Title
Advanced Light Source Report Vol 8 No 1

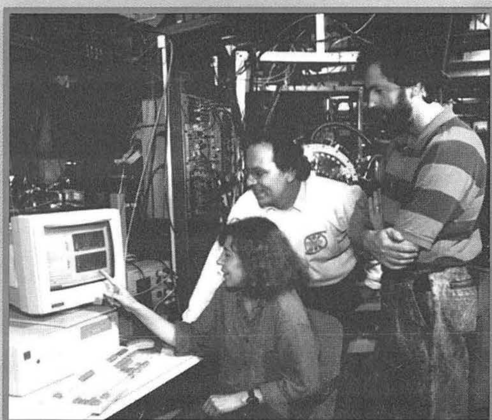
Author
Lawrence Berkeley National Laboratory

Publication Date
1995-05-01

DISCLAIMER

ADVANCED LIGHT SOURCE REPORT

Vol. 8, No. 1 — *Lawrence Berkeley Laboratory / University of California* — May 1995



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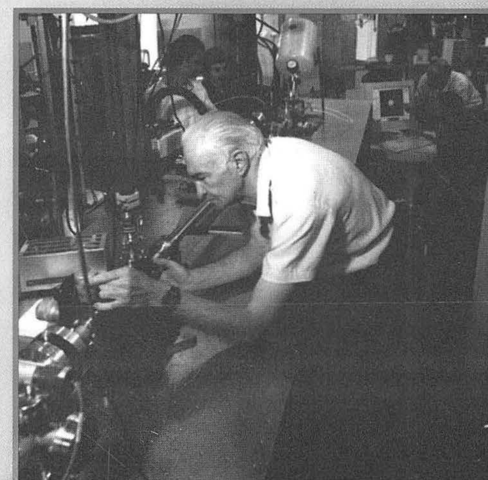

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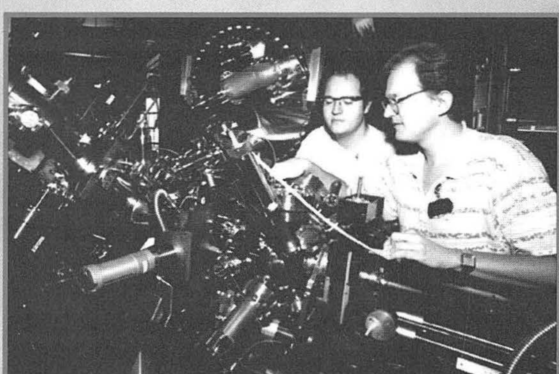

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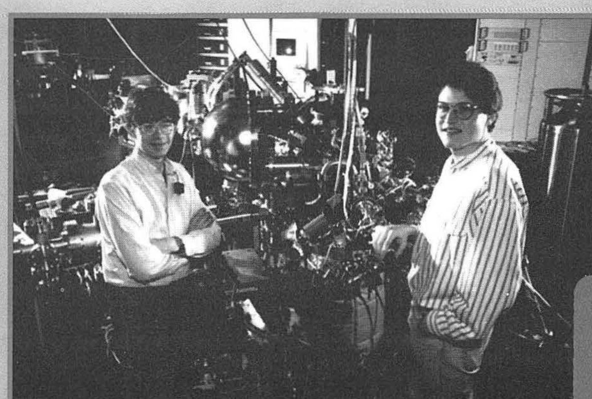

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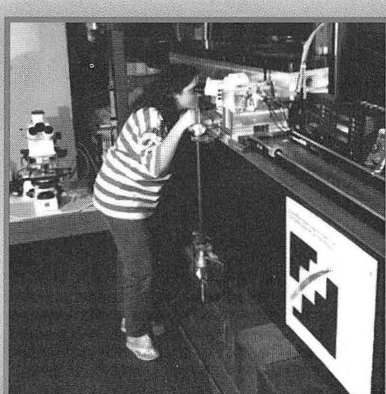

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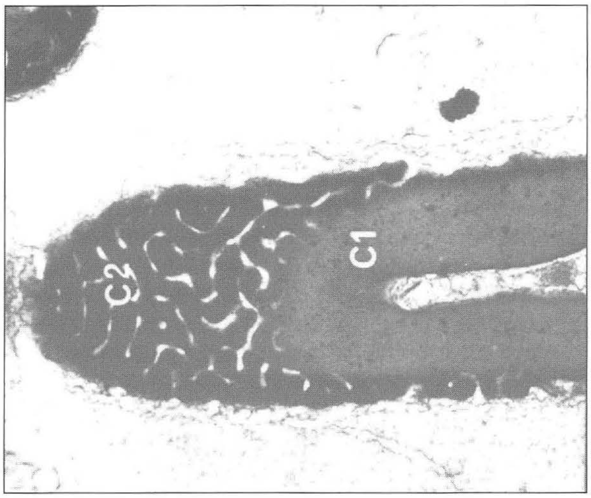
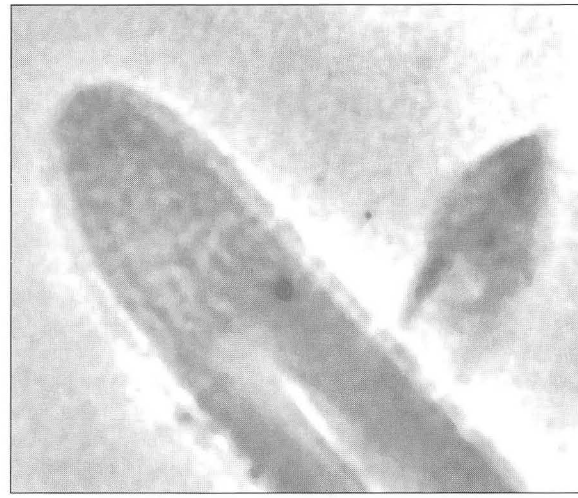




Images of chromatin distribution in sperm cells of marsupial mice, taken using transmission electron microscopy (left) and x-ray microscopy (right). The x-ray image confirms that the grainy pattern at the cell tips is primarily related to chromatin mass distribution and is not an artifact of the staining process required to prepare the sample for the electron micrograph.

X-RAY MICROSCOPE CONFIRMS CHROMATIN OBSERVATIONS

Some of the more striking images coming out of the ALS research program are being produced by the x-ray microscope (XM-1) on Beamline 6.1. X-ray microscopy provides the ability to image thick (up to 10 μm) samples under conditions approximating their natural environments: no staining or thin-sectioning is necessary, and samples can be imaged in aqueous solutions. These abilities make it a useful complement to electron microscopy, which gives excellent resolution but requires extensive sample preparation, and to visible light microscopy, which is relatively non-destructive of samples but has lower resolution than x-ray microscopy.

X-ray microscopy's success in imaging unstained samples proved valuable in a recent investigation of the distribution of chromatin in the heads of sperm cells from marsupial mice (*Sminthopsis*). Chromatin consists of long, thin strands of DNA, complexed with organizing proteins into thicker strands. Researchers have characterized the first few levels of DNA's organization into chromatin by a number of methods providing atomic-scale resolution. Because of the limitations of these methods and of existing microscopies, however, they have not successfully analyzed the subsequent levels of chromatin organization that lead to larger structures, allowing billions of DNA base pairs to fit inside a cell nucleus about 5 μm in diameter.

Researchers from Lawrence Livermore National Laboratory and from the University of Adelaide in Australia were investigating chromatin distribution on these intermediate scales, using transmission electron microscopy (TEM) to image the marsupial sperm cells. They observed an inhomogeneity in the appearance of the chromatin near the cell tip, but there was some question whether this graininess actually represented the distribution of chromatin mass or was an artifact of the staining process required in their sample preparation. At these researchers' request, Werner Meyer-Ilse and Héctor Medecki of LBL's Center for X-Ray Optics examined a similar cell without staining. They first used the beamline's visible-light microscope (VLM) to find the relevant sample location and focus without using x rays (which could damage the sample in extended exposures). Then they stored this information in the XM-1 control computer and transferred the sample to the XM-1 stage, where a system of kinematic mounts under computer control placed the chosen sample location in position for a short x-ray exposure. The same inhomogeneity in the cell's chromatin emerged in the x-ray image, confirming that the grainy pattern is primarily related to chromatin mass distribution. Biologists can now work to explain the causes and consequences of this arrangement of chromatin, with the confidence that they are investigating an actual biological phenomenon rather than an experimental artifact.

ON THE COVER

Clockwise from upper left: Nora Berrah, Burkhard Langer, and Ovidiu Toader (Beamline 9.0.1); Héctor Medecki (front), Raúl Beguiristain, Jim Smithwick, Jeffrey Bokor, and Kenneth Goldberg (Beamline 9.0.1); Jonathan Denlinger and Eli Rotenberg (Beamline 7.0); Lotti Jochum (Beamline 6.1); Martin Weinelt and Anders Nilsson (Beamline 8.0).

High-Resolution Photoelectron Spectroscopy

Beamline 9.0.1 has already become a workhorse for atomic and molecular physics research because of its high brightness and high energy resolution. These qualities were taken to full advantage by a research group led by Nora Berrah (Western Michigan University) to exceed previous resolution limits in the study of autoionization resonances in argon gas. During the group's experiments, incoming photons interacted with argon atoms in a gas-phase sample, producing autoionization resonances which show as characteristically shaped dips in the spectrum of electron yield with changing photon energy.

