= Donald William Kerst =

Donald William Kerst (November 1 , 1911 ? August 19 , 1993) was an American physicist who worked on advanced particle accelerator concepts (accelerator physics) and plasma physics . He is most notable for his development of the betatron , a novel type of particle accelerator used to accelerate electrons .

A graduate of the University of Wisconsin , Kerst developed the first betatron at the University of Illinois at Urbana Champaign , where it became operational on July 15 , 1940 . During World War II , Kerst took a leave of absence in 1940 and 1941 to work on it with the engineering staff at General Electric , and he designed a portable betatron for inspecting dud bombs . In 1943 he joined the Manhattan Project 's Los Alamos Laboratory , where he was responsible for designing and building the Water Boiler , a nuclear reactor intended to serve as a laboratory instrument .

From 1953 to 1957 Kerst was technical director of the Midwestern Universities Research Association , where he worked on advanced particle accelerator concepts , most notably the FFAG accelerator . He was then employed at General Atomics 's John Jay Hopkins Laboratory from 1957 to 1962 , where he worked on the problem of plasma physics . With Tihiro Ohkawa he invented toroidal devices for containing the plasma with magnetic fields . Their devices were the first to contain plasma without the instabilities that had plagued previous designs , and the first to contain plasma for lifetimes exceeding the Bohm diffusion limit .

= = Early life = =

Donald William Kerst was born in Galena , Illinois November 1 , 1911 , the son of Herman Samuel Kerst and Lillian E Wetz . He entered the University of Wisconsin , where he earned a Bachelor of Arts (BA) degree in 1934 , and then his Doctor of Philosophy (PhD) in 1937 , writing his thesis on " The Development of Electrostatic Generators in Air Pressure and Applications to Excitation Functions of Nuclear Reactions " . This involved building and testing a 2 @.@ 3 MeV generator for experiments with the scattering of protons .

= = Betatron = =

After graduation , Kerst worked at General Electric Company for a year , working on the development of x @-@ ray tubes and machines . He found this frustrating , as x @-@ ray research required high energies that could not be produced at the time . In 1938 he accepted an offer of an instructorship at the University of Illinois at Urbana Champaign , where the head of the physics department , F. Wheeler Loomis encouraged Kerst in his efforts to create a better particle accelerator . The result of these efforts was the betatron . When it became operational on July 15 , 1940 , Kerst became the first person to accelerate electrons using electromagnetic induction , reaching energies of 2 @.@ 3 MeV .

It took longer to name the device . Colleagues suggested names such as the German " Ausserordentlichhochgeschwindigkeitelektronenentwickelndenschwerarbeitsbeigollitron " . In December 1941 Kerst decided on " betatron " , using the Greek letter " beta " , which was the symbol for electrons , and " tron " meaning " instrument for " . He went on to build more betatrons of increasing energy , a 20 MeV machine in 1941 , an 80 MeV in 1948 , and a 340 MeV machine , which was completed in 1950 .

The betatron would influence all subsequent accelerators . Its success was due to a thorough understanding of the physics involved , and painstaking design of the magnets , vacuum pumps and power supply . In 1941 , he teamed up with Robert Serber to provide the first theoretical analysis of the oscillations that occur in a betatron . The original 1940 machine was donated to the Smithsonian Institution in 1960 .

= = World War II = =

During World War II , Kerst took a leave of absence from the University of Illinois to work on the development of the betatron with the engineering staff at General Electric in 1940 and 1941 . They designed 20 MeV and 100 MeV versions of the betatron , and he supervised the construction of the former , which he brought back to the University of Illinois with him . He also designed a portable 4 MeV betatron for inspecting dud bombs .

Kerst 's engineering and physics background placed him near the top of the list of scientists that Robert Oppenheimer recruited for the Manhattan Project 's Los Alamos Laboratory , which was set up to design the atomic bomb . In August 1943 , Kerst was placed in charge of the Laboratory 's P @-@ 7 Group , which was responsible for designing and building the Water Boiler , a nuclear reactor intended to serve as a laboratory instrument to test critical mass calculations and the effect of various tamper materials . Primarily drawn from Purdue University , his group included Charles P. Baker , Gerhart Friedlander , Lindsay Helmholtz , Marshall Holloway , and Raemer Schreiber . Robert F. Christy provided help with the theoretical calculations .

Kerst designed an aqueous homogeneous reactor in which enriched uranium in the form of soluble uranium sulfate , was dissolved in water , and surrounded by a beryllium oxide neutron reflector . It was the first reactor to employ enriched uranium as a fuel , and required most of the world 's meager supply at the time . A sufficient quantity of enriched uranium arrived at Los Alamos by April 1944 , and the Water Boiler commenced operation in May . By the end of June it had achieved all of its design goals .

The Los Alamos Laboratory was reorganized in August 1944 to concentrate on creating an implosion @-@ type nuclear weapon . Studying implosion on a large scale , or even a full scale , required special diagnostic methods . As early as November 1943 , Kerst suggested using a betatron employing 20 MeV gamma rays instead of x @-@ rays to study implosion . In the August 1944 reorganization , he became joint head , with Seth Neddermeyer , of the G @-@ 5 Group , part of Robert Bacher 's G (Gadget) Division specifically charged with betatron testing . Oppenheimer had the 20 MeV betatron at the University of Illinois shipped to Los Alamos , where it arrived in December . On January 15 , 1945 , the G @-@ 5 Group took their first betatron pictures of an implosion .

= = Later life = =

Kerst returned to the University of Illinois after the war . From 1953 to 1957 he was technical director of the Midwestern Universities Research Association , where he worked on advanced particle accelerator concepts , most notably the FFAG accelerator . He developed the spiral @-@ sector focusing principle , which lies at the heart of many spiral ridge cyclotrons that are now in operation around the world . His team devised and analysed beam stacking , a process of radio frequency acceleration in fixed field machines that led to the development of the colliding beam accelerators .

From 1957 to 1962 Kerst was employed at the General Atomics division of General Dynamics 's John Jay Hopkins Laboratory for Pure and Applied Science in La Jolla , California , where he worked on plasma physics , which it was hoped was the doorway to the control of thermonuclear energy . With Tihiro Ohkawa he invented toroidal devices for containing the plasma with magnetic fields . The two completed this work at the University of Wisconsin , where Kerst was a professor from 1962 until his retirement in 1980 . Their devices were the first to contain plasma without the instabilities that had plagued previous designs , and the first to contain plasma for lifetimes exceeding the Bohm diffusion limit . From 1972 to 1973 he was also chairman of the Plasma Physics Division of the American Physical Society .

Kerst was married to Dorothy Birkett Kerst . They had two children , a daughter , Marilyn , and a son , Stephen . After he retired , Kerst and Dorothy moved to Fort Myers , Florida . He died on August 19 , 1993 at the University Hospital and Clinics in Madison , Wisconsin , from a brain tumor . He was survived by his wife and children . His papers are in the University of Illinois Archives .

= = Awards and honors = =

Honorary degree , Lawrence College , 1942 .
Awarded Comstock Prize in Physics , National Academy of Sciences , 1943 .
Awarded John Scott Award , City of Philadelphia , 1946 .
Awarded John Price Wetherill Medal , Franklin Institute , 1950 .
Elected to the National Academy of Sciences , 1951 .
Honorary degree , University of Sao Paulo , 1953 .
Honorary degree , University of Wisconsion , 1961 .
Awarded James Clerk Maxwell Prize in plasma physics , American Physical Society , 1984 .
Awarded Robert R. Wilson Prize for accelerator physics , 1988 .
Honorary degree , University of Illinois , 1989 .