



# Helen T. Edwards: A Trailblazer

Valerie Higgins

Fermilab Community Advisory Board

22 September 2022



Helen Thom Edwards (1936-2016)

(Fermilab photo from 2002)



## Helen Thom, Madeira School class of 1953.

(<https://www.madeira.org/alumnae/notable-alumnae/women-who-change-the-world/?decade=1950>)



Helen Thom in Alpha Phi at Cornell  
(yearbook photos from Ancestry.com)



Helen Thom in Alpha Phi at Cornell  
(yearbook photos from Ancestry.com)

POLARIZATION OF  $\Lambda$  HYPERONS IN THE REACTION  $\gamma + p \rightarrow K^+ + \Lambda$

A Thesis  
Presented to the Faculty of the Graduate School  
of Cornell University for the Degree of  
Doctor of Philosophy

by  
Helen Thom Edwards

September 1966



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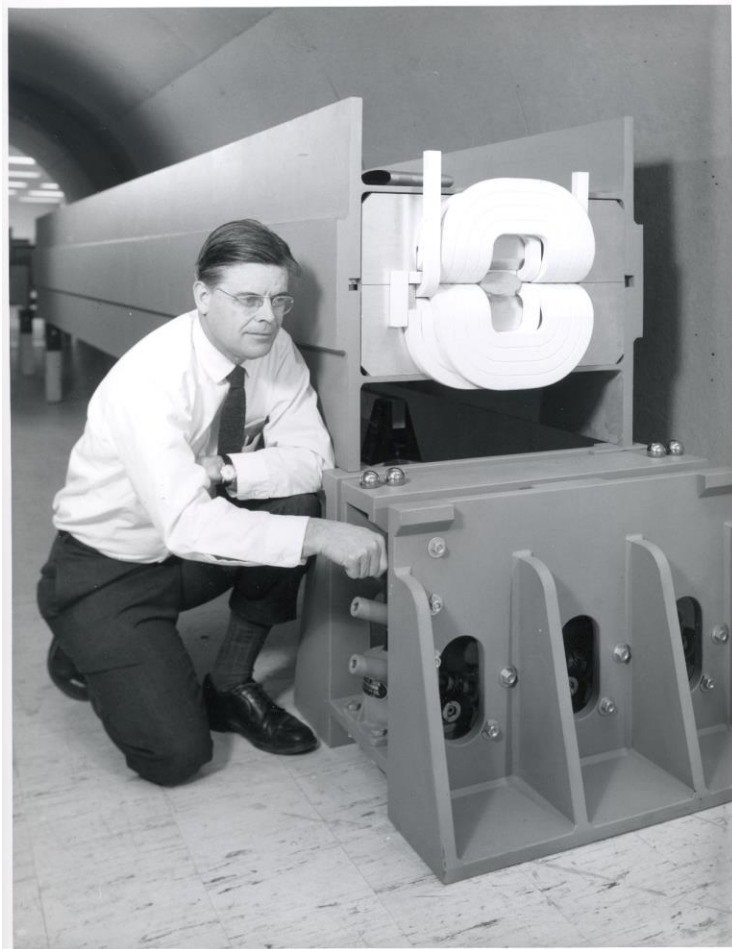
September 1966



## Hans Bethe and Boyce McDaniel bicycling in the Wilson Synchrotron.

(Cornell University photo)





Robert R. Wilson with a magnet  
model.

(Fermilab photo)

HELEN EDWARDS IS ASSOCIATE HEAD OF BOOSTER SECTION

Helen Thom Edwards has been appointed by Dr. Robert R. Wilson, to serve as Associate Head of the Booster Section.

Dr. Edwards received her Bachelor of Arts degree from Cornell University, Ithaca, New York in June 1957 and her PhD in Experimental Physics in September 1966. For the past four years, she has been a Research Associate at the Laboratory of Nuclear Studies, Cornell University.

