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# Advanced Light Source Report

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# Call for the First PRT Proposals Issued

## *Proposals for the development and operation of the initial complement of ALS experimental facilities must be received by August 15*

Letters were mailed on March 17 to the almost 800 names on the ALS mail list, and advertisements appeared in the April issues of several scientific publications serving the synchrotron-radiation community, all to announce a Call for Proposals from participating research teams (PRTs) to develop and operate the initial complement of beam lines and experimental facilities at the Advanced Light Source (ALS). The deadline for receipt of proposals is August 15, 1989.

A national user facility funded by the U.S. Department of Energy for the production of high-brightness, partially coherent x-ray and ultraviolet (XUV) synchrotron radiation at the Lawrence Berkeley Laboratory (LBL), the ALS is scheduled to begin serving users in the spring of 1993. Research areas are expected to include materials and surface science and technology, biology and medicine, atomic and molecular physics, chemistry, earth science, and microfabrication.

The design of a series of insertion devices (undulators and wigglers) and associated beam lines that span the spectral range accessible to the ALS is now under way, based on input from the ALS Science Policy Board and from the user community through a series of workshops and letters of interest that were solicited from potential PRTs.

Proposals are now invited from PRTs to work with the ALS staff on the design, construction, and commissioning of insertion devices and beam lines, to develop the associated experimental apparatus, and to carry out the initial scientific program with these facilities. Proposals are especially encouraged from insertion-device teams, although proposals from bending-magnet teams will be considered to the extent that resources permit.

Privileged access to the facilities it helps develop will be assigned to each PRT for its own research program, with the amount of access dependent on the resources (personnel, funding, and equipment) provided for the facilities by the PRT. The remaining access will be available to general users. There will be a call at a future date for proposals from general users desiring to use these facilities.

The first decisions on PRT proposals are expected to be announced in December of this year. All proposals will be evaluated by the ALS staff and by the ALS Program Review Panel (see page 3).

ALS Scientific Program Coordinator Fred Schlachter, to whom all proposals should be sent, emphasizes the importance of this round of PRT proposals. Although spring 1993 may seem far in the future, the design, fabrication, installation, and commissioning of the ALS and its insertion devices and beam lines are such complex tasks that decisions need to be made this year to ensure that operations begin as scheduled. It is therefore essential, says Schlachter, that proposals be submitted by all PRTs desiring to work on the initial complement of ALS experimental facilities.

Technical information is available to help in the preparation of a proposal. In particular, the ALS Handbook (LBL PUB-643 Rev. 2) has been revised to show the most recent calculations of spectral brightness and flux for several planned insertion devices and for the bending magnets.

A particularly useful feature of the revised handbook is a set of tables calculated by the lead engineer for beam lines, Dick DiGennaro, giving detailed performance figures for the associated insertion-device beam lines, which are based on spherical-grating monochromators. The recent use of an LBL-designed and -constructed spherical-grating monochromator to record an ultrahigh-resolution x-ray absorption spectrum of gaseous molecular nitrogen confirms that the ALS beam line planning is on the right track. The nitrogen spectrum, taken on the VUV branch line of beam line VI at the Stanford Synchrotron Radiation Laboratory by LBL scientists, was good enough to resolve molecular vibrations (see page 9).

Copies of the Call for Proposals and the ALS Handbook can be obtained by returning the postage-paid form in the newsletter after checking the appropriate boxes. All questions about proposals should be directed to Schlachter, who can be reached by telephone at 415-486-4892, by facsimile at 415-486-4873, or by e-mail (bitnet, Internet/ARPAnet, or DECnet/HEPnet) with user name FRED and node LBL.

### ALS Progress Reports

# Demolition Activities Pace ALS Building Construction

A $12.5-million contract for ALS conventional facilities has been awarded to C. Overaa and Co., a well-established, family-owned and -operated construction firm based in Richmond, California. A medium-sized contractor, Overaa has many Bay Area commercial, community, and institutional structures to its credit. The company began its ALS construction work on December 1, 1988. The term conventional facilities refers to the structures that house the technical facilities (the electron linear accelerator, the booster synchrotron, the storage ring, the beam lines, and the experimental hall). Associated work includes site preparation and improvement and connection of electrical and mechanical utilities.

In anticipation of the contract award, the ALS project began site preparation last June. This work was subsequently assumed by Overaa. Major activities included removal of the 184-Inch Cyclotron and its shielding, modifications to a nearby building, and demolition/removal of surrounding structures and buildings (see drawing). An obsolete cooling tower and electrical substation, presently still intact, will be torn down in the near future.

A critical aspect of ALS site preparation is the decommissioning and removal of the transformer substation that, for almost 40 years, ably serviced the cyclotron and other buildings in the immediate vicinity, a geographic area designated as the Original Laboratory Site (OLS). The substation still services the rest of the OLS community and will be replaced by a more powerful 12.5-MW substation.

Before the awarding of the contract, LBL initiated substation site-preparation activities by purchasing the transformers and switchgear, installing new underground conduits, and beginning construction of the substation foundation (later completed by Overaa—see photo). The transformers and switchgear have recently been installed, although wiring and testing will continue through the end of May.

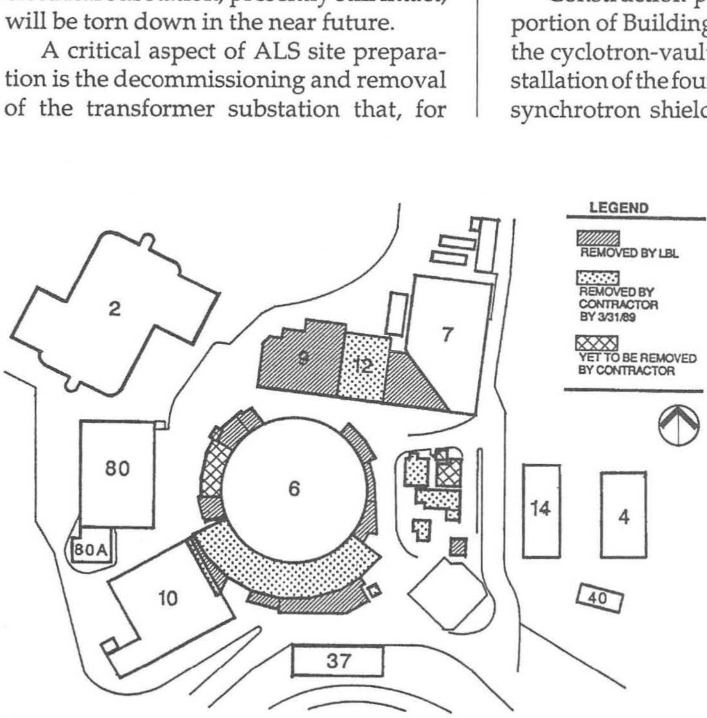
Once the new substation is fully operational, the old one will be demolished and removed, along with the remaining cooling tower situated near related electrical equipment. The way will then be clear to complete the foundation for the 60,000-square-foot addition to the cyclotron building (Building 6) that will encircle the existing building and house the storage ring, beam lines, and experimental hall.

