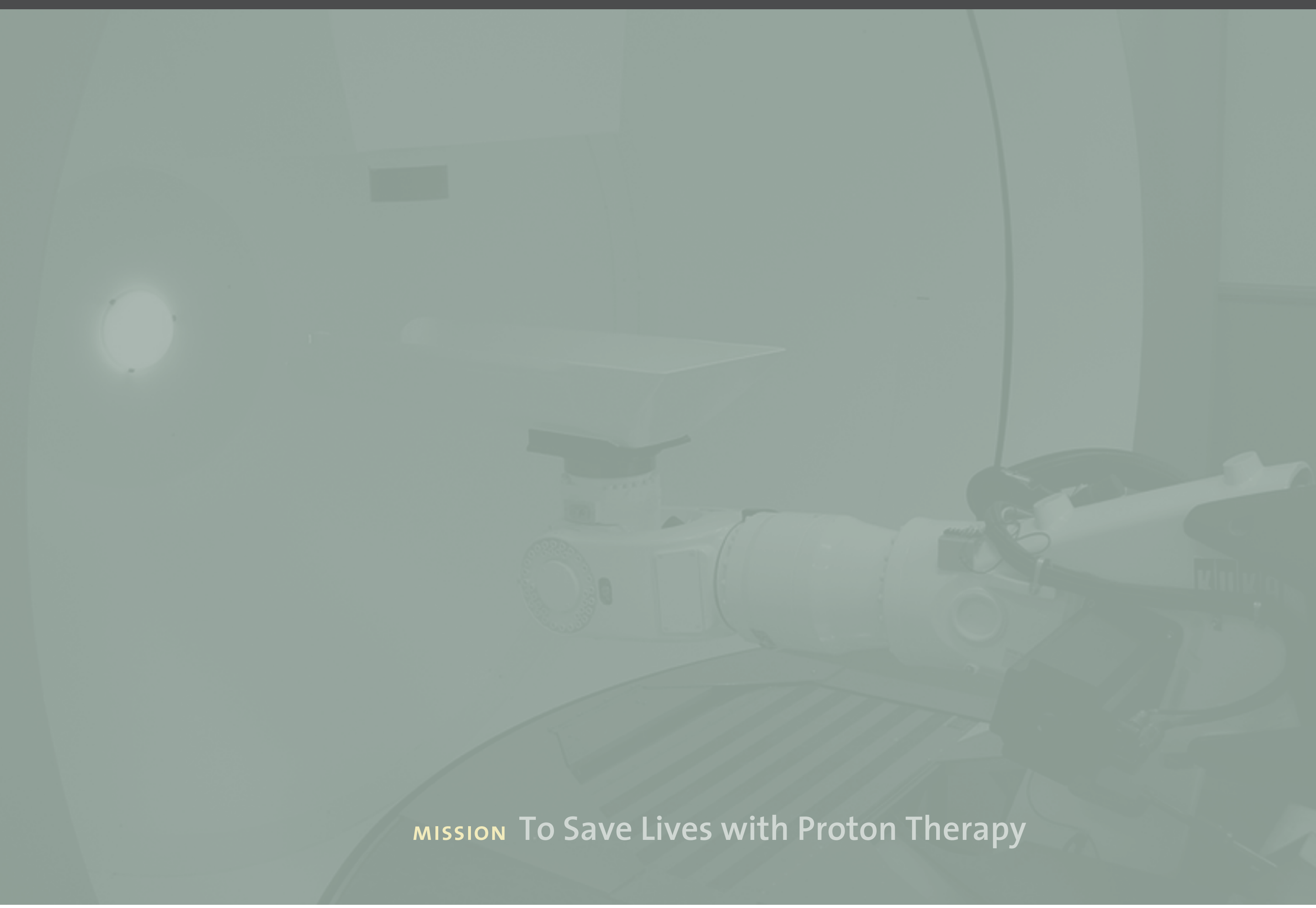
OPTIVUS
PROTON THERAPY

History of Proton Therapy

"Our time is distinguished by wonderful ***achievements*** *in the fields of* ***scientific understanding*** *and the technical application of those insights."* — *Albert Einstein*



