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Advanced Light Source Report

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ALS Construction Passes Halfway Mark

January beneficial occupancy of Building 6 and magnet construction open the way for installation of linac and booster synchrotron

[This article was adapted from the Accelerator and Fusion Research Division 1989 Summary of Activities *(in preparation), edited by J.T. Chew.]*

Lines on paper turned into concrete and steel in 1989 as the renovation of the 184-Inch Synchrocyclotron building (Building 6) was completed and the framework of a 61,000-square-foot addition took shape around it. Meanwhile, the mechanical, electrical, electronic, and accelerator systems that make up the heart of the ALS continued their progress from design into fabrication, both by LBL and by private industry. Throughout these activities, extensive testing and verification work was performed under the comprehensive quality-assurance policies of the ALS project.

Conventional Construction

The general contractor, C. Overaa Construction Company, moved onto the ALS site in December 1988 to begin work, monitored by the architectural firm of Keller and Gannon-Tudor for technical compliance with plans and specifications. The remodeled Building 6, the 184-Inch Synchrocyclotron building, was taken over by LBL crews on schedule in January 1990. This historic building will house the ALS injector complex. Around it, the contractor completed the foundation, floor slab, and steel skeleton for the addition, where the storage ring, beamlines, and experimental stations will be installed. A massive concrete retaining wall was built on the steep slope between the ALS site and Building 2, the new Advanced Materials Laboratory. Replacing the exterior roof of the building 6 dome was on the contractors agenda for early in 1990.

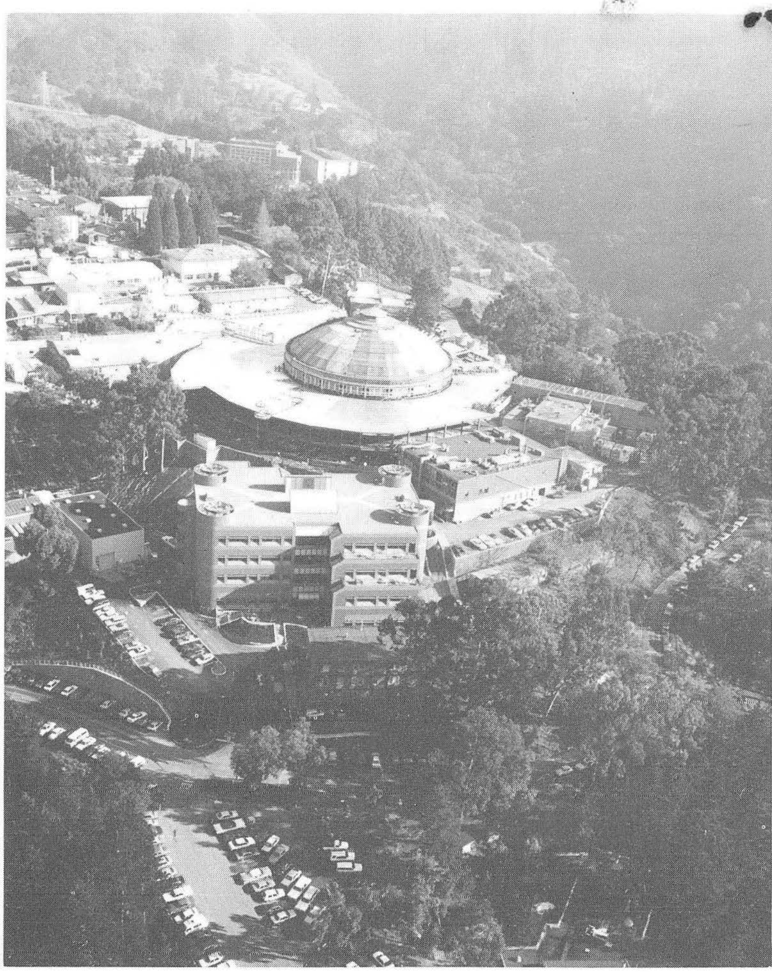
Photo by Steve Adams

Aerial view *of the LBL original site area in its hillside setting shows the structural steel and roofing in place for the new addition to the ALS building. The Advanced Materials Laboratory is in the foreground.*

Utility installation was another significant 1989 accomplishment. A maze of existing utilities, including an electrical substation, had to be relocated with a minimum of disruption to other Laboratory activities. The complex task of activating the new substation was completed by May so ALS foundation work could proceed at the old substation site. Mechanical and electrical utilities for the linac and booster synchrotron, along with renovated lighting, were installed in Building 6.

LBL engineering effort continued on the design of precast shielding for the linac and storage ring, as well as on the design of the new control room in Building 80. Control room construction began in December and will continue through spring 1990.

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First PRTs Chosen for ALS Insertion-Device Beamlines

LBL Director Charles Shank announced in mid-December the approval of the first participating research teams (PRTs) to work with the ALS staff on the design, construction, commissioning, and operation of the initial experimental facilities (insertion devices, beamlines, and end stations). To help assure the successful development and use of these facilities, a memorandum of understanding is being worked out between each PRT and the ALS. The memorandum will outline a path for the implementation of the beamline and demonstrates the commitment of sufficient financial and intellectual resources to accomplish the task. It will also contain a plan for how the PRT will meet its responsibility to provide independent users access to its facilities.

Between them, the nine PRTs selected have interests that span the full ALS ultraviolet and x-ray spectral range, exploit both high-brightness undulators and high-flux wigglers, and cut a broad swath through materials, interface, and surface science; atomic and molecular physics; chemical-reaction dynamics; and life sciences.

To ensure that ALS operations begin as scheduled in 1993, engineering design of insertion devices and beamlines needed to begin well in advance. A Call for Proposals was issued last March with an August 15 deadline for their receipt. The first decisions on PRT proposals were promised for December, a promise that has now been kept.

The response to the Call for Proposals was gratifying and closely followed the response to the Call for Letters of Interest issued in 1988. A total of 18 proposals was received involving 208 persons from 68 academic, industrial, and federal institutions in 28 states, the District of Columbia, and four countries. Proposals included both insertion-device and bend-magnet PRTs. The 12 insertion-device proposals received were evaluated both by the ALS staff and by the ALS Program Review Panel. Consideration of bend-magnet proposals was deferred to this spring.