Construction progress in the original portion of Building 6 includes removal of the cyclotron-vault concrete floor and installation of the foundation for the booster-synchrotron shielding and of steel reinforcing bars for its sidewalls. It is anticipated that this area will be ready for occupancy by next January, so that installation and testing of the linac and booster can begin while Overaa completes the annular addition.

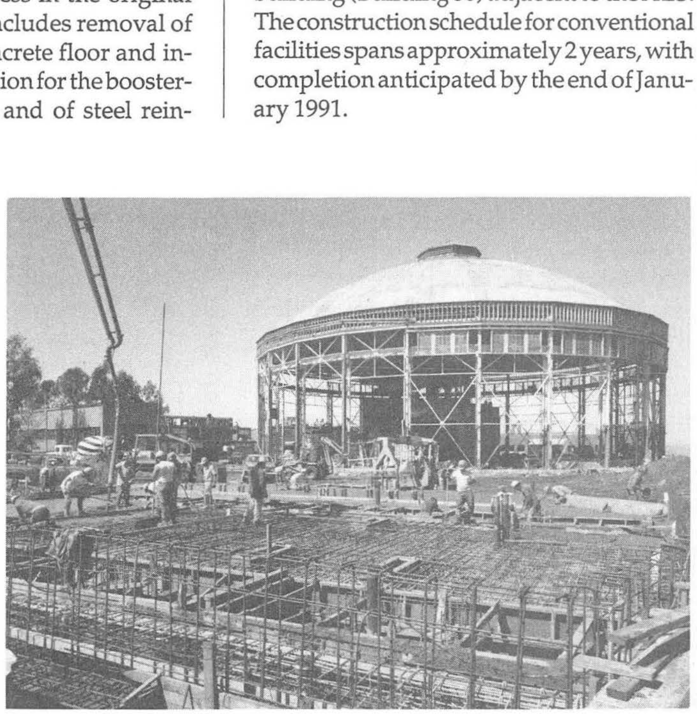
Foundation work for the addition is just getting started, and structural steel is being fabricated in anticipation of installation this summer. This activity will include installation of heavy beams and girders for the mezzanine level of the addition, which is designated for user offices and light lab space (see page 5).

***The construction schedule for conventional facilities spans 2 years, with completion anticipated by January 1991.***

Other work in progress includes the construction of a large retaining wall on the northwest corner near the new Advanced Materials Laboratory, as well as design of precast shielding blocks for the storage ring and design of the ALS control room, which is to be located in an existing building (Building 80) adjacent to the ALS. The construction schedule for conventional facilities spans approximately 2 years, with completion anticipated by the end of January 1991.




*__Demolition and removal__ of structures in the vicinity of the ALS site to make room for the new building are partly the responsibility of LBL and partly of the conventional-facilities contractor. The drawing shows progress through March 31.*



*__A new 12.5-MW substation__ will provide electrical power to the ALS and to other buildings in the neighborhood known as the Original Laboratory Site. Here the conventional-facilities contractor is pouring the substation foundation.*

**From the Chairperson**
**Users' Executive**
**Committee:**

# Three UEC Subcommittees Are Now Seeking User Input

Much has happened at the ALS since my last letter. Perhaps most important, at long last, there are real, visible changes at the construction site (see page 2). At the same time, the ALS has been accumulating the administrative machinery and gathering the user community that are necessary to a first-class, successful facility. The Science Policy Board, formed at the end of last year, had its first meeting in February, and the Program Review Panel (PRP) has now also been assembled.

The PRP is of particular importance to users since it will be making recommendations concerning the allocation of beam lines and of resources from ALS construction funds for the next few years. The PRT proposal process is also proceeding rapidly under the able direction of Scientific Coordinator Fred Schlachter, who recently contacted many of you. The time is now approaching when we can roll up our sleeves and think about real beam lines.

The UEC has been helping to plan the next ALS Users' Association annual meeting, scheduled for this August 7, as advertised on page 4 of this newsletter. This date was chosen so that we can overlap with the Sixth National Conference on Synchrotron Radiation Instrumentation, otherwise known as SRI 1989, which will be held in Berkeley from August 7 through August 10. Here are a few things you might wish to think about before the meeting.

Recently, the UEC has begun forming three subcommittees. The first concerns time-resolved experiments at the ALS and is headed by Tom Baer and Dennis Lindle. They have organized a workshop to be held during the SRI 1989 meeting. I encourage any of you who have any interest in using the time structure of the ALS to attend.

The second subcommittee is involved in planning user-support space. It is hoped that funds will be available to complete a 15,000-square-foot portion of the mezzanine above the experimental floor (see page 5). This area will be used for user offices, light laboratory space, and other amenities. The subcommittee will work with ALS staff to plan the optimum use of the mezzanine.

The third subcommittee will advise the project staff concerning user needs related to the ALS control system. Operations at the ALS will require unprecedented interaction and communication between the control system for the storage ring and insertion devices and the experimenters. This subcommittee will therefore be composed of personnel from both the ALS and the UEC.

For the moment, any of you who have ideas about mezzanine-space planning or control-systems issues that should be considered by these subcommittees are invited to contact me. There will also be opportunities to discuss these matters at the August annual meeting.

***The time is now approaching when we can roll up our sleeves and think about real beam lines.***

Finally, there is the nomination and election process for new members of the UEC. As you know, the UEC will continue to offer important input to the ALS management during the construction and commissioning periods. It is therefore very important to have active representation from all communities. As was done last year, we will replace four current UEC members with three newly elected members who will serve 3-year terms.