MISSION To Save Lives with Proton Therapy

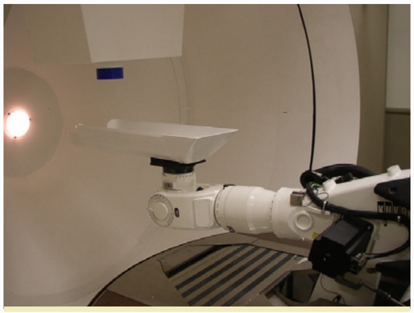
History of Proton Therapy

Throughout history, scientific and medical advancements are often met with criticism, and proton therapy has been no exception. Over time, the physics and radiobiology of proton therapy have been proven to the extent that early critics of the modality can no longer deny the success and benefits of this therapy. Today, proton therapy is expanding at an impressive rate due to the pioneering contributions of the innovators within these pages.

As the pioneers in proton therapy technology, Optivus has defined the "gold standard," in this life-saving form of radiation treatment.

OPTIVUS®
PROTON THERAPY

TABLE OF CONTENTS



OPTIVUS®
PROTON THERAPY

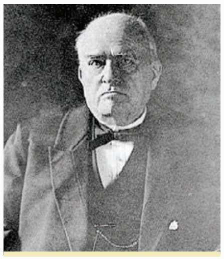
DISCOVERY OF RADIATION

Wilhelm Conrad Röntgen

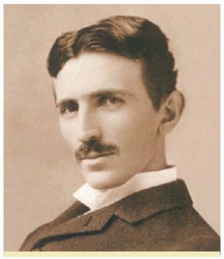
(1845 – 1923) was a physicist at the University of Würzburg. On November 8, 1895, he produced and detected electromagnetic radiation in a wavelength range today known as X rays or Röntgen rays, an achievement that earned him the first Nobel Prize for Physics, in 1901.

Wilhelm Conrad Röntgen

Röntgen did not make his discovery in an intellectual vacuum. His work followed prior investigations and was coterminous with the efforts of other researchers who were exploring the effects of high-tension electrical discharges in evacuated glass tubes. For example, **Johann Hittorf** (1824 - 1914) observed tubes with energetic rays extending from a negative electrode. The rays produced fluorescence when they hit the glass walls of the tubes, an effect that was named "cathode rays" in 1876. Later, **Sir William Crookes** (1832 – 1919) investigated the effects of energy discharges on rare gases and built what came to be called the Crookes tube, a glass vacuum cylinder containing electrodes for discharging a high-voltage electric current. Crookes discovered that when he placed unexposed photographic plates near the tube, some of them were flawed by shadows. He did not investigate that finding. In 1887, **Nikola Tesla** (1856 - 1943) began to investigate these rays by using high voltages and vacuum tubes of his own design, as well as, Crookes tubes. Tesla's publications indicated that he invented and developed a special single-electrode X-ray tube; he reported on his findings in 1897, and the principle behind his device came to be called the Bremsstrahlung process. By 1892, Tesla had performed several such experiments but had not categorized the emissions as what were later called X rays.



Johann Hittord



Nikola Tesla

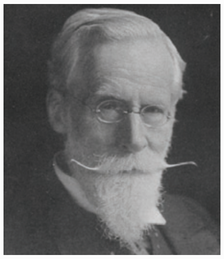
Röntgen produced and detected electromagnetic radiation in a wavelength range today known as X rays or Röntgen rays, an achievement that earned him the first Nobel Prize for Physics, in 1901.

In 1892, **Heinrich Hertz** (1857 - 1894) demonstrated that cathode rays could penetrate thin aluminum foils. Hertz's student, **Philipp von Lenard** (1862 - 1947), further researched this effect, developing a version of the cathode-ray tube and studying the penetration of various materials by X rays, albeit he did realize that he was producing such rays.

It was in this milieu that Röntgen made his discovery. During 1895 he was using equipment developed by his colleagues. One of these pieces of equipment, reputedly, had been given to him by **Prof. Ivan Pulyui** (1845 – 1918); this "Pulyui lamp" had been used by Pulyui to investigate "cold light," and Pulyui reputedly had used the device to discover X rays in 1881. His report, written in obscure language and using obsolete terminology, did not receive wide circulation. In early November, 1885, Röntgen was repeating an experiment with one of Lenard's tubes, in which a thin aluminum window had been added to permit the cathode rays to exit the tube but a cardboard covering was added to protect the aluminum from damage by the strong electrostatic field needed to produce the cathode rays. The rays penetrated this covering and projected through many layers of other