In addition, representatives of candidate PRTs were invited to meet with the ALS experimental systems staff. The spirit of the day's discussions was noncompetitive and mutually supportive, in the interests of fostering a convergence of ALS beamline plans and users' needs and expectations. Finally, Fred Schlachter, the Scientific Program Coordinator, encouraged candidate PRTs with plainly congruent interests to merge in the interest of more effective exploitation of the available ALS experimental facilities.

After its November meeting in which representatives of the candidate PRTs were interviewed, the Program Review Panel turned in its recommendation to ALS Director Jay Marx, who passed them along with his own evaluation and recommendation to Director Shank for final disposition. The decisions are shown in the table. Three of the PRTs selected as Type Cs are associated with major LBL initiatives, for which funding is now being sought: the Combustion Dynamics Facility (Baer PRT) and the Life Sciences Center (Rothman and Quintanilha PRTs).

The memorandum of understanding will be a dynamic document.

Although details may vary, in general a Type A PRT finances one or more experimental stations at the end of its beamline; a Type B PRT finances its experimental stations and beamline; and a Type C PRT finances its experimental stations, beamline, and insertion device. The distribution of PRT types reflects the resources anticipated to be available from the PRTs and the need to optimize the exploitation of the available ALS resources.

The memorandum of understanding will address both construction and operation of the PRT's end stations, beamline, and insertion device. The agreement will define the responsibilities of both the PRT and the ALS. Its goal is to provide a clear understanding of the resources, effort, and schedule needed to develop the experimental facilities and to use them successfully to exploit the capabilities of the ALS for forefront science.

The agreement is envisaged as a dynamic document that can be modified as conditions change. It will also be used as one input in the frequent performance reviews of each PRT by the Program Review Panel during beamline construction and later during operation. ■

ALS Participating Research Teams

*Insertion Device**	*Scientific Focus*	*Spokesperson*	*PRT Type*
U10.0	Chemical Dynamics	Tomas Baer, U. of North Carolina	C
U8.0	Atoms, Molecules, Ions	Denise Caldwell, U. of Central Florida	A
U8.0	Pump-Probe, Timing, Dynamics Experiments	Victor Rehn, Naval Weapons Center	C
U5.0	Surfaces and Interfaces	Brian Tonner, U. of Wisconsin-Milwaukee	A
U5.0	Surfaces and Interfaces	Joachim Stöhr, IBM-Almaden	B
U5.0	Materials Sciences	Stephen Kevan, U. of Oregon	C
U3.9	X-ray Imaging and Optics for Life and Physical Sciences	Stephen Rothman, U. of California, San Francisco	C
W13.6	Atomic, Molecular, Optical Physics; Materials Sciences	Bernd Crasemann, U. of Oregon; Philip Ross, LBL	B
W13.6	Life Sciences	Alexandre Quintanilha LBL	C

**U indicates an undulator and W a wiggler; number is the period length in centimeters.*

From the Chairperson Users' Executive Committee:

Halfway Home!.... But Not Yet Time for Champagne!

The ALS has grown from an idea that not long ago seemed far from a working reality to one that is now just over halfway through its construction phase. Other articles in this newsletter discuss construction progress. It is a credit to Jay Marx, the ALS director, and his team that project completion is still forecast for April 1993. Only about 3 years thus separate us from what should be the brightest source of VUV/soft x-ray radiation in the world.

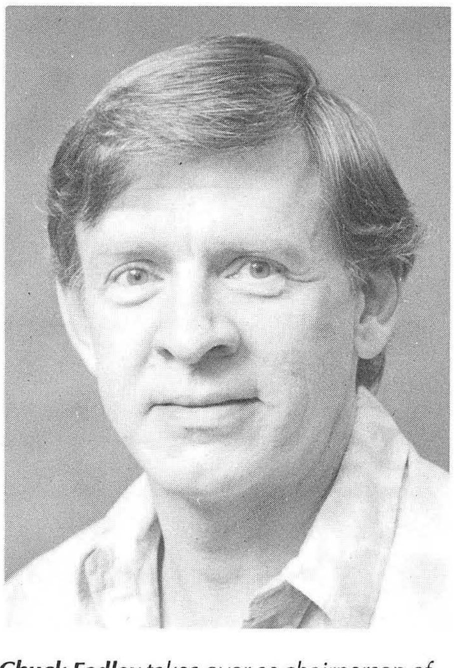
Since the last UEC report to you in June, 1989, the ALS Program Review Panel under the direction of Neville Smith (AT&T Bell Labs/Murray Hill) has done an excellent job of objectively appraising the proposals submitted by candidate insertion-device PRTs. This evaluation recently resulted in the selection of nine teams for involvement in the initial complement of ALS beamlines (see story on page 2).

In addition, major proposals have also been submitted for two national user facilities, a Life Sciences Center (coordinated by Stephen Rothman of UC San Francisco and the LBL Center for X-Ray Optics) and a Combustion Dynamics Facility (CDF, headed by Yuan T. Lee of LBL and the UC Berkeley Department of Chemistry). The CDF is intended to include a separate, dedicated infrared free-electron laser, other lasers, molecular-beam sources, and ALS VUV beamlines. Thus, there is potential for an exciting range of beamlines and facilities at the ALS.

Another major event at LBL has been the changing of the guard in the Director's Office, with David A. Shirley, under whose able leadership the ALS was born, being succeeded by Charles V. Shank (formerly of AT&T Bell Laboratories/Holmdel). Dr. Shank is very supportive of ALS issues, and the UEC looks forward to working with him on the important remaining phase involving the realization of a unique facility serving a broad community of both full-time and part-time users. (David Shirley is currently taking a well-deserved sabbatical at BESSY and the Free University in Berlin.)

As with most, if not all, other federally funded projects in the U.S. today, the ALS has not been without some difficulties that are a cause of concern to users. The basic structure of a second-floor mezzanine area for user offices and light-laboratory space was added to the project after the funding level was established, and the additional \$2.2-million cost was taken out of funds originally set aside for five insertion devices and their beamlines. Even so, the mezzanine area will initially be an unfinished shell, with additional funding needed to complete the interior. Moreover, it was demonstrated within the past year that air conditioning of the storage-ring tunnel and beamline areas would be needed in order to maintain the beam stablility necessary with such a bright source. The \$4.7-million cost of providing the required temperature stability further reduced the amount for facility-funded insertion devices and beamlines to four insertion devices and two high-quality insertion-device beamlines. So far, efforts by the ALS, LBL, and the UEC to get additional funds for the project from DOE to offset these costs have been unsuccessful.