The members whose terms will end this year are Allen Hartford (Los Alamos), Franz Himpsel (IBM Yorktown Heights), Janos Kirz (SUNY Stony Brook), and Joachim Stöhr (IBM Almaden). The UEC has formed a nominating committee composed of the four members who are stepping down. I encourage you to send your suggestions for new UEC members to these people. Alternatively, as was done last year, nominations made during the annual meeting over the signatures of five ALSUA members will be added to the list of candidates for election by mail ballot.

I look forward to seeing you in August.

**Stephen D. Kevan, Chairperson**
**Users' Executive Committee**

# Program Review Committee Formed

A nine-person Program Review Panel (PRP) has been appointed by LBL Director David Shirley to provide him, through the ALS Director, with recommendations on the disposition of proposals for the development and use of ALS insertion-device and bending-magnet beam lines. The first chairperson will be Neville Smith of AT&T Bell Laboratories. Membership in the PRP will be for staggered terms of three years, renewable for no more than one term, but some charter members will have two- or four-year terms to establish the rotation sequence.

The main work of the PRP in the time before the ALS begins operations in April 1993 will be to review and evaluate proposals from participating research teams (PRTs) to design, construct, and operate a beam line, whereas later on the activity will be divided among proposals from new PRTs, performance reviews of existing PRTs, and proposals for general-access time on beam lines that have already been commissioned. It is expected that the PRP will meet at least twice yearly.

Members of the PRP are

- Neville Smith, AT&T Bell Laboratories (Chairperson)
- C. Richard Brundle, IBM Alamaden Research Center
- Sheldon Datz, Oak Ridge National Laboratory
- Michael Knotek, National Synchrotron Light Source
- Robert Macey, University of California at Berkeley
- Giorgio Margaritondo, University of Wisconsin–Madison
- Keith Moffat, Cornell University
- Joe Wong, Lawrence Livermore National Laboratory
- J. Michael White, University of Texas at Austin

## Second ALS Users' Association Annual Meeting in August

The second ALS Users' Association (ALSUA) annual meeting will be held in conjunction with the 6th National Conference on Synchrotron Radiation Instrumentation (SRI 1989), which will run from Monday, August 7, through Thursday, August 10, at the Clark Kerr campus of the University of California at Berkeley. The ALSUA meeting will take place on Monday evening at 8 PM.

Since the call for proposals to form participating research teams (PRTs) to develop, commission, and operate the initial ALS experimental facilities has been sent to all ALSUA members and advertised in several publications serving synchrotron-radiation users, the meeting emphasis will be on issues relating to the selection and activities of the initial PRTs. A progress report will focus on how insertion devices and beam lines are being developed in light of input from the users.

Additional discussions will include plans for ALS auxiliary facilities, such as laboratories and office space, the need for user housing, and an update on computer-control systems. ALSUA business matters will include the nomination of new members to the ALS Users' Executive Committee, which is the primary interface for communicating user needs to the ALS staff, and a review of a joint effort by the UECs of synchrotron facilities to enhance communication with one another and with the facilities.

Members of the ALSUA will also be interested in a set of five parallel workshops to be held on Wednesday, August 9, at 1:00 PM as part of SRI 1989. The workshop topics and chairpersons are

- Undulators for Advanced SR Sources
  W. Hassenzahl, LBL
- Photon and Electron Beam Stability
  A. Warwick, LBL
- Detectors for Advanced SR Sources
  J. Jaklevic, LBL
- Time-Resolved Experiments
  T. Baer, U. North Carolina and
  D. Lindle, NIST
- Imaging Experiments
  C. Jacobsen, LBL.

To receive the SRI 1989 brochure, which contains registration and hotel-reservation information, check the appropriate box and return the postage-paid form in this newsletter.

# First ALS Beam Recorded in the Electron-Gun Test Stand

At 5:45 PM on Monday, April 10, just hours before the Department of Energy semiannual review of the ALS (see page 5), the first electron beam was produced in the electron-gun test stand. The electron gun is the very first section of the accelerator complex that injects electrons into the ALS storage ring and is now the first operational piece of accelerator hardware.

Achieving the first beam, which had an energy of 60 keV, was the result of months of effort by the project team, culminated by two weeks of intense activity by lead engineer Brian Taylor and his team of installation technicians coordinated by Ken Baptiste.

The test stand marries all the necessary components for a fully operational ALS subsystem: the hardware itself, a complete vacuum system, conventional facilities (such as low-conductivity water and compressed air), power supplies, the control system, interlocks, and diagnostic equipment. That the system does function as a unit is shown by the photo of an oscilloscope trace of a current pulse through the test stand.

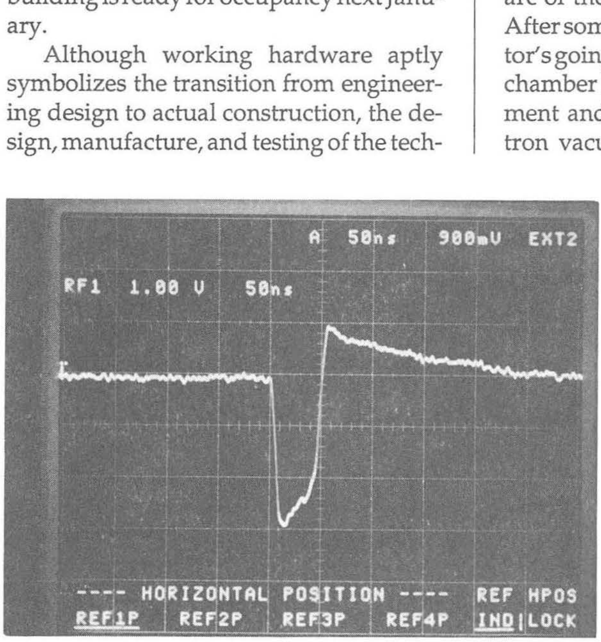
Subsequent activity will include developing an optimized procedure for tuning the electron beam in preparation for further acceleration to 50 MeV in the S-band electron linear accelerator. Temporarily housed in a concrete bunker alongside the Bevatron at LBL, the test stand will be moved after the first part of the ALS building is ready for occupancy next January.

