Robert R. Wilson: Physicist, Architect, Artist

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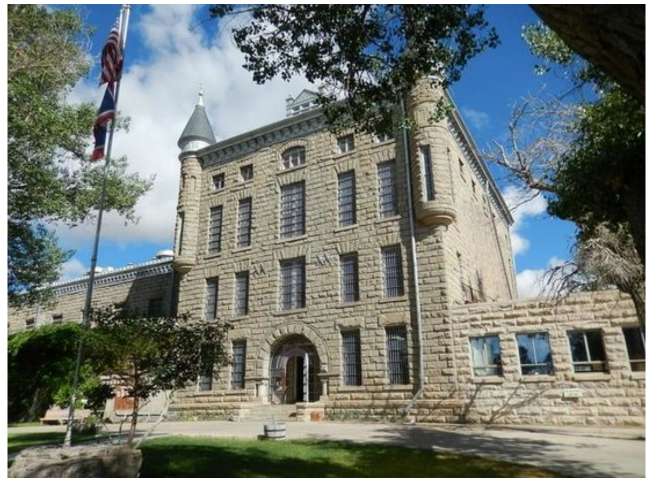
Early Life and Education

Young Robert Wilson



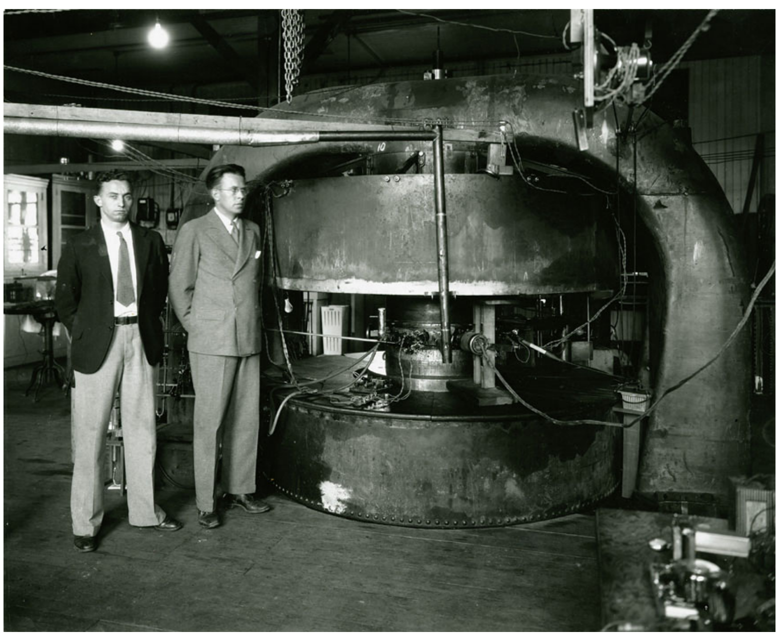
Frontier, Washington

Robert Rathbun Wilson was born in the small town of Frontier, Washington in the Spring of 1914, the son of Platt Elvin and Edith Elizabeth (Rathbun) Wilson. His mother was the daughter of a rancher, Charles Rathbun, who had come to Wyoming during the Gold Rush, and his father was from Montezuma, Iowa, who was trained in civil engineering and worked on railroads, where he met his wife and had Robert. Platt Wilson later worked in the automobile industry, and then became a state senator in Wyoming. During his early life, Robert Wilson was often relocated due to the separation of his parents when he was eight years old. He spent most of his time living on ranches where horses and cows were raised, and he changed schools very frequently due to his parent's frequent relocations. As a child, Robert was very close to his maternal grandmother, Nellie Rathbun, who was a house mother at a private school, The Todd School for Boys, where Robert attended as a child. Nellie was very passionate about African American rights, and she brought a number of black families from Kentucky to Wyoming where they became very respected families around the area that Robert grew up.

Robert grew up with a passion for mechanics and tinkering. When he was a teenager, he and a friend built a hang glider, which was able to fly very impressive distances. He talks fondly of this in an interview with Spencer Weart in 1977, saying that they "would take the glider to a nearby hill, and run as fast as possible, and eventually come to the brink of a hill — there was always a wind — the glider would go up and fly for a few hundred feet. On the first flight, though, (his friend) crashed and broke his leg. Our parents then took a somewhat dimmer view. But we did put the glider together again and made more flights, once he had recovered."

