Kellogg Laboratory: The Early Years

by Thomas Lauritsen

When C. C. Lauritsen came to Caltech in 1926, the stage was set for 40 years of enthusiastic and prodigious research in nuclear physics.

Like many ventures of its kind, the Kellogg Laboratory's entry into nuclear physics arose through a combination of serendipity and a favorable environment. In 1932, when Cockcroft and Walton announced that man-made machines could be used to disintegrate nuclei, Charlie Lauritsen was listening, and he had a laboratory ready to go. Of course it was luck. He just happened to be working with million-volt vacuum tubes, he just happened to see a future in this newborn field, and he just happened to know a way to put some junk together for an ion source and get in business. He also just happened to know R. A. Millikan.

C. C. Lauritsen came to Pasadena in 1926 after hearing a lecture by Millikan in, of all places, St. Louis. A graduate architect from Odense Technical School in Denmark, Charlie had emigrated in 1917 to find his fortune in America. After various undertakings, from designing naval craft in Boston to professional fishing off the Florida coast, he went to Palo Alto in 1921 to work on ship-to-shore radio for Federal Telegraph. There his interest turned to designing radio receivers, and, together with a couple of enthusiastic partners, he started producing them in a rented garage.

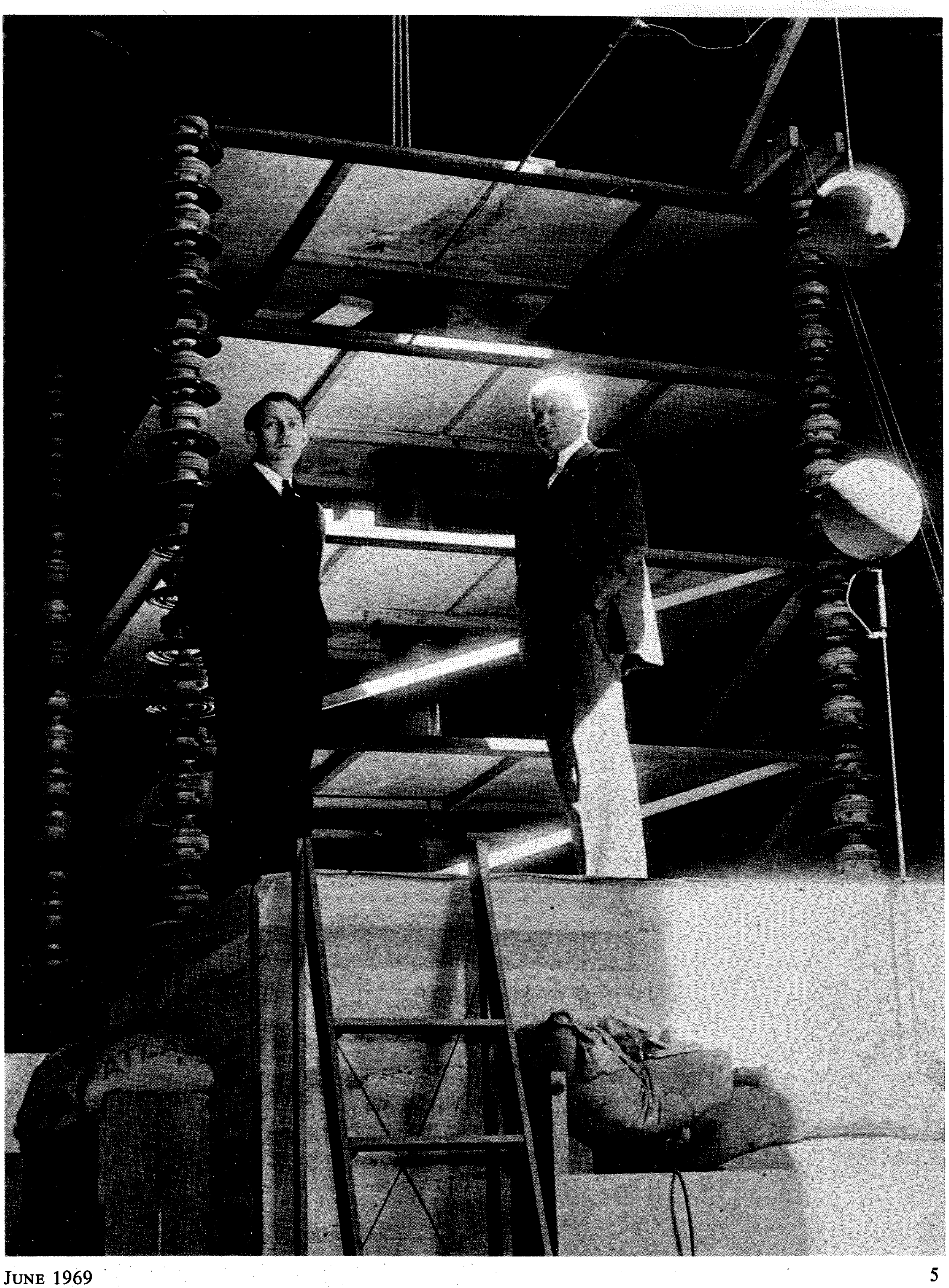
Radio receivers were pretty complicated in those days, with those great big blue tubes sticking out the top and a rat's nest of handmade components inside, and Charlie's had an especially sensitive regenerative circuit. In fact it would oscillate uncontrollably if a curious competitor took it out of the cabinet without noticing that half of a crucial condenser was imbedded in the woodwork. However, the recognition that nationwide companies were not buying his products two at a time for entertainment alone induced Charlie to patent his circuit and join the big operators. In 1923, then, he went off to St. Louis to become chief engineer for the Kennedy Corporation and started making those 50-pound, 10-tube monsters that brought music and status to tens of thousands of American households.