In early January, Dr. Wilson announced the appointment of Roy Billinge as Section Leader of the Booster group. Billinge joined NAL after serving in the senior scientific office of the Rutherford High Energy Laboratory at Chilton, Berkshire, England, from 1959 to 1968. He was a tutor in electro-magnetic theory (1965-66) at the Oxford College of Advanced Technology. While in Europe, Billinge served as a guest member of the European Committee for Future Accelerators (1966-67), focusing on the study group on Boosters.

Dr. Edwards' husband, Dr. Donald Edwards, is with the Accelerator Theory Section at NAL and, at present, is mainly concerned with the control system of the accelerator. The Edwards reside in Elgin, Illinois.

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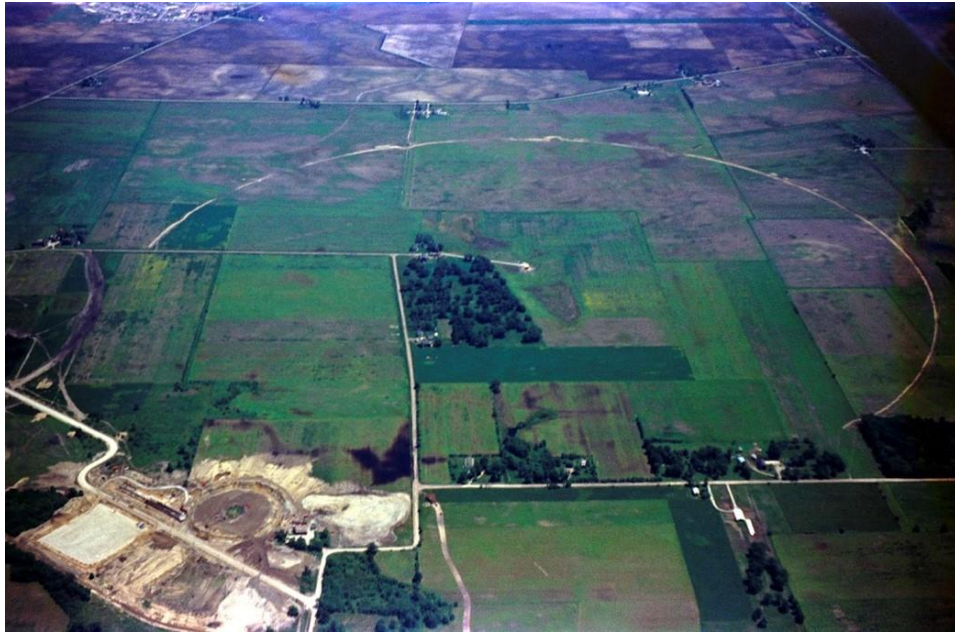


Roy Billinge, Helen Edwards

Clipping from the March 19, 1970, issue of *The Village Crier* (the lab's employee newsletter) on Edwards's appointment.



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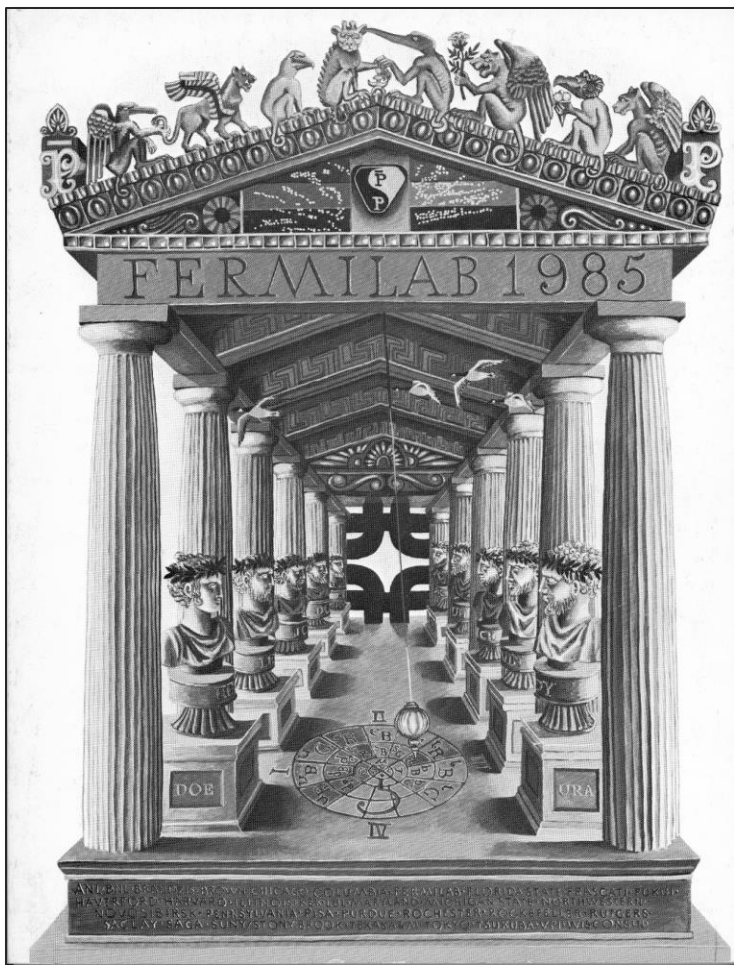