material to form an image on the wall of his laboratory. Röntgen speculated that a new kind of ray might be responsible. He temporarily termed the new entities X rays, using the mathematical designation for something unknown. On December 28, 1895, Röntgen wrote a paper, "On a new kind of ray: A preliminary communication" and submitted it to the Würzburg's Physical-Medical Society journal. This was the first formal and public recognition of the categorization of X rays. On January 5, 1896, an Austrian newspaper reported Röntgen's discovery. Röntgen was awarded an honorary Doctor of Medicine degree from the University of Würzburg; he published three papers on X rays between 1895 and 1897. Today, Röntgen is considered the father of diagnostic radiology.

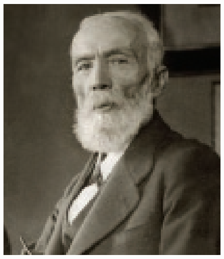
Röntgen repeated an experiment in which the rays penetrated a cardboard covering and projected through other layers of material to form an image on the wall of his laboratory. Röntgen speculated that a new kind of ray might be responsible. He temporarily termed the new entities X rays, using the mathematical designation for something unknown.



Sir William Crookes

Heinrich Hertz

Phillip Von Lenard



Prof. Ivan Pulyui

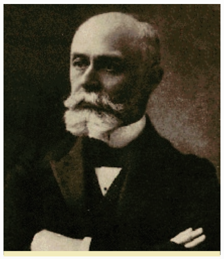
SCIENCE AND MEDICINE

Marie Sklodowska Curie

(1867 – 1934), with her husband, Pierre, was inspired to study radioactivity after Henri Becquerel's discovery of the phenomenon in 1896. Their research, often pursued under difficult conditions, nonetheless was brilliant and led in 1898 to the isolation of a new element, polonium, named after Poland, the country of Mme. Curie's birth, as well as radium. Mme. Curie developed methods for separating radium from radioactive residues in sufficient quantities to allow it to be characterized and for its properties to be studied. This made possible the therapeutic use of radium, which was of great interest to Mme. Curie. She retained her enthusiasm for science and for the medical uses of radioactivity throughout her life and did much to establish a radiation laboratory in her native city, Warsaw.

Mme. Curie's importance to science is reflected in several awards. Together with her husband, she was awarded half of the Nobel Prize for Physics in 1903, for their study into the spontaneous radiation discovered by Becquerel, who was awarded the other half of the prize. She also received, jointly with her husband, the Davy Medal of the Royal Society (London) in 1903. In 1911, then a widow, she received a second Nobel Prize, this time in Chemistry, again in recognition of her work in radioactivity.

Pierre Curie



Henri Becquerel

Marie Sklodowska Curie

The Road to Radiation Therapy

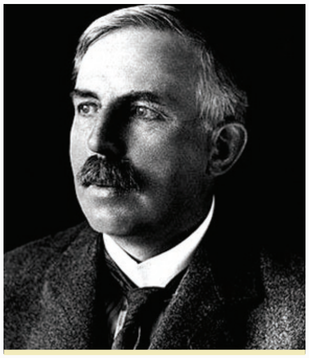
Ernest Rutherford

(1871 – 1937), a New Zealander who made his greatest discoveries in England, played a major part in the great intellectual ferment of the late nineteenth and early twentieth centuries, in which discoveries in electromagnetism led to a fundamental understanding of the atom. Rutherford invented a detector for electromagnetic waves, worked jointly with his mentor, Professor J.J. Thomson, on the behavior of the ions observed in gases that had been treated with X rays, on the mobility of ions in relation to the strength of the electric field, and on related topics such as the photoelectric effect. Rutherford collaborated in creating the "disintegration theory" of radioactivity, which regards radioactive phenomena as atomic rather than molecular processes.

Mme. Curie, together with her husband Pierre, was awarded half of the Nobel Prize for Physics in 1903, for their study into the spontaneous radiation discovered by Becquerel, who was awarded the other half of the prize.

In 1910, Rutherford's investigations into the scattering of alpha rays and the nature of the inner structure of the atom led to his concept of the atomic nucleus. His studies showed that essentially the entire mass of the atom and, at the same time, all the positive charge of the atom, is concentrated in a minute central space. This fundamental discovery was followed in 1919, when Rutherford discovered that the nuclei of certain light elements, such as nitrogen, could be "disintegrated" by the impact of energetic alpha particles coming from some radioactive source, a process during which protons were emitted. He received the Nobel Prize for Chemistry in 1908, and also received many other honors in his lifetime.

