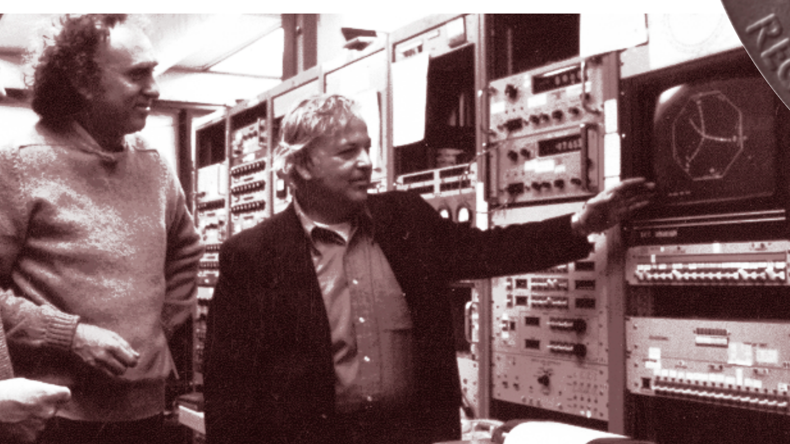
Highlights from the History of SLAC

The present SLAC site houses the two-mile long electron and positron linear accelerator (linac), built to provide high energy beams (14 GeV) of electrons and secondary beams of hadrons to a host of fixed-target experiments. Since the original construction the linac's peak energy has been raised twice to enable the production of 50 GeV beams of highly polarized electrons and unpolarized positrons for the linear collider program. The original program of fixed target experiments lead to the first evidence for the parton-nature of matter, for which Professor Richard Taylor was awarded the 1990 Nobel Prize in Physics.

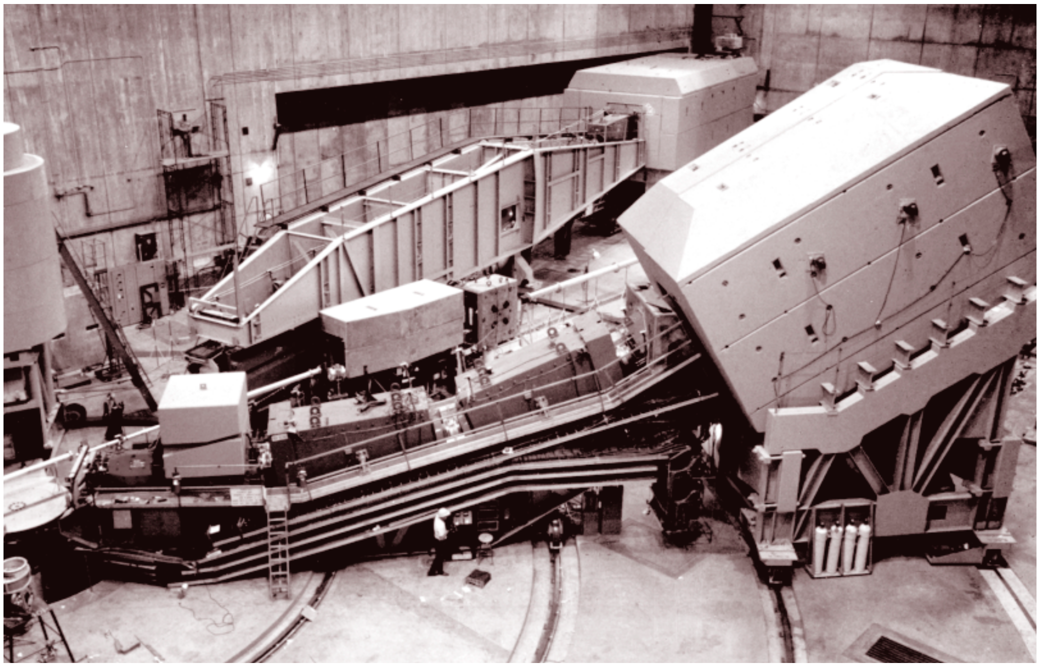
The electron linac has been used subsequently as the injector to several generations of e^+e^- storage rings. Research at the first of these, the SLAC Positron-Electron Accelerator Ring (SPEAR) began in 1972 and in 1974 lead to the Nobel Prize winning discovery of the Psi particle, ψ. The discovery of this bound state of a pair of new heavy quarks with the flavor quantum number "charm" was made by Professor Burton Richter. This period became known as the "November-Revolution" in particle physics and provided strong experimental support for what we now know as the "Standard Model," the theoretical model that has guided our understanding of the quark-lepton nature of matter and the unification of the weak and electromagnetic forces governing their interactions. Several years after the ψ discovery, researchers at SPEAR provided first evidence for a new heavy lepton, the tau, τ. For the discovery of the tau lepton, Professor Martin Perl was awarded the Nobel Prize in 1995. With two interaction regions, SPEAR continued to operate for high energy physics through the late 1980's and provided increasingly precise measurements of charm mesons decays, τ decays, and ψ decays. SPEAR was eventually turned over to the non-high energy physics community for fulltime operation as a synchrotron radiation light source.