Main Ring under construction.  
(Fermilab photos)

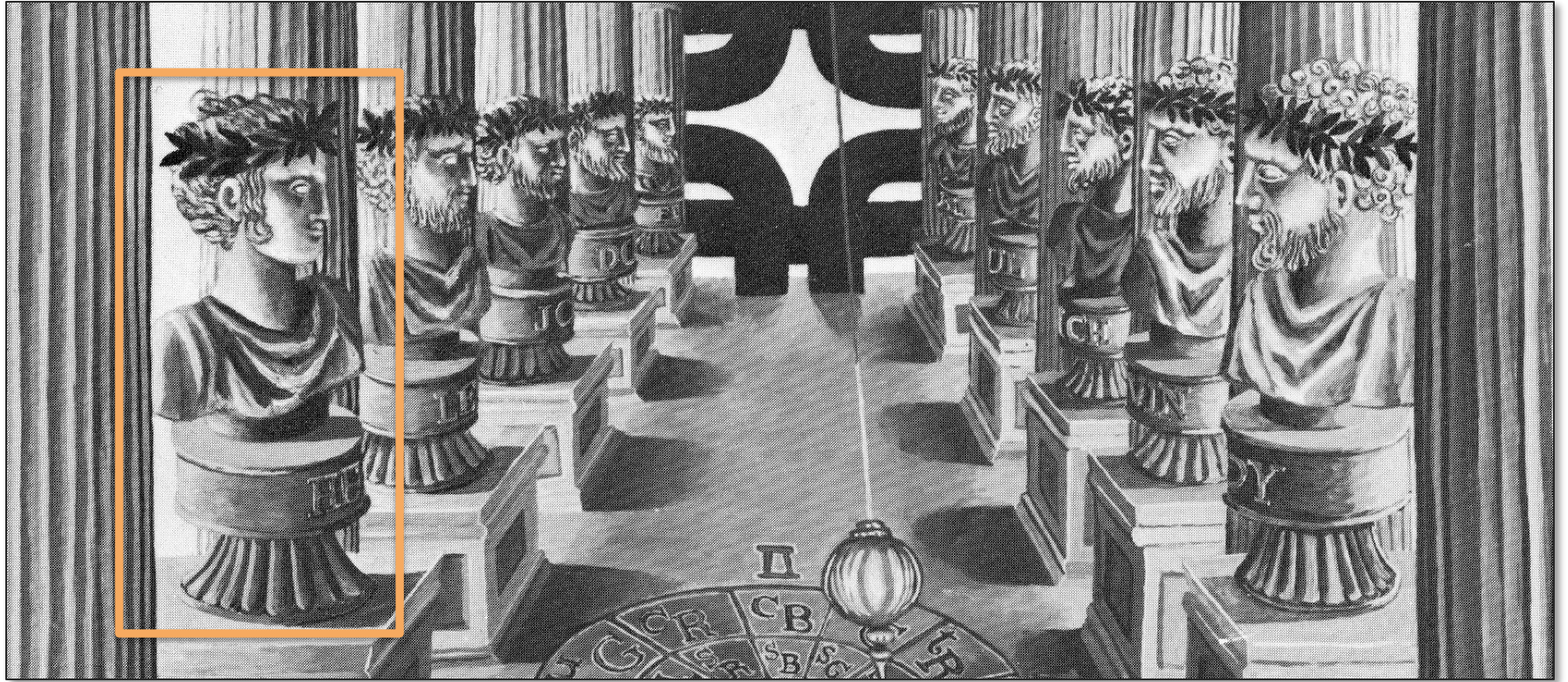


Helen Edwards monitoring display panels at the National Accelerator Laboratory in 1971.

(Fermilab photo)



Fermilab 1985 annual report cover by lab artist Angela Gonzales.





### THE TEVATRON PROGRAM

The Tevatron Program will build the 1,000 GeV superconducting accelerator, using magnets supplied by the Energy Doubler Magnet Division. The machine will be constructed from plans being developed by a design task force under the leadership of Helen Edwards.

Clipping from the January 25, 1979, issue of *Ferminews* (the lab's employee newsletter).

Helen Edwards speaking at Fermilab's 1979 Users Meeting.

(Fermilab photo)



## From “The Tevatron Energy Doubler” by Helen Edwards, 1985:

“The design of a superconducting-magnet accelerator presented many real engineering challenges and raised several accelerator physics questions...”

- “...the magnets had to be protected from their own stored energy in the event they stopped superconducting or ‘quenched...’ The big question was how to wind and clamp the coils so they would not move under ramping field forces, and so that they had highly linear and reproducible magnetic fields throughout their excitation cycle.”

“The major accelerator physics questions were threefold.”

- “First, how good did the magnetic fields have to be over what region of the magnet aperture?”
- “Second, could beam losses be kept low enough so as not to quench the magnets during normal operation?”