In 1929, Lawrence invented the cyclotron, the particle accelerator that is the forerunner of the machines used in proton treatment facilities today.


Ernest Rutherford


Ernest O. Lawrence

Ernest O. Lawrence

(1901 – 1958) was an American physicist best known for his invention, utilization, and improvement of the cyclotron, the particle accelerator that is the forerunner of the machines used in proton treatment facilities today.

Lawrence, who had been on the physics faculty at Yale, was appointed to the physics faculty at the University of California, Berkeley in 1928; two years later he became Professor. In 1929 he invented the cyclotron, a (then) small device that nonetheless accelerated nuclear particles to very high velocities without the use of high voltages. The invention accelerated particles that were used to bombard atoms of various elements, disintegrating the atoms to form, in some cases, new elements. Hundreds of radioactive isotopes of the known elements were also discovered. His brother, Dr. John Lawrence, who became Director of the University's Medical Physics Laboratory, collaborated with him in studying medical and biological applications of the cyclotron; medical applications were tried and the first patients to be treated with neutrons, were treated at Berkeley. Ernest Lawrence built larger and more powerful versions of the cyclotron as the years went by; he built up his Radiation Laboratory, which would become the world's foremost laboratory for the new field of nuclear physics research in the 1930s. Lawrence won the Nobel Prize in 1939 for the invention and development of the cyclotron and for the results he obtained with it, especially the development of artificial radioactive elements.

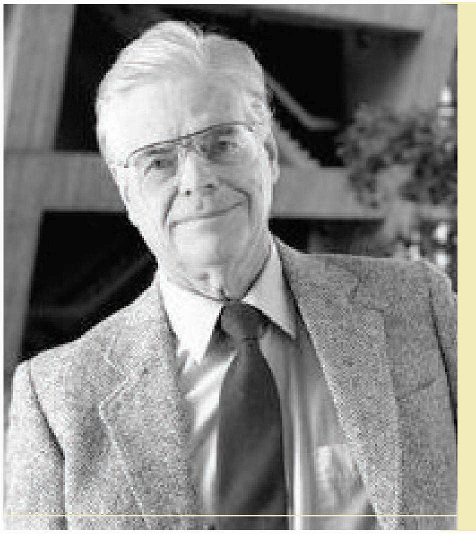
OPTIVUS PROTON THERAPY

DEVELOPMENT OF THE MODALITY

Robert R. Wilson

(1914 – 2000) was an American physicist who, probably more than any other, is identified with proton radiation therapy. Wilson was a student of Ernest O. Lawrence, and began his studies at Berkeley in 1932, and thus was exposed to the ferment in experimental and theoretical physics under Lawrence and J. Robert Oppenheimer. He also was exposed to the medical applications of the accelerator under Dr. John Lawrence and other physicians such as Robert Stone. In 1946, following his service to the atomic-bomb project during World War II, Wilson wrote a paper, in which, he proposed proton beam usage for medical treatments, citing the therapeutic potential of the Bragg peak and the localization of the proton beam that would be fulfilled in later applications of the modality. Wilson's proposal was original in that it specified the mechanisms by which proton radiation treatment would work. After the war, Wilson helped form the Federation of American Scientists and served as its chairman in 1946. During the same period he accepted a short appointment at Harvard (most of which was spent at Berkeley), at which time he designed the cyclotron that would be used subsequently to begin proton radiosurgery and radiation therapy at Harvard.

In 1967, Wilson was tapped to become director of the not-yet-existent National Accelerator Laboratory, which was to create the largest particle accelerator of its day, at Batavia, Illinois. He essentially designed the facility, including, not only its massive synchrotron, but the architecture and artwork on its campus. In 1972, as the facility was nearing completion, Wilson authorized colleagues to suggest the development of a proton treatment facility at the Laboratory to serve the Chicago area. There was enthusiasm for neutron therapy at the time, and local physicians advocated for a neutron facility



Robert R. Wilson

at the Laboratory, which subsequently was built and exists today. Wilson and his colleagues never lost their enthusiasm for proton therapy, and later supported the Loma Linda effort of creating a hospital-based proton facility. Wilson served as director of Fermilab until 1978 (the Laboratory had been re-named for the famous Italian physicist, Enrico Fermi, in 1974), and then joined the faculty of the University of Chicago. Wilson is considered by many to be the "father of proton therapy," although he always maintained that his insights stemmed from a collegial endeavor that was nurtured by his experience at Berkeley. Even so, in recognition of his seminal insight, one of the gantry treatment rooms at the Proton Treatment Center at Loma Linda University Medical Center bears his name.

