1. Opening Remarks

The photograph in Figure 1 was taken exactly four years ago today. It shows an undisturbed, 79-acre site at Argonne. All that you see in the next photograph (Fig. 2) has been constructed on that site in the last four years.

Our goal in designing and constructing the Advanced Photon Source (APS) has always been to provide a facility which, to the greatest extent possible, maximizes the user’s time here. That philosophy has, we feel, been manifested in the buildings and technical components alike.

![Fig. 1. The APS site on May 25, 1990.](image)

![Fig. 2. The APS site on May 12, 1994.](image)
Fig. 3. Plan view of the Advanced Photon Source.
2. Facility Construction

2.1 Conventional Facilities

One result of that philosophy has been our awareness of the need to provide adequate conventional facilities in support of the experimental program. We wanted the user lab/office modules (LOM) to be as efficient as possible. For instance, they are located in close proximity to the experiment hall (Fig. 3). They have space for shop facilities. A number of truck locks have been designed into the facility so that users can bring equipment conveniently to their beamline without leaving a door open to the weather. The first and second LOMs are under construction at this moment. They are scheduled for completion by October of this year. The next two LOMs (of a planned eight) are scheduled for occupancy in December of 1994. We have also issued a notice to proceed on the fifth module, which should be available in 1995. Construction of the remaining three LOMs will be decided based on availability of contingency funds and scientific imperatives. The fifth module is one more than was called for in the original project scope. It is being constructed at no increase in the project total estimated cost.

The experiment hall (Fig. 4) has been designed to be stable and quiet. We worked hard to reduce the noise in the experiment hall. We believe it will be a pleasant place to work, where one will be able to hear a colleague from two feet away without shouting. The HVAC system is designed so that the zones match the topology of each sector, providing some control over the distribution of the air in each sector to offset any beamline hot spots created by equipment. Suffice it to say that the buildings are meeting all of our objectives, and we are proud of our Conventional Facilities Group for achieving that goal and doing so on schedule.
2.2 Central Laboratory/Office Building

A 170,000-sq-ft central laboratory/office building (CLO), which will be located adjacent to the experiment hall, is scheduled for completion in September of 1995. The CLO (Fig. 5) will have a 550-seat flexible meeting facility, offices for APS staff and long-term visitors, and a number of amenities for users, including various conference rooms and 44 laboratories, each 500-sq ft, located in a 4-story wing.

2.3 User Residence Facility

Detailed design for a user residence facility (URF) is on-going. The URF (Fig. 6) is being completely funded by the State of Illinois in what we think is a remarkable commitment. Illinois Governor Jim Edgar came to Argonne recently and presented a check in the amount of $1.5 M for design of the URF. We plan to finish the design by midsummer, at which point we hope to have received the balance of the State appropriation in the amount of $17.4 M for construction. We’re very grateful to the State of Illinois for following through on a promise made several years ago by a previous administration.

The multistory, 140,000-sq-ft URF is to have a capacity of 240 beds — 160 in single, hotel-type rooms, and an additional 80 beds in 24 quad units. The URF is designed to operate like a hotel, with staff present 24 hours a day. Users can check in or check out and interact with the staff at any time. The URF will have a dining facility to provide dinner for 200 people at a seating, a meeting room, a user lounge, and various support facilities including a laundry. An innovative
consideration is the network of fiber-optic data links that will connect work stations in every
room to the residents’ experiments, allowing residents to monitor their experiments at any time.

In developing the rate structure for the URF, we have decided to run the facility on a full cost
recovery basis. We believe that will be possible because the building is being funded by the
State of Illinois. Since we will have no mortgage, we expect to use the resulting financial flexi-

bility to provide a discounted room rate for students. If you can think of anything else that
might make this building user friendly, please let us know.

Fig. 7. The APS electron gun and electron linac.

3. Accelerator Systems

3.1 Accelerator Commissioning

The first electron beam at the APS was accelerated in October of 1993. The electron linac (Fig.
7) is now operating at the design energy of 200 MeV and is performing very well. All modula-
tors and accelerating sections in the positron linac (Fig. 8) are operating. This segment of the
linac has been used to accelerate electrons (we are not yet producing positrons) to energies near
400 MeV for injection into the positron accumulator ring (PAR). We hope to produce and accel-
erate positrons in late summer or early fall of this year. Meanwhile, we are commissioning the
rest of the booster complex with electrons. PAR commissioning with electrons began in
February (Fig. 9). We achieved a few turns of stored beam in April and, in fact, injected into the
booster (Fig. 10) and achieved one turn. So we can now say that particles have traveled through
the entire injection system. We haven’t done any significant synchrotron commissioning at this
point, other than running some of the subsystems and working on the controls and diagnostics,
which are functioning extremely well.