The UEC is thus concerned about both the decreased funds for the initial complement of insertion devices and beamlines and the need for fully finished space to accommodate the many users that will visit the facility when it becomes operational.



Chuck Fadley *takes over as chairperson of the Users' Executive Committee.*

We are working with the ALS and LBL administrations and with the DOE to try to solve these problems in a timely way, but additional user support and suggestions are welcome.

Some additional items that have been considered by the ALS and the UEC are the availability of low-cost accommodations in Berkeley (partly solved by a proposed dormitory-style modification of the Durant Hotel), access to parking at LBL (for which a new structure has been designed), and the accommodation of independent users on PRT-based beamlines (so far, primarily the responsibility of the PRT).

Looking beyond the initial configuration of accelerator, storage ring, insertion devices, beamlines, and ancillary office and laboratory space needed in 1993, the ALS management and the UEC are also beginning to think about the need for additional office and laboratory space for the ALS staff. An independent review of "conventional facilities" was recently carried out by a panel headed by Walter Trela of Los Alamos. Planning must also begin for any ALS "Phase II" that might include various technical improvements and additions.

So the situation on this hill in Berkeley is certainly very dynamic and promising! But there is a lot more work to do to make sure that the ALS lives up to its full potential.

The UEC has during the past year benefited from the able services of four members who rotated off the Committee at the end of 1989: Allen Hartford of Los Alamos, Franz Himpsel of IBM-Yorktown Heights, Janos Kirz of SUNY-Stony Brook, and Joachim Stöhr of IBM-Almaden. Three newly elected members joining us this year are Cynthia Friend of Harvard University, Rupert Perera of LBL, and Piero Pianetta of SSRL. Dennis Lindle of N.I.S.T. has also been elected to vice chairperson and will succeed me as chairperson in 1991. We are also very indebted to Steve Kevan of the University of Oregon, who has served a double term as chairperson. Thanks to all of you, but especially to Steve.

Please feel free to contact me at the address on page 12 of this newsletter if you want to comment on the issues discussed here or anything else of relevance to the success of the ALS.

Finally, an important date to note on your calendars is that of the next ALS Users' Association Annual Meeting, which will take place in Berkeley on August 23 and 24, just after an ALS workshop on surface and interface theory (see story on page 6). We hope to see you there! ■

Charles S. Fadley, Chairperson
Users' Executive Committee

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Electronics/Accelerator Systems

Most of the 1989 work was focused on design, documentation, and purchasing of the electrical and electronic systems for the injection complex (electron gun, linac, and booster synchrotron) so that it can be installed and commissioned while work on the storage ring is under way.

Control System. A prototype of the ALS control system, comprising all major parts of the final system, was installed at the linac test stand. This prototype gave accelerator physicists their first "live" experience with the system's interactive user interface.

Beam Position Monitors. The beam position monitoring system crates went into production, and 50 were completed. This is one of the key instrumentation systems for the accelerators because it provides high-quality diagnostic and status information concerning the position of the electron beam; these data are provided to the beam-stability feedback systems for the storage ring. Each crate has an on-board computer that can correct for known systematic errors. The net result is the ability to determine the beam position to within 20 µm.

Photo by Steve Adams

Five major pours *totaling 4500 cubic yards of concrete were needed for the foundation and floor of the addition to Building 6. Consuming all of last summer, this work was completed last October 6, making way for erection of the new structural-steel framework.*

Linac. The first third of the 50-MeV electron linac—including the electron gun and subharmonic bunchers—delivered its first beam on schedule in April at the newly constructed test stand. The test stand is being used to examine the transverse shape, temporal characteristics of the beam and to study single- and multi-bunch operation. The transverse emittance was less than 10 π-mm-milliradians, which is at least four times better than the requirement and slightly better than the electron-gun manufacturer's estimate. The remaining linac components have been received and are being prepared for installation.

RF components. The 300-kW rf system for the storage ring was ordered and should be delivered this fall. A high-power test stand for the rf systems of the various accelerators was installed so that the booster synchrotron and storage ring rf cavities can be tested upon their arrival in early 1990. The test stand has delivered 30 kW into a dummy load.

Booster Magnet Power Supplies. The power supplies for the quadrupole magnets in the booster synchrotron were undergoing factory testing at the end of the year. These 75-kW power supplies must have exceptionally quick response so the quadrupole magnetic fields can track the dipole fields within 10 µs. The other commercial power supplies for the booster-synchrotron magnets and the 1000-kW supplies for the dipoles have been received.

Radiation Safety Review. The design of the overall ALS radiation safety system was favorably reviewed by experts from LBL, the National Synchrotron Light Source, and the Stanford Linear Accelerator Center. An appropriate subset of this safety system, incorporating commercial radia-