Autoionization resonances occur when two processes, direct photoionization and a more indirect path, lead to the same final ionic state. Thus they cannot be separated from each other, but interfere in a quantum-mechanical sense. The processes can be written as follows:

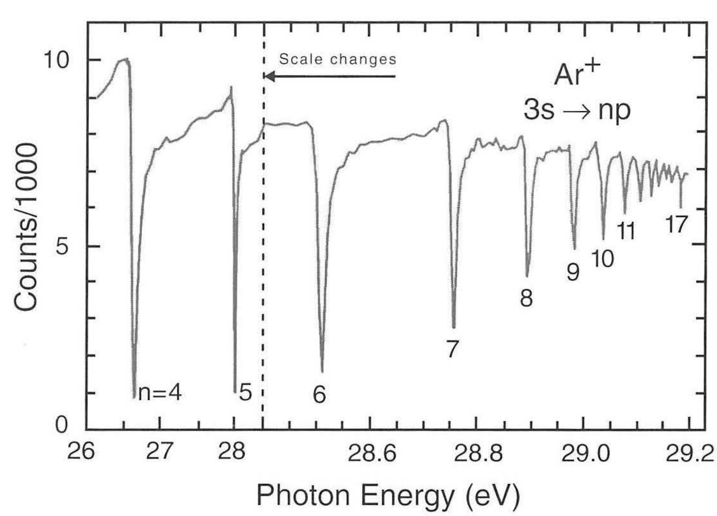
Direct $Ar(3s^2 3p^6) + h\nu \rightarrow Ar^+(3s^2 3p^5) + e^-$

Indirect $Ar(3s^2 3p^6) + h\nu \rightarrow Ar^*(3s3p^6 np) \rightarrow Ar^+(3s^2 3p^5) + e^-$

where n represents an atomic energy level of 4 or more. In the direct photoionization process, the photon ($h\nu$) is absorbed and one electron (e^-) is emitted directly into the continuum. In the indirect process, the atom is first excited so that one of its electrons is in a state above the first ionization threshold. In a second step the excited state decays, emitting an electron.

The spectrum shows a separate autoionization resonance for each atomic energy level n to which electrons are excited. Previous experiments had mapped argon's $3s^2 3p^6 \rightarrow 3s3p^6 np$ autoionization resonances (called the Rydberg series) only up to $n = 8$. Berrah's group, using the high photon energy resolution and high brightness at Beamline 9.0.1, was able to measure the Rydberg series all the way through $n = 17$.

Once the researchers had measured these new experimental data, they compared their results to previous measurements and theories. The cross sections for the first five autoionization resonances agreed well with those measured by other methods. The group's experiment chamber had two newly designed time-of-flight analyzers which rotated around the horizontally polarized beam. The electron energy spectra and angular distribution data collected with these detectors were used to test formerly untried theoretical calculations of photoelectron angular distribution: agreement of the measurements with theory was excellent.



Argon $3s^2 3p^6 \rightarrow 3s3p^6 np$ autoionization resonances, as seen in a scan of the photoelectron yield at an angle of 0° with respect to the polarization of the synchrotron light. The resonances of this Rydberg series, measured at Beamline 9.0.1 to a value of n = 17, had previously been measured only to n = 8.

Finely Tuned Photons Probe Femtosecond Phenomena

Researchers from Uppsala University and IBM Almaden Research Center refined their understanding of charge transfer times, a critical aspect of bonding at surfaces and interfaces, in a recent experiment facilitated by the high photon energy resolution (better than 0.1 eV at 244 eV) at Beamline 8.0. Their goal was to measure the charge transfer time for a species of excited argon atoms; that is, they wanted to know the amount of time required for the excited atoms to lose their outermost electrons to a platinum (111) substrate. This time is difficult to measure directly because the times involved are on the femtosecond (fs, or 10^{-15} second) scale, and because charge transfer is not the only means by which the excited atoms can decay. The Beamline 8.0 group, however, turned this last fact to their advantage in making their measurements.

The group used x rays from the beamline's undulator to excite argon atoms, cooled with liquid helium so that they adhered to a platinum (111) substrate, such that a 2p electron in each atom rose to the 4s atomic energy level, resulting in the core-excited species $Ar^*(2p^5 3p^6 4s)$. Two decay processes are available to this Ar^*: in one, called spectator decay, one 3p electron drops to fill the 2p core hole, while another 3p electron leaves the atom and is detected. In the other decay mode, first the 4s electron transfers from the Ar^* to the platinum substrate (charge transfer), and then the same 3p electron activity occurs as in spectator decay. Without the 4s electron present, however, the energy of the ejected electron is different from that in spectator decay, so each process has its own signature energy.

Researchers can compare the time the two processes take by finding the ratio between the numbers of 3p electrons emerging with these two different energies. This kind of comparison is based on the assumption that if a substance can decay by either of two available processes, more of the substance will become involved in the faster process than in the slower process. In this case, the ratio was approximately 1:1, indicating that spectator decay and charge transfer take about the same amount of time. Since the time for spectator decay was already known to be 5 fs, the group concluded that the charge transfer time must also be 5 fs. This method of measuring charge transfer time by comparing it to a known time for spectator core-hole decay is sometimes called the "core-hole clock" method.

The new development in this experiment came when the researchers changed the energy of the incoming photons in 0.1-eV increments (photon energies over a 5-eV range could all excite the 2p → 4s transition, because the substrate's proximity broadened the 4s state). This variation in incoming photon energy produced a variation in the charge transfer time from about 2 to 10 fs (reflected in the changing ratios of charge-transfer to spectator processes). The researchers measured very fine details in this charge transfer time variation, which may be related to overlap between the 4s state and empty electronic states in the platinum substrate. The endstation used for this work was featured in *R & D Magazine* (October 1994, pp. 105–106) for its innovative design.

At-Wavelength Testing of EUV Optics

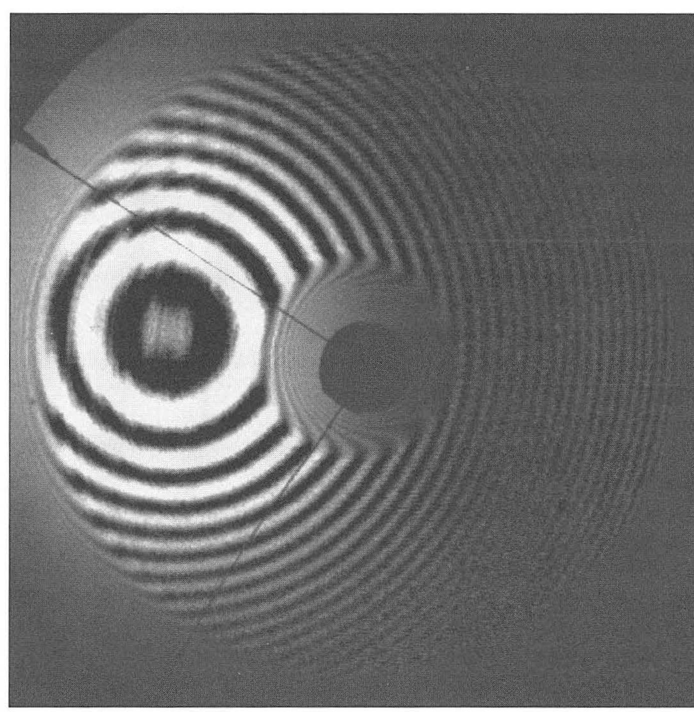
An EUV optics testing group has developed a point diffraction interferometer (PDI) which takes advantage of the laser-like spatial coherence of ALS undulator light to evaluate precision optical components. The PDI may provide one of the tools for making extreme ultraviolet (EUV) lithography a practicable reality, thereby answering a key challenge in the continued miniaturization of integrated circuits (ICs).

The smallest mass-produced ICs today are fabricated using a form of lithography in which ultraviolet light (with wavelengths in the range 2480–3650 Å) shines through a mask with absorbing and transmitting regions in the desired circuit pattern, travels through optics which demagnify the pattern, and then exposes a photoresist-coated silicon wafer with the mask pattern in miniature. Any light-based technique for pattern reproduction, however, is limited in resolution by the wavelength used: the shorter the wavelength, the smaller the minimum feature size. The minimum feature size in production today is between 0.35 and 0.6 μm (1 μm = 10,000 Å), and the IC industry is considering EUV lithography (using wavelengths around 130 Å) in the future as a way to produce features less than 0.1 μm across.

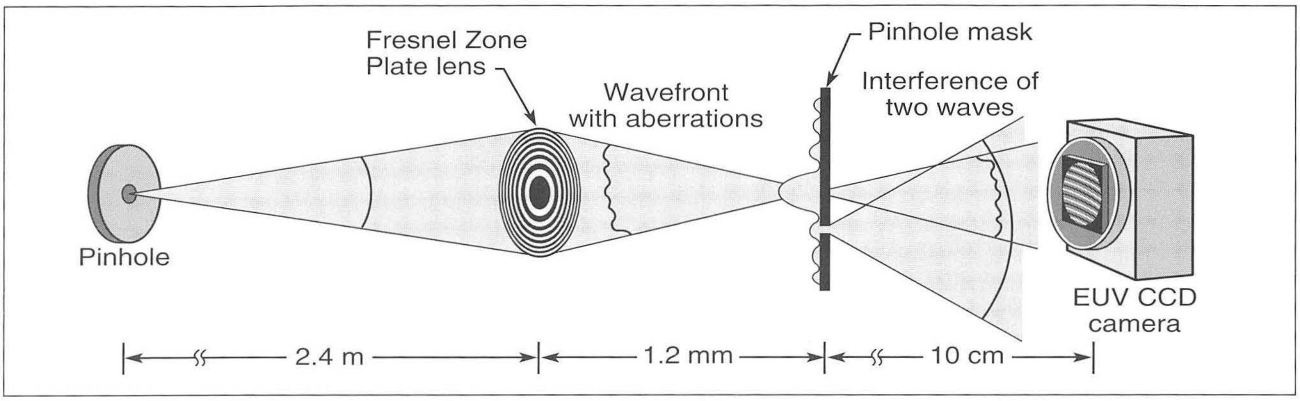
Multilayer mirrors for EUV have been developed which will, in theory, give the needed demagnification. In practice, however, a critical flaw in an EUV optical system can be tiny enough to escape detection by optical interferometry (the current state-of-the-art in optical testing). The success of EUV lithography depends on developing techniques for "at-wavelength" testing—testing performed using the wavelength at which the lithography system operates.