As for the storage ring, it is approximately 60% installed. By the end of last week, 115 out of
200 girders were in place in the tunnel (Fig. 11). One can enter the storage ring tunnel and walk
Fig. 8. Looking upstream along the APS positron linac.

Fig. 9. The APS positron accumulator ring.

Fig. 10. The APS booster synchrotron.
for quite a distance past seemingly endless sections of storage-ring girders. That is a source of
great pleasure for all of us. We are anticipating completion of storage-ring girder installation in
September of this year, followed by various other activities directed at completing the storage
ring by mid to late November. That schedule should allow us to meet the January 1, 1995, start-
of-commissioning milestone. I’m very pleased that the Accelerator Systems Division has not
flinched from the challenge of getting this complex machine into that tunnel on that time scale
and beginning commissioning. If you encounter someone from the Accelerator Systems
Division during this meeting, you might want to congratulate them on their success so far.

3.2 Control System Software

In addition to a great deal of work on hardware, there has also been extensive effort directed at
software development. One result has been our codevelopment (with Los Alamos National
Laboratory) of the EPICS (or Experimental Physics and Industrial Control System) software.
This high-performance, distributed run-time environment for data acquisition and control has
proven to be a great success. EPICS is being used to run all of our accelerators and beamlines.
It is designed for ease of use and has been adopted by a number of other accelerator laborato-
ries. When Governor Edgar visited us to deliver the $1.5 M for the URF, we took advantage of
his presence to help debug the EPICS system. We invited the Governor to push a button that
sent a signal via EPICS to fire the first official pulse of electrons in the linac (Fig. 12). The feed
from video cameras, which we were assured were looking at the fluorescent screens, started
flashing. All we asked was that the linac appear to be running, and I think it actually was.

4. Experimental Facilities

4.1 Insertion Devices

There is a tremendous amount of work going on in the Experimental Facilities Division (XFD),
as you will see during your visit. Some highlights include completion of the first production
APS Undulator A by the vendor, STI Optronics. The device is measuring up very well in vendor tests. Its field characteristics are 10% in excess of our requirements, so we are sure that Undulator A is going to yield the kind of performance that we’ve all been hoping for. By implementing some mechanical improvements, we have eliminated the so-called “brilliance gap.” As a result, these IDs are going to provide a wide range of spectral tunability at brilliance levels in the $10^{18}$ and the $10^{17}$ regime. Work is also proceeding on the design for wigglers.

4.2 Front-End Components

All of the bid packages for front-end components have been awarded and some of the first articles have been received. As part of the facility tour, you will be able to see the front-end prototype that has been assembled by the XFD Mechanical Engineering Group (Fig. 13). This prototype is being used to refine the design and also to train technicians. This way, when front-end installation begins in the storage ring, we will be able to make efficient use of the limited time that is going to be available due to the fact that this activity will be interleaved with storage ring commissioning.
4.3 Monochromators

Another highlight of the year from the Experimental Facilities Division is the success of the inclined monochromating crystal. This double-crystal monochromator, the basic crystal-carrying assembly, was built by Kohzu. It has been integrated with our liquid-gallium-cooled, inclined crystal geometry and is ready for test (Fig. 14). It, too, is available for you to observe during the course of the meeting.

As you can imagine, many other achievements have been attained by the Divisions. Tomorrow you will hear about them in considerably more detail, including specific planning dates for storage ring commissioning, for undulator installation, and for beam availability throughout the course of 1995 and early 1996.

We continue to be very interested in joining our resources with those of ESRF and the Japanese Super Photon Ring 8-GeV (SPring-8) in order to deal with some of these challenging problems, particularly that of high heat loads. The advent of diamond crystals affords an opportunity to combine some of the high-heat-load engineering with diamond crystal technology to devise monochromators that work at extreme levels of thermal load. The Japanese have made arrangements with their Sumitomo Laboratory to produce diamond crystals, and we find that a very attractive prospect. Diamond crystals are actually in use at ESRF, but there is also experience here in the U.S., primarily at NSLS. There is an active effort around the world to develop diamond monochromators. It will require a very substantial effort to build a robust monochromator based on a readily available supply of diamonds if we’re going to count on this kind of technology. There are a number of other projects where the three laboratories can benefit from each other’s expertise.