In 1928 the radio business was booming, but Charlie didn't like the noise. He thought he detected an instability in the frenetic maneuvering of the financial giants of industry who seemed to be trying to reap more than could be sown. A certain uneasiness about the future of this line of endeavor, together with the gentle reminder from Millikan that there was a more interesting world, led him to pick up his wife, chattels, and an unpromising 10-year-old offspring and head for Mecca.

In Pasadena, he found much to his surprise that you could get paid—though not handsomely—for working at a place like Caltech, and he settled down to work. He signed up for large chunks of Epstein and Smythe and Tolman and Bowen and Zwicky and Bateman, and started to rebuild his intellectual capital. More than that, he went to the Chief and asked for a project.

One of the most astonishing things about R. A. Millikan was his uncanny gift for knowing where the action was. On all of the crucially important experiments of the era—the measurement of e, the photo effect, x-ray spectroscopy, spectra of stripped atoms, cosmic rays—the Chief's intuition never failed. And he didn't disappoint Charlie, either. What was bothering him in the fall of 1926 was the cold-emission effect: pulling electrons out of metals by high electric fields. If you put in the experimental numbers, it appeared to be easier to get electrons out than the

The million-volt x-ray tube, developed and built at Caltech by C. C. Lauritsen (left) and colleagues in 1928, prompted R. A. Millikan (right) to interest W. K. Kellogg in financing a new laboratory to house the research.



theory would allow, considering that they had to be pulled over a quite formidable potential barrier at the surface. Would Charlie like to look into it? (Present-day graduate students might note that, in those days, such questions were entirely rhetorical.)

Look into it he did. With balls of wax and pieces of string and a joyously acquired skill in quartzblowing and microscopic fiddling, Charlie tracked the beast to its lair. As with many other experiments guided by Millikan, it developed that you had to work hard to get a really clear result, but when you did, it was pretty interesting. In the present instance, it was possible to show that the field emission was quite insensitive to temperature and displayed a simple exponential dependence on field strength that agreed very well with a theory developed by Oppenheimer on the basis of quantum-mechanical barrier penetration. This was 1928.

Field emission, vacuum tubes, and Sorensen's million-volt testing laboratory led Charlie to x-rays. No longer playthings to be stored in cigar boxes, his new tubes took on Brobdignagian proportions, with 6-inch vacuum plumbing and 12-inch glass gasoline pump cylinders (remember them?) for the tubes. With R. D. Bennett, B. Cassen, H. R. Crane, and others, Charlie built a series of these tubes in the old High Voltage Lab, operating up to 750 kilovolts.

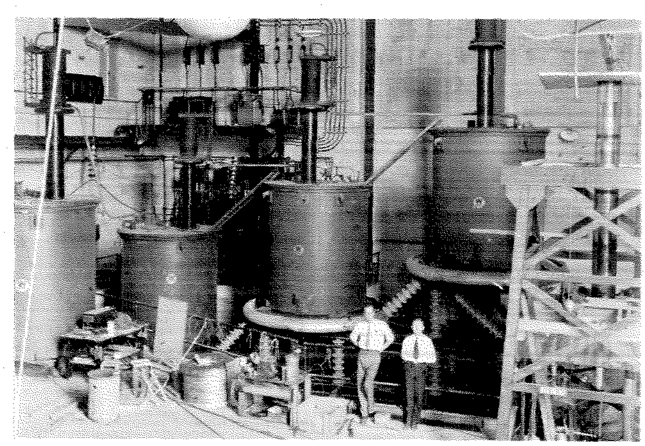
Three-quarters of a million volts was quite a step forward in the technology of 1928. The largest medical x-ray tubes then available were fragile overgrown glass bulbs rated for 200 kilovolts and worth their weight in gold. It seemed natural, then, to explore whether the bigger tubes offered any new opportunities in medicine, particularly in the treatment of deep-seated malignant tumors. This idea proved quite interesting to Albert Soiland, a distinguished radiologist in Los Angeles, and after some preliminary experiments with animals, treatment of patients with "super voltage" x-rays began in the Hi Volts lab in October 1930. In the following year, Millikan got W. K. Kellogg interested in improving the facilities, and the Kellogg Lab emerged from a dirt pile behind Hi Volts.

