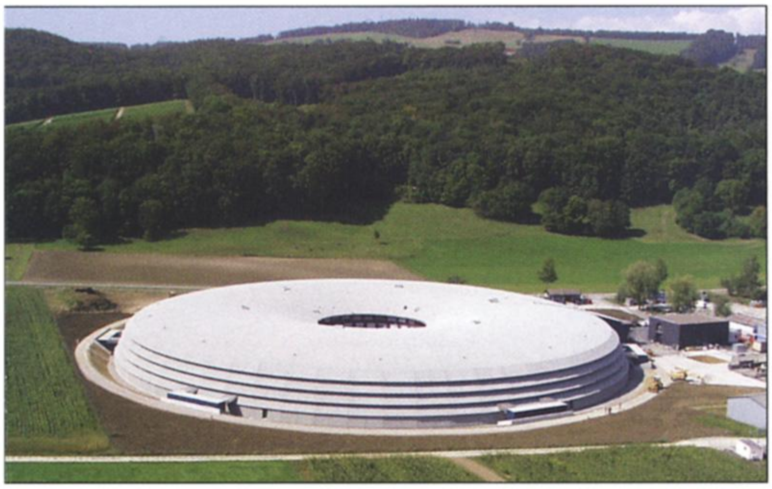
SYNCHROTRON RADIATION

Swiss Source Shows Small Is Powerful

VILLIGEN, SWITZERLAND—This week Swiss researchers will proudly unveil the Swiss Light Source (SLS), a modestly sized synchrotron that punches well above its weight. Based here at the Paul Scherrer Institute, the SLS produces high-energy, or "hard," x-ray beams comparable to much bigger sources such as the European Synchrotron Radiation Facility (ESRF) and the U.S. Advanced Photon Source. Such beams are essential for unraveling the structure of complex biological molecules and a host of other applications.

Local researchers are looking forward to having such a machine on their home patch. Tim Richmond and his colleagues at the Swiss Federal Institute of Technology in Zürich rely on x-rays to elucidate the mechanisms underlying gene expression. In earlier work teasing out the atomic structure of the nucleosome—the DNA packaging apparatus—Richmond's group had to travel to Grenoble, France, to use the ESRF. Now, they have a state-of-the-art facility just down the road. "It's the difference between being able to conceive of doing a large project and not being able to," Richmond says, "and doing it on a reasonable time scale."



Ready to roll. The Swiss Light Source will soon welcome researchers from across the globe.

Synchrotron light was discovered in the 1940s in early particle accelerators. When physicists bent a beam of fast-moving particles, they found that some of the energy was shed as light. The laserlike light soon proved useful in other branches of physics as well as materials science and, more recently, biology.

In the SLS, a beam of electrons is boosted to close to the speed of light in a circular accelerator and then transferred to an outer storage ring, where magnets keep the particles circulating at constant energy for between 10 and 30 hours. As the electrons round each bend, they emit light of varying wavelengths that is tapped off along beamlines to experimental stations.

As researchers get more skilled at using synchrotron radiation, they are demanding higher energies and more intensity (more photons per second). This usually means bigger machines. For example, the ESRF, which came online in the early 1990s, is 844 meters in circumference and produces an electron beam with an energy of 6 giga–electron volts (GeV). The ESRF uses specialized magnetic devices known as undulators and wigglers to manipulate the electron beam and customize the x-rays to researchers' needs.

For the SLS, project leader Albin Wrulich says, designers used a few "tricks" to get similar performance out of the new machine, pushing current undulator technology to the limit to increase x-ray intensity and the range of wavelengths available. As a result, although the SLS is just 288 meters around and has a 2.4-GeV electron beam, it produces x-rays of almost the same intensity as the ESRF's and, at $89 million, cost less than a third as much.

After its 19 October inauguration, engineers will continue to fine-tune the SLS before it is opened to the research community in January 2002. For Richmond, who hopes to show people what DNA looks like in higher cells through x-ray crystallography and to relate that structure to its function, the SLS is the perfect tool. All he needs now, he says, is a crystal. –**GISELLE WEISS**

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WEATHER FORECASTING

Getting a Handle on The North's 'El Niño'

The lowermost layer of Earth's atmosphere—the troposphere, the place where all the people live—is a forecaster's nightmare. Weather patterns are capable of jumping without respite or warning from one mode of operation to another. This volatility is especially dramatic in winter. Frigid winds and powerful storms might first range far south of their usual haunts then retreat farther northward than usual, seemingly unpredictably, producing a midwinter respite. Only El Niño had seemed able to lock the weather into one regime or another long enough for forecasters to anticipate prolonged periods of extreme winter weather weeks or months ahead. Now forecasters have the prospect of another, unlikely steadying influence on the weather: the wispy stratosphere overlying the troposphere.

On page 581 of this issue of *Science*, meteorologists Mark P. Baldwin and Timothy J. Dunkerton of Northwest Research Associates in Bellevue, Washington, report that despite its reputation as a lightweight, the stratosphere at times reaches down through the troposphere to push Northern Hemisphere weather toward one extreme regime or the other for a couple of months at a time. That could give forecasters an edge in long-range predictions at middle and high latitudes comparable to that provided by El Niño at some latitudes. And it clearly shows that "there's no brick wall up there" sealing off tropospheric weather from the rest of the atmosphere, says meteorologist Marvin Geller of the State University of New York, Stony Brook. "To understand weather or climate, it's good to look at how the whole atmosphere is behaving."

Atmospheric scientists had long identified higher latitude weather oscillations in the stratosphere and troposphere, but until now they hadn't established a downward connection between the two. In the stratosphere, a polar vortex of high-speed winds that swirls around the North Pole in a ring 10 kilometers or more above Canada, Scandinavia, and Siberia waxes and wanes, sometimes abruptly. At the surface, the North Atlantic Oscillation (NAO)—a wobbly seesaw of varying atmospheric pressure that spans from Iceland to Lisbon—swings from one extreme to the other, redirecting winds around the North Atlantic and switching regional weather between cold and stormy and mild and fair (*Science*, 7 February 1997, p. 754).

In 1998, meteorologists David Thompson of Colorado State University in Fort Collins and John M. Wallace of the University of Washington, Seattle, expanded the NAO concept to encompass the entire higher latitudes and called it the Arctic Oscillation (AO). The tropospheric AO works much as the polar vortex does in the stratosphere. The AO involves the prevailing westerly winds that oscillate in strength and position to shift weather patterns around the hemisphere (*Science*, 9 April 1999, p. 241). When the shifts persist long enough, climate changes.

Thompson and Wallace's work prompted Baldwin and Dunkerton, who are stratosphere specialists, to look higher in the atmosphere for AO connections. To their surprise, they found downward links as well as upward ones. A switch from a strong stratospheric vortex to a weak one, say, would move down through the stratosphere, entering the tropo-

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