Nobel Laureates Martin Perl and Burton Richter in the SPEAR/MARK I Control Room.

Tests of the Standard Model continued to be the focus of elementary particle physics research for three decades since SPEAR. Following SPEAR in the early 1980's a higher energy storage ring PEP-I was built. The upgraded linac provided 20 GeV beams to this storage ring and important measurements were made confirming that the "gluon" mediator of the strong force between quarks could be described in a similar mathematical framework as the electroweak theory. PEP-I experiments pioneered the first measurements of the lifetimes of the new heavy quarks, charm and beauty, the tau lepton and the technologies needed to do so.

In the early 1980's a novel accelerator was proposed to upgrade the energy of the linac to ~50 GeV and accelerate and collide highly focused bunches of polarized electrons and positrons on each other to create the Z^0 boson at rest and study its decays. The ability to longitudinally polarize the electron beam would provide some the most stringent tests of the Standard Model. The accelerator, called a "single-pass linear collider" or SLC, was designed and built in a new tunnel at SLAC. Two experiments, Mark-II and SLD, used this facility to carry out precision tests of the Standard Model through the end of the 1990's. The success of the SLC demonstrated the viability of the new linear collider technology to take e^+e^- collisions to the highest energies and lead to the ongoing design and proposal for the 0.5 TeV to 1 TeV International Linear Collider known as the ILC.

By the end of the 1980's observation of a large rate of mixing of neutral B-mesons made at Cornell's e^+e^- Storage Ring (CESR), combined with the precise measurement of B-meson lifetimes at PEP-I, SLC, and LEP lead the world to believe that charge conjugation-parity violation (CP violation) might be experimentally observable in the neutral B-meson system. To date, only mesons containing strange quarks had exhibited this small asymmetry between particle and anti-particle decay. To carry out this experiment required a means of producing B-mesons at a rate more than 10 times higher than that of Cornell. In addition, a means of tagging the initial state B^0 as particle or anti-particle was essential. By the early 1990's the technology to carry out this measurement was understood and construction of a new storage ring called "PEP-II" was undertaken in the original PEP tunnel. Approval for construction of a new detector nicknamed "BABAR" followed immediately thereafter. In late 1999 the experimental program began and by 2002 the first evidence for CP violation in the B-meson system was published. By summer 2004 evidence for direct CP Violation in the B system was emerging. The B-physics program is presently undertaking its first upgrades to allow data taking to continue competitively until the end of the decade. The last decade of neutrino physics and astrophysical observation, combined with the results of more and more precise accelerator-based experiments has lead to new insights, as well as fundamental questions about our picture of the nature of matter in the universe. Recognizing the value of non-accelerator-based research, SLAC physicists began participation in several new projects in the early 1990's: the Fractional Charge Search, a state-of-the-art search for fractional charge in matter; EXO, in the area of neutrino physics; and GLAST, a joint NASA-DOE spaced-based observatory scheduled for launch in 2007. The extent of SLAC experimental particle astrophysics programs and the onset of a theoretical research component broadened significantly with the founding of the Kavli Institute for Particle Astrophysics and Cosmology at SLAC and Stanford, in 2003.



Spectrometer that Provided First Proof of Partons in Matter, and the Nobel Prize for Richard Taylor.