When the cataclysmic (to nuclear physicists) events of 1932 came along, the x-ray business was just moving out of Hi Volts and into Kellogg, and Charlie was working with Dick Crane to see how you would make a tube if you had money enough to have parts made to order. Came the news then that there was gold in positive ions, and they immediately got to work, converting an x-ray tube with a bottle of gas and a primitive ion source. One of the first projects, published in September 1933, was the artificial production of neutrons by bombarding beryllium targets with helium ions up to 950 kilovolts. The neutrons were detected with a simple quartz fiber electroscope that Charlie had developed for the x-ray work, now furnished with a lining of paraffin. Neutrons had been caught just the year before, after being chased all over Europe by people trying to understand the rare but potent radiations produced by bombarding beryllium with alpha particles from radium. The discovery that you could now make them in a machine by the tens of thousands instead of one at a time made quite a difference in their prospects for gainful employment.

Not very long after, G. N. Lewis supplied Charlie with a sample of heavy water which could be used to make deuterons to bombard lithium and beryllium for an even more copious source of neutrons. Heavy water turned out to be so useful that Dick Crane put together a big electrolytic cell that electrolyzed gallons of sparkling distilled water down to a few drops of repulsive, but heavy, mud. Do-it-yourself deuterons were the order of the day for a long time until some Norwegians made heavy water into a commercial enterprise.

Through all of this, there was Millikan, popping over from time to time with enthusiasm for the new discoveries and working like fury to keep the show on the road and the wolf from the door.

One of the fun things that occurred during these first years of nuclear physics in Kellogg was the discovery that you could make radioactive substances by



Ralph Bennett (left) and C. C. Lauritsen were chiefly responsible for the building of the first million-volt x-ray tube (in the wooden tower at the right) at Caltech. Four cascade transformers supplied the power.

bombarding various things with deuterons. This was first published by Lauritsen, Crane, and Harper in early 1934. From carbon there was produced a 10.3 min activity ^{13}N which not only produced positrons—which weren't very old by then—but also annihilation radiation, the last agonized cry of a positron that has met its match. These experiments, and some others with boron, induced a brief flurry of controversy on this side of the ocean, which finally got resolved when experimental techniques got tightened up a bit. Something that always amused Charlie was that the ^{13}N, which ought to be a gas, stuck firmly in the targets, while ^{11}C usually escaped as CO or CO_2, falsifying the half-life.

Friendly controversies about new results in this fast-growing field were not infrequent. One of these had to do with whether protons could be captured by carbon, making nitrogen 13 and gamma rays. The resolution of this matter led to the discovery of resonance capture, a phenomenon that theorists were quite confident could not occur in nuclei. Niels Bohr's invention of the liquid drop model in 1936 cleared that up.

With the medical operations transferred to Kellogg Lab, Charlie had lots of space in Hi Volts. Together with his students, he built several positive ion accelerators on various concrete huts around the place and kept the million-volt transformer set buzzing day and night. But ac is not the best possible power supply for a nuclear physicist, especially if he's interested in resonances that occur at sharply defined voltages. In 1937 R. G. Herb at Madison had done beautiful things with a Van de Graaff generator enclosed in a pressure tank with a tube that really worked at high voltage. This seemed a good thing to get onto, so Charlie and his gang cleaned out a hut on the floor of Hi Volts and built a version of Herb's machine with some local modifications. Money was a little more plentiful by then, and the pressure tank was specially built for $1,500. That did it for the budget, however, and everything else was either scrounged or made to order by graduate students. Still it was a wonderful machine when it finally ran in late 1938, and it remains a thing of joy, if not beauty, to this day.

The x-rays were turned off in Kellogg in early 1939, when adequate commercial tubes became available in hospitals. Together with its gaggle of graduate students the Van de Graaff was moved in to replace them, along with some other nuclear enterprises just coming into being. Sadly, this promising effort had only just time to get going when the troubles of World War II intervened to shut down the lab for five long years. Charlie went off to Washington to join the fray in early 1940, and there was no more physics until the end of 1945.

Thomas Lauritsen (son of C. C. Lauritsen), professor of physics, has been at Caltech since student days, 1932.

These prewar years saw Caltech's first venture into the world of big accelerators and big projects. In today's terms, of course, neither the machine nor the budgets would be called big; in fact one would today characterize such budgets as an almost negligible perturbation on the poverty level. Still, there was enough money—Millikan saw to that—and more important, there was enthusiasm, and wonder and adventure, on a prodigious, boundless, all-encompassing scale—and this was Millikan, and Charlie, and four generations of horny-handed graduate students.