- “Third, what sort of accelerator adjustment and control, instrumentation, and diagnostics would be required to aid in smooth commissioning and operation of an accelerator in which it was proposed to challenge the laws of nature that require an environment a few degrees above the absolute zero of temperature?”

(Ann. Rev. Nucl. Part. Sci. 1985. 35: 605-60)



The lower set of magnets were part of the Tevatron. It used over 1,000 superconducting magnets to accelerate protons and antiprotons to 99.999954% of the speed of light and produced collisions between them.

(Fermilab photo)



Aerial view of the Main Ring,  
which also housed the  
Tevatron.

(Fermilab photo)



Helen Edwards at the  
installation of the last  
superconducting magnet for  
Fermilab's Tevatron on March  
18, 1983.

(Fermilab photo)

## *Resolution*

At its Friday, June 17, meeting at Fermilab, the Universities Research Association (URA) Board of Trustees voted by acclamation the following expression of recognition of the Laboratory's attainment of an initial beam in the superconducting ring:

"Be it resolved that the Board of Trustees of the Universities Research Association congratulates the Director and staff of the Fermi National Accelerator Laboratory for reaching an impressive milestone of the Saver project in record time. In particular we wish to acknowledge the singular accomplishments of Dr. Rich Orr and Dr. Helen T. Edwards in leading this distinguished effort."