Fermilab

Enrico Fermi

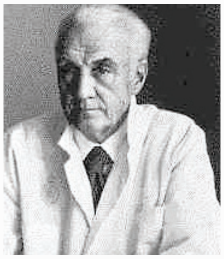
Cornelius A. Tobias, PhD

Early experimental applications of proton therapy occurred at various research institutions in the world. By "early" is meant the use of protons without recourse to precision, three-dimensional, beam's-eye-view therapy planning, which did not appear until the mid 1980s. The later development of therapy planning was essential for exploiting the Bragg peak to full advantage, that is, localizing the peak in the target volume, but efforts were made to use protons for tumors in which the target could be localized with reasonable precision even in the absence of a precision planning system. All early applications occurred at high-energy-physics research facilities, wherein facilities were provided for occasional patient treatments and clinical research.

In 1954, at the University of California, Berkeley, the first patient was treated with protons. Berkeley investigators, notably a physicist by the name of Cornelius A. Tobias, PhD, were instrumental in helping to spread the practice of proton treatment in other research laboratories around the world. One of these was the University of Uppsala, Sweden, where, at the Karolinska Institute, **Professor Lars Leksell** (1907 – 1986), a neurosurgeon, developed the first stereotactic apparatus that was used exclusively for human neurosurgery. The Leksell Stereotactic Frame was used originally with proton therapy in the late 1950s, with the beam at the Uppsala research accelerator, and still is in wide use today. In later years, when proton beam time became more limited, Leksell developed the Gamma Knife, an attempt to use gamma beams to create the high-dose region needed to treat intracranial lesions, albeit without benefit of the Bragg peak, which gamma beams do not have. Even so, Leksell was able to develop pioneering paradigms for treatment of Parkinson's disease.

In 1961 Raymond Kjellberg began to use protons for patient treatments at Harvard Cyclotron Laboratory. **Raymond Kjellberg**, (1925 - 1993) a young neurosurgeon at Massachusetts General Hospital in Boston, became the first to use the Harvard beam to treat pituitary adenomas. Kjellberg also used the proton beam for radiosurgery of ateriovenous malformations, the first parenchymal lesions on which radiosurgery were extensively evaluated. Development of single-dose radiation for this type of lesion required determination of the tolerance of normal brain and of the brain surrounding AVMs to radiosurgical doses. Using a combination of clinical and experimental observations, Kjellberg proposed the standard dose effect curves for radiation necrosis in proton therapy of the brain. Kjellberg's one percent dose-diameter line for radiation necrosis also serves as the basis for Gamma Knife and linear accelerator dosimetry. By the time of his death in 1993, Kjellberg had treated nearly 3,000 patients.

During the 1960s, 1970s, and 1980s, other physics facilities around the world offered proton and other heavy-charged particle treatments, but all were based in research laboratories, not in hospitals.



Prof. Lars Leksell

Raymond Kjellberg

Kjellberg became the first to use the Harvard beam to treat pituitary adenomas.

PROTON PIONEERS

Development of the First Hospital-Based Proton Treatment Center

In 1970, **James M. Slater, MD** was recruited to develop a radiation oncology program at Loma Linda University Medical Center (LLUMC). Dr. Slater graduated from Loma Linda University (LLU) School of Medicine in 1963. His major field of interest prior to medicine was physics, and during his residency he became dissatisfied about the side effects that radiation treatment often caused in cancer patients. When he arrived at LLUMC to begin a radiation oncology program, he and a few colleagues began studies of heavy-charged-particle radiation treatment for a hospital environment.

