specific, the Conventional Facility Groups of both SLAC and Fermilab have continued their study, using a location in California and two locations in Illinois, one for a deep tunnel and the other for a cut and fill depth tunnel, as reference sites. While their effort to understand the cost factors involved in the conventional facility is valuable, more important is the insight they bring to the understanding of the ground motion, both from natural sources and from civilization near by. One should remember that the source of the civilization noise is not only passing automobile traffic a few miles away but also noise caused by the accelerator itself.

Last, but not least, the Accelerator Physics Group has done an outstanding job in developing a comprehensive picture of the NLC, that should give the luminosity of 20~25 x 10^{33} cm^{-2} s^{-1} at the center of mass of 500 GeV in the first stage (length ~ 18 km), and 25~30 x 10^{33} cm^{-2} s^{-1} at the center of mass of 1 TeV in the second stage (length ~ 32 km), and perhaps 1.3 TeV but with reduced luminosity. With their simulation tools, they have begun to carry out detailed studies on the dynamics of beams through the collider reaching to the interaction point. These tools also allowed them to participate in the study group of the Loew Technical Review Committee in a ery meaningful manner.

The present stage of the NLC R&D must move rapidly forward to conclude successfully the high power rf demonstration by the end of 2003 so as to allow a meaningful discussion for the technology choice. My colleagues in the Committee and I am looking forward to hearing about the progress made toward this goal at the MAC meetings, the next one is being planned in May 2003. I have full expectations that the R&D effort for the next linear collider will continue beyond 2003, whatever the choice turns out to be, because the USA will be a key player in the construction and physics exploitation of the linear collider, wherever it will be built, and this collaboration is expected to carry the ball in this endeavor.

Collaboration Meeting Nov. 10-12, 2002 Plenary Session Summary

John C. Cornuelle

The most telling indicator that the Linear Collider activity in HEP is looking more and more like a real companion for the LHC is that one whole plenary session was dedicated to a discussion of the recently-formed national, regional, and international steering groups and related activities in support of an LC. Jonathan Dorfan made an initial presentation with the balance of the time spent in a question-and-answer format.

The International Steering Group on LC's (ILCSC) with Maury Tigner as chair has already met twice. Regional steering groups with roughly the same mandate have been established in Asia, Europe, and the U.S. (ALCSC, ELCSC, USLCSC). The mandate for the ILCSC is to engage in outreach; to engage in defining the scientific roadmap, the scope, and primary parameters for the machine and the detector; to monitor the machine R&D activities and make recommendations on the coordination and sharing of R&D tasks; to identify models of the organizational structure, based on international partnerships, adequate for constructing the LC facility; and to make recommendations regarding the role of the host country in the construction and operation of the facility.

Another critical international element preparatory to an LC is the International Linear Collider Technical Review Committee (TRC) chaired by Greg Loew for ICFA. By ranking the key R&D goals that each LC approach needs to demonstrate and providing a time frame, the TRC can assist in keeping the momentum up and begin to define the issues involved in a selection of the best accelerator technology for the LC. Since the energy reach of the LC is possibly its most important attribute, the top R&D needs for the warm machine approach (like the JLC/NLC) and the cold approach (like TESLA) are demonstrating the viability of the accelerator structures with the design gradients (65 MV/m and 35 MV/m respectively), and in the case of the JLC/NLC to also demonstrate the rf compression system (SLED-II) with high power. A not well-advertised advantage of the warm approach is that by lowering the number of bunches in a bunch train and consequently reducing the current in the accelerated beam, the accelerating fields in the accelerator structures are pushed higher, resulting in a nominal 1 TeV JLC/NLC being able to operate at 1.3 TeV on request with no hardware modifications and only a trade-off in luminosity.

In the spirit of speaking with one voice, the physicists in the three regions have agreed to put together a single document containing the physics goals followed by one with the desired LC parameters. The idea of a single International Design Group has also been well received.

In the discussion, Dorfan eloquently stated that "It's the integrated luminosity, stupid", and described that the B-Factories, which are running ahead of their luminosity goals both at SLAC and KEK, were designed from the ground-up to be "factories" and not R&D experiments. Because of its size and complexity, the LC will also demand this philosophy in order to produce reliably the needed integrated luminosity, so that there is not only the well-known accelerator technology choice to make, but in addition a set of design choices within any accelerator technology will also have to be made. The lesson from running the three-kilometer LC at SLAC is that the integrated luminosity is a hostage to the amount of instrumentation and diagnostics available, and this has been incorporated into the JLC/NLC design. Whether the LC technology selected is warm or cold, the machine design will have to be scrutinized from head to toe and back again with respect to ensuring integrated luminosity.