Although working hardware aptly symbolizes the transition from engineering design to actual construction, the design, manufacture, and testing of the technical components of the remainder of the ALS accelerator complex also signal tremendous progress.

Engineering models of all booster-synchrotron and storage-ring magnets have been built, and their performance is being evaluated in an area near the electron-gun test stand by lead engineer Jack Tanabe and his team of magnet designers. The results of testing done so far are good enough that all booster magnets (dipoles, quadrupoles, and sextupoles) have been accepted for production. Production has already begun on the dipoles and the quadrupoles in other buildings on the LBL site. In addition, contracts have been signed for the first girder and struts that will support the booster magnets in the ALS building when installation begins next year.

The ALS control system developed by lead engineer Steve Magyary and his crew is based on a highly distributed system of intelligent local controllers (ILCs). The ILCs have been designed and reduced to the size of 3U Eurocard modules, as shown in the photo. Ten ILCs are now in use in the electron-gun test stand. One is also in place in the engineering test chassis that has been developed for the electron-beam-position monitors.

As designed by the engineering team lead by Kurt Kennedy and Tom Henderson, the vacuum chamber of the ALS storage ring includes 12 sections, one for each arc of the ring, each 10 meters in length. After some delay due to the initial contractor's going into bankruptcy, the first article chamber has been delivered for measurement and testing. The booster synchrotron vacuum vessels have already been

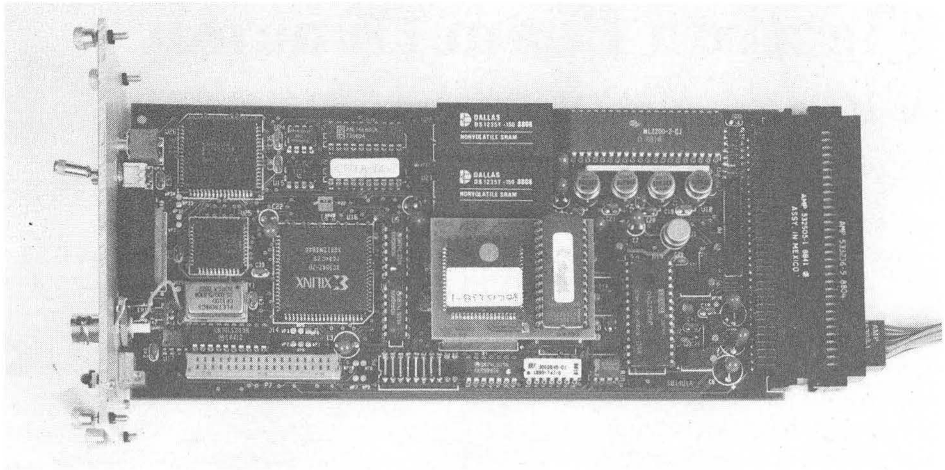



***Oscilloscope trace*** *from a monitor in the electron-gun test stand shows a 1-A peak current in a pulse with a 50-ns width. Eventually, the peak current will be doubled and the pulse width reduced to 2.5 ns.*

built at LBL and are awaiting their incorporation into the dipole magnets during assembly.

A contract for the design and manufacture of rf accelerator cavities for the booster synchrotron and for the storage ring has been placed, with delivery of the first cavity scheduled for this fall. In preparation for testing this cavity, a test stand complete with a 500-MHz, 60-kW transmitter is being set up at a fourth LBL site.

Finally, 120 equipment racks will be needed to house the power supplies, control equipment, interlock systems, and so on for the ALS injector and storage ring. About two-thirds of these racks have been delivered and are now being loaded with linac and booster equipment in still another LBL building.



***The intelligent local controller*** *(ILC) is the foundation of the highly distributed ALS control system. Each ILC is the size of a 3U Eurocard module.*

# DOE Reviews a Scope Increase for the ALS

At six-month intervals, the U.S. Department of Energy (DOE) reviews the status of the ALS project to see that construction milestones are being met and that budget projections remain valid. In the most recent semiannual review during April 13–15, the DOE reviewers also evaluated plans for a proposed increase in the scope of the ALS project. The scope increase has as major goals (i) improving photon-beam stability and hence the probability that a high synchrotron radiation source brightness, especially that of undulators, would be realized for experiments at an early date after project completion and (ii) providing office and light laboratory space to users without the disruption caused by construction after facility operations begin. It would raise construction costs of the $99.5-million ALS by about $9.7 million but would not change the date for initial operations, now scheduled to begin in April 1993.

In addition to being reviewed by DOE, the plans for the scope increase were presented to the ALS Science Policy Board at its initial meeting on February 9 and 10, and they have been discussed with the ALS Users' Executive Committee, whose input has helped shape the specifics of the proposal. Although there is general concurrence among these groups that the implementation of the increase would benefit users and boost the scientific productivity of the ALS, final approval rests first with the Administration in Washington, which must include it in a budget request, and with Congress, which must appropriate funding. ALS Director Jay Marx has been working hard to get the scope increase included in the FY 1991 budget.

Although the need for a stable photon beam has always been appreciated, the depth of the appreciation has grown as the scientific opportunities afforded by finely focused XUV beams have been clarified in the ALS topical workshops held during the past two years. Moreover, understanding of the engineering requirements to provide the necessary stability has also grown. Much attention in the base-project engineering design was given to controlling short-time-scale perturbations due to vibrations and the like. Recent experience at other facilities has led to the formation of a special ALS task force to study the extent to which dimensional changes in the storage-ring and in the beam lines due to slow temperature changes result in unacceptable beam motion.

In a presentation to the DOE reviewers, task-force member Tony Warwick noted that the requirement for a stability equal to one-tenth the beam size meant that the horizontal and vertical electron beam positions in an undulator must be constant to within 33.0 and 6.3 m, respectively. Similarly, the horizontal and vertical divergences must be constant to within 3.0 and 1.6 rad, respectively. Warwick argued for a layered thermal stabilization system. The first layer would consist of temperature control of magnet cooling water and air conditioning of the storage-ring tunnel and the beam-line area for "rough" stabilization. The second layer would be based on electronic feedback from photon-beam position monitors in the beam lines for "fine" stabilization. Beam-position monitors are already part of the ALS scope, but temperature control is needed to avoid an unreasonable feedback-gain requirement.