It quickly became apparent that 1970 was too early to develop a hospital-based, patient-dedicated treatment facility. A medical particle accelerator and its extensive control system had to be highly reliable, with very little "downtime," and required much greater computing power for the entire systems control system than was then available. Imaging capabilities also had to be greatly improved before building a hospital-based proton treatment system. There was little that could be done at Loma Linda to pursue development of a proton accelerator and its associated systems, but much that could be done to develop a therapy planning system that would be needed for proton therapy and also would benefit planning for photon-beam treatments.

In 1971, Dr. Slater and his colleagues; notably Ivan Nielsen, PhD, William Chu, PhD, and Rowland Able, engineer, developed the world's first computer-assisted treatment planning system.

James M. Slater, MD, FACR

In 1970 and 1971, Dr. Slater and his colleagues; notably Ivan Nielsen, PhD, William Chu, PhD, and Rowland Able, engineer, developed the world's first computer-assisted treatment planning system. This system employed ultrasound digital images and digitized data taken from those images, thus enabling the physician to plan treatments with information derived directly from the patient. This did much to overcome the deficiencies of focusing an invisible radiation beam on an invisible target within a patient. The new computer-assisted radiation treatment planning allowed the physician to define the patient's anatomy more precisely and to demonstrate the actual distribution of radiation in the patient. This system was improved after 1973 when computed tomography (CT) imaging became available; again, the same LLU investigators were the first in the world to undertake this advance. The technology was accepted immediately and spread throughout the world, being produced by many manufacturers and employed by many users within the subsequent decade. Today, CT-based systems are the foundation for radiation treatment planning virtually everywhere.

In the early 1980s it became apparent that CT-based treatment planning was extremely useful for x-ray treatment planning and that computer and imaging competencies were ready to support proton therapy adequately. Accordingly, Dr. Slater began to assemble a small team of scientists to develop a hospital-based system. John O. Archambeau, MD, FACR was the first faculty member Dr. Slater recruited for this purpose. Dr. Archambeau had investigated proton radiation therapy since the early 1970s, using the Brookhaven National Laboratory synchrotron.

Dr. Slater was one of the organizers of a symposium on hospital-based proton therapy systems, held at Fermilab in January 1985. This date, and event, can be regarded as salient in the history of hospital-based proton treatment, for it brought together physicists from all over the world who were interested in working toward that end. Dr. Slater and other LLU investigators participated in the symposium and its successors, which followed rapidly owing to the great interest generated by the first event. At the second Fermilab meeting, held in August 1985, Dr. Slater began making inquiries of the Laboratory's deputy Director, Philip Livdahl, as to whether Fermilab might be interested in collaborating with Loma Linda University in developing a proton synchrotron for hospital-based proton treatment. He did so because Fermilab was the most experienced accelerator builder in the world, and because he had made inquiries of private industry as to whether they would, or could, build a proton accelerator and delivery system for use in a hospital. All of the major manufacturers declined to accept the challenge.

Philip Livdahl and
James M. Slater, MD

Dr. Leon Lederman

National Laboratories do not compete with private industry, but Dr. Slater learned that Fermilab could participate under its "work for others" program, which was designed to promote technology transfer. Subsequently, Fermilab's director, Dr. Leon Lederman, the Universities Research Association, operators of Fermilab for the U.S. government, and the U.S. Department of Energy (DOE) granted the approvals required for Fermilab's participation.

In January 1986, Dr. Slater made a formal proposal to the Loma Linda University (LLU) and Loma Linda University Medical Center (LLUMC) Boards that requesting an agreement for a conceptual design be entered into with Fermilab. This was done, and in February 1986, LLU and Fermilab formally agreed to build the world's first hospital-based proton treatment system. Subsequently, the LLU team was expanded to include three engineers, Jon Slater, David Lesyna, and James Nusbaum, all of whom were positioned at Fermilab during the design and fabrication process. These Jon and David later created an engineering firm named, Optivus Proton Therapy, Inc.

Dr. Slater confirmed his early concepts that a synchrotron offered the best combination of precision, dependability, flexibility, and delivery of optimum beam characteristics for a medical machine with far less residual radiation than other types of accelerators; accordingly, the decision was made quickly to design a system based on a proton synchrotron accelerator. In February 1987, LLU and Fermilab published the engineering design report for the LLU proton synchrotron and beam transport systems, and LLU announced publicly that it would build the world's first hospital-based proton treatment facility.