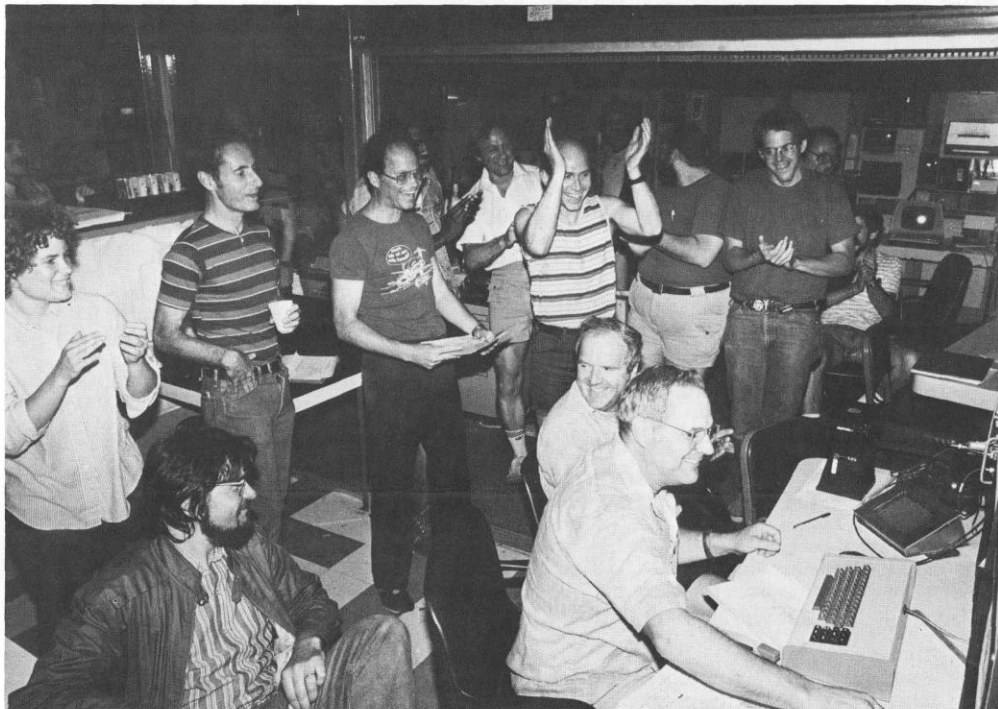
This was submitted to Leon Lederman by Dr. H. Guyford Stever, president of URA, in a letter dated June 23.

Clipping from the July 7, 1983, issue of *Ferminews* about a resolution by Universities Research Association congratulating the lab on its progress on the Tevatron and acknowledging Edwards's "singular accomplishments... in leading this distinguished effort."

July 7, 1983

FERMI NATIONAL ACCELERATOR LABORATORY

## SAVER REACHES GOAL, SETS ENERGY RECORD!



Clipping from *Ferminews* on the Tevatron achieving an important milestone on July 3, 1983: accelerating protons to 512 GeV. This was a new world record.



Edwards and Leon Lederman  
(Fermilab's second director) on  
July 3, 1983, the day the Tevatron  
achieved 512 GeV.

(Fermilab photo)



Helen Edwards speaking at the 12th  
International Conference on High-  
Energy Accelerators at Fermilab in  
August 1983.

(Fermilab photo)