The widespread user interest in the ALS and the likelihood of a significant number of researchers on site at an early date have helped dramatize the need for user offices, light laboratory space, storage areas, utility room, and other amenities, such as conference rooms, a library, and staff rooms. The shortage of building space on the LBL site makes the addition of a mezzanine to the new ALS building the most practical solution. With DOE's concurrence, the project has already committed more than $2 million of construction funds to build the basic structural skeleton of the mezzanine, thereby avoiding the need for a shutdown later after facility operations have begun. It is now proposed to finish concurrently with the construction project enough of the mezzanine to accommodate some 60 users when operations begin. The remainder of the mezzanine can be completed without disrupting operations if additional funds become available in the future.

Finally, it is proposed to add several bending-magnet front ends with shutters and isolation valves during the construction project. In this way, the investment required of users to develop bending-magnet beam lines in addition to any funded by the ALS construction project is reduced substantially. In addition, the beam lines can be incorporated in the future without the need for a shutdown to open the storage ring to the atmosphere and the concomitant inconvenience to users.

# Electron Beam Dynamics Clears Panel of Reviewers

In keeping with the ALS policy of holding external reviews, the single-particle dynamics studies of the accelerator physics group were the focal point of a two-day review last February 15 and 16. Single-particle dynamics refers to the behavior of the individual electrons in the beam as they move in the magnetic fields produced by the ALS bending, focusing, steering, and chromaticity-correction (sextupole) magnets and by insertion devices.

The ALS storage ring, with its very low beam emittance, requires very strong sextupoles. These are inherently non-linear devices whose fields lead to unstable particle motion at large amplitudes. Moreover, the strong magnetic fields of the insertion devices, which include both linear and nonlinear components, can also lead to lower stability. To achieve the project goals of low beam emittance and long lifetime, it is necessary to assess any errors in these magnetic fields and then determine their effects on beam properties.

The figure of merit for these effects is the dynamic aperture, which corresponds to the maximum stable horizontal and vertical amplitudes for betatron motion in the storage ring. For a particular machine design, we must ensure via simulations that the dynamic aperture is large enough both to permit beam injection and to accommodate scattered particles whose loss would degrade the beam lifetime.

Although substantial work on single-particle dynamics had been carried out in the design phase of the ALS, the February review provided an opportunity to describe new work by Bruno Autin, Swapan Chattopadhyay, Etienne Forest, Al Garren, Klaus Halbach, Alan Jackson, Roderich Keller, Charles Kim, Hiroshi Nishimura and Mike Zisman.

The review panel consisted of four experts from the accelerator physics community: Donald Edwards, Fermilab (Chair); Samuel Krinsky, National Synchrotron Light Source; Helmut Wiedemann, Stanford Synchrotron Radiation Laboratory; and Albin Wrulich, Sincrotrone Trieste. They were asked to review accelerator physics issues critical to ALS performance, especially our approaches to the specification and evaluation of magnet tolerances and on our studies of the effects of magnetic imperfections and insertion devices on the electron beam. They were also asked for their judgment on whether the dynamic aperture estimated for the ALS is sufficient for machine operation.

Preparation for the review included the development of an entirely new simulation code, the GEMINI package, that can track particles with specified initial conditions through a "realistic" storage ring that includes the effects of:

- systematic magnetic field errors
- random magnetic field errors
- transverse magnet misalignments
- magnet rotations about the beam axis (roll)
- linear and nonlinear magnetic fields arising from insertion devices
- synchrotron oscillations of the electron beam

The machine lattice considered, an updated version of that in the 1986 ALS conceptual design report, has a natural emittance of 3.5 nm-rad, as compared to the design specification of 10 nm-rad.

The availability of engineering models for many of the storage ring magnets motivated us to review all ALS magnet-design tolerances in the light of measured performance. These refined tolerances were then used in realistic simulations of the injection process.

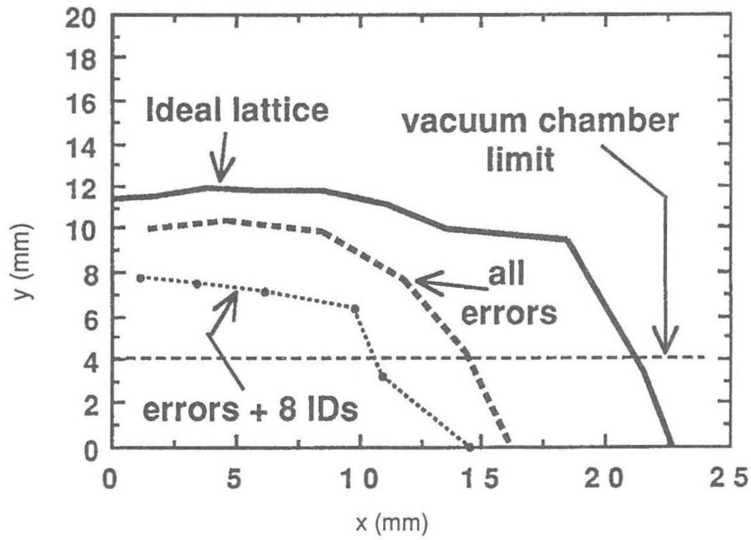
A systematic study of the effects of a single insertion device was also completed. This study included all field and misalignment errors, the influence of higher spatial harmonics in the insertion device fields, and consideration of several alternative techniques for matching the insertion device with the lattice optics. The effects of multiple insertion devices were also looked at.

Lastly, we investigated the effects on beam lifetime of the reduced dynamic aperture due to errors, synchrotron oscillations, and insertion devices.

Our main conclusion is that the ALS dynamic aperture—based on the assumed magnetic field and alignment tolerances and on our ability to achieve rms closed-orbit distortions below 0.2 mm—is adequate for injection and routine operation. With errors included, the effects of the insertion devices were found to be insensitive to the alternative matching schemes investigated, so that sophisticated schemes with many quadrupoles are unnecessary.

Moreover, we have demonstrated (see figure) that the dynamic aperture does not degrade significantly as additional devices are added. However, when synchrotron oscillations are included in the simulations, the Touschek lifetime does appear to degrade somewhat and will likely be lower than that originally estimated.

In general, the reviewers were pleased with the work that was done and agreed with our conclusions. However, they did urge us to explore a relaxed lattice configuration, with higher emittance, to reduce the sensitivity to closed-orbit distortions. This effort is presently under way.