Due to his background on a cattle ranch, he was a very independent person. In his adolescence he worked in a blacksmith shop, where he learned to work with his hands and use machinery. He stated working in the shop “was a very useful part of (his) training.” During his time in high school, he even set up a rudimentary laboratory where he would tinker with vacuums using his own vacuum pumps that he constructed himself. Robert had a very close connection with nature, and he would often look for inspiration from Native Americans when he was out in the wilderness. He spoke of this in his interview, saying that “knowing about Indians and Indian’s ways was considered the highest kind of knowledge. There was a tradition of the mountains, the mountain men lived as Indians. There was a deep tradition there. Something highly respected in Wyoming was the mountain man.” He recalls his journeys out in the wilderness, where he rode “all alone with a packhorse many miles away — sometimes days away — from other people, days without seeing anybody, I had the impression of being completely independent. I think this idea of being out in the country, and you're the only person, gives you a feeling of being unique in the world, which is somewhat different from the feeling you get living in the city.” This independence and hands-on experience during his formative years would later prove to be characteristic of his determination and ingenuity that he would possess throughout his life.

Berkeley and Early Experience with Particle Accelerators

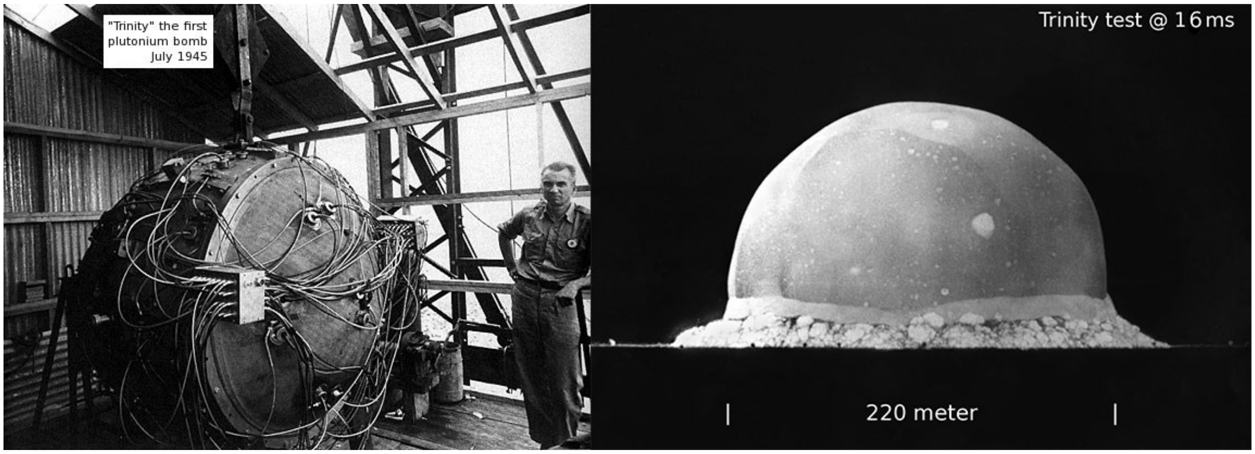


Ernest Lawrence and the Cyclotron

In 1932, Wilson enrolled at the University of California, Berkeley (UCB) and was awarded a Bachelor of Arts degree cum laude in 1936. In his senior year of high school, he took a course in physics, and he quickly became very passionate about the subject. He was also very passionate about philosophy, and wished to be a philosopher at one particular time, but found physics to be more practical. At Berkeley he decided to study electrical engineering, as he did not know it was possible to major in physics at the time. During his junior year of college, he worked in the Berkeley radiation laboratory, which is where he first met Ernest Lawrence, physicist and inventor of the cyclotron. Robert initially worked as an assistant to Harry White, who worked closely with Lawrence at the time. After White's departure, Wilson continued to work on the experiments that White had been working with, and it was there that Wilson invented a vacuum switch that could be used to speed up voltage transfer in a spark gap within an accelerator. He also studied gaseous discharge, where he developed a new method of studying the time lag between different spark discharges. This finding was later published in the *Physical Review*, a peer-reviewed scientific journal during his senior year. As a graduate student, he continued research in the radiation laboratory under the guidance of Ernest Lawrence. He published multiple papers during his time which detailed certain advancements and studies on the behavior of cyclotrons, such as his paper on the first theoretical analysis of the stability of cyclotron orbits. It was there that he also invented a vacuum sliding seal so that objects could be placed more easily within the path of the accelerated particles without losing the vacuum within. In 1940, he received his doctorate degree for his thesis on the "Theory of the Cyclotron", and in the same year he married his wife Jane Inez Scheyer.

He then moved to Princeton University, where he worked closely with physicist Henry DeWolf Smyth. It was there that he was involved with Smyth's development of ways to separate uranium-238 from uranium-235, which is an important step in the development of nuclear energy along with nuclear weapons. In 1941, Wilson, leading a team of about 50 scientists and technicians at Princeton, created a device known as the "isotron", which, unlike the calutron developed by Ernest Lawrence, used an electric field to separate uranium isotopes instead of a magnetic field, which was considered to be more efficient. Wilson was then requested to help with the war effort and was asked to assist in setting up a cyclotron laboratory at the new Los Alamos Laboratory in New Mexico during 1943.

