SSRL REPORT

SPEAR BECOMES A SHARED FACILITY

In October 1979, a kind of marriage took place at SLAC. This was the start of an agreement that SLAC and SSRL would "share equitably in the use of all the resources of the SPEAR facility," and also that they would "share equitably the annual operating costs...." As with any marriage, the beginning of conjugal life was preceded by a long period of getting to know each other, working together and gradually getting more involved.

History Of The Development Of SPEAR

SPEAR began operating as a colliding-beam storage ring in June 1972. Storing electrons (and positrons) in a circular orbit inevitably results in the production of "synchrotron radiation"—intense beams of ultraviolet light and X-rays that fly off tangentially from all curved parts of the orbit.

The designers of SPEAR had had the foresight to include a tangential spout to facilitate the extraction of synchrotron radiation even before a program for the use of such radiation existed. A pilot program to utilize the radiation from this spout was initiated in late 1972 in cooperation with the Stanford Center for Materials Research. One experiment began operating inside the SPEAR tunnel in July 1973.

In June 1973 the National Science Foundation funded the Stanford Synchrotron Radiation Project (SSRP) as a national facility for research in this field. The facility began operation in May 1974, with 5 experimental stations sharing the beam line.

Growth Of Synchrotron Radiation Research

According to the original agreement between SSRP and SLAC, synchrotron radiation research was conducted parasitically during colliding-beam runs of SPEAR. However, even within the severe limits imposed by this parasitic mode of operation, the research program of SSRP grew rapidly. Many new experimental techniques were developed, and many important results were achieved. A second beam line with 4 additional experimental stations began operating in May 1976.

By the end of 1976, the SSRP user community had grown to about 200 scientists from 52 different institutions, and there were 138 active research proposals. At that time a new proposal was submitted for an expansion of research facilities, including a new experimental hall, new beam lines and a wiggler magnet. This proposal was approved by the NSF, and a three-year construction program was begun. The scope of the activities had grown to the point where it was clearly no longer simply a "project," and in 1977 the name of the facility was changed to the Stanford Synchrotron Radiation Laboratory (SSRL).

Stanford scientists were not alone in their interest: similar developments had been occurring at other laboratories, most notably at the University of Wisconsin which began operation of Tantalus, a 240 MeV storage ring, for synchrotron radiation in 1968; and at Orsay, France, where a parasitic program was begun in 1971 using the 540 MeV storage ring ACO.

The increasing numbers of physicists, chemists and biologists eager to use synchrotron radiation in their research led to the expansion of facilities at many existing sources and also to the construction of eight new storage rings around the world as dedicated sources. At SLAC it was clear that the experimental possibilities of the new and growing facility would need a stronger relationship between SPEAR and SSRL, one in which SSRL would have more control over operating conditions.

Consequently, an agreement was reached with SLAC in 1976 that SPEAR would become available as a dedicated synchrotron radiation source for 50% of its operating time as soon as the new PEP storage ring was ready. For a variety of scientific and budgetary reasons, the 50-50 shared mode of SPEAR operation actually started in October 1979, some months earlier than the original target date.

Advantages Of Dedicated Operation

In dedicated operation for synchrotron radiation research, the SPEAR ring is filled only with electrons, and no colliding-beam work is done. The stored current is no longer limited by interactions between the two beams, so much higher currents are possible. Also, the energy of the stored electron beam can be determined by the needs of the SSRL program, rather than by those of the high energy physics experiments. Typically, the beam energy is chosen to be in the range from 2.6 to 3.7 GeV, with most operation around 3.0 GeV.

In parasitic operation during colliding-beam runs, the synchrotron radiation is usually much weaker than in dedicated operation. For example, during the past several years about 3/4 of the high energy physics experiments required beam energies in the range from 1.8 to 2.2 GeV, and at these energies the beam-beam interactions limit the stored current in each beam to about 10 milliamperes (mA). Under such conditions the total synchrotron radiation power is only about 1 kilowatt, and the highest useful photon energy radiated from the bending magnets is about 6 KeV. This is partially offset by the fact that the special 18-kilogauss wiggler magnet in SPEAR does provide at present a high flux of photons with energies out to about 20 KeV in one of the SSRL beam lines.