The Beamline 9.0.1 EUV optics testing group, led by Jeffrey Bokor (LBL's Center for X-Ray Optics and U. of California Berkeley) is working to provide these techniques. Their PDI can evaluate multilayer mirrors, zone plates, and other EUV optics at-wavelength. Its design is elegantly simple: spatially coherent EUV light filtered from the beamline's undulator illuminates the optical device being tested. The resulting wavefront strikes a thin absorbing membrane containing a tiny (< 1500 Å) pinhole. Diffracted light from the pinhole forms a spherical reference wavefront which interferes with the wavefront transmitted through the membrane from the device under testing. (Other optical testing schemes compare a component under testing to a well-characterized optical reference surface. A beam splitter divides light between the two, then recombines the reference and aberrated wavefronts to form an interference pattern. EUV reference surfaces and beam splitters suitable for this use do not yet exist.) The resulting interferogram, recorded by a CCD camera, is analyzed for aberrations in the optical device.

The first experiments using the PDI have measured the EUV light diffracted from a Fresnel zone plate lens. Zone plate lenses are important to many EUV and x-ray devices, including microscopes. In future experiments zone plate lenses may also be used to spread the thin undulator beam into the broad cone of light necessary to test reflective optical systems for EUV lithography.



Interferogram of an annular Fresnel zone plate lens, produced by the EUV optics testing group. The rings in this image are characteristic of the patterns produced when the PDI's absorbing mask and pinhole are intentionally placed somewhat outside the zone plate lens' focal plane to allow analysis of the rings for aberrations in the zone plate lens. The presence of these clear interference patterns demonstrates the laser-like spatial coherence of ALS undulator light.



Schematic drawing of the point diffraction interferometer being used to evaluate the wavefront from a Fresnel zone plate lens. Reflective optical systems will be tested using an analogous setup, with the component(s) under test in place of the zone plate lens.

RESONANT PHOTOEMISSION IN POLYMERS

The combination of high photon flux (hence rapid data collection) and high energy resolution at their ultraESCA endstation has allowed a Beamline 7.0 research group to produce richly detailed information on the electronic structures of polymers. Analogous experiments in the past, limited by slow data collection, have produced series of electron energy spectra at relatively widely spaced photon energies, usually plotted "waterfall" fashion with one spectrum below another. The current experiments, however, produce spectra so quickly that the experimenters can vary their photon energy in smaller steps and plot the resulting spectra as continuous surfaces, each composed of scores of closely-spaced spectra and each offering a wealth of information on the band structure, orbital symmetries, and other characteristics of the polymer from which it is taken.

The researchers, led by Brian Tonner of the University of Wisconsin Milwaukee, illuminate a polymer sample with x rays at a given energy (near the carbon-K absorption threshold) and measure the resulting electron emission from the sample. The poly(α-methylstyrene) plot shown on page 6 consists of 101 such spectra at photon energies only 0.2 eV apart, with a total data collection time under 1.5 hours. Various parts of the plot show evidence of several processes that occur in response to the x-ray excitation.

DIRECT PHOTOEMISSION (a, e)

Incoming x rays can eject valence electrons directly from their orbitals. This valence-band photoemission produces peaks (a) at the binding energies of the valence orbitals involved, regardless of the incoming photon energy. A similar peak (e) arises from another direct photoemission process in which radiation from the second undulator harmonic ejects carbon core electrons from their orbitals.

AUGER DECAY (b)

If an incoming photon ejects a core electron from an atom, Auger decay can occur. A valence electron drops to fill the core hole and transfers its lost energy to another valence electron, which leaves the atom. Auger decay produces a broad, step-like rise in the surface plot for photon energies above 286 eV (the minimum energy required to eject a carbon core electron).

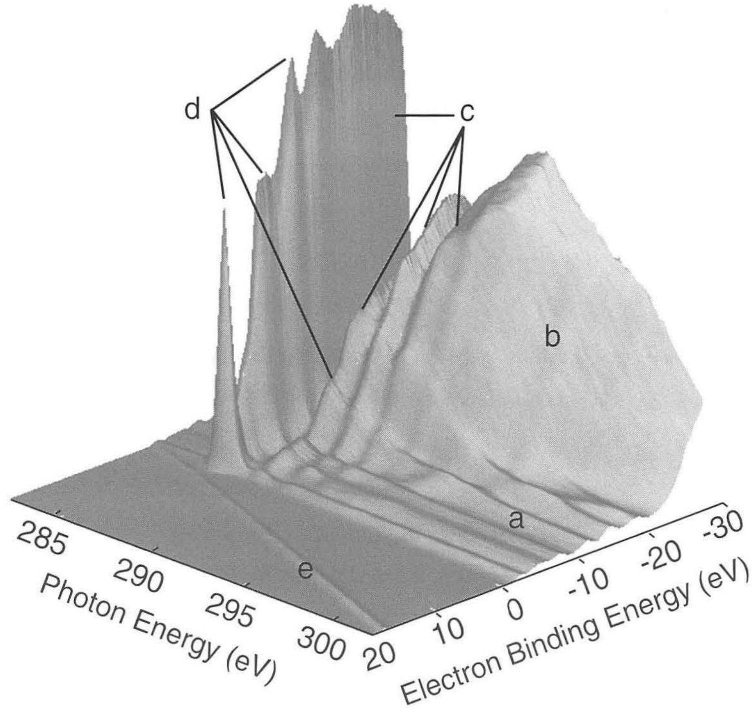
RESONANT PHOTOEMISSION (c, d)

When the energy of the incoming photon is exactly the amount of energy required to excite a core electron to one of several higher-energy, unoccupied orbitals, resonant photoemission can occur. The two resonant decay processes are called spectator and participator decay, according to the behavior of the excited core electron. In spectator decay, once the core electron has been excited, it stays in the higher energy level. Then, in an Auger-like process, a valence electron drops to fill the core hole, transferring its lost energy to another valence electron which leaves the atom. Spectator decay produces a series of ridges (c) on the surface plot.

In participator decay, the excited core electron and one valence electron participate in an Auger-like process. One of these two electrons drops to fill the core hole, transferring its energy to the other, which leaves the atom. Participator decay produces bumps (d) along the spectator decay ridges in the surface plot. The photon energy of each such bump specifies the unoccupied orbital to which the core electron was excited, and the binding energy specifies the valence orbital that loses an electron. Thus,

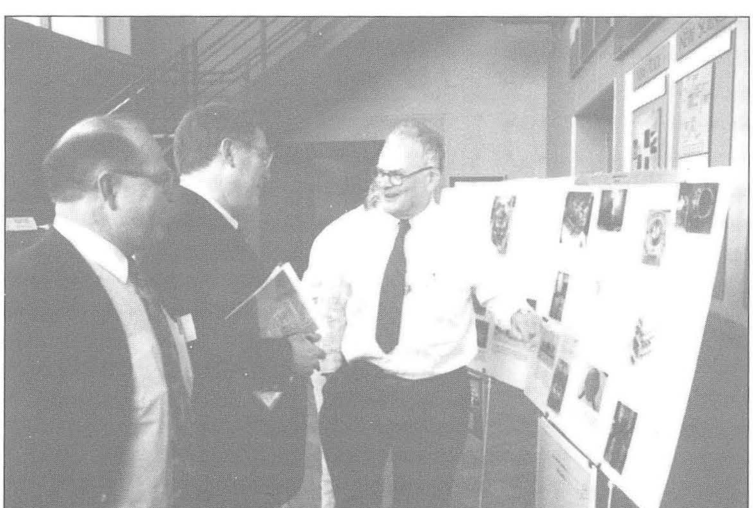
Recent Research Results continued on page 6.

the bumps on the surface plot summarize which unoccupied orbital/valence orbital pairs can transfer energy through participator decay. Because these energy transfers are governed by rules involving characteristics of the orbitals such as symmetry, localization, and/or spatial distribution, the plot gives information on all these attributes. Researchers are already using these plots to gain insight into polymer decay mechanisms and band structures, as the detailed data sets bring subtle features to light.



Resonant photoemission plot for poly(α-methylstyrene). Contributions to the photoemission intensity (height on this plot) include normal valence band photoemission (a) with resonant enhancements (c, d), normal Auger emission (b), and carbon 1s core-level photoemission excited by the second undulator harmonic (e).

SYMPOSIUM HONORS KLAUS HALBACH



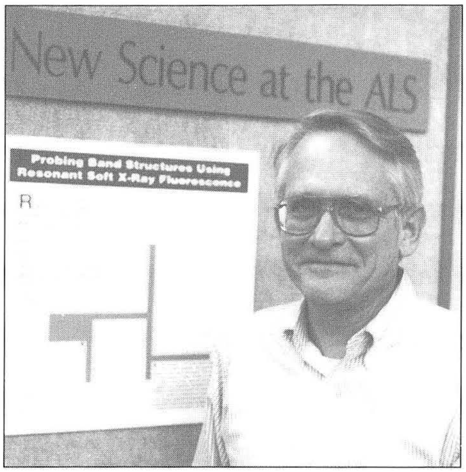
Klaus Halbach (right) enjoys reminiscing about one of his projects with Bill Hassenzahl (left) and Brian Kincaid.

Colleagues and students of Klaus Halbach from around the world gathered at LBL on February 3 for the Halbach Symposium on Magnet Technology. Held in celebration of Halbach on his 70th birthday, the symposium drew over one hundred participants. The scientific community has benefited substantially from Klaus' work on accelerator magnets, computer models, and beam position monitors, and especially from his work on permanent magnet insertion devices, which made third-generation rings such as the ALS feasible. He has consulted at most storage ring projects around the world, many of which have installed Halbach design undulators and wigglers.

The day-long symposium featured technical presentations, personal recollections by long-time associates, and the publication of two volumes assembled specifically for the meeting. Entitled "The Art and Science of Magnet Design," the volumes include a festschrift of technical papers written especially for the symposium and a selection of Klaus' scientific notes. Organizers of the event were Brian Kincaid and Ross Schlueter of the ALS and Roger Carr of Stanford Synchrotron Radiation Laboratory.

From the Chair, Users' Executive Committee

News for ALS Users



UEC Chair Tom Callcott by the ALS display of recent research results.

One principal responsibility of the Users' Executive Committee (UEC) is to communicate the needs and suggestions of the user community to ALS management on a regular basis. At our first joint meeting of the year held on February 24, a wide range of operations and user services issues were discussed that affect ALS users. I would like to take this opportunity to summarize the key points of the meeting as well as report on recent progress on recommendations made by the UEC.