*__Effects of realistic errors__ and multiple insertion devices on the ALS dynamic aperture. The curve labelled "all errors" shows the decrease in dynamic aperture when magnetic field errors, magnet misalignments, and a corrected closed-orbit distortion are included. Even after the addition of eight undulators, the dynamic aperture is larger than the effective vacuum-chamber aperture at the tracking point.*

Please copy this card for your colleagues

## ADVANCED LIGHT SOURCE INFORMATION

To receive information about the ALS, check the appropriate boxes, fill in your address, clip the postage–paid card and drop it in the mail.

- ☐ I did not receive a copy of the *Advanced Light Source Report* addressed to me; please add my name to the ALS mailing list.
- ☐ I would like the brochure containing information about the ALSUA annual meeting and SRI 1989.
- ☐ I would like information on submitting a proposal for participation in the ALS as a member of an insertion-device team or a bending–magnet team.
- ☐ I would like to receive LBL PUB-643 Rev. 2, "An ALS Handbook."

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- ☐ Life Science
- ☐ Surface Science
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- ☐ Other ______________________________

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# SGM Proves Itself on the BL-VI VUV Branch at SSRL

ALS optical scientists have long planned to use beam lines equipped with spherical-grating monochromators (SGMs) to collect, focus, and spectrally disperse the high-brightness radiation from undulators. The recently installed VUV branch of beam line VI at the Stanford Synchrotron Radiation Laboratory (SSRL) serves partly as a prototype for this approach. Designed and built by LBL staff to receive radiation from a 54-pole wiggler, the VUV branch line is con-structed around a 55-meter SGM.

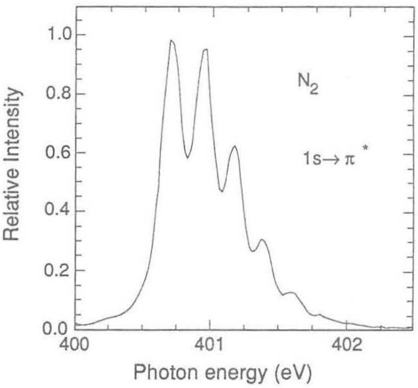
In its first major test, the SGM has come through with flying colors. X-ray absorption spectra made by Phil Heimann of LBL and Fred Senf of SSRL of the 1s → * electronic transition near 401 eV in gaseous molecular nitrogen clearly show vibrational structure with a resolution of 60 meV. This is state-of-the-art performance and matches that achieved with the somewhat similar cylindrical-element (Dragon) monochromator of C.T. Chen of AT&T Bell Laboratories in measurements on the U4B beam line at the National Synchrotron Light Source.

Project manager for building and installing the VUV branch was Wayne McKinney, an optics specialist who joined LBL two years ago to work on the ALS. Ted Lauritzen was the lead engineer in a group that included John Chin and Bill Gath.

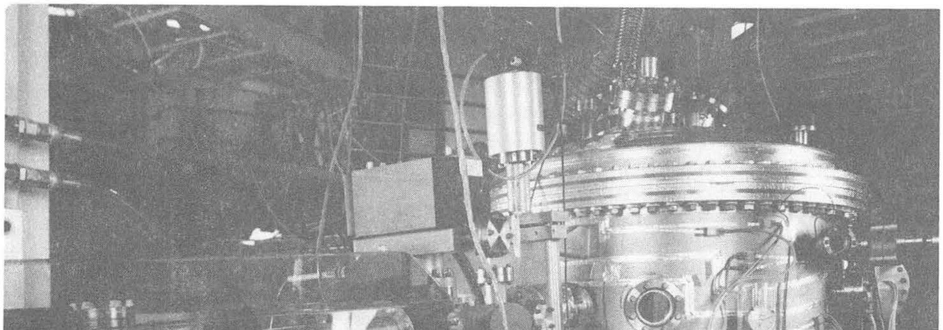
The optical design of the SSRL SGM and of those proposed for the the ALS is due to LBL's Malcolm Howells. Spectral resolution and resolution-blurring aberrations are issues with the toroidal-grating monochromators that are now widely used at synchrotron light sources. The spherical-grating approach is capable of excellent resolution, and spherical optical surfaces are easier to manufacture than toroidal, although they provide no astigmatism correction.

According to the scheme published by W.A. Rense and T. Violett in 1959, the astigmatism associated with spherical gratings can be corrected by a condensing system that images the source onto the entrance slit in the dispersion (vertical) plane and onto the exit slit in the horizontal plane. Although wave-length tuning is by simple rotation of the grating, the penalty for taking this tack is that the entrance and exit slits must be movable to keep them on the Rowland circle during wavelength scanning, as shown in the photo below.

The condensing system chosen by Howells for undulator beam lines consists of two spherical mirrors with their planes of incidence perpendicular to each other in the configuration originated by Kirkpatrick and Baez in 1948. Because of the low emittance of the ALS storage ring, the monochromator can accept the entire undulator beam in most cases, even at a slit-with of 10  m. Although individual variations in details are under consideration, such as the elimination of one or both of the condensing mirrors, all ALS undulator beam lines now being designed by the project staff are of this type.




***X-ray absorption** spectrum of gaseous molecular nitrogen has a resolution of 60 meV, which is good enough to clearly resolve vibrational structure in the 1s → * electronic transition.*



***Spherical-grating monochromator on beam line VI at** the Stanford Synchrotron Radiation Laboratory. The grating chamber is at the right and the movable entrance-slit assembly is at the left.*

The SSRL beam line VI VUV branch follows a similar philosophy but has a single toroidal mirror as the condensing system. Although they are not yet in place, the SGM is designed to use water-cooled gratings, as in the ALS. The present 600-lines/mm grating, made by Ferranti Astron, is fused silica and covers the spectral range from 180 to 820 eV.

Key subsystems of the monochromator include the water-cooled gratings, which must operate in an UHV environment, a kinematic-mounting with six invar struts to adjust the position and orientation of the grating chamber to within 0.001 in., and a high-resolution, laser-interferometer-based wavelength-drive system. The Orasis Corporation of Oakland, CA manufactured slit slides and motors for the slit and wavelength drives. The slit slides are flat and parallel to 4  m. Finally, the legs of the grating chamber are water-filled to provide thermal mass and resist the dimensional changes associated with temperature fluctuations.