Time During the Second World War



Trinity - the First Nuclear Weapon, 1945

Nuclear research and development played an extremely important role during the Second World War. It was rumored that Nazi Germany had begun development on an atomic weapon, so the United States government created the Manhattan project in 1942. This mobilized scientists and researchers from around the United States to develop an atomic weapon in the hopes of creating one before Germany or Japan.

Robert Wilson was requested to help with the war effort in 1943, and was sent to Los Alamos Laboratory in New Mexico. "Like a bunch of professional soldiers, we signed up, en masse, to go to Los Alamos", Wilson later said when recalling the experience. The director of Los Alamos Laboratory was J. Robert Oppenheimer, who later became famous for being the wartime head of the creation of the world's first atomic bomb. Wilson and a few other Princeton scientists moved the Harvard cyclotron down to Los Alamos and began to study nuclear fission and ways to develop the atomic bomb. Wilson was head of the cyclotron group during his time at Los Alamos, which was tasked with studying the use of the cyclotron for measuring the neutron cross section of plutonium. In 1944, he was appointed to be the head of the Physics Research Division by Oppenheimer, which was responsible for experimentation with nuclear fission in the hopes of creating an implosion-type nuclear weapon. In March of 1945, he was also the head of the development of instrumentation that would later be used in the Trinity Nuclear Test in July of the same year.

In May of 1945, Nazi Germany surrendered, ending the war in Europe. This initially caused decreased motivation among the scientists at Los Alamos to continue development of the nuclear bomb, especially after it was discovered that scientists who were researching the nuclear bomb in Germany were years behind the scientists in the United States. This push to cease development of the nuclear bomb was met with harsh criticism by Major General Leslie Groves, head director of the Manhattan Project. Thus, development continued with the hope of using the atomic bomb to end the war with Japan more expeditiously. In the early hours of July 16th, 1945, the United States army detonated the first atomic bomb in the Jornada del Muerto desert of New Mexico, with Robert Wilson being one of the chief physicists in charge of its creation.

Wilson, as a pacifist, deeply regretted his work as a scientist involved with the Manhattan Project. In the documentary *The Day After Trinity*, Wilson would later say that he regretted not ceasing his work on the atomic bomb after Germany's surrender in 1945. His initial motivation was to develop the bomb before Germany in hopes of saving more lives, but he lost much of his passion for the work after having heard that Germany's development of nuclear technology was years behind the United States. This deep regret would later prompt him to push for peaceful uses of nuclear energy and research, leading him to later help organize the Association of Los Alamos Scientists (ALAS), which called for controlled uses of atomic energy throughout the world. In 1946, he wrote an article titled "Radiological Use of Fast Protons", which was published in the medical journal *Radiology*. In this article, Wilson proposed different ways that particle accelerators could be used in the treatment of cancer, which was revolutionary at the time, founding what is now known as proton therapy.

Time at Harvard and Cornell

The Laboratory of Nuclear Studies at Cornell University

After the war, in the Fall of 1946, Wilson accepted a position as an associate professor at Harvard University. During the months prior, he had worked on a 150 MeV cyclotron at Berkeley, which he intended to use to replace the one that was taken from Harvard to Los Alamos. His stay at Harvard was short, and in the winter of 1947 he went to Ithaca, New York to begin teaching as a professor of physics and the director of the new Laboratory of Nuclear Studies at Cornell University. During his time at Cornell, he developed four new electric synchrotrons. The first of which, a 300 MeV synchrotron, was already being built when he arrived. By 1952, as advancements in physics were being discovered extremely rapidly, Wilson helped to design and construct a new 1.4 GeV synchrotron that would be able to perform remarkable feats of physics. He describes it in a quote from his 1953 annual report to the Office of Naval Research:

"The Laboratory has indulged itself in some high adventure. A new synchrotron has been designed which is to give over a billion electron volts of energy. The design is highly controversial in that the new machine is exceedingly small and cheap for what it will do, hence there is considerable risk that it may not work at all. On the other hand, if we are successful, we shall have the largest electron accelerator in the world"

Evidently, the creation of this new synchrotron was controversial, but Wilson was no stranger to taking risks. In 1952, the 1.4 GeV synchrotron was constructed, and it was a great success. It was the first operating synchrotron that implemented the technique of strong-focusing, and it was used to test quantum electrodynamics along with measuring the structure of nucleons with great precision. The last machine Wilson helped to design at the Cornell Laboratory of Nuclear Studies was the 12 GeV synchrotron, which is still in use today as an injector for the Cornell Electron Storage Ring. This synchrotron was the first to have the entire magnet assembly evacuated so that it was not necessary to create another vacuum area within the magnet assembly, which made it possible to reduce the space taken up by the synchrotron. This design would later be used in the accelerator at Fermilab in the 1960s.