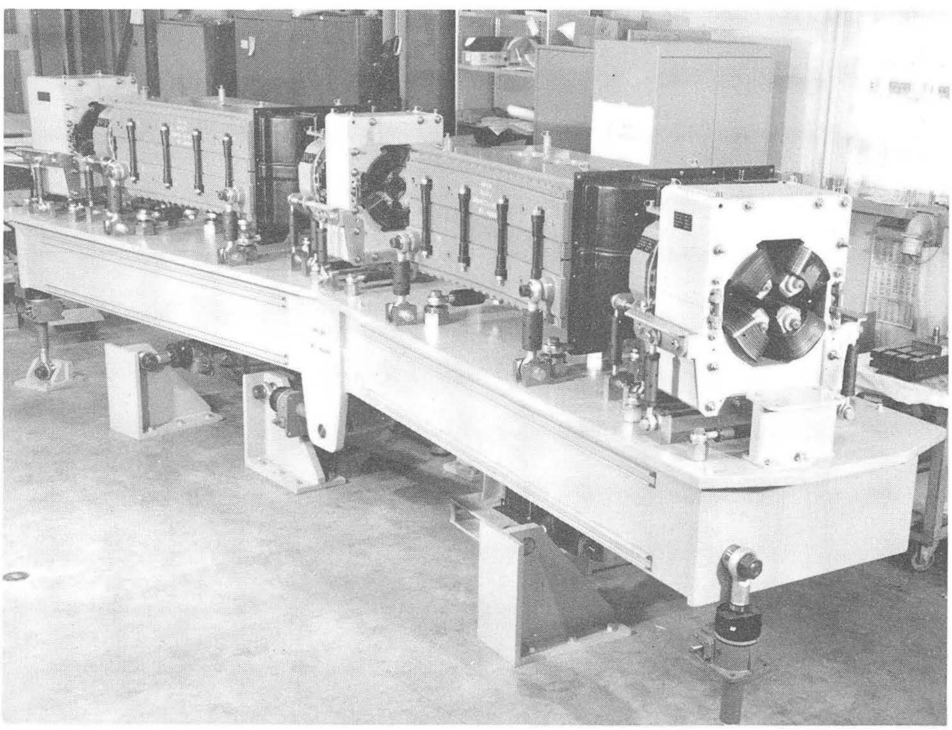
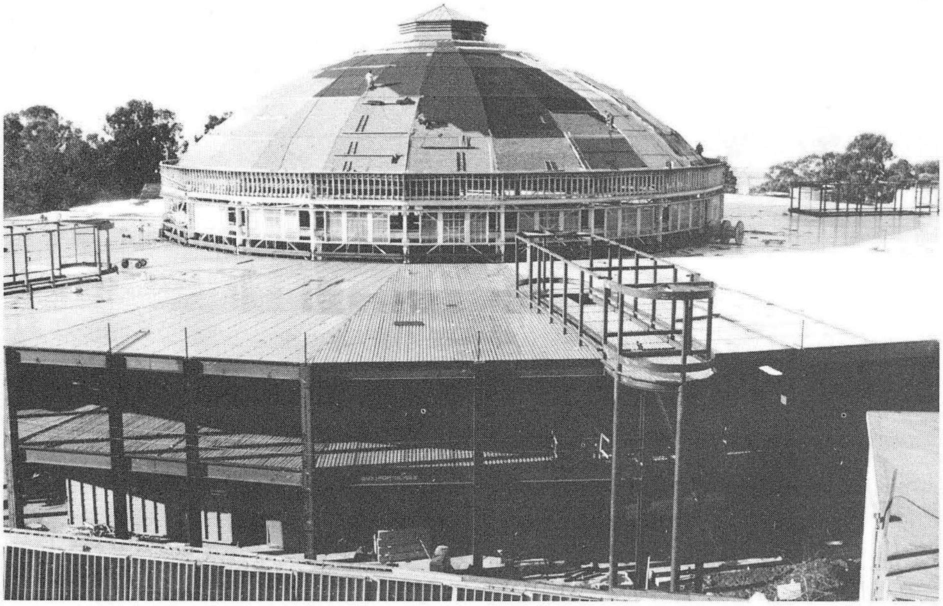


Photo by Steve Adams

Booster-synchrotron *magnets are kinematically mounted by means of struts on girders, which in turn are kinematically attached to the floor. Here two booster dipoles, three quadrupoles, and three sextupoles are shown before insertion of the vacuum chamber.*



A 1000-ton skeleton *of structural steel, essentially completed in January, and a layer of metal roofing make the outlines of the ALS building plainly visible. Workers are shown replacing the roof of the Building 6 dome with a new one.*

tion monitors and associated electronics, will be in place by the July 1990 commissioning of the linac.

Mechanical Systems

During 1989, the ALS mechanical-systems efforts moved from prototype testing of various magnets and of vacuum-system components to assembly of the production versions. All work is on schedule to meet the overall project milestones.

Magnets. By the end of the year, the full complement of magnets for the booster synchrotron had been completed. Production of the sextupole magnets for the storage ring was well under way, and the storage-ring gradient (dipole) and quadrupole magnets were approved for production.

Along with production went magnetic measurement, a critical quality-assurance activity in light of the machine's stringent performance specifications. In 1989, all components of the booster's magnetic lattice—24 dipoles, 32 quadrupoles, 20 sextupoles, 32 correctors, and spares for each type—were examined. The level of quality and uniformity proved to be high enough to eliminate the need for sorting prior to installation.

Considerable progress was made in the design and fabrication of support systems for the magnets. Here, too, the overall ALS performance requirements led to exacting subsystem specifications; the mounts have to lend themselves to precision alignment and must provide a high degree of vibration damping and isolation. Seismic safety must also be engineered in. To solve these problems, a six-strut kinematic support system was devised. By the end of the year, all girders and magnet mounts for the booster were on hand, and survey preparations were under way for the first installation activities.

Vacuum Vessel. The curved vacuum vessels for the storage ring are among the more innovative mechanical features of the ALS. Each vessel is machined from two billets of solid aluminum, which are then welded together. The shape is complex and the work must be precise, but the necessary tooling and expertise turned out to be readily available in the aerospace industry.

The fabrication contractor unexpectedly filed for bankruptcy before the first article was delivered, but swift and decisive action by LBL engineering and purchasing staff members averted what could have been a major setback for the project. Another vendor completed the prototype vessel, and successful tests of welding and photon-stop and vacuum-pump installation were performed. The contract to fabricate the 12 production vacuum vessels was awarded in November, and no impact on the overall project schedule is anticipated.

Survey and Alignment. Considerable precision in component placement and alignment is needed at the ALS. The project benefited from the considerable expertise