# Engineering Design Begins for First Insertion Device

Specially designed insertion devices will be required to realize the high-brightness photon beams made possible by the low emittance of the ALS electron beam. Based on input from the user community through a series of workshops and letters of interest, a team headed by Bill Hassenzahl is designing a set of insertion devices (IDs) and associated beam lines that span the spectral range accessible to the ALS. The first devices will have nominal periods of 3.9, 5.0, 8.0, and 13.6 cm. The first three are undulators and will be 5.0 m long; the 13.6-cm-period ID will be a wiggler with a length of 2.5 m. The goal of very high brightness and useful fifth-harmonic output, as shown in the figure below, imposes unusually tight tolerances on the magnetic field quality and thus on the mechanical structure.

The figure on the next page shows the major subsystems (magnetic structure, support structure, drive system, and vacuum system) for the proposed 5-m-long insertion devices. The design philosophy for the initial complement of insertion devices is to create a generic insertion-device design and thereby reduce engineering and fabrication costs and make for easier maintainability. Undulator and wiggler components that will be similar include the backing beams, support structures, drive systems, vacuum chambers, and pumping systems. The support structures, backing beams, and positioning systems are all designed to function comfortably with a maximum magnetic load of 38,000 kg, which will occur with U8.0 at high K values. The first device to be designed and constructed will be the 5.0 cm period undulator, U5.0. This device was chosen because it will have nearly maximum performance when the undulator gap is at the commissioning value of 2.4 cm.

A group of outside experts participated in a "physics review" on January 27 to assess the calculations of errors and tolerances and the design approach. The general conclusion was that the understanding of the characteristics of insertion devices was good and that the design process should proceed. Lead engineer Egon Hoyer and the insertion-device group are now working on a conceptual design of U5.0. The result of this effort will be a design with sufficient detail to develop a cost estimate. The conceptual design will be reviewed in June before detailed design begins.

Some parameters and tolerances for U5.0 are given in the table. Each tolerance in the table is set by a calculation of its effect on spectral performance or on the ALS electron beam.

The ALS insertion devices will use the hybrid magnetic configuration invented by Klaus Halbach, which consists of Nd-Fe magnetic blocks and vanadium permendur poles. The hybrid is chosen because of several advantages over the pure current-sheet-equivalent-material (CSEM) design. In addition to being less sensitive to errors in the characteristics of the magnetic material, it is simpler to achieve high peak fields.

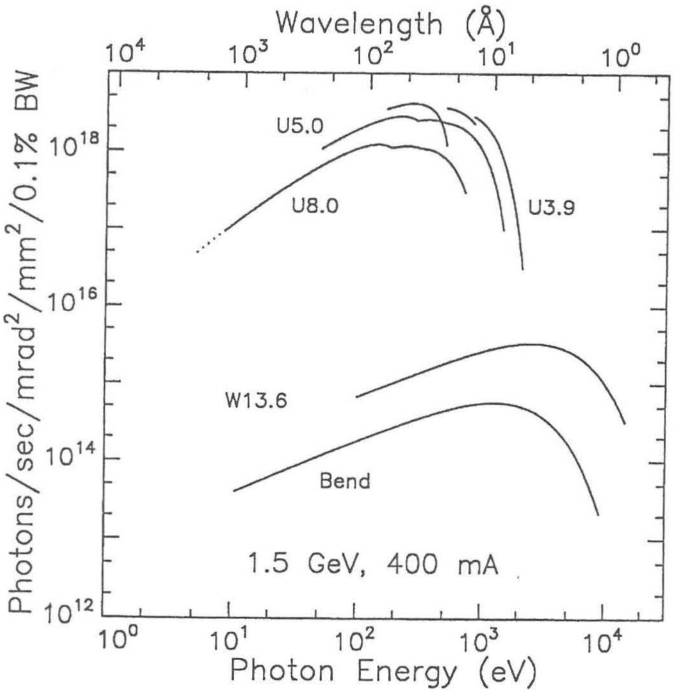
The proposed U5.0 magnetic structure includes

- Half-period pole assemblies, each consisting of an aluminum keeper, a vanadium permendur pole (8 cm wide by 11 cm high by 0.90 cm thick), and Nd-Fe blocks (6.4 cm by 3.53 cm by 1.60 cm in the orientation direction). Pole-assembly fabrication is planned to be similar to that used on the LBL-built wigglers on beam line VI and beam line X at the Stanford Synchrotron Radiation Laboratory.
- Pole-assembly mounts fabricated from jig-plate aluminum for mounting and accurately positioning approximately 30 pole assemblies each. Each pole-assembly mount is in turn kinematically mounted onto a backing beam.
- Steel backing beams hold the magnetic structure components and provide magnetic shielding. These 5-m-long beams (2.5 m for the wiggler) are rigid, with a deep, 81-cm, web and an 89-cm-wide flange to minimize systematic gap variations that cause a loss in spectral performance.
- Sets of rotators, for nulling the field integral, similar to those used on the beamline-VI wiggler, are planned.
- Tuning studs and auxiliary coils have been considered and will be designed and built if required.

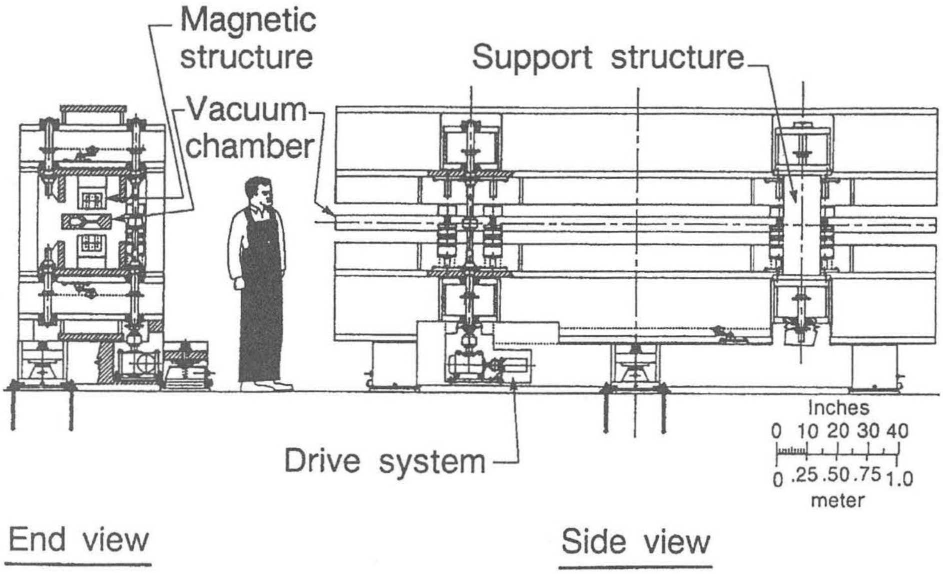
Two types of support structure, four-post and C-frame, were evaluated in the