In July 1987, **Jerry D. Slater, MD** was recruited to the Department of Radiation Medicine, following his training at M.D. Anderson Hospital and Massachusetts General Hospital, the latter in their proton treatment program at Harvard Cyclotron Laboratory. Dr. Jerry Slater immediately began to develop protocols for treating patients with protons at LLU. (He became Vice Chairman of the department in 1994 and Chairman in 2001.)

In April 1988, ground was broken on the LLUMC campus for the proton facility. Congress subsequently appropriated several million dollars for the facility through the Department of Energy.

In 1989, the LLUMC synchrotron was commissioned at Fermilab. Meanwhile, Optivus engineers were designing the control system for the synchrotron and the entire hospital-based facility.

LLUMC

Jerry D. Slater, MD

OPTIVUS: PROTON THERAPY PIONEERS

Optivus Proton Therapy, Inc. grew quickly to employ scores of engineers. In early 1990 the accelerator and support systems were installed at LLUMC. During the Summer and Fall, testing of the 250-million-electron-volt (MeV) synchrotron was conducted at LLUMC, with engineering expertise provided by Optivus. By October, the Optivus team completed the tuning and commissioning of the accelerator and fixed-beam room.

On October 20, 1990, the first patient, a woman with an ocular melanoma, was treated at the new Proton Treatment Center at LLUMC.

Early 1991 , the first gantry was commissioned at the new proton treatment facility at LLUMC, marking the first time in history that a gantry was used to deliver a proton beam.

In March 1991, the second beam line was commissioned, enabling treatments to begin for patients with brain tumors and tumors of the head and neck. Later that year, the first gantry was commissioned at the proton treatment facility, marking the first time in history that a gantry was used to deliver a proton beam. The first patient treated with the gantry was a brain tumor patient. Subsequently, the gantry made it possible to deliver the first proton treatments at Loma Linda for a patient with prostate cancer. In later years, men with prostate cancer comprised more than 60% of the patients coming to Loma Linda for proton radiation treatment.

In 1992, groundbreaking ceremonies were held for the radiobiological research building at LLUMC. The support of U.S. Congressman Jerry Lewis was acknowledged with the naming of a floor in his honor. **By July 1993** molecular radiobiological research associated with projects of the National Aeronautics and Space Administration (NASA) bagan at the new research facility. The cooperative LLU-NASA research program initiated studies of living systems to discover ways in which charged particles in space are likely to affect space travelers and scientific equipment. Actual construction of the laboratories began in 1994, and late that year, NASA and LLUMC officials signed a Memorandum of Agreement to study ways to protect astronauts from radiation in space. The ability of the LLU proton accelerator to simulate space radiation, made such research possible.

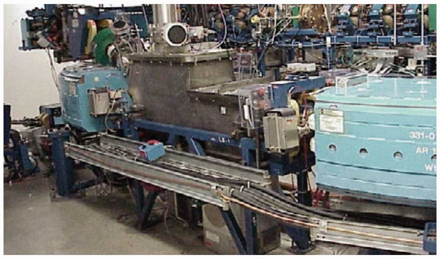
In 1994, the two remaining treatment rooms, Gantries 2 & 3, were completed.

In 1995, the research room was outfitted with dedicated beam lines for radiobiological and physics studies. That year marked the fifth anniversary of the proton facility, and Dr. Robert R. Wilson attended as special guest. One of the gantries was named in his honor, and in recognition of the seminal insights he expressed nearly 50 years previously.

The cooperative LLU-NASA research program initiated studies of living systems to discover ways in which charged particles in space are likely to affect space travelers and scientific equipment.


