magnets that greatly intensify the radiation beams—and the beam lines and detectors where experiments are conducted. That means researchers who have their plans approved will be directed to an already existing experimental station (seven at first, 30 by 1998). At APS, however, the current budget covers the construction of only half of the insertion devices and their support instrumentation, but none of the actual experimental stations. Thus universities, national laboratories, and industry must go out and find funding to build optics and experimental stations of their own. Nineteen consortia have already been formed for this purpose.

David Moncton, the associate laboratory director at Argonne responsible for the APS project, argues for this system. He says that when scientists create their own beam lines, they "have a much more substantial stake in the facility, and they have a much easier mode of access to it. They are not writing elaborate proposals for each piece of beam time they get."

The Big Three

	ESRF	APS	SPRING-8
Energy	6 GeV	7 GeV	8 GeV
Main ring circumference	844m	1104m	1435m
First use	1993	1996	1998
Final no. of beam lines	30	70	80
Cost	**$500m**	**$456m[1]**	**$1000m[2]**

[1]Only half insertion devices and beam line front ends included.
[2]Current estimate.

But Moffat does not entirely agree. He is co-director for biological sciences of the Consortium for Advanced Radiation Sources (CARS), a group based at the University of Chicago and including scientists from about 30 institutions. "It's like going out and buying an automobile off the showroom floor, but without the steering wheel, the instruments, or the seats," he complains. "The plus side is that the beam lines will be custom tailored for the needs of a specific group of scientists. But uncertainty comes from not knowing whether we will be able to raise the money. If you can't afford the complete new car, you might have to stick with the old one."

The old car is, in any case, what most Americans will have to stick with until the opening of APS. ESRF officials say that foreigners will be welcome—but beam time will be allocated to scientists roughly in proportion to how much cash their respective countries donated to construction costs. That means, in most cases, that researchers from outside nations who want a piece of the new synchrotron action will have to form collaborations with eligible users. The other route, Haensel says, is by an arrangement in which an institution in another country makes a "contribution against a certain share of beam time." That would close the circle—three decades after being labeled a parasite on other people's machines, Haensel now finds himself contemplating charging researchers to use Europe's world-leading facility. ■ MICHAEL BALTER

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The Biggest and the Brightest

Tokyo—Japan's SPring-8 (Super Photon Ring-8 GeV) will be the last of the big three synchrotrons to be completed, but by 1998 it will be the most brilliant x-ray source in the world. "That is what makes it exciting for me," says Hiromichi Kamitsubo, a nuclear physicist who heads the project.

Construction is set to begin next week at Harima Science Garden City, a new town about 60 miles west of Osaka. Original plans were for a 6-GeV machine similar to that at European Synchrotron Radiation Facility (ESRF), but the demands of Japanese atomic spectroscopists forced planners to head for the world's most powerful machine, says Kamitsubo. Researchers wanted 20-25 keV x-rays capable of reaching the binding energies of inner-shell electrons of heavy elements, he says, giving them the unique capacity to study the electronic structure of atoms, all the way up to uranium. To generate x-rays that powerful, the storage ring energy had to be boosted to 8 GeV.

With its higher energy and brilliance, SPring-8 will push the frontiers back even further than ESRF and the Advanced Photon Source in terms of the speed and resolution with which it will be able to gather data. Thanks to its added power, SPring-8 will also have a big advantage in the international race to realize the x-ray crystallographer's dream—x-ray holography.

If high-resolution x-ray holography can be made to work, it would be possible "to directly visualize—not just see complex x-ray diffraction patterns of—the structure of materials, as if we are looking at them with a microscope," says Kamitsubo. The principle is just like conventional holography in which a beam of coherent laser light is scattered from an object, recombined with a reference beam, and a three-dimensional hologram created in a photosensitive material. The problem is that there is no easy way to produce high-powered coherent x-rays.

One possibility is to use the Mossbauer effect, in which gamma rays (high-powered x-rays) emitted from a nucleus keep their natural very narrow energy line width. To stimulate gamma ray production—in, for example, the 14.4 keV transition of the Fe57 nucleus—an extremely powerful source of synchrotron radiation is needed. At 8 GeV, SPring-8 may have what it takes to steal a march over its competitors.

X-ray holography is just one possible application for SPring-8, however. Like the other big two synchrotrons, SPring-8 will provide for an extraordinarily diverse set of research areas: everything from nuclear excitation and atomic physics through nuclear resonance scattering and photoacoustic spectroscopy to studies of biological macromolecules in solution.

But even in more conventional areas some Japanese researchers are clearly worried about their ability to take a world lead. Japan may not have enough engineering manpower for such a difficult project, says Seiji Iwata, head of the physics department at Japan's High-Energy Physics Research Institute (KEK), even though the project is backed by two of Japan's biggest research institutes—the Institute of Physical and Chemical Research (RIKEN) and the Japan Atomic Energy Research Institute (JAERI).

Kamitsubo admits the challenge is great but says that Japan has succeeded in the past. "When we made our cyclotron, we used a staff one-tenth of that at a similar project in France," he says. Once the project is under way, he believes he will be able to borrow many talented engineers from industry. And until then he is using scientists from around the world to obtain feedback on SPring-8's design. Final details, he says, will be worked out in the light of their comments. ■ FRED S. MYERS

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