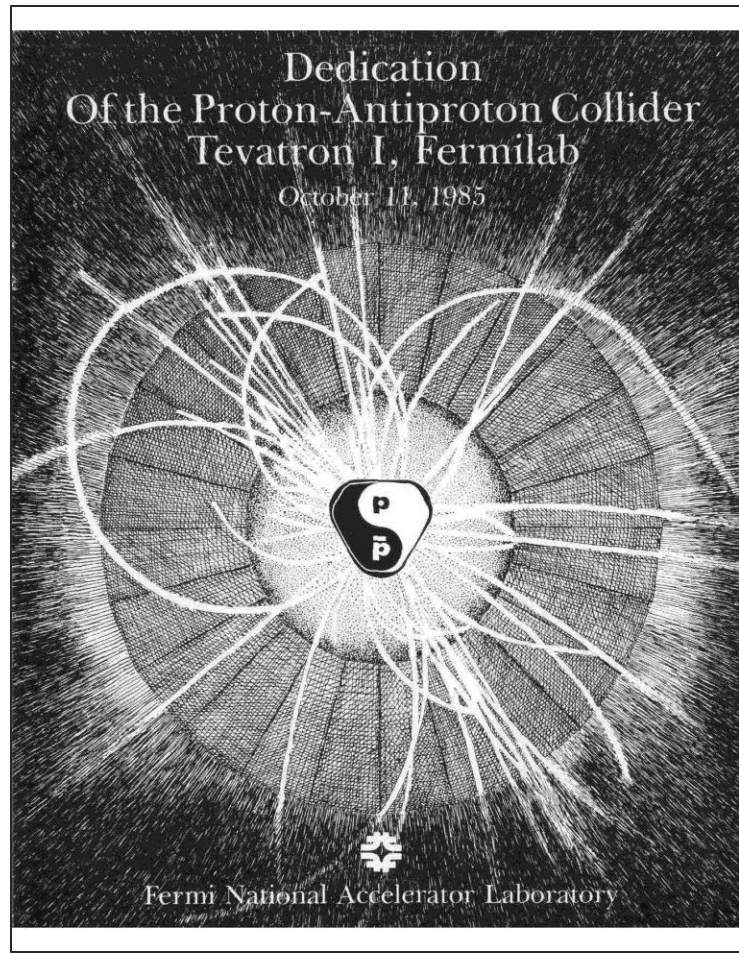


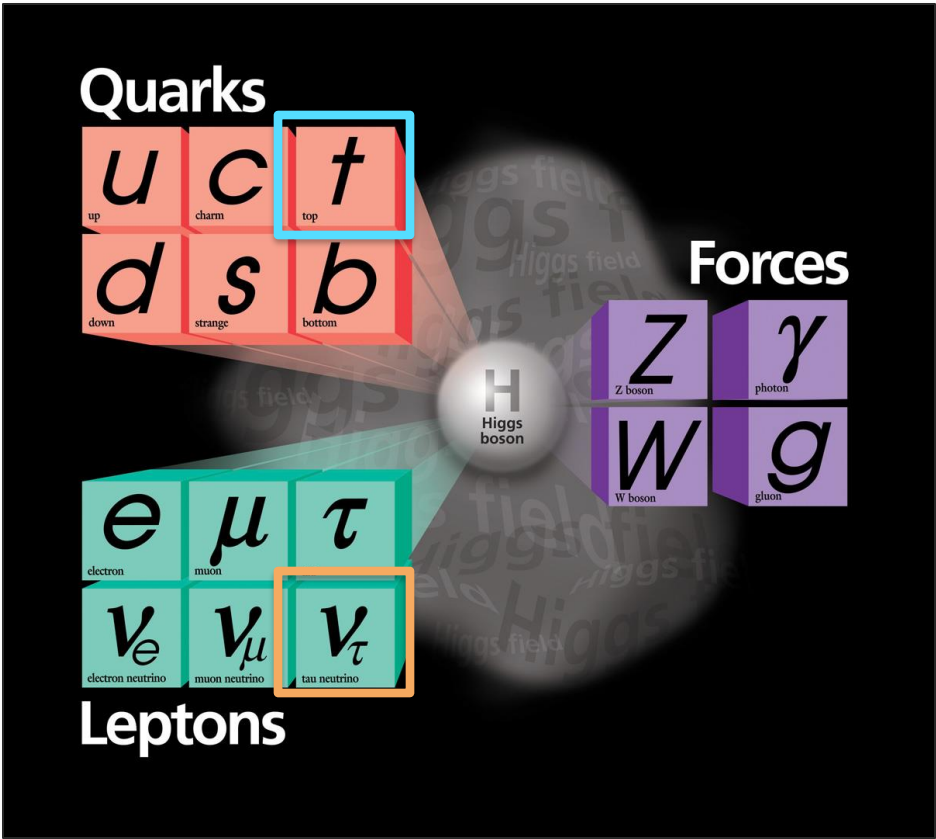


Helen Edwards in a 2002 article:

“To begin with, there was indeed a good bit of skepticism over whether [the Tevatron] would work,” she recalled. “By the time we were ready to turn it on, I was pretty confident that it would work, and work well. I think that had to do with the many iterations of testing things, installing, re-installing and getting all the engineering to work. It began as a fixed-target machine, of course, then two years later joined up with the Pbar Source to run as a collider. So there were two major steps involved.”