Let me begin by congratulating the ALS on the success of the recent shutdown and on the post-shutdown performance of the machine. The shutdown was completed on time, and the ALS resumed full operations precisely as scheduled. These two outstanding achievements alone are ample evidence of the excellent planning and execution involved in these efforts.

Prospects for FY96 Funding

We were delighted to hear Brian Kincaid's generally optimistic assessment on the possibility of obtaining funding in FY96 for the Department of Energy (DOE) Scientific Facilities Initiative (described in more detail in the Director's Message on page 8). Despite severe constraints on DOE funding in many areas, there has apparently been a good response to this initiative, which would provide enhanced funding to support operations at many DOE user facilities. If approved, this initiative would have a direct and immediate impact on ALS users by permitting 24 hour, 7-day-a-week operation, which would nearly double the shifts available to users. The second priority for use of these funds would be to provide additional user services and service personnel.

Because of the importance of this issue to all of us, ALS users are urged to express their opinions by writing to the members of Congress who represent their home institutions, and to the chairs of the specific committees who will vote on the funding for the initiative. Since many of you work at more than one DOE facility, you may wish to address the initiative, which includes many facilities, as a whole. Details about how your own research program will be affected by the initiative should also be included. Further information can be obtained from ALS Administration, including a breakdown of proposed funding changes and a list of committee chairpersons.

ALS User Policy

Neville Smith, ALS scientific program head, initiated a vigorous discussion on whether the draft user policy of the ALS (created in 1988) was still a good working model for allocation of beamtime to PRTs and Independent Investigators. Though few firm conclusions were reached, the UEC recommended that the ALS conclude written Memoranda of Understanding with all PRTs to establish a clear understanding of the mutual obligations of the PRTs and the ALS; and that the recently developed ALS peer review process for beamtime proposals be applied uniformly to all requests (yet allow flexibility in types of proposals accepted: one-time use, extended studies, etc.).

Improvements in User Services

The UEC commends the ALS for involving users in the development and review of the new short- and long-term operations schedules (see New Operations Schedules on page 16). We ask that this effort continue so that the entire user community has ample opportunity to comment on the proposed schedules well in advance of their implementation. One concern expressed about the new weekly schedule is the reduced availability of support services during weekend operation. The committee requested that the ALS work to provide services such as an emergency supply of stockroom items and access to critical LBL facilities during weekends.

Finally, a number of nuts and bolts issues were addressed by the committee, and the ALS has moved quickly to satisfy many of our suggestions. For example, all the user documentation has been consolidated into a User Information Book available by each beamline; and there is now a user shipping and receiving area to help expedite delivery of user equipment, including direct delivery of express mail and small packages.

Two committee members left the meeting with special assignments. Eli Rotenberg is to compile a list of supplies for an ALS supplemental stockroom (items that users often need on an emergency basis), and Lou Terminello is developing a list of desired "loaner equipment" to be available for temporary use. Users are invited to contact Eli and Lou with their suggestions.

I conclude by encouraging ALS users to voice their concerns to the UEC. Our next meeting in late May will focus primarily on planning the Annual Users' Association Meeting scheduled for October 23-24, but will also pursue some of the issues described above.

Tom Callcott
Chair, ALS Users' Executive Committee

Report from the ALS Director

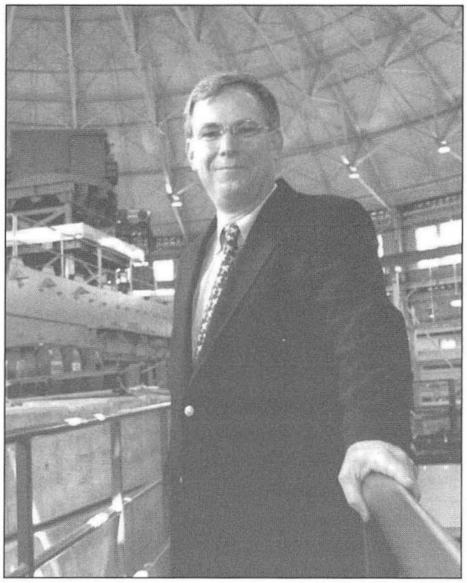
I like to summarize the recent highlights and activities of the ALS in two words: It Works! The machine continues to rack up an unprecedented level of performance, and its reliability, combined with the quality of our R&D expertise, is a key contributor to the wealth of new scientific results being produced by our users. Our successful operations and technical achievements have led to continued strong support from the scientific community, such as the recent decision by the Office of Health and Environmental Research (OHER) to fund the start of the ALS Protein Crystallography Facility.

Scientific Facilities Initiative

As you look at the chart of ALS performance for 1994 on page 16, imagine how much more science could be done if all the gaps were filled in by 7-day-a-week operations. Unfortunately, constraints caused by our present low operating budget permit us to operate for only 14 8-hour shifts per week, with 9 allocated to user experiments and 5 set aside for maintenance and machine physics. This under-utilization of the ALS and other national user facilities is now being addressed by the Scientific Facilities Initiative which will increase funding for user facilities in the Department of Energy (DOE). The Initiative, now working its way through Congress, will allow us to go to full operation of the ALS, increase our user support services, and develop more beamline instrumentation for users.

This Presidential Initiative, part of President Clinton's budget for FY96, provides an additional $100M for operations, research, and capital equipment for user facilities in DOE's Basic Energy Science, High Energy, and Nuclear Science areas. It would significantly increase research time available to users and enhance the quality of service the facilities can offer. A fifth of the funds, $20M, would go directly to users of the facilities through a university grants program.

The allocation of funds to specific facilities was done by the DOE based on information provided by the user facilities. If the Initiative is approved by Congress as currently written, the ALS operating budget would go from the current funding of $21.2M to nearly $30M in FY96. This includes a small increase in base funding proposed by the DOE plus $6.6M from the Initiative. Our capital equipment and ARIM funding (for instrumentation and beamline construction) would also increase, for a total of $10.6M in increased funding from the Initiative.



ALS Director Brian M. Kincaid

The figure was based on input we provided to the DOE and the Office of Management and Budget (OMB) on how much additional funding was needed for full utilization of the ALS as a national user facility—to deliver on the promises made when the ALS was originally proposed and funded, and meet the ever-increasing demands of our growing user community.

Priorities for Additional Funding

The table shows the scenarios we developed for the OMB to show our priorities in the event increased funding became available. Our top priority is to increase available user beamtime from nine 8-hour shifts per week to 16, an increase of 78%. Increased funding would also provide a more appropriate level of support for the increase in user activities we expect with each year of operation. In addition, with the funds provided by the Initiative, we will expand R&D activities to develop new instrumentation for ALS users and add the technical staff and facility infrastructure to improve all operations, including providing more direct scientific support for user activities.

The Initiative includes instrumentation upgrades for NSLS, an increase in operating funds for SSRL allowing them to approach full operations, and support for the full operating budget needed to start the APS. Thus the entire synchrotron community benefits from this across-the-board boost.

To be funded, the Initiative must gain the support of the authorizing and appropriating committees of both Congressional houses. The initial review of the proposal has been relatively positive, primarily because it provides a cost effective way to maximize the return on the large investment the U.S. has made in the DOE user facilities including the ALS.

What happens if the Initiative fails and our funding for FY96 remains close to FY95 levels or even decreases? We will have to reduce operations and user support as increasing costs take their toll. The beamline buildup presently underway will slow down and commitments for additional insertion devices will remain uncertain. Of course, fewer support personnel and user services also mean less beamtime available to users. Hopefully, the Initiative will result in a permanent change in our base funding. If not, life will get very difficult in a couple of years.

I am pleased to say that all the DOE light sources have collaborated on their requests for additional funds. Led by Artie Bienenstock of SSRL, we have had great support and encouragement from Emily Pelton and Gary Bennethum of OMB, and from Martha Krebs, Director of the Office of Energy Research. This cooperative way of doing business should be our model for all future interactions, since, as Ben Franklin said at the beginning of the American Revolution, "We must all hang together, or we will surely all hang separately."

I remain hopeful the ALS will receive the additional funding required to expand our operations and services. The recent scientific results featured in this newsletter are ample evidence that we have a facility that can lead to new frontiers for science and technology given the opportunity. I am confident that our continued success—based on the hard work, skill, and creativity of the ALS staff and users—will ensure that we are well-positioned for the exciting prospects that lie ahead.

Brian M. Kincaid
ALS Director

ALS Operating Budget Scenarios

Priority		Hires	Cost (k$)	Totals (k$)	
1	**Nominal Operations**				
	▼ Reach Steady-State 21 Shift Operation				
	Accelerator Operators	2	250		
	Electronic Maintenance Techs	2	220		▶ *Allows full utilization of the ALS by moving to 7 day/week operation, providing 16 user shifts/week instead of only 9. Hire operations staff and pay for increased power.*
	User Coordinators	2	250		
	Supplies & Expenses		100		
	Power		250		
		6	1,070		
	▼ Provide Appropriate User Support				
	Scientific Liaison	1	125		
	User Administrator	1	125		▶ *Provides for proper level of support for scientific users. Expect rapid growth in scientific utilization of facility.*
	Clerical Support	1	125		
	Beamline Techs	2	220		
	Supplies & Expenses		100		
	Misc. User Support		350		
		5	1,045		
	Total			2,115	
2	**Industrial Outreach & R&D Programs**				
	▼ Initiate Industrial Outreach Program				
	Industrial Liaison Scientists	2	250		▶ *Begin necessary outreach activities with full-time liaison scientists in order to educate industrial and other users about ALS capabilities.*
	Special Outreach Materials		75		
	Supplies & Expenses		35		
		2	360		
	▼ Support Basic R&D Activities				
	Vac. Eng. Controls	3	525		
	R&D Support		550		▶ *Support advances in key instrumentation needed to develop industrial and other scientific use of the facility.*
	Visiting Scientists		360		
	Students, Post-docs		360		
	Supplies & Expenses		110		
		3	1,905		
	Total			2,265	
3	**Infrastructure Support**				
	▼ Ensure Timely Beamline Installation				
	Mechanical Technicians	2	220		
	Mechanical Designers	2	250		
	Electronic Installation Techs	1	135		▶ *Provide adequate staff to ensure timely assembly and installation of beamlines and experimental equipment to support user research.*
	Electronic Coordinators	1	125		
	Supplies & Expenses		100		
	Beamline Maintenance & Spares		290		
		6	1,120		
	▼ Proper Facility Infrastructure				
	R&D Support		450		▶ *Maintain leadership position in key areas of research. Ensure proper facility infrastructure to support both accelerator and experimental facility operations.*
	Quality Assurance	0.5	95		
	Budget, Misc.	1	150		
	EH&S Staff	2	230		
	Supplies & Expenses		50		
	Mgmt. Reserve		125		
		3.5	1,100		
	Total			2,220	
	Increase Totals			6,600	

Priorities for use of proposed additional ALS funding.

Crystallography Beamline Gains Substantial Funding

The high technical and scientific marks received by the ALS protein crystallography facility proposal during its extensive review process have led to a commitment of \$3.85M in capital and \$250k per year in operating funds by the Department of Energy's Office of Health and Environmental Research (OHER). These funds, along with \$500k already committed by the University of California through LBL Director Charles Shank, assure that a beamline with at least one branchline and endstation (of the three that are planned) will be built. Additional funding is now being sought from the private sector to build the remaining branchlines and endstations, based on strong support of the proposal by local pharmaceutical companies.

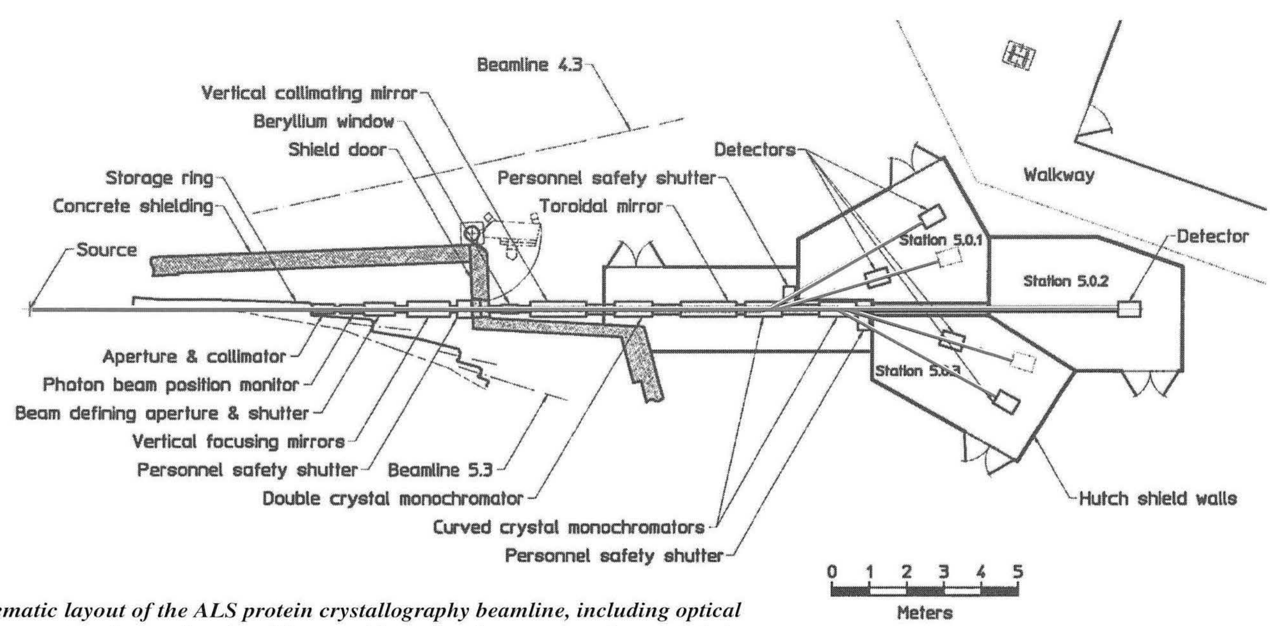
The ALS Protein Crystallography Facility will offer a choice of crystallographic techniques with semi-automated operation and rapid sample turnaround, making it fully competitive with the best synchrotron sources in the United States. Its prime location guarantees a large base of potential users, including the west coast biotechnology industry, LBL's Structural Biology and Life Sciences Divisions, and the crystallography groups at University of California Berkeley and U.C. San Francisco. The performance and reliability of the ALS, combined with the expertise and support facilities on site and nearby, offer the possibility for unprecedented productivity.

The branchlines and endstations are in the final design process, with the first endstation scheduled to begin operation in May 1996. The crystallography facility represents a team effort under the leadership of Sung-Hou Kim, Director of LBL's Structural Biology Division. Key players include Thomas Earnest, also of the Structural Biology Division, Howard Padmore and Carl Cork of the ALS Experimental Systems Group, Jim Krupnick of the ALS Planning and Development Group, and Glen Dahlbacka of LBL's Technology Transfer office.

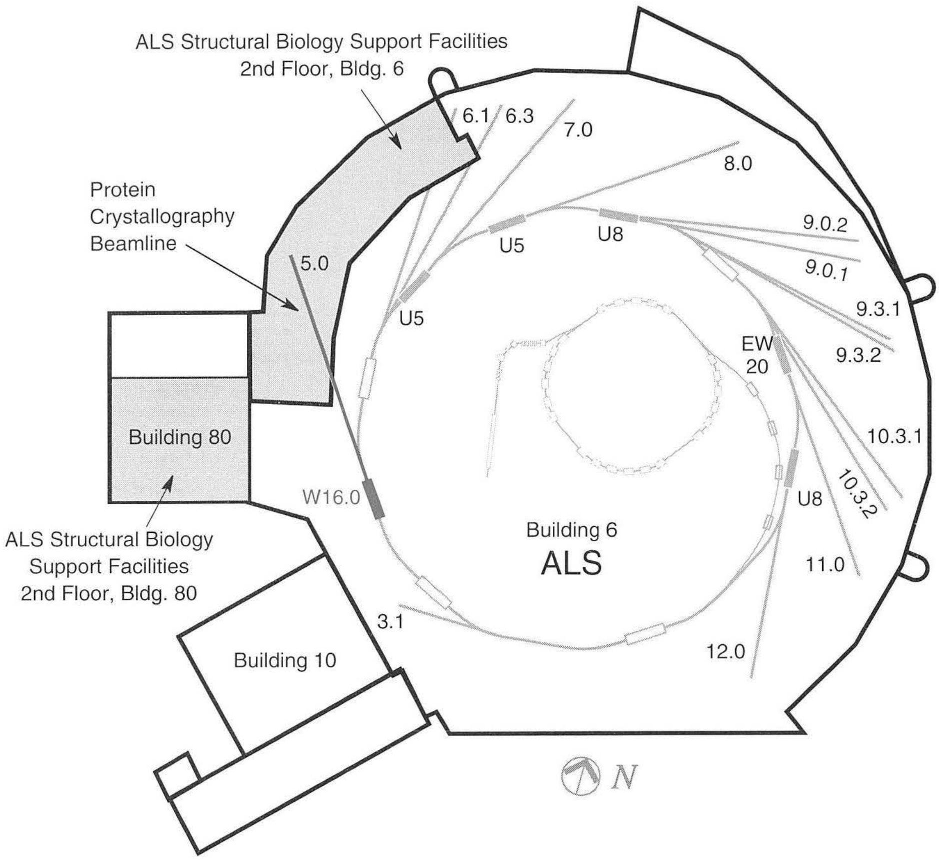
Facility overview

Plans for the crystallography facility call for a multipole wiggler beamline with three automated endstations. The 38-pole, 2-tesla wiggler source will provide three distinct advantages over conventional x-ray sources for crystallography. First, its high flux (photons per second) will speed data collection by increasing data count rates, especially when the ALS operates at 1.9 GeV electron energy. Second, the wiggler radiation's high degree of collimation will make it possible to resolve diffraction spots from large unit cells (when matched with appropriate detectors) and to work with micro-crystals. Third, the wiggler provides x rays over a continuous synchrotron radiation spectrum (wavelengths planned for use are 0.9–3.0 Å). Broad bands of this spectrum can be used for time-resolved Laue diffraction, or precise tuning within the spectrum can facilitate multiple-wavelength anomalous diffraction (MAD) techniques. MAD, which can provide the phase information essential to solving the structure of many crystals, is gaining importance as an alternative to other phasing methods which require finding heavy-atom derivatives, since such derivatives are not always available for the molecules of interest.

The construction of the wiggler is already well underway with completion targeted for November 1995. The design and fabrication is a joint effort of the ALS Insertion Device



Schematic layout of the ALS protein crystallography beamline, including optical components and x-ray hutches. The two side station detectors are shown at their positions for maximum and minimum x-ray wavelengths.



Plan view of ALS and adjacent buildings, showing the crystallography beamline and Structural Biology Support Facilities.

Engineering and R&D sections: both groups collaborated on the conceptual design, engineering is responsible for the fabrication, and R&D is carrying out the magnetic design and measurements.

The three planned endstations will primarily be used simultaneously. The central station (first to be constructed) will offer monochromatic crystallography capability as well as rapid tunability for MAD phasing, and a white-light mode for Laue diffraction. This station will receive the on-axis, brightest portion of the wiggler light, while the two side stations will use off-axis light for monochromatic crystallography. Alternatively, in a time-sharing mode of operation, the side-station optics can be translated to intercept the brightest, on-axis light.

When the useful photon flux is as high as it will be in the crystallography beamline, data recording times become so short that detector readout time can cause a serious bottleneck in the experimental process. The ALS facility will address this by using state-of-the-art matrix CCD detectors that have readout times of about 1.7 seconds, but which do not sacrifice other desirable qualities such as high quantum efficiency, high dynamic range, and small point-spread function. Since CCDs acquire an image of a crystal's diffraction pattern over a given exposure time, they are best suited to studying macromolecules in steady states. To study processes as they occur, a "pixel" detector is being developed for Laue diffraction at the central endstation, with individual counting electronics behind each pixel. The pixel detector will allow continuous monitoring of time-dependent processes, without the time-averaging inherent in CCD and photographic-plate technologies.

Additional Support Facilities

The ALS Structural Biology Support Facilities, a fully funded $7.9M Department of Energy project now under construction, will provide an essential part of the infrastructure for the protein crystallography facility. Designed for ease of use and located directly adjacent to the beamline, the support facilities will provide space and equipment for laboratory and computing work to users of the crystallography beamline. Researchers will have access to equipment for biochemistry, spectroscopy, crystallography setup and testing, and computerized data processing with graphics capabilities.

The Support Facilities, scheduled for October 1996 completion, will be located on the second floor of the ALS building above the crystallography beamline, and in the adjoining Building 80. To make way for the construction activity, the ALS management, administration staff, and accelerator group (currently in Building 80) have moved to Building 4.

Fact sheets with more detailed, technical information are available for the Protein Crystallography Facility and the Structural Biology Support Facilities. You can request copies by completing the business-reply insert on page 13.

BEAMLINE UPDATE

6.3.2 IN OPERATION

The calibration and standards beamline, in operation since December, is already in demand by scientists in several disciplines. Operating over an energy range of 50–1000 eV, it is designed primarily for calibrating soft x-ray and extreme ultraviolet (EUV) optical components such as mirrors, gratings, and multilayers; and for providing the x-ray intensity and wavelength standards necessary for tasks such as calibrating the efficiency of a detector over a range of wavelengths.

The beamline was first used to measure optical quality (reflectivity, uniformity, etc.) of multilayer optics for EUV projection lithography. Other applications include gas phase, solid state, and atomic physics. Users in these fields appreciate the beamline's high flux (10^{11}–10^{12} photons/sec) and its simplicity and convenience. The beamline's varied-line-spacing plane-grating monochromator, the first of its kind at the ALS, consists of a spherical mirror, a plane grating, and a fixed exit slit. It has no entrance slit and demagnifies its bend-magnet source by a factor of 10. This design makes it remarkably compact, fitting on a 2-meter table. The spokesperson for the beamline is Jim Underwood (LBL's Center for X-Ray Optics).

FIRST LIGHT TO 9.0.2

On March 24, ALS light shone through Branchline 1 of the chemical dynamics beamline for the first time. The first activity was to take transmission grating spectrometer measurements characterizing the performance of the beamline's novel harmonic filter. The windowless, differentially pumped rare-gas filter lets the low-energy (8–30 eV) undulator fundamental pass through unattenuated, while suppressing higher undulator harmonics to 0.01% or less of their original flux, for spectral purity unprecedented in a raw undulator beam. The 8-cm-period undulator (U8) now in use will be replaced by a U10 in September 1995, lowering the beamline's minimum photon energy to 5 eV.

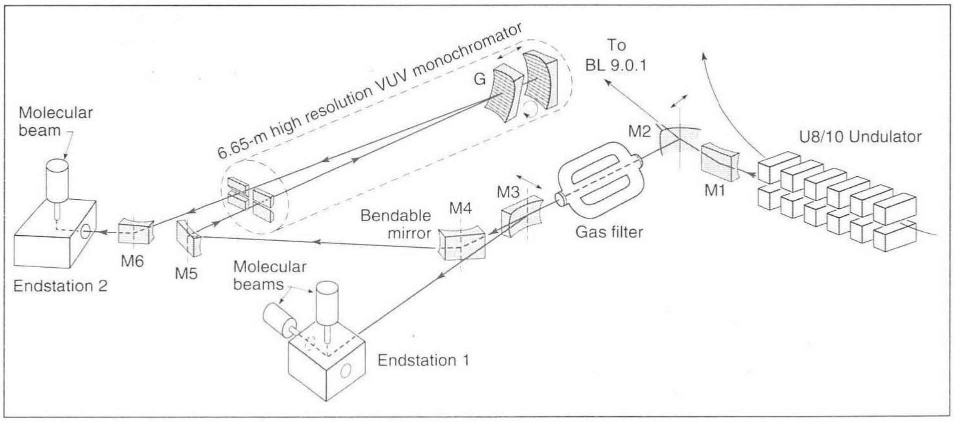
Branchline 1 will deliver high-flux (~10^{16} photons/sec), "white" (2% bandwidth) radiation to Endstation 1 for photodissociation and crossed-molecular-beam experiments. Branchline 2 will use an off-plane, 6.65-meter, normal-incidence Eagle monochromator to achieve resolving powers between 50,000 and 100,000 with various gratings. Endstation 2 will include time-of-flight equipment for coincidence detection, and will offer high-resolution electron spectroscopy with excellent sensitivity.

The beamline will also incorporate several lasers. An excimer laser will provide high-power UV light for photochemistry studies and to produce beams of radicals. A pumped dye laser system will produce intense, pulsed visible and UV light suitable for running Endstation 2 when Endstation 1 has the undulator beam. A custom-built infrared laser system will round out the beamline's capabilities. Arthur Suits (LBL's Chemical Sciences Division) is the spokesperson for the beamline, and Phil Heimann (ALS) is the beamline coordinator.

9.3.1 NEARS COMPLETION

Another center of recent activity is Beamline 9.3.1, with the first experiments slated for May. It has the distinction of being the first monochromatic hard x-ray beamline at the ALS, and the brightness at the sample will be an order of magnitude higher than presently available anywhere in the 1 to 6 keV photon energy range. In addition, it will provide flux and resolution comparable to other beamlines. To achieve these goals, beamline designers incorporated two technical improvements relative to existing beamlines. First, they adopted a novel optical design in which identical toroidal mirrors are positioned before and after the double-crystal monochromator. This configuration allows for high resolution by passing a collimated beam through the monochromator, and for high brightness by focusing the source on the sample with unit magnification. Second, they developed a new "Cowan" type double-crystal monochromator based on the NSLS beamline X-24A design. The mechanical precision of the monochromator shows significant improvement over existing designs, essential because of the high brightness of the radiation and the large focal lengths of the mirrors (12m).

The endstation for the beamline includes capabilities for electron, ion, and x-ray spectroscopy and is designed specifically to study interactions of x rays with gases in the 1–6 keV range. This energy region, in which a number of qualitatively different atomic and molecular phenomena occur, remains largely unexplored. The local contact for the beamline is Rupert Perera (ALS), and the beamline's research team is led by Dennis Lindle (University of Nevada, Las Vegas).



Schematic of the chemical dynamics beamline, excluding lasers and showing the geometry of the Eagle monochromator in Branchline 2. A time-sharing arrangement allows undulator light to reach Beamline 9.0.1 or either branch of Beamline 9.0.2, depending on the positions of mirrors M2 and M3.

Advanced Light Source Information

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To receive information about the ALS, complete this form, clip, fold, and mail (postage-paid).

- ☐ 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 to subscribe to ALSNews, the weekly news bulletin sent by electronic mail. To subscribe, enter your complete internet address when completing the address information below. (An alternative is to access ALSNews on the World Wide Web. Current and past issues are available at http://beanie.lbl.gov:8001/als/als_news/als_news.html.)
- ☐ Please send me "Advanced Light Source: Ultraviolet and Soft X-Ray Beams for Research," LBL PUB-703.
- ☐ Please send me "The Advanced Light Source: America's Brightest Light for Science and Industry," LBL PUB-742.
- ☐ Please send me the report of the Annual Meeting of the ALS Users' Association held on October 20–21, 1994, LBL-36500.
- ☐ Please send me "Advanced Light Source Users' Handbook," LBL PUB-3123.
- ☐ Please send me information on the Protein Crystallography Facility and the Structural Biology Support Facilities now under construction at the ALS.

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Progress in Operations

Much of the activity at the ALS revolves around making sure the needs of our users are met and that we maintain high quality in both machine performance and user services. This involves planning the shutdowns required for major equipment installations so they have a minimal impact on user operations, carrying out accelerator physics studies devoted to improving machine performance to meet the ever more demanding requirements of user experiments, and working with the users to develop operations schedules which allow them to work efficiently and productively. We have made significant progress on all of these areas during the past several months: a few of the recent highlights are described below.

Year Begins With Successful Shutdown

The ALS started 1995 with a scheduled six-week shutdown for equipment installation and accelerator improvements. Some of the major tasks included installing a narrow-gap vacuum chamber in sector 7 of the storage ring, installing a new mirror tank in Beamline 9.0 that allows the beam to be deflected into the 9.0.2 branchline, and installing the front end for Beamline 7.3. Other shutdown activities included making a number of improvements to the rf system to ensure smooth running at 1.9 GeV, and installing a new electron gun cathode in the LINAC ion source to improve single-bunch purity.

The new narrow-gap vacuum chamber allows the 5-cm-period undulator (U5) in sector 7 to be used with a smaller magnetic gap, and therefore a higher magnetic field, between the magnetic poles (the new chamber permits a minimum magnetic gap of 14 mm, down from 23 mm). The possibility of using a smaller undulator gap lowers the threshold for the energy range the undulator can produce. This makes it possible to perform certain lower-energy experiments without reducing the storage ring electron energy. The minimum photon energy on Beamline 7.0 has now decreased from 124 eV to around 50 eV, giving access to the silicon 2p edge at 99 eV and allowing studies on the oxidation of silicon and its interaction with adsorbed metal layers.

Much of the success of the shutdown can be attributed to creating a precise schedule for the six-week period—an effort coordinated by Gary Krebs, deputy leader of the Operations Group. Another key to keeping the schedule on track was the extensive use of the ALS-developed dry-tent technique during equipment installation, obviating the need for baking out the sections of accelerator and beamline vacuum chamber that had been brought up to atmospheric pressure (described in the last *ALS Report*, September 1994). Use of the dry-tent technique reduced the shutdown period by at least three weeks.

Startup is Instant Success

The ALS stored beam on the first day after resuming operations and achieved a beam lifetime of 8 hours with a current of 400 mA by the start of user operations on February 22. Despite the new narrow-gap chamber installed in sector 7 and the changes to the rf system, the machine was back to (and in some ways surpassing) its near-perfect performance from before the shutdown.

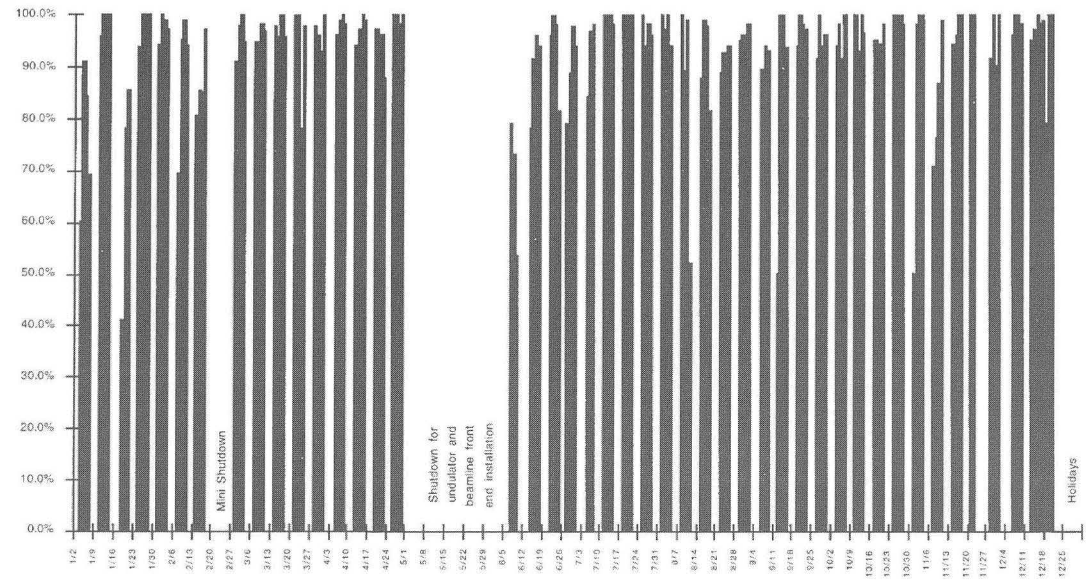
The virtually instant success of the startup is primarily due to the hard work of the ALS Operations, Accelerator, and Mechanical and Electrical Engineering Groups, who coordinated their efforts to characterize post-shutdown ALS machine performance, make improvements as required, and restore quality beam. In just one week of operation, the control room operators reduced the startup time for the machine each morning to less than one hour, an exceptional achievement.

Innovative Tools for Survey and Alignment

One group that has been particularly busy during the last several months is the ALS survey and alignment crew. Their goal was to complete a survey of all the monuments in the storage ring and beamline area to form a new monument network, more accurately and more efficiently than had been done previously. The monuments (100-plus markers in the ALS floor) form a network of reference points which are used for maintaining proper storage-ring alignment (thus contributing to longer beam lifetimes) and for accurately aligning new beamline components. Careful initial alignments, coupled with high-quality design and engineering, have allowed beamlines at the ALS to obtain publishable data within days of their first commissioning efforts.

An important key to doing the survey and alignment work efficiently was gaining self-sufficiency in the surveying process (previously we had relied on the Precision Alignment Group from Stanford to make surveys of ALS monuments). To accomplish this, the ALS devised a new tool

Alex Gavidia sights from one monopod to another atop the storage-ring shielding. The monopod extends through the shielding to a monument set in the floor under the storage ring; shorter ones are used for measurements made from the experiment floor.



ALS performance for 1994 was 92.4% overall and 94.5% for user shifts (actual/scheduled), which shows the machine is extremely reliable. The gaps reflect the fact that there were no machine operations during weekends due to insufficient funding.

called a monopod that substantially decreases the time required for monument surveys, while increasing the accuracy. The advantage of using a monopod derives from the need to know the height of the surveying tool as exactly as its horizontal position. In the past, determining an instrument's height required making an additional sighting; now the monopod's height is a known constant. Bill Baldock originated the idea for the monopod, and he and Robert Duarte (both of the ALS Mechanical Engineering Group) led its design.

Another innovative tool used to complete the network of reference points was StarNet, a computer program which facilitates the task of processing the large number of measurements necessary for a monument survey. The survey team takes the monument measurements using a Mekometer and theodolites mounted on monopods. The Mekometer, an electronic laser device, measures long distances extremely accurately, and the precision theodolite measures horizontal angles to 1/3-arc-second resolution. After the measurement data are entered, StarNet uses a least-squares fit to determine the location, horizontal error ellipse, and vertical error bar for each monument. The results of this fit for the recently completed monument survey were outstanding: the monument coordinates in the storage ring area are now known to within 60 μm.

NEW OPERATIONS SCHEDULES

The ALS has been working closely with the user community to develop weekly and long-term schedules that incorporate the suggestions and requests solicited from the users for the modes of operations they prefer. The result was a new weekly schedule for operations put into effect after the February shutdown, and a long-term schedule for operations through August. In the new weekly schedule, the 9 user shifts per week are day shift (0800–1600) on Wednesdays, and day and swing shifts (0800–2315) on Thursday–Sunday (incorporating the users' request to eliminate owl shifts for user operations). The long-term schedule allocates specific weeks for the various modes of operation requested by users, including 1.0, 1.5, and 1.9 GeV operations, and two-bunch operation. The maximum beam current at 1.9 GeV may be limited in 1995 due to restrictions associated with the power loading capabilities of the rf cavity windows; we expect at least 250 mA current at 1.9 GeV.

IMPROVEMENTS IN MACHINE PERFORMANCE

The ALS performance for machine operations during 1994 was 94.5% availability of beam for user shifts (actual/scheduled), a testament to the quality of engineering and the hard work of the accelerator physics and operations groups. Not satisfied with quantity of operating time alone, however, these groups also strive to improve the quality of the beam they provide to users.

MEASUREMENT-BASED MODEL

In pursuit of ever-higher accelerator performance, the accelerator group has abandoned its original, simulation-based model of the storage ring and developed a model based on empirical measurements of how the accelerator actually behaves. The model is derived by making changes to a single device, such as a corrector magnet, and measuring the effects of the changes on different parameters, including closed-orbit, chromaticity, betatron tune, and several others. These measurements combine to form response matrices, which can be used in control algorithms such as the "feed-forward" algorithm which prevents adjustments in undulator gaps from causing significant beam movement. The accelerator measurements also show how well the storage ring conforms to its design tolerances: ALS magnet fields are within 10^{-3} of their design values, and magnet positions are accurate to 100 μm.

BEAM POSITION STABILITY

Photon beam drift and jitter continue to be issues at the ALS. Part of the problem is that it can be very difficult to separate the photon beam motion caused by movement of the electron beam from that caused by movement of optical elements at individual beamlines. The present beam position monitor system cannot detect electron beam motion at the levels necessary for establishing how electron beam motion is affecting photon beam motion. However, a prototype electron beam monitor (being developed for a system to protect the vacuum chamber from errant photon beams in undulators) has proved to be sensitive to movements of less than 1 μm, and thus is perfect for observing electron beam jitter. Also, because the monitor is anchored to the floor, it can be used to detect longer-term drifts in beam position.

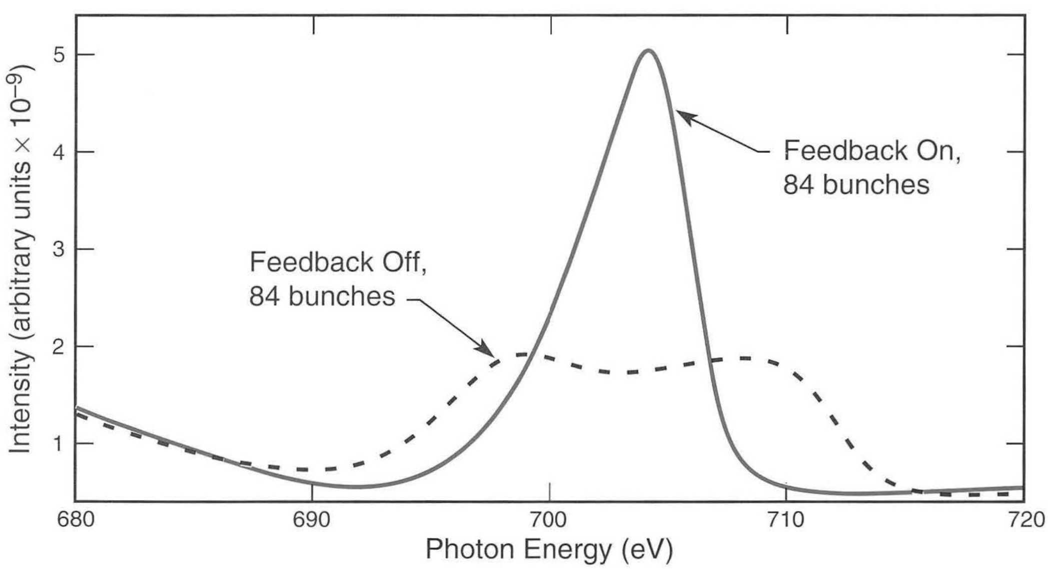
The new monitor's measurements reveal beam jitter (albeit well within the specified tolerances for beam position stability), in which one of the frequency components corresponds to a torsional oscillation mode of a girder supporting magnets in the storage ring. Other periodic beam motions have been correlated with changes of temperature in the low-conductivity water (LCW) cooling system and in the surrounding air. We will continue to address the beam stability issue using additional electron beam monitors like those described above and the diagnostic beamline.

The diagnostic beamline allows real-time observations of beam position, movement, and size, as well as electron bunch lengths, bunch purity, and time-dependent variations of all of these quantities. It is also an extremely versatile tool for diagnosis of instabilities and of drifts in accelerator mechanical and electrical systems. Commissioning of the beamline in its present form started last December.

LONGITUDINAL AND TRANSVERSE INSTABILITIES

When electron bunches interact with each other through self-induced electromagnetic fields in the rf cavities and/or the vacuum chambers, coupled-bunch instabilities (CBI) result. In the ALS, the longitudinal CBI is responsible for a four-fold increase in the energy spread of the electron beam. This energy spread value dominates the linewidths of third, fifth and higher undulator harmonics. A novel feedback system using state-of-the-art digital processing techniques is being developed jointly with groups from Stanford Linear Accelerator Center and LBL's Center for Beam Physics (CBP). Feedback system tests with 84 electron bunches in the storage ring show the expected improvement in spectral performance; full implementation in 320-bunch mode will be possible once the full array of electronics is in place. This work continues to be a high priority for the accelerator group.

When longitudinal feedback is turned on, increasing the peak current and reducing the energy spread in each bunch, a transverse instability appears which results in vertical oscillations of the electrons, increasing the vertical beam size and emittance. The CBP Beam Electrodynamics Group has begun commissioning a transverse feedback system to correct this instability. Full testing of the transverse feedback system, using the eyes provided by the diagnostic beamline, can take place once the longitudinal feedback system is fully commissioned.



Measurement of the fifth harmonic on Beamline 7.0 with and without longitudinal feedback. The feedback system uses state-of-the-art digital processing to reduce the energy spread of the electrons in each bunch, thereby improving the linewidth and intensity of the undulator harmonics.

Workshops Explore New Scientific Opportunities

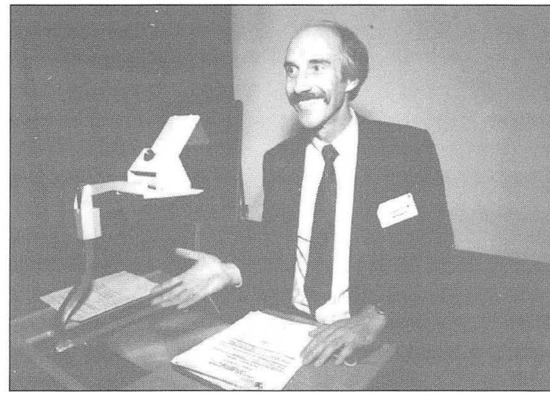
The ALS co-sponsored four workshops held directly before or after the ALS Annual Users' Meeting designed to explore new opportunities and applications of synchrotron radiation.

International Workshop on Photoionization

The ALS hosted over 100 photoionization experts from 16 countries at the third International Workshop on Photoionization in San Francisco, October 24–27. Organized by François Wuilleumier (a member of the ALS Program Advisory Committee) and Fred Schlachter of the ALS, the workshop provided a forum to discuss the status of atomic and molecular photoionization research, including prospects for advances in the field using third-generation synchrotron light sources such as the ALS.

Both synchrotron light sources and lasers have fueled rapid advances in photoionization, contributing to exciting results in atomic and molecular physics. Workshop participants expressed enthusiasm about the active interplay between experiment and theory, and about the important advances photoionization is stimulating in the fundamental understanding of atomic and molecular processes. One important area of progress is electron correlation, which involves looking at atoms as whole entities rather than in a simplified single-particle model.

The results presented at IWP94, including talks by John Bozek (ALS) on the ALS gas-phase undulator beamline (9.0.1) and by several recent ALS users, gave participants a sampling of the exciting new science in atomic and molecular photoionization which is expected to come from all the third-generation synchrotrons including soft x-ray sources such as the ALS and ELETTRA, which cover the photon energy range from the visible to a few keV; and from new high-energy sources such as ESRF, APS (available in 1996 for research) and SPring-8 (available in 1998).



Gwyn Williams from Brookhaven National Laboratory chaired the workshop on infrared microspectroscopy.

Infrared Microspectroscopy With Synchrotron Radiation

The successful implementation and utilization of the U2B infrared microspectroscopy beamline by Gwyn Williams and co-workers on the VUV ring at the National Synchrotron Light Source (NSLS) for the study of a wide range of problems in materials science has raised the possibility of installing a similar facility at the ALS. To explore this issue, an informal workshop chaired by Williams was held at LBL on October 21 to review the performance of the NSLS beamline and discuss the possibility of an infrared (IR) beamline at the ALS.

François Wuilleumier (left) and Fred Schlachter, with Susan Sands, organized the International Workshop on Photoionization.

Infrared spectroscopy has been a mainline analytical tool for decades, both in industry and in the laboratory, owing to its ability to identify molecular constituents of complex materials from their vibrational spectra (molecular fingerprints). In the last decade, advanced optics and detectors have made spatially resolved infrared spectroscopy (microspectroscopy) a popular technique for the analysis of inhomogeneous samples and small particles. IR spectromicroscopes have been limited in resolution because of the low brightness of a black-body source.

Synchrotron radiation is, however, a very bright source of IR radiation: for example, the NSLS VUV ring, the source of the two NSLS infrared beamlines in operation, is at least 300 times brighter than a black-body source over the wavelength range from 1 to 1000 μm.

Workshop talks, primarily given by industrial users of the NSLS infrared beamline, included a comparison of results obtained using IR microspectroscopes and the NSLS VUV ring as the source, and an overview of some of the industrial research applications. The strong interest expressed by the scientific community for additional infrared beamlines led to the decision to build one at the ALS, and the initial design is now underway.

State-of-the-Art Monochromator Design

Specialists in the design, construction, and use of grating-based monochromators convened at LBL on October 24–26 to survey the current status of vacuum-ultraviolet (VUV) and soft-x-ray monochromators. The second in a series of workshops begun at BESSY in March 1991, the meeting attracted some 60 participants.

In several talks, speakers described existing facilities and reviewed the major types of grating-based monochromators—spherical grating (SGM), plane grating (PGM), and varied-line-spacing (VLS). Meeting participants concluded that no single design clearly leads the others in performance, and that a variety of designs would continue to be constructed. Participants also described parallel areas of work such as multilayer optics and x-ray interferometry.

The workshop also provided an excellent opportunity for equipment manufacturers to demonstrate the latest products to their customers in the synchrotron radiation community. Several companies accepted the invitation to display their work, and were included in the oral presentations. Conference organizers were Wayne McKinney, Howard Padmore, and Malcolm Howells at the ALS, and Fred Senf, Bill Peatman, and Wolfgang Gudat from BESSY.

Analytical Applications for Synchrotron Radiation

At a workshop co-sponsored by the Stanford Synchrotron Radiation Laboratory (SSRL) and the ALS on October 19, over 100 scientists gathered to discuss the new SSRL multipole-wiggler beamline for molecular-level analysis of chemical contaminants in diverse environments, and plans at SSRL and ALS to develop facilities for measurement of microcontamination of silicon wafers (eventually as a service to the semiconductor industry).

The morning session featured talks on the potential of the comparatively new field of molecular environmental science to play an important role in radioactive and other waste cleanup because of its ability to identify the elements present and to determine their chemical states. A review of recent experiments using x-ray absorption spectroscopy indicated it appears likely to be one of the main techniques employed in environmental science studies, particularly the techniques of EXAFS (extended x-ray absorption fine-structure spectroscopy) and XANES (x-ray absorption near-edge spectroscopy).

The second major focus of the workshop was to promote discussion on the issues related to the detection of surface contaminants on integrated circuits. Sematech, the collaborative research organization of the U.S. semiconductor industry, is studying the applicability of synchrotron-based total reflection x-ray fluorescence (TXRF) for wafer screening prior to production runs. Piero Pianetta of SSRL reviewed plans underway at both SSRL and the ALS for establishing dedicated TXRF facilities with advanced detectors and wafer handling capability.

Annual Users' Meeting Draws Record Crowd

The opportunity to hear about the exceptional science emerging from the ALS user program drew a record crowd of over 250 to the Annual Meeting of the ALS Users' Association held October 20–21 at LBL. Organized by Users' Executive Committee Chair Michael White (Brookhaven National Laboratory), the program began with remarks from Bill Oosterhuis of the DOE's Office of Basic Energy Sciences, who congratulated the ALS for having exceeded user expectations and described efforts to increase ALS funding in FY96. The rest of the morning featured an overview of ALS operations, beamline construction and commissioning activities, and scientific program development given by ALS management.

The afternoon session was devoted to new results from ALS users, providing ample evidence that the promises of "unique research opportunities" and "experiments not possible anywhere else" made at the inception of the ALS are indeed coming true.

On the second day, the theme was future scientific opportunities at the ALS such as protein crystallography, polymer microscopy, and infrared spectromicroscopy. At lunchtime, everyone gravitated to the ALS to get a closeup view of the beamlines and discuss new products with the 28 vendors who had set up exhibits. A summary of the meeting presentations has been prepared by the ALS; use the insert on page 13 to request a copy. See the back page of the newsletter for the announcement of this year's meeting.

Michael White (right), chair of the Users' Executive Committee (UEC) for 1994, chats with Neville Smith (left) and Jeffrey Bokor, vice-chair of the UEC for 1995.

GET THE LATEST ALS NEWS

Looking for the latest on ALS research, operations, workshops, and other developments? You can find this and more in ALSNews, our weekly electronic newsletter. To join over 450 subscribers in 25 countries who receive ALSNews by electronic mail, please send a "subscribe me" message, including your complete internet address, to alsnews@lbl.gov.

Current and past issues of ALSNews are also available on the World Wide Web at <http://beanie.lbl.gov:8001/als/als_news/als_news.html>. Other links from the ALS HomePage offer current machine status, operations schedules, beamline information, how to become an ALS user, and more.

MARK YOUR CALENDAR!

The Annual Meeting of the ALS Users' Association will be held Monday and Tuesday, October 23-24, 1995, at Lawrence Berkeley Laboratory.

HOUSING ASSISTANCE AVAILABLE FROM LBL RECEPTION CENTER

The LBL Reception Center now offers a variety of housing services to assist visitors to the Laboratory. They can help arrange short-term housing at local hotels or Bed and Breakfast accommodations, and assist with mid- to long-term rentals.
Tel: (510) 486-6198 Fax: (510) 486-6169

ALS ADMINISTRATION NOW IN BUILDING 4

The ALS management, administration staff, and accelerator group moved from Building 80 to Building 4 in May to make way for the construction of the Structural Biology Support Facilities. Phone numbers, fax numbers, and mailing addresses were not affected.

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.

Editor: Jane Cross
Writer: Deborah J. Dixon
Design & Layout: Paula Laguna