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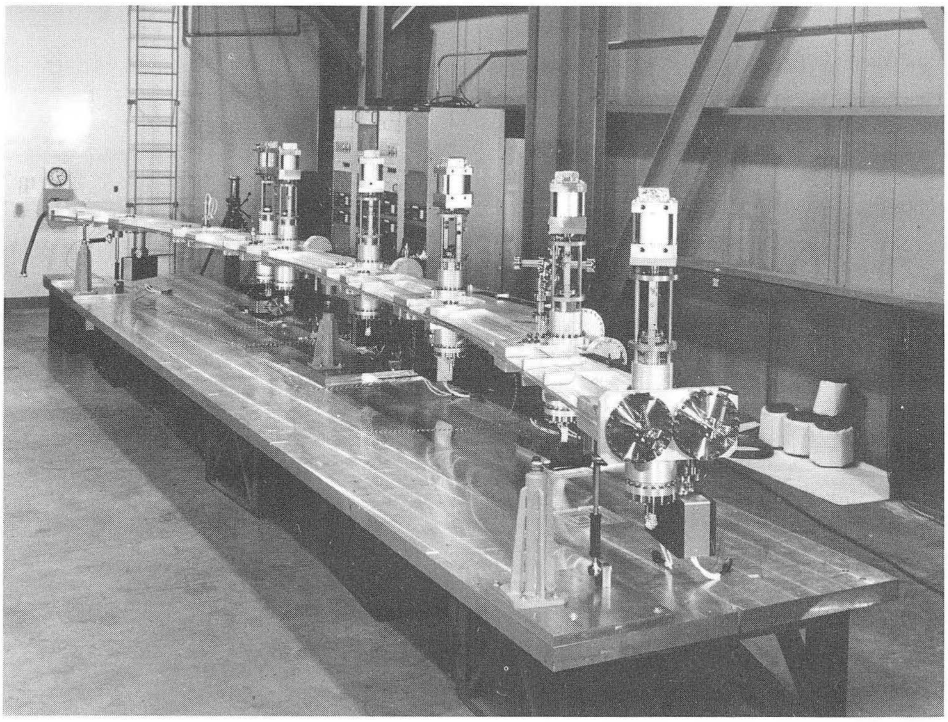

Prototype arc-sector *vacuum chamber with photon stops, actuators, titanium sublimation pumps, and sputter ion pumps in place. The ALS storage ring will have 12 chambers, each 10 m long with top and bottom halves machined from aluminum plate and welded together.*

Interface Workshop and Users' Meeting Both Set for August

Members of the ALS user community are invited to set aside the week of August 20 for two meetings of great interest.

First, a workshop on "Challenges for Interface Theory" is being organized by Michel Van Hove of the LBL Materials and Chemical Sciences Division. The workshop will take place at LBL on August 20 and 21. No registration fee will be charged.

Intended to serve both the theoretical and experimental surface/interface communities, aims of the workshop include identifying major opportunities for surface and interface theory and projecting where theory is headed in the 1990s and beyond. For experimentalists, the program will address issues of basic theory as they relate to experiment, as well as theoretical methods for analyzing experimental data.

The format of the workshop will center on two days of formal presentations, open to all interested persons. The program will include (tentatively 14) distinguished speakers who will address topics of particular relevance to the opportunities made available by advanced experimental facilities, such as the ALS. After these sessions, the speakers will write a report that will be publicly available.

Those interested in attending the workshop should contact Van Hove at:

Dr. M. A. Van Hove
Lawrence Berkeley Laboratory
MCSD
MS 66
Berkeley, CA 94720 USA
Telephone: 415-486-6160
Fax: 415-486-4995
E-mail: VANHOVE@LBL

A final program will be sent before the meeting to those responding.

Second, the ALS Users' Executive Committee has announced that this year's Users' Association annual meeting will be held in Berkeley on August 23 and 24. The program will tentatively include ALS staff reports on construction progress, insertion-device and beamline engineering, and PRT selection. There will be presentations from the insertion-device PRTs, reports from other facilities with an emphasis on undulators, and workshops on nanostructure research and on novel photon and electron detectors.

An announcement with information about local arrangements will be sent automatically to those receiving a copy of this newsletter. ■

Bend-Magnet PRT Proposals Solicited

Proposals from PRTs interested in working with the ALS staff to design, construct, commission, and operate bend-magnet beamlines and associated experimental facilities are invited. For further information, contact:

Alfred S. Schlachter
ALS Scientific Program Coordinator
Lawrence Berkeley Laboratory
MS 46-161
Berkeley, CA 94720

DOE Secretary Visits ALS!

Photo by Doug McWilliams

Secretary of Energy *James Watkins October 1989 visit to LBL featured a presentation by ALS Director Jay Marx (far left), who highlighted research opportunities at the new light source. From the fourth floor of the Advanced Materials Laboratory, Watkins (on Marx' left) and LBL Director Charles Shank (far right) compared construction progress at the adjacent ALS site with a model of the completed building.*

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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 information about the ALS workshop "Challenges For Interface Theory"
- ☐ I would like information on submitting a proposal for participation in the ALS as a member of a bend–magnet PRT.
- ☐ I would like to receive LBL PUB-643 Rev. 2, "An ALS Handbook."

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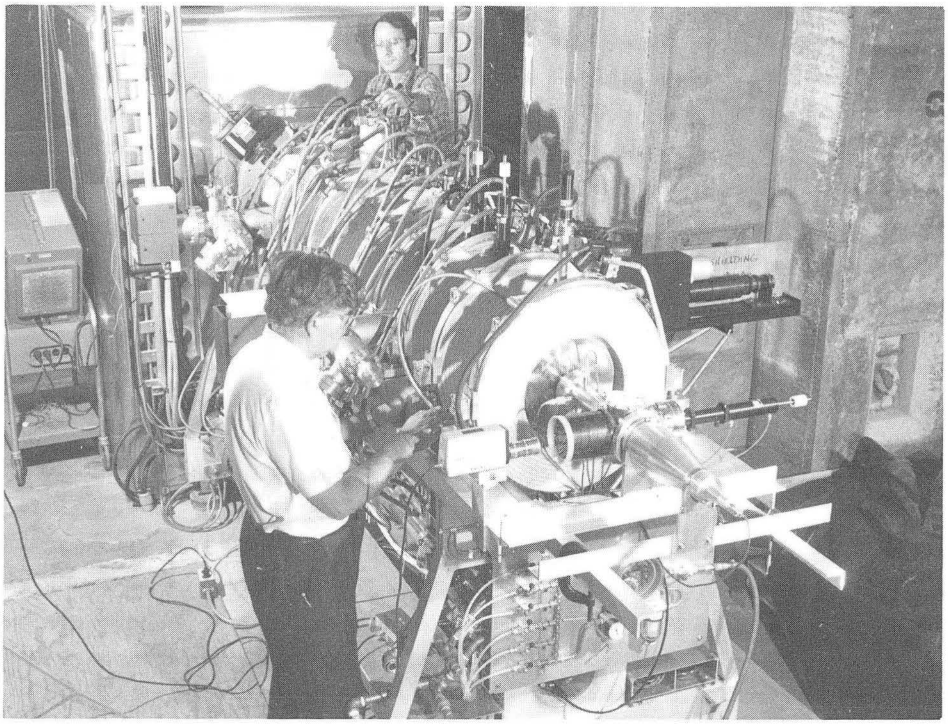