Dave Burke began to set the stage and the goals for this specific meeting with a quick review of the progression of the NLC from the ZDR (1996) through the current SLED-II version. The current configuration has much in common with the SLED-II-based rf system that has been powering R&D in the NLCTA since 1996 except that we are now aiming at a higher accelerating gradient, using two modes instead of one to shorten the SLED-II delay lines, and using higher-powered PPM instead of solenoid-focussed klystrons. A 500-GeV version of the NLC could actually be constructed using the well-demonstrated NLCTA technology were it necessary to start today. The Phase I of the Eight-Pack project has been adjusted accordingly so that by the end of calendar 2003 a two-mode SLED-II system will be feeding NLC-nominal or higher power down to three sets of loads in the NLCTA housing, so that only the connection to structures needs to be made to complete one NLC rf unit.

The primary goals for the meeting were to confirm that the demonstration of an accelerator structure at gradient and the SLED-II system at high power are optimally planned and organized for success. Secondary goals were to look beyond into calendar year 2004 and make the same assessment when the SLED-II system will be connected to JLC/NLC-like accelerator structures, advanced rf components will be tested that would allow for higher efficiency and/or lower cost rf systems, and any relevant R&D needed in support of a U.S. bid for an LC would be accomplished. A significant amount of work was done both during this and later plenary sessions as well as in individual working group sessions to define meticulously and detail out all of these activities to ensure that there were no points of confusion, vagueness, or omission.

Tor Raubenheimer outlined the current SLED-II-based JLC/NLC since it is different from the DLDS-based machine that most of the participants were familiar with from past meetings. The only significant difference between the JLC and NLC at the present time is that they are operating at different harmonics of their respective AC power grids with different base frequencies – the JLC at 150 Hz and the NLC at 120 Hz. Tor elegantly understated the luminosity required in the JLC/NLC as only a "few times 10^4" that was demonstrated in the existing SLAC S-Band linac. He showed how the additional luminosity required was being "budgeted" across different machine parameters – a longer bunch train, lower geometric emittance, lower beam normalized emittance from the damping rings transported through the linacs, stronger focusing, and adiabatic damping from the higher energy beams. Unfortunately, the luminosity is much more difficult to demonstrate (software simulations) than the rf hardware (build the hardware). However, most of the requirements needed to produce and preserve the luminosity have either been shown to have been attained in existing operating facilities (like synchrotron light machines), or demonstrated in experimental facilities (such as the ATF or FFTB). Such facilities are not yet available to validate a superconducting approach.

Peter Tenenbaum and Andy Wolski provided a much more detailed view of the luminosity/emittance preservation issues for the whole JLC/NLC and the damping rings in particular. They were followed by Dave Schultz who discussed the new Eight-Pack project configuration and schedule. Chris Adolphsen brought the group up-to-date on the efforts to produce accelerator structures that do not suffer from rf breakdown at the JLC/NLC gradients. At the present time it appears that the breakdown in the input and output couplers needs to be treated differently from that of the regular accelerator cells that make up the balance of each structure. We have now demonstrated both couplers and regular accelerator cells that break down at rates below that required by the NLC/JLC and also remain undamaged, but the couplers and cells have been on different physical structures (many different structure variants have been designed, built, and tested). These need to be consolidated onto a small subset of designs so an optimized choice can be made, and the features in the cells needed to damp the unwanted higher-order modes in the cells need to be added to make sure that they do not bring some unwanted effect. A substantial amount of time in one of the working-group sessions was also devoted to this subject, and this planning will need to carry over to ISG-9 and beyond since it will be months before all the needed test results are in.

These plenary sessions, spread out over the first two days, were followed by nine different parallel working group sessions whose results were reviewed in the final plenary session on Tuesday afternoon. Individual reports from a number of the working groups follow.

Structures Working Group Summary

Harry Carter

During the November 2002 NLC Collaboration meeting, the structures working group was organized and led by co-conveners Juwen Wang [SLAC] and Harry Carter [FNAL].

A series of informative presentations were given by collaboration members, detailing recent work in the areas of structure design, structure testing and simulation, and structure fabrication. Interested parties can view these presentations in their entirety at http://www-project.slac.stanford.edu/lc/local/Reviews/Nov2002Rev/Agenda.htm.

A joint session was held with the Eight Pack working group in which several issues with respect to deliverables and their configuration, as well as the schedule for structure delivery for Phase II of the Eight Pack Project were resolved.

One of the most important outcomes from the structures working group was agreement among collaborators with respect to the fabrication and testing schedule for structures in CY03. It was also agreed that decisions on fabrication-related issues for several of the structures included in that latter part of that schedule would be deferred until the ISG9 meeting this December at KEK.

Magnet Working Group

Cherrill Spencer

An ever-increasing number of people working on NLC magnet R&D held discussions during the November 2002 MAC and Collaboration meetings. Physicists and engineers from Brookhaven National Lab, FERMILAB, LBNL, SLAC, UC Davis and UCLA are working on various aspects of NLC magnets. The 4 major topics we covered were (1) experimental tests of radiation damage to permanent magnet (pm) bricks in small, crude quads, using the thermal and fast neutron field of the McClellan nuclear reactor run by UCD; (2) to respond to the continuing concern about hidden changes in the strength of any fixed pm bricks in an adjustable pm, and how that could affect the efficiency of the Beam Based Alignment process (BBA), we will work with some accelerator physicists to develop tolerances on the properties of the pm bricks and the whole magnet; (3) planning sensitivity analyses of a proposed rotating ring adjustable pm quad and (4) planning measurements of vibrations in existing superconducting magnets at the MAGCOOL facility at Brookhaven and at SLAC.