(from *Ferminews* article, November 22, 2002)





# The Standard Model

(Fermilab graphic)

# Helen Edwards Receives 1985 Physics Award

Helen Edwards, Deputy Head of the Accelerator Division, has been awarded one of two Achievements in Accelerator Physics and Technology awards for 1985, the first year the award is being given. Edwards was cited for her "essential contributions in making the world's first superconducting synchrotron a reality." The award was presented on the evening of July 25, 1985 at SLAC during the Summer Accelerator School. Helen's co-recipient was John M.J. Madey of Stanford University, cited "for the invention and demonstration of the free-electron laser."



*Helen Edwards*

Clipping from *Ferminews* on August 8, 1985.



# FermiNews

October 27, 1989 Vol. XII, No. 18

Fermi National Accelerator Laboratory

Medals, Prizes, and Awards. . .

**Nat'l Medal of Technology to Edwards, Lundy, Orr, Tollestrup**

“Helen Edwards, currently Head of the Accelerator Division at the Superconducting Super Collider Laboratory, served as Deputy Project Manager on the Tevatron. She is credited with providing "the basic intellectual talent required to design" the Tevatron. She specified the magnet acceptance parameters and supervised some 100 physicists and engineers in the design of the accelerator lattice, the high-power rf acceleration, the state-of-the-art computer controls, the beam diagnostics, and the technique for extracting and distributing accelerated protons.”



Helen Edwards receiving  
the 1989 National Medal  
of Technology from  
President George H.W.  
Bush at the White House  
on October 18, 1989.

(<https://web.archive.org/web/20201123221515/https://nationalmedals.org/laureate/helen-edwards/>)