Photo by Steve Adams

The gun-to-linac *test stand includes all the components in the first third of the 50-MeV electron linac in the ALS injection system. Brian Taylor (front) and Dexter Massoletti (rear) are shown using the test stand to measure electron-beam spatial and temporal characteristics.*

(Continued from page 5)
developed in this field by the Stanford Linear Accelerator Center (SLAC). ALS and SLAC personnel developed an observation plan for the ALS survey monuments that uses the SLAC software package GEONET. The plan gives error ellipses smaller than 50 μm. in characterizing the locations of the survey monuments. The ideal fiducial positions of all booster-synchrotron magnets upon their girders were also calculated.

Experimental Systems

As the ALS progressed toward construction, the Experimental Systems Group expanded its activities. The insertion-device engineering project that began in 1988 bore fruit with the issuance of the U5.0 Conceptual Design Report, and work began on the two other types of insertion devices that will be built with ALS project funds. Beamline engineering began in earnest as the participating research teams' (PRTs') performance requirements became more clearly defined.

Insertion Devices. A major effort that began in 1988 and increased considerably in 1989 was the design of the first insertion device, with the larger goal of arriving at a generic design. The first design was for U5.0, a soft-x-ray undulator that can be used for high-resolution spectroscopy to support materials, surface, and interface studies. The "5.0" refers to the device's 5.0-cm magnetic period. The same basic design will be used for the other ALS insertion devices.

The ALS project will fund four insertion devices. Two identical U5.0 undulators will be built, one for a Type A and one for a Type B PRT. Another undulator, a U8.0 meant for atomic and molecular physics, will be built for a Type A PRT. There will also be a 2-tesla wiggler, W13.6, to produce hard x-rays for a large Type B PRT interested in atomic, molecular, and optical physics and in materials science.

Assuming PRT funding is forthcoming, other undulators will be built for Type C PRTs. Undulator U3.9 would support soft-x-ray imaging and related technology development for the proposed Life Sciences Center. Another device, U10.0, would be built to provide x-rays for the proposed Combustion Dynamics Facility. A second W13.6 for life sciences, including protein crystallography, would also be built.

Beamlines. High-performance beamlines with spherical-grating monochromators will be designed and built by the ALS for U8.0 and for one of the two U5.0 undulators. Other beamlines will be provided by the PRTs.

Experimental Systems Quality Assurance. A wide variety of measures are being taken to ensure that the small, powerful, high-brightness photon beams from the ALS can be consistently generated and delivered with the expected degree of quality and precision. Error control in insertion-

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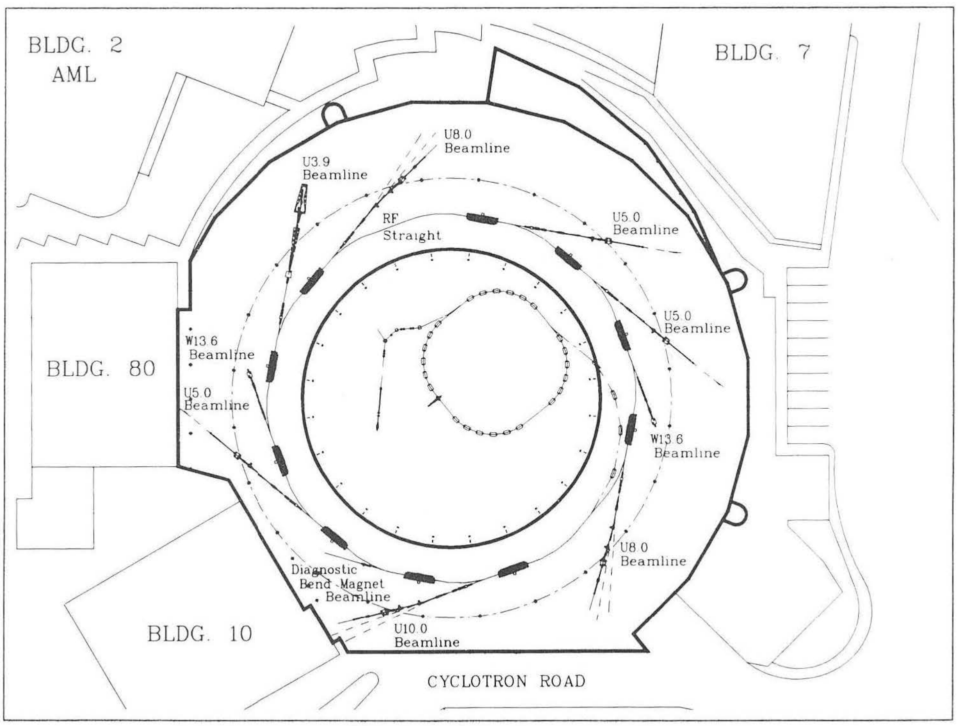
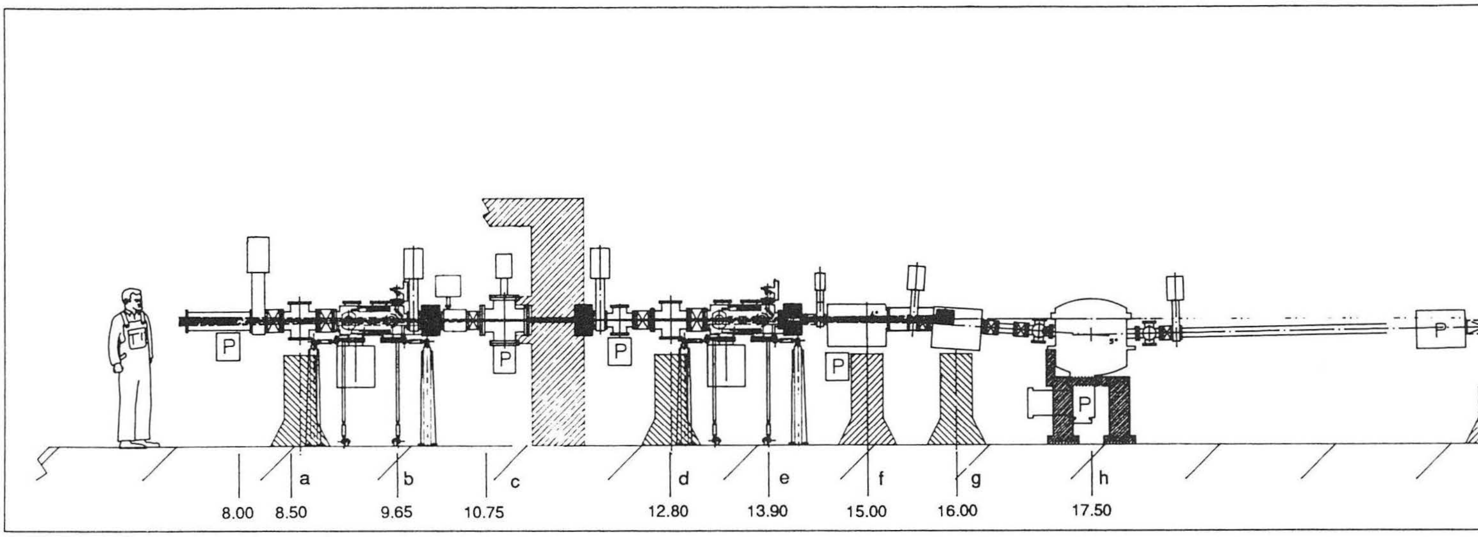


