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# From prairie to energy frontier

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*Fermilab: Physics, the Frontier and Megascience*
Lillian Hoddeson, Adrienne W Kolb and Catherine Westfall
2008 University of Chicago Press
£31.00/$40.00 hb 512pp

Fermilab, the scientific research facility, has for the past 37 years transformed a 10-square-mile patch of the Illinois prairie into the frontier of high-energy particle physics. *Fermilab*, the book, is the first written history of this unique place, covering both the birth of the Fermi National Accelerator Laboratory and its journey to its current position as a world centre of “megascience”. Yet *Fermilab* is far from being a dry historical account. It spans the entire spectrum of what is required to establish a cutting-edge facility and perform research there — from organizational aspects and technological choices to the sociology and politics of funding and site selection. The creation of Fermilab was a far cry from the establishment of a shining light on

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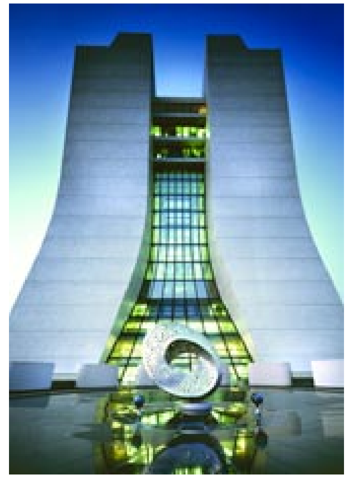
the prairie; rather, it was a practical solution for passionate researchers, driven to do physics amid the real-world constraints of shrinking federal science budgets.


Monument to megascience

One reason that there is more to *Fermilab* than just a simple history is that its authors Lillian Hoddeson, Adrienne Kolb and Catherine Westfall all have a long association with the lab. Hoddeson, the Thomas M Siebel Professor of History of Science at the University of Illinois at Urbana-Champaign, was first hired by Fermilab to document its history in 1977, just five years after the lab opened. Kolb has been Fermilab's archivist since 1983, while Westfall, currently visiting associate professor at Lyman Briggs College at Michigan State University, wrote about Fermilab's history in her doctoral dissertation, which was directed by Hoddeson. This closeness allows the authors to give the reader a true insider's perspective, and by "living" their story they can offer insight and commentary that go beyond the bare facts. They give a sense of the drama and understand the personalities of those involved, and their passion and fondness for Fermilab come shining through in this illuminating book.

*Fermilab* concentrates on the first two decades of research at the lab, when physicists were engrossed in the hunt for new particles and new interactions, as well as the underlying explanation for what they found. The book is heavily footnoted and carefully referenced, and the text is sometimes quite dense; it includes many technical details that are only relevant to those in the business of high-energy physics. However, underneath this detail is a simple, clear narrative that follows the paths of the lab's first two directors, Robert Wilson and Leon Lederman, their unique visions for the facility and their quests to realize their dreams for its future.

The book begins in the postwar era of the 1960s, when resources for science were abundant and particle physicists were busy finding new particles. Further progress in this search — then as now — required beams of ever-increasing energy. In the field of particle physics, scientists can convert energy into mass; thus a higher-energy collider allows physicists to create more massive particles and probe deeper into the quantum universe. Fermilab was envisioned by the US high-energy physics community as the next step in that progression. However, neither the type of accelerator nor its location were unanimously agreed upon by the high-energy physics community at the time. For example, the book's first 100 pages describe in striking detail the dramatic way in which scientific and political discussions during the 1960s led to the selection of the Weston, Illinois, site over the perhaps more obvious Lawrence Radiation Laboratory in Berkeley, California.

A second controversy surrounded the choice of Robert Rathbun Wilson, an outspoken and perhaps brash opponent of the Berkeley design, as the lab's first director. Wilson's credo was that "any technology that works the first time is overdesigned and thus overpriced", and his style was to cut costs to a bare minimum. His inspirational leadership and cowboy ingenuity got Fermilab through a trying construction phase. Wilson was able to establish a working accelerator laboratory, and in so doing, he also established a culture and spirit that exists at the lab to this day.

Still, the 1970s were a difficult period for the lab. It is not enough to merely establish a new facility; one has to then use it to advance our understanding of nature. However, in the beginning Fermilab was not awash with discoveries. Important developments in physics like the discovery of weak neutral currents and the charm quark — both well within the lab's grasp — took place at competing facilities. Wilson resigned in 1978 amid funding troubles, leaving the lab's future in the hands of Leon Lederman, then a professor of physics at Columbia University.

Known for his keen instincts, sharp wit and strong advocacy for physics and physics education, Lederman would go on to share the

1988 Nobel Prize for Physics for his pioneering work with neutrinos. As Fermilab director, he used his considerable personal charisma to garner the political support that the lab needed to build the Energy Doubler, a new accelerator that used superconducting-magnet technology to give Fermilab an unprecedented new window into the world of quarks. This was a major scientific step forward, and one Wilson had been unable to accomplish. In 1983, the Doubler beam was commissioned, and the accelerator renamed the Tevatron.

During the Lederman era, which ended when he stepped down in 1988, experiments grew larger and more complex, as improving our understanding of the fundamental questions that govern matter required big experimental tools and, consequently, large teams of scientists. By the early 1980s, when the lab secured funding from the US Department of Energy for two new colliding-beam detectors, true large-scale science was becoming the norm. Building the Collider Detector at Fermilab (CDF) required a team of several hundred physicists; DZero, a second giant detector built across the ring from (and in competition with) CDF, needed another few hundred. In 1986 a programme of colliding proton and antiproton beams was in place, and the effort paid off: the book ends in 1995 with the joint discovery of the top quark by the CDF and DZero collaborations.

*Fermilab* will be of interest to anyone curious about science and science policy, as well as those who want a better understanding of what it is like to perform large-scale research in high-energy particle physics. It is particularly relevant reading now, with CERN’s Large Hadron Collider (LHC) about to restart. Many decisions facing CERN today have parallels in issues that Fermilab dealt with decades earlier — including how to commission a new accelerator safely, and the trade-offs between perfection and just making things work.

Both labs are currently involved in a decade-long search for the Higgs boson — the long-sought and perhaps final missing piece in the Standard Model of particle physics. However, Fermilab’s long-term future is currently uncertain. It will soon hand over the mantle of the “energy frontier” to CERN, leaving it without a clear mission. The lab has ambitious plans to redefine itself and to take over leadership of the “intensity frontier” — that is, to create a new accelerator complex capable of producing the high-intensity beams of particles necessary for a different “brand” of physics. However, only time will tell how *Fermilab Volume II* will read.

## About the author

Robert Roser is a staff scientist at Fermilab, where for the past five years he has co-led the CDF collaboration