Wilson was very focused on the purpose of these synchrotrons, along with the philosophy that guided their creation. In 1948, he detailed their purpose in his annual report to the Office of Naval Research:

"The most important problems of nuclear physics, to our minds are: What are the elementary particles of which nuclei are made and what is the nature of the forces that hold these particles together? A more general but connected problem concerns the general expression of electrical laws at such high energies as will be produced by our synchrotron. Our experiments are planned to attack all three problems. Thus we hope to produce artificial mesons which are supposedly elementary particles and to study the interactions of these mesons with nuclei. Further, we shall explore the electrical interactions of high energy electrons with electrons and protons in search of evidence pointing to a correct theory of electricity at high energy."

Director of the National Accelerator Laboratory (Fermilab)

Fermilab in 2019

In 1967, after the completion of the 12 GeV synchrotron, Wilson was chosen to be the director of the newly planned National Accelerator Laboratory, today known as Fermilab, located in Batavia, Illinois. The site was chosen for its close proximity to a large metropolis (Chicago), along with having good geology and readily available amounts of power and land. Measuring five miles in circumference, it was the largest particle accelerator ever constructed until the creation of the Large Electron-Positron Collider at CERN in 1989. It has a circumference of 5 miles long and was initially intended to produce an energy of 400 GeV. Wilson aimed for the National Accelerator Laboratory to be practical yet also aesthetically pleasing, and took part in the construction of numerous sculptures and pieces of art throughout the facility. Wilson was extremely ambitious and confident as director, and he promised to double the energy output that was originally planned for the accelerator without increasing the cost. In 1968, construction on the lab was initiated, and it was completed six years later, on time and below the originally proposed budget of 250 million U.S. dollars. Wilson was able to accomplish this feat through some ingenious engineering, such as by redesigning the magnetic structures and lattice, which meant for higher magnetic fields and an accelerator that was able to produce a much higher energy. This courageous and imaginative mindset is very characteristic of his career, no doubt due to his upbringing as a rancher. Famously, in 1969, during a congressional meeting with the Joint Committee on Atomic Energy, Wilson was called upon in order to justify the $250 million budget for the National Accelerator Lab. When questioned by Senator John Pastore on what the accelerator had to do with the defense of the United States, Wilson responded:

“It has only to do with the respect with which we regard one another, the dignity of men, our love of culture. It has to do with are we good painters, good sculptures, great poets? I mean all the things we really venerate in our country and are patriotic about. It has nothing to do directly with defending our country except to make it worth defending.”

Thanks to Wilson’s attitude and determination, the National Accelerator Laboratory was a huge success, and only experienced minor hiccups in construction, such as when a large amount of magnets suffered an insulation failure. In 1974, the National Accelerator Laboratory was renamed Fermi National Accelerator Laboratory in homage to Italian American physicist Enrico Fermi. It is frequently referred to as “Fermilab”.

After the construction of the main accelerator, Wilson initiated the design of the Tevatron, or a 1 TeV particle accelerator. The Tevatron required the use of superconducting magnets, and after years of strenuous research and development spearheaded by Wilson, the cost required to create such a particle accelerator was decreased drastically. However, in 1978, Wilson was unable to receive adequate funding for the construction of the Tevatron from the Department of Energy. Displeased with the decision, he resigned from his position as director in protest, and was thus unable to fully direct the construction of the Tevatron. He was then succeeded by his colleague Leon Max Lederman.

Later Life

After his resignation as director of Fermilab, Wilson then taught at the University of Chicago as Ritzma Professor at the Enrico Fermi Institute. In 1980, he then became a professor at Columbia University, where he worked until 1983 until he retired. He lived at his home in Ithaca, New York, with his wife and three sons until his death on January 16th, 2000 at the age of 85. He is buried at the Pioneer Cemetery on the Fermilab site.

Honors and Awards

Robert Wilson, Photo Taken at Fermilab

Robert Wilson received many awards throughout his lifetime, including honorary degrees from Notre Dame University, Harvard University, University of Bonn, and Wesleyan University. He received the Elliott Cresson Medal from the Franklin Institute, the National Medal of Science, the Department of Energy's Enrico Fermi Award, the Wright prize, the del Regato Medal, and the Gemant award. He was also a member of the National Academy of Sciences, the American Academy of Arts and Sciences, and the American Philosophical Society. Throughout his life, his dedication and passion for particle physics was radiant, and he inspired countless other individuals through his accomplishments and good character.

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