Floor plan of the ALS building *shows possible locations of the insertion devices and beamlines for the nine approved PRTs. Four insertion devices and two beamlines will be part of the construction project; completion of the remainder depends on external or future funding.*



Possible layout for a U5 beamline *includes the following components: (a) photon beam-position monitor, (b) photon shutter, (c) personnel safety shutter, (d) photon beam-position monitor, (e) horizontal beam-defining aperture, (f) vertical-deflection mirror, (g) fixed entrance slit,*

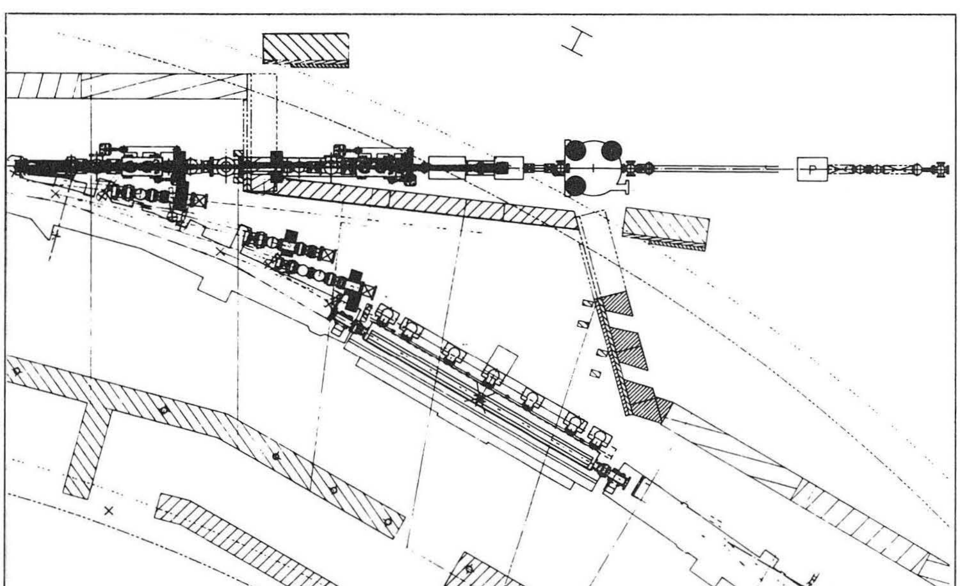
(Continued from page 9)
device fabrication is a prime example. Both manufacturing errors and variations in the characteristics of the permanent-magnet blocks manifest themselves in the spectral performance of the device.

Major progress has been made in the theoretical and experimental study of such errors. This knowledge is being reduced to practice, and the ALS undulators are being constructed to exceptionally close tolerances in the most important areas. Field errors of 0.25% rms or below are expected, a record level of design compliance for permanent-magnet undulators. This quality will allow experimenters to reliably use, for the first time, the fifth harmonic of the undulator's fundamental wavelength.

Achieving such close tolerances involves the precise characterization of thousands of permanent-magnet blocks. Novel, semi-automated measurement systems allow rapid, on-the-fly Hall-probe readings and new surface-field measurements that have never before been applied to insertion-device construction. New methods of block selection and undulator-field data analysis are also expected to be developed as this work continues.

Optical metrology—the evaluation of optical surfaces—will play an important role at the ALS for testing and diagnostic work on optical elements. Two interferometric optical profilers will be built. One will be kept at LBL for research and development and for quality control of optics bought from outside vendors, and the other will be loaned to the vendor (yet to be selected) that makes the mirrors and grating blanks.

A feedback system that includes high-precision photon beam position monitors and active mirror supports is being prototyped. Thermal stability, a relevant issue of considerable importance, continues to be studied at some length; the ALS is the first synchrotron radiation facility to examine the issue in such detail before construction. The study has resulted in the addition of temperature-stability systems, including air conditioning of the experimental floor and storage-ring tunnel, shunt regulators for cooling-water temperature, and thermal compensation devices for various mechanical supports.

