

# MEMORIAL RESOLUTION EDWARD LEE GARWIN

(1933-2008)

Edward Lee Garwin, SLAC Emeritus Professor of Applied Research, passed away in Stanford, California on November 11, 2008. Ed was born on March 22, 1933, in Cleveland, Ohio, son of Robert Garwin and Leona Schwartz Garwin, and brother of Richard Lawrence Garwin. Ed received his Bachelor's degree in Physics from the Case Institute of Technology, and his PhD in Physics from the University of Chicago in 1958, with Valentine Telegdi as his advisor. Ed married Elaine Judith Katz of Cleveland in 1954; who also found employment working for Telegdi scanning photographic emulsion detection of nuclear events. After Ed received his doctorate, he moved to the University of Illinois at Champaign-Urbana. Next he worked briefly for the GTC Corporation in Redondo Beach, CA.

Ed Garwin came to SLAC in 1962, just as construction of the two-mile accelerator was getting underway. The design of the accelerator itself had been refined and tested, but the experimental facilities and the beam "switching" to those facilities were still very much in the conceptual stage. SLAC beams were projected to be more than one hundred times more powerful than the beams at the High Energy Physics Laboratory (HEPL) linear accelerator on the Stanford campus. This raised a host of challenging problems to design a system for controlling and guiding the beams from the accelerator to all the experiments. Ed immediately became heavily involved in the overall design of the so-called "beam switchyard," where he took particular responsibility for the vacuum system and for problems posed by beam-absorbing components such as slits and beam dumps, and for studies of radiation activation and radiation shielding questions. His expertise on heat transfer led him, working in collaboration with engineers whom he hired and trained, to develop innovative designs for beam dumps, which could absorb the full two megawatts of beam power from the accelerator. Several of these engineers later played essential roles in the experimental programs that established SLAC's reputation as a leading laboratory in experimental physics in the following quarter century.

In 1964, Ed became head of a group called Physical Electronics, which first investigated some ideas for secondary emission beam monitors using potassium chloride. Under his leadership, Ed's group then branched out into surface physics in general, and, in particular, into electron and photon induced emission of electrons from various materials. This led him to studies of vacuum systems for storage rings. First, in the evaluation of induced emissions in the original electron-electron storage rings at HEPL, and then in the design and construction of the Stanford Positron Electron Accelerating Ring (SPEAR) at SLAC, to which he made major contributions. His work on the surface physics of gas desorption from materials bombarded by electrons, ions and photons led to the innovative design of extruded aluminum chambers with corrugated inner walls and built-in ion pumps. This became the standard design for generations of later storage rings around the world.

In 1971, during his involvement with SPEAR, Ed, together with SLAC's Gerry Fisher, came up with a very creative idea that opened the door to what are now known as

synchrotron light sources. Realizing the impact that the use of intense X-rays produced by synchrotron radiation could make on many other fields of science, they were able to convince Burton Richter, leader of the SPEAR project, to equip the storage ring with the first exit port to extract this radiation tangentially to the ring. This provided physicists, chemists and biologists with X-rays of intensities never before available, thereby facilitating myriads of new studies of materials at the atomic and molecular scale and eventually spawning the subsequent construction of dozens of synchrotron light facilities worldwide. Around this time, Ed became SLAC Professor of Applied Research.

Starting in 1970, Ed also became involved in a proposal from Yale University to generate polarized electrons that could be accelerated in the SLAC linac without losing polarization and thus used to study spin structure of protons via inelastic scattering of high energy polarized electrons from polarized protons. In one way or another, this activity grew and evolved over time, keeping Ed busy for the next thirty years. The Yale source consisted of a polarized Lithium-6 atomic beam and required a powerful ultra-violet flash lamp to strip the outer polarized electron from the atoms. Ed undertook the design of that flash lamp, based on ideas he had seen in the literature. The challenge was to achieve very high UV light intensity while preserving long lamp lifetimes. The flash lamp he built consisted of a closed loop of argon gas actively flowing through a quartz envelope, powered by a SLAC modulator, a device used throughout the accelerator to pulse the klystrons, which generate the microwave power for the accelerator. Ed's design allowed the source, which was called PEGGY, to produce a low-intensity beam with 90 % polarized electrons. This beam provided the first study of the spin structure of the proton.

In 1974, while on sabbatical at ETH Zurich, Ed and Hans C. Siegmann proposed a new source design, which would yield higher intensities than the PEGGY source. It was based on photoemission from Gallium Arsenide (GaAs). They recognized that the GaAs crystal internal structure, when illuminated with circular polarized light, would pump polarized electrons into the crystal conduction band, from which they could be ejected from the crystal surface. The ETH Zurich lab undertook to build and demonstrate a first such photoemission source of polarized electrons in 1976.

In parallel with the Zurich work, upon his return to SLAC, Ed was asked by Director "Pief" Panofsky to develop and build a GaAs source capable of yielding even much higher currents suitable for the SLAC linac, using a laser beam to drive the photoemission. A demonstration test in December 1977 at the linac injector was successful and achieved 40% polarization at the full SLAC beam current. A few months later this source was used to observe the phenomenon of Parity symmetry violation in deep inelastic scattering of the polarized electrons from deuterium, thereby providing crucial evidence in support of the theory of weak interactions, known as the Weinberg-Salam theory, that is now a key part of the Standard Model theory of particle physics.

The Stanford Linear Collider (SLC) project was developed at SLAC in the early 1980's as the next big step in the laboratory's program. Physicists proposed to incorporate polarized electron sources into the physics program of this facility, to study polarized phenomena involving the Z boson. Substantial improvements to the existing GaAs source were required to achieve the proposed program. In the mid 1980's work began on a new source suitable for this use. Together with colleagues at SLAC, LBNL, and the University of Wisconsin, Ed proposed to double the approximately 40% polarization value achieved in GaAs by mechanically distorting (compressing) the crystal, thereby achieving the desired doubling of the polarization. Ed and one of his students had demonstrated this effect on a smaller scale in 1982

in his lab. With the help of commercial labs outside SLAC, electron sources made of strained GaAs were fabricated and first demonstrated to achieve high polarization in Ed's lab in 1991. They were quickly incorporated into the SLC design, together with many other technological innovations led by Bob Kirby, in Ed's group, and others. The SLC source operated successfully from 1992 to the end of the SLC operations in 1998. It achieved a polarization of 80% at the full SLC beam current, as required.

During these years Ed also worked in many other areas, such as the surface physics of superconducting RF cavities, and ultra-fast magnetic switching, using the high magnetic field caused by the short electron "bunches" of the tiny-diameter, linear accelerator electron beam. After his retirement from SLAC in January 2005, Ed became Professor Emeritus of Applied Research and his broad knowledge and experience made him a valued consultant on a wide range of technical matters.

Ed enjoyed scuba diving, downhill skiing, puns, wine and chocolate. He was a devoted counselor at Kara ("grief support and education for our community") in Palo Alto, California from 1989 until his death. He is survived by his life-partner, Zora, three children, Steve, Laurel and Lawrence, one grandchild, and his brother, Richard Garwin. Ed Garwin was loved and respected and will be missed.

Committee:

Helen R. Quinn, Chair  
Jean M. Deken, SLAC archivist  
Gregory A. Loew  
Charles Y. Prescott