Conventional Facilities and Site Selection Working Group

Victor Kuchler

The Conventional Facilities and Site Evaluation" Working Group spent a good deal of time interacting with other parts of the collaboration as well as devoting some time to the fine tuning of the plan of action for the coming year with respect to the MAC comments of the previous week. A good portion of the Sunday afternoon session was devoted to a combined discussion with representatives of SLAC, KEK, LLNL and FNAL exploring options for klystron configuration in the support tunnel. Several combinations were discussed which provided very useful information that will affect the support tunnel diameter and general cross-section development. Later that afternoon we also discussed issues related to existing Conventional Facilities cost estimate reconciliation.

On Monday at a morning plenary session, Jonathan Dorfan presented an overview of the International and Regional Process that is working to develop an International Linear Collider Project. This information was very useful and must be factored into any project scheduling efforts that will be forthcoming. In the afternoon, the CF Group combined with the "Toward a Conceptual Design" Working Group for a discussion of project models which could be used to help generate a path to an NLC CDR. Ted Lavine presented information from the Organization for Economic Cooperation and Development, Global Science Forum as well as organizational information from the Atacama Large Mllimeter Array (ALMA) Project. Both offered valuable information regarding the organization of global science projects.

The CF Group spent the rest of the available time refining the group goals for the year and assigning some action items for the near term. All in all it was a very interesting meeting with a lot of good information exchanged. The Conventional Facilities Group has a full plate and a clear direction for the coming year.

'Toward a Conceptual Design' Working Group Summary

Ted Lavine

A small working group at the U.S. NLC Collaboration Meeting reviewed the development of a project execution planning model for linear collider construction. The evolving model is the result of a series of discussions involving participants from the LC R&D program and the project management community. The discussions have focused on articulating and understanding a feasible story line for an LC project, on the sequencing and interrelationship of project events, and on the impact of various alternatives for acquisition and contracting. The model reflects cognizance of lessons learned from large scientific facility construction projects (such as SSC, LHC, PEP-II, and LIGO) and international, multilateral scientific construction projects (such as the BaBar and ATLAS detectors). The working group also discussed aspects of the path leading up to the initiation of an international LC project.

The participants agreed on the importance of developing a comparative understanding of the construction issues and timelines for a small set of representative sites. The critical and near-critical paths to be evaluated over the next few months are related to (1) the design and construction of the accelerator housings in time for the installation of technical components, (2) the preparation of site utilities and the accelerator control center in time for injector commissioning, (3) the production, delivery and installation of the large quantities of main linac components, and (4) the completion and commissioning of the positron injector systems (which are significantly more involved than the electron injector).

Recent Linear Collider Publications

If you would like to have 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-0107,"Design Studies for Flux and Polarization Measurements of Photons and Positrons for SLAC Proposal E166: An experiment to test polarized positron production in the FFTB," M. Woods, Y. Batygin, K. C. Moffeit and J. C. Sheppard, November 2002.

LCC-0108, "Comparison of Emittance Tuning Simulations in the NLC and TESLA Damping Rings," Andrej Wolski and Winfried Decking, November 2002.

LCC-0109, "Alignment Stability Models for Damping Rings," Andrej Wolski and Winfried Decking, November 2002.

II. Other Publications

SLAC-PUB-9558. F. Le Pimpec, S. Adiga, F. Asiri, G. Bowden, D. Dell'Orco, E. Doyle, B. McKee, A.Seryi, H. Carter, C. Boffo, "Effect of Cooloing Water on Stability of NLC Linac Components," October 2002, Nanobeam 2002 Workshop, Lausanne, Switzerland.

Calendar of Upcoming Events

Conferences and Workshops of Interest

9th SLAC/KEK ISG Meeting, KEK, Tsukuba, Japan, December 10-13,s 2002, http://wwwproject.slac.stanford.edu/lc/ilc/ISG_Meetings/ISG9/nlcisg9.htm

15th Workshop on Beyond the Standard Model, 9-13 Mar 2003, Bad Honnef, Germany, http://www.physik.uni-halle.de/Fachgruppen/Theorie/qft/BadHonnef/

Particle Accelerator Conference (2003 PAC) Portland, OR, 12-16 May 2003; Siemann@slac.stanford.edu

IEEE/NPSS Real Time Conference, 18 – 23 May 2003, Montreal, Quebec, Canada, http://www-dapnia.cea.fr/rt2003/confComit.php.

ICALEPCS 2003, 13-17 October 2003, Gyeongju, Korea, Axel Daneels, co-chair, isc-chair@icalepcs.org,http://www.icalepcs.org

IEEE NPSS Nuclear Science Symposium, 19 - 24 October 2003, Portland, OR. Ralph James