***U5.0 Parameters and Tolerances***

| | |
|---|---|
| *Period* | *5.0 cm* |
| *Overall Length* | *5.0 m* |
| *Number of Periods* | *98* |
| *Maximum Operation Field* | *0.9 T* |
| *Minimum Operational Gap* | *1.4 cm* |
| *Usable Spectral Harmonics* | *1, 3, & 5* |
| *Block Material* | *Nd-Fe* |
| *Pole Thickness* | *0.88 cm* |
| *Gap Variation - Systematic* | *20 μm* |
| *Single Pole Tilt* | *0.2 mrad* |
| *Pole Thickness Variation* | *50 μm* |
| *Block Easy-Axis Orientation* | *+/- 1.6°* |
| *Pole-Width Variation* | *50 μm* |




***Spectral** brightness for the three ALS undulators, the wiggler, and the bending magnets. Each undulator curve is the locus of narrow peaks of radiation, tuned by altering the undulator gap, and represents the envelope of the first, third, and fifth harmonics. The dotted extension of the first harmonic of U8.0 represents the performance when the undulator field exceeds that of the bending magnets, which may affect storage-ring operation.*




***The generic mechanical** structure for the LBL Advanced Light Source insertion devices. The structure is 5.0 m long and is designed to accommodate magnetic loads up to 38,000 kg with acceptable deflections.*

process of designing U5.0. The four-post support structure was selected because of the following advantages:

- Greater tunnel walkway clearance.
- Less gap deflection because the structure is more rigid.
- No pole rotation (tilt) because the loading is symmetrical.
- Better access for assembly of components.

Advantages of the C-frame included easier vacuum-chamber installation and the possibility of using external magnetic-measurement equipment.

The four-post design consists of a rigid base with three kinematic floor mounts and alignment assemblies, four horizontal members that pass through the two backing beams, and four vertical posts. This modular design provides for easy assembly and servicing. The four horizontal members pass through the backing beams, thereby allowing the structure to fit within a 2.4-m-high tunnel.

# Charles Shank Will Be LBL Director

Charles Vernon Shank, 45, director of the Electronics Research Laboratory of AT&T Bell Laboratories in Holmdel, NJ, has been named to succeed David A. Shirley as Director of LBL on September 1.

University of California President David Gardner recommended Shank to the University's Board of Regents after receiving the advice of an advisory committee consisting of Regents and members of the scientific, University, and LBL communities. The Regents approved the selection at their meeting of March 17. The U.S. Department of Energy, for whom the University manages LBL, concurred in the choice of Shank to become the fifth LBL director and the first to come from outside the Laboratory.

In announcing the selection, Gardner said, "Dr. Shank is an extremely impressive individual with impeccable credentials as a scientist and engineer." Shank is a member of both the National Academy of Sciences and National Academy of Engineering. He is particularly well known for his work in the spectroscopy of ultrafast events in physical and chemical systems and for the development of so-called femtosecond lasers with which to do experiments on the required time scale.

"I am honored and challenged by the opportunity to join a research institution with the tradition of excellence that has been established by the Lawrence Berkeley Laboratory," said Shank in a prepared statement. "LBL is a particularly exciting place to be, with its commitment to fundamental science and its role in education." A news story reported that Shank named the ALS as a "wonderful" LBL attraction that helped him to make the decision to come to Berkeley.

## CALENDAR

**July 10–14.** Fourth International Conference on Electron Spectroscopy. Honolulu, HI. Contact: C.R. Brundle, IBM Almaden Research Center, 650 Harry Road,San Jose, CA 95120-6099.

**July 17–21.** Ninth International Conference on Vacuum Ultraviolet Radiation Physics. Honolulu, HI. Contact: Charles S. Fadley, University of Hawaii, Department of Chemistry 2545 The Mall, Honolulu, HI 96822.

**July 26–August 1.** Sixteenth International Conference on the Physics of Electronic and Atomic Collisions. New York, NY. Contact: Michael S. Lubell, City College of the City University of New York, Department of Physics, New York, NY 10031

**August 3–4.** Workshop on High Heat Load X-ray Optics. Argonne, IL. Contact: Robert K. Smither, Argonne National Laboratory, Advanced Photon Source, 9700 S. Cass Ave., Argonne, IL 60439 or Andreas Freund, European Synchrotron Radiation Facility, B.P. 220, 38043 Grenoble Cedex, FRANCE.

**August 6–11.** Three Conferences on X-ray Optical Technology. San Diego, CA. Contact: SPIE, Technical Program Department, P.O. Box 10, Bellingham, WA 98227-0010.

**August 7.** Advanced Light Source Users' Association Annual Meeting. Berkeley, CA. Contact: Stephen D. Kevan, University of Oregon, Department of Physics, Eugene, OR 97403

**August 7–10.** Sixth National Conference on Synchrotron Radiation Instrumentation. Berkeley, CA. Contact: Klaus Berkner, Lawrence Berkeley Laboratory, MS 50-149, 1 Cyclotron Rd., Berkeley, CA 94720. Program includes five parallel workshops on August 9:

- Undulators for Advanced SR Sources
- Photon and Electron Beam Stability
- Detectors for Advanced SR Sources
- Time-Resolved Experiments
- Imaging Experiments.

**August 7–11.** Gordon Conference on X-ray Physics. New London, NH. Contact: Roberto Colella, Purdue University, Department of Physics, West Lafayette, IN 47907.

The *Advanced Light Source Report* is published periodically at Lawrence Berkeley Laboratory for members of the Advanced Light Source Users' Association and other interested persons.



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