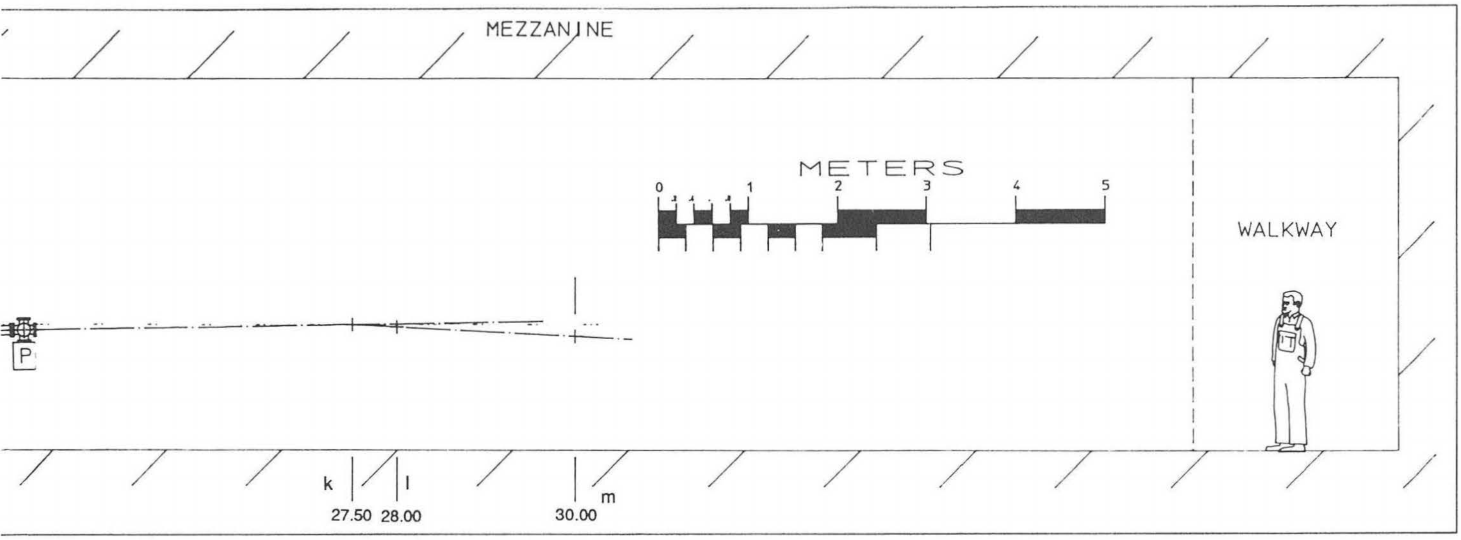


Plan view of an undulator *beamline from the source to the movable exit slit of the spherical-grating monochromator also shows the two front ends for the center bend-magnet ports in the downstream arc of the storage ring, as well as the next downstream insertion device.*

Accelerator Studies

The Accelerator Studies Group within the ALS project works closely with the engineering groups to support testing of various systems (such as the magnet and linac tests described earlier) and to write specifications. These specifications include limits on permissible variance, which are derived by estimating the impact on ALS performance.

During 1989, the group's efforts were mainly focused on understanding the perturbations of single-particle behavior that stem from imperfections in the synchrotron



(h) monochromator, (i) moving exit slits, (j) diagnostic, (k and l) possible vertical and horizontal refocus mirrors, and (m) sample position. Distances are measured from the radiation source in meters. The 6-foot engineers give a feeling for beamline height and vertical distances.

magnets and from the complicated magnetic fields of insertion devices. Both factors proved to have significant implications for the dynamic aperture (the maximum transverse area throughout which the beam remains stable and for Touschek scattering. Touschek scattering is the most important factor that determines overall beam lifetime in low-energy storage rings, and dynamic-aperture limits must be understood because they bear upon the injection process and help determine the lifetime of the beam.

Previous studies indicated that the dynamic aperture would be fairly forgiving of magnetic errors. In response to suggestions from a review panel, we examined these phenomena in more detail. These studies revealed that storage-ring performance is not especially sensitive to small (<1 mm) distortions of the ideal closed orbit, and that, if necessary, alternative configurations of the magnetic optics could be found that would increase the dynamic aperture without the need for additional quadrupole magnets.

Ways of compensating for the beam-quality effects of wigglers, which have stronger magnetic fields than undulators, were studied in detail for the first time. The compensation schemes useful for undulators turned out to be ineffective for wigglers unless sets of wigglers are placed symmetrically across the ring. However, the study concluded that by judicious tuning of the full complement of independently powered quadrupole magnets, schemes could be found to compensate for any arrangement of wigglers and undulators.

In sum, at the halfway point in the construction project, the ALS is on track and headed for on-time completion. ■

ALS Appropriations Stay on Track

The ALS budget news continues to be predominantly on the cheery side. Congressional appropriations for fiscal year (FY) 1990 construction match the figure needed for construction to keep pace with the project plan. Equally important, they contain the first large increment of preoperations funding. Moreover, President Bush's budget request for FY 1991, announced in early February, continues to ramp up the preoperations funding toward the level planned for full operation. On the down side, the sought for $9.7-million increase in the scope of the ALS construction project was not in the Presidential request.

First the good news. When Congressional budgetary action for FY 1990 was completed last fall, the Energy and Water Development appropriations bill, which covers ALS funding, contained the full $26 million that had been requested for construction. Likewise, the Presidential request for FY 1991 of $23 million keeps the project on track by restoring a $5-million shortfall resulting from an earlier reduction by Congress for FY 1989 construction (see Vol. 2, No. 2, pg. 2).

To have an operating facility at the end of a construction project, it is important that there be adequate support for commissioning and related activities (collectively called preoperations). ALS Director Jay Marx and the project management have worked hard to develop a preoperations schedule and the funding profile needed to support it. In FY 1990, Congress appropriated $5.5 million to cover preoperations and R&D, the first large increment in the ramp up towards the planned annual operations level of $24 million (in FY 1993 dollars). The Presidential request for FY 1991 contains $10.9 million for this activity.

Historically, synchrotron facilities have found it harder to maintain planned levels of funding for operations than for construction, so the requested figure is by no means secure. But it is encouraging that the need is being recognized so far by the Department of Energy (DOE), the Office of Management and Budget, and Congress, as shown in budget actions.

Finally, the bad news. ALS and LBL have been working toward gaining approval for a $9.7-million increase in the scope of the $99.5-million construction project (see Vol. 2, No. 3, pg. 5). The increase would cover partial completion of a mezzanine to provide space for users, for a temperature-control system needed to improve photon-beam stability, and additional bend-magnet front ends. However, the FY 1991 budget request contains nothing for the scope increase.

Because photon-beam stability is essential for the challenging experiments users want to do at the ALS, it has been decided, with DOE concurrence, to finance the temperature-control system (primarily air conditioning) from the existing project funds. This will reduce the amount available for insertion devices and beamlines. Based on the resources anticipated from the PRTs that have been selected (see story beginning on page 1 and that on page 2), the decision is to use project funds for four insertion devices and two beamlines.

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