David Lesyna


Original Optivus Team


Synchrotron and Gantry


Congressman Jerry Lewis

OPTIVUS® PROTON THERAPY

MILESTONES

- **In 1996**, digital imaging was used for the first time at the Proton Treatment Center. This technology permitted more-rapid verification of patient positioning and set-ups. The 2,000th patient was treated during 1996.
- **In 1997**, the 3,000th patient was treated, and radiobiological research, for both medical and space-travel applications, began in the new laboratory facilities. During the year, a NASA upgrade and a new beam transport system were emplaced at the Loma Linda proton facility.
- **In 1998**, the Department of Radiation Medicine reported treating 100 patients with protons and 100 patients with photon beams in a single day. That year also, Optivus reported a 98.5% uptime for their proton therapy system at LLUMC.
- **In 1999**, Optivus upgraded its ion accelerator.
- **In 2000**, Optivus created beam scanning on the new Conforma 3000 treatment system. Optivus gained FDA clearance for the Conforma 3000, the most advanced, precise, and most environmentally friendly proton therapy system. That same year, Optivus completed a PBTD control upgrade at the LLUMC facility.
- **The 5,000th patient** was treated at LLUMC during the year 2000.
- **2001**, LLU radiation oncologists were treating 140 patients daily with proton beams. During 2001 also, Optivus installed beam energy/intensity performance enhancements at the LLUMC facility.
- **In 2002**, the number of patients being treated daily with protons at LLUMC reached 150, and by late summer of that year, the 7,500th patient had been treated.
- In **2003** the Conforma 3000 had an accelerator control update,
- **In 2004**, a successful active (scanning) proton beam was tested, and a flat-panel digital capability installation occurred at the LLUMC proton center.
- **In 2005**, the 10,000 patient was treated on the LLUMC system.

Today, Loma Linda, using Optivus' proton therapy systems, has treated more than 13,500 patients, delivering nearly 1/2 million individual treatments with a perfect safety record. Thus Optivus commissioned the LLUMC proton facility when it opened, continued to maintain the system, and over the years developed improvements and new technology according to clinical specifications laid down by the facility's physicians and physicists. They continue that task to this day.

In 2000, Optivus gained FDA clearance for the Conforma 3000, the most advanced, efficient, reliable, precise and environmentally clean proton therapy system on the market today.

TECHNOLOGY ADVANCES

The advances noted here have been made possible by the ongoing research and dedicated work of the physicians and physicists at the LLUMC proton treatment facility, assisted by the expertise of Optivus engineers. Continued research helps to refine proton treatments, to discover new applications, and to make proton radiation treatment more effective and available to more people by developing a variety of techniques, including spot scanning, raster scanning, and fully electronic computer-controlled treatment delivery. All these new advancements have been FDA cleared.

FUTURE FDA CLEARED ADVANCES INCLUDE

- **2008, Optivus will roll out a new robotic Precision Patient Alignment System (PPAS).** The system will be installed into one of the LLUMC treatment rooms.
- **A DICOM treatment planning proton system** and electronic variable energy capability.
- **Active beam scanning (ABS) system** will be installed in a treatment room, (currently installed in the research room.).
- **Optivus and LLUMC will put into use an Intensity Modulated Proton Therapy (IMPT) System** to treat larger and multi-site tumors. IMPT will enhance the capabilities of the Conforma 3000 to treat more than twice as many cases as disease sites.

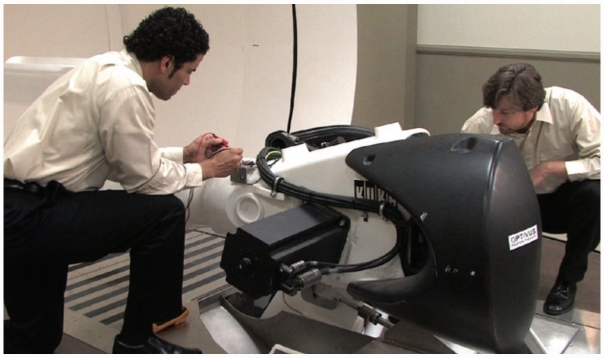
Continued research helps to refine proton treatments, to discover new applications, and to make proton radiation treatment more effective and available to more people.

THE FUTURE OF PROTON THERAPY AND OPTIVUS

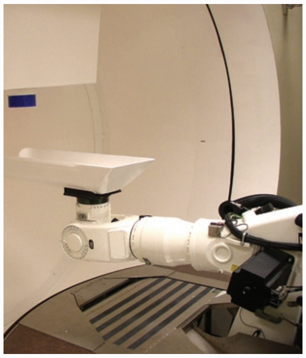
Optivus leads the industry in design advances, service and maintenance, reliability, throughput and safety.

Optivus' team of innovators and visionaries are dedicated to advancing proton therapy; expanding its capabilities and accessability to patients throughout the world.

- Proton radiosurgery and functional radiosurgery
- New disease applications
- Future advances in neurology



Precision Patient Alignment System



Robotic Positioner

OPTIVUS PROTON THERAPY

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Building Exterior


Lobby


Control Room

MISSION To Save Lives with Proton Therapy