1989 National Medal of  
Technology recipients:  
(left to right)

Richard A. Lundy

J. Ritchie Orr

Helen T. Edwards

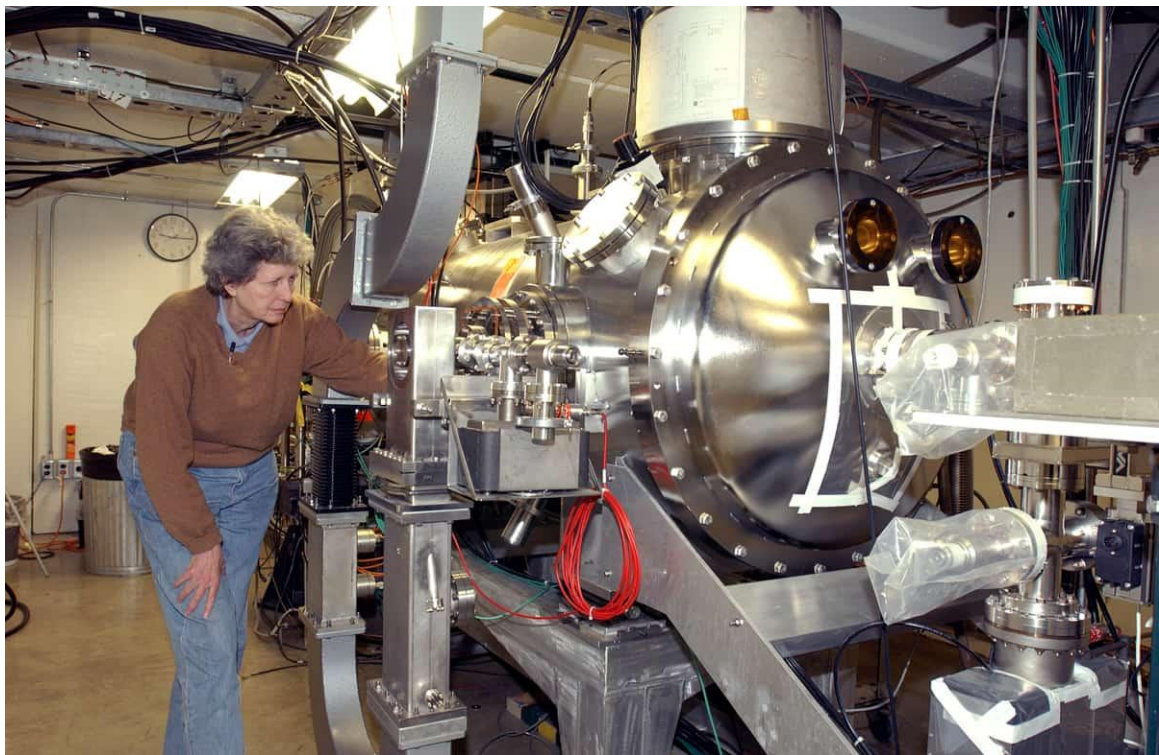
Alvin V. Tollestrup

(Fermilab photo)



Magnet Development  
Laboratory building at the  
Superconducting Super  
Collider site in  
Waxahachie, TX, c. 2008.  
(Wikipedia)





Edwards working on research and development of superconducting magnets and cavities for DESY's TESLA linear collider at Fermilab's AZero in 2004.

(Fermilab photo)



Edwards at the Tevatron  
shutdown ceremony on  
September 30, 2011.

(Fermilab photo)



Edwards at the Tevatron  
shutdown ceremony on  
September 30, 2011.

(Fermilab photo)

Helen Edwards was an author on at least 161 articles, conference papers, and other research works.

*Ann. Rev. Nucl. Part. Sci. 1985. 35: 605-60*

# THE TEVATRON ENERGY DOUBLER: A Superconducting Accelerator

*Helen T. Edwards*

Fermi National Accelerator Laboratory,<sup>1</sup> Batavia, Illinois 60510

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Design of

1.

Development of Energy  
way at Fermilab since mid  
the point where dipole ma  
teristics and reasonably  
The focus of the effort  
the magnet design and de  
manufacture magnets of v  
desired.

Some of the develop  
individual testing and  
tests in the design loc  
the Main Ring magnets  
for some years a small  
aspects of the design.  
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with 24 $\mu$  processors (one in each  
which are in constant communication  
Each is constantly checking voltage  
rt of the magnet string. Any  
or noise can potentially turn off  
stem and/or quench the magnet

<sup>12</sup> for the superconducting magnets  
ted than for a standard accelera-  
sists of an outer vacuum jacket  
er volumes each of which must be  
lating vacuum. These volumes  
high vacuum region in which the  
e phase helium space; c) the  
d) the nitrogen shield space.  
de pumps and instrumentation  
uum systems, but during instal-  
st be performed on the four  
s where the flange joints are  
for classical leak check pro-  
vantage is that the beam  
w temperature and provides  
discussions have raised the  
vacuum instability problem



Edwards with Fermilab's  
AZero Photo Injector  
Group in 2008.  
(Fermilab photo)

# Awards and Honors...

- Fellow of the American Physical Society, 1984
- U. S. Particle Accelerator School Achievement in Accelerator Physics and Technology Award, 1985
- Department of Energy's E. O. Lawrence Award, 1986
- MacArthur Fellowship, 1988
- National Medal of Technology, 1989
- Robert R. Wilson Prize from the American Physical Society, 2003
  - “for her pivotal achievement and critical contribution as the leader in the design, construction, commissioning and operation of the Tevatron, and for her continued contributions to the development of high gradient superconducting linear accelerators as well as bright and intense electron sources.”

# Legacy...

“Helen Edwards, visionary behind Fermilab’s  
Tevatron, dies”  
(Fermilab, 2016)

“DESY mourns Helen Edwards”  
(DESY, 2016)

“Architect of Tevatron dies”  
(science.org, 2016)

“Helen Edwards: pioneer of Fermilab’s Tevatron”  
(*Physics World*, 2022)

# Legacy...

- Helen Edwards and her husband Don