In contrast to these numbers for parasitic operation, the dedicated mode of SPEAR running makes use of a 3 GeV beam having about 100 mA of stored current, which produces a radiated power of 50 kilowatts and a highest useful photon energy from the bending magnets of about 20 KeV.

Another advantage of dedicated operation is the fact that the stored electron beam has a smaller cross-sectional area or reduced emittance. This results in synchrotron radiation beams of higher brightness, which means that the experimenters generally get a counting rate that is some 2-5 times higher per mA of stored beam. Furthermore, the lifetime and stability of the stored beam are much improved compared to colliding beam operation. Considering all these advantages, and the fact that most of SSRL's 280 presently active proposals require photon energies between 5 and 20 KeV, the dedicated mode of SPEAR operation adds immensely to the laboratory's capabilities.

With synchrotron radiation research having equal priority on SPEAR, it is now possible to study and improve the ring to realize more fully its potential as a synchrotron radiation source. For example, machine physics studies are planned to increase the stored current, decrease the emittance (which increases beam brightness), shorten the bunch length, improve the control of the orbit and beam-line steering, and reduce the noise levels. A new "ramping" procedure has already been developed to improve the efficiency of dedicated operation. With this new procedure, electrons are injected from the SLAC linac at an energy of 2.6 GeV (the highest energy that can be handled by the injection transport system). Then the beam is "ramped" up to, say, 3 GeV and is stored for some 6-10 hours, after which time the stored current has decayed to about 60% of its initial value. The SPEAR energy is then ramped back down to 2.6 GeV, injection proceeds to top-up the current to 75-100 mA, and the energy is then ramped up again to 3 GeV. Under good conditions, the entire rampdown, top-up and ramp-up procedure takes only about 20 minutes or even less.

All in all, as a dedicated synchrotron radiation source SPEAR provides much improved intensity, spectral range, lifetime, stability and duty cycle as compared to colliding-beam operation; and these improvements are having a major impact on SSRL's experimental program. The faster rate at which experiments can now be performed is beginning to ease the large backlog that accumulated during the "X-ray drought" of parasitic operation. In addition, the large increase in photon flux now available has opened up new experimental possibilities in areas where the counting rates were too low during parasitic operation. A particular example is the use of X-ray absorption spectroscopy in the study of the local atomic environments around specific elements that are only present in extremely low concentrations, e.g. surface monolayers or the active sites in biological enzymes or chemical catalysts.

The marriage of high energy physics and synchrotron radiation research at SPEAR has already lasted about three months. The partners are learning to work effectively together and to accomodate eachother's needs. Evidence of the consumation of the marriage is expected in about nine months, when twin wiggler magnets are scheduled to appear in SPEAR. The increase in colliding beam luminosity plus the enhancement of synchrotron radiation that will be provided by these magnets is likely to strengthen the bonds between the SPEAR partners.

—John Harris & Herman Winick

MARGARET HERNANDEZ JOINS AFFIRMATIVE ACTION OFFICE

I would like to introduce Margaret Hernandez, the new Assistant Affirmative Action Officer at SLAC. "Margie" is a native Californian who came to Stanford University in 1971 to pursue a Bachelor's degree in Anthropology, which she received in 1975. According to Webster's Dictionary, anthroplogy is "the science of man; esp.: the study of man in relation to distribution, origin, classification and relationship of races, physical character, environmental and social relations, and culture." Since Webster was not very progressive, Margaret also conscientiously included the study of "woman."

Margaret is currently attending Santa Clara University School of Law to complement her career. Her previous experience at Stanford includes work in the Office of Chicano Affairs, after her graduation, and also a part-time position as an Activities Advisor in the Office of Student Affairs. She is thus very familiar with the Stanford Community.

Her specific interest in equal employment opportunity and the administrative skills she has acquired while at Stanford will be important assets here at SLAC. We trust that her professionalism and cooperativeness will be evident to all as she begins to exercise her responsibilities in the laboratory.

—SueVon Gee