5. Operations Objectives

5.1 Operating Energy

As the Project moves forward, we feel more and more assured that our principle performance goals will, in fact, be achieved. We are not planning to operate at 7.5 GeV, but we believe we can if we so desire. In fact, where appropriate we have used this higher energy as a design parameter to ensure that we could reach 7.5 GeV if need be. This approach affords a comfort margin that is important psychologically if nothing else, but that also might well be important technically. The machine can operate at 300 mA at 7 GeV, or 200 mA at 7.5 GeV. Of course, the
initial plans are for 100 mA/GeV operation. We do not, at this point, have the technology needed to cool a monochromator crystal being heated by beam currents that are substantially higher than 100 mA. That is a long-term R&D objective. But we believe that all of the storage-ring components, including the shielding, the crotch absorbers, and all the storage-ring hardware, can tolerate as much as 300 mA. So, the challenge is in the optics. We believe that the accelerator issues, while not trivial, are now taken care of.

5.2 Beam Stability

Beam stability is extremely important, as you know. We are doing many things to address that concern, such as designing the entire complex to operate in top-off mode in order to provide constant current to the users. We are quite confident that we will easily achieve the 10% of emittance specifications that we have advertised for many years. The PAR seems to be working very well. We needed the PAR in order to take full advantage of the high-frequency linac and to achieve fast injections with positrons. By adding that ring to the accelerator complex, our injection rates were increased to the degree that we can achieve 100-mA currents in less than a minute. That is being done regularly with electrons at the European Synchrotron Radiation Facility (ESRF) in France. It is a real pleasure for the ESRF user community to see injection occur in less than a minute following a beam loss. That way, your whole experimental team doesn’t diffuse away to the coffee pot and then require another hour for recollection. They get the beam right back and nobody has time to leave. (If that’s a disadvantage, let us know.) As difficult as it is to achieve that kind of injection with electrons, it is more difficult with positrons because only a few positrons are produced in the target for every thousand electrons. The accumulator ring will also provide extremely clean bunches for timing experiments.

6. Collaborative Access Teams

6.1 Memoranda of Understanding

The Proposal Evaluation Board (PEB) has to date approved 20 of our 35 sectors for use by 15 Collaborative Access Teams (CAT). The number of sectors that we currently plan to instrument in the first phase is 16. There is an obvious difference between these two numbers. We will have to rectify this gap by securing funds for additional front ends and insertion devices. The number of sectors where we have actually entered into formal Memoranda of Understanding (MOU) as of this date is nine. The number of sectors for which we expect to have signed MOUs by the beginning of August 1994 is 14. So we are still within our first-phase capability. The CATs requesting the remaining six sectors are faced with funding problems. It will be some time before they arrive here looking for front ends. In the meantime we will be working on the funding to provide additional front ends and insertion devices for the storage ring.

6.2 CAT Funding

Our CATs have had remarkable success obtaining financial support in a very difficult climate for funding. Teams have raised some $115,000,000 so far, which is approximately 60% of the initial estimate for construction of 14 sectors. That success is enabling these 14 sectors to proceed with design and construction of 28 beamlines. We believe that the majority of those beam-
lines will exist when the APS begins operations in 1996. We do not foresee two or three years of operations with only a small number of beamlines on the floor. Rather, we expect to have on the order of 20 or so beamlines relatively soon with the balance to follow in good time.

6.3 Foreign Participation in Research at APS

We now have international participation from Canada, which has membership in two of our CATs. We are in discussions with research institutions in Israel, Taiwan, and Australia about the possibility of their involvement at APS. Israel has expressed some interest in developing a full sector, although they may also join with another group. The other two countries are interested primarily in collaborations of various sorts rather than in developing their own sector. Recently, the Japanese have expressed curiosity as to whether we would accept a proposal from their industry to do research at the APS. It is an interesting question, particularly for the Department of Energy people in the audience, as to whether we would like to do that or not.

7. Concluding Remarks

All of the accomplishments noted here (and more) have been realized by many individuals, including one large group of people who have labored on our behalf over the life of the project. Users, obviously, have a vested interest in this facility. Those of us on the Project are paid to do this job, so that's at least one motivation, although we have others. But the people I’m addressing right now are not paid and they are, in most cases, without any direct interest in using this facility. These people come here and give us their counsel. They have worked very hard over the last six or seven years to assist in bringing this project to its current stage. So, as we move closer to the day when the APS begins operations, it is very appropriate to thank all the members of our various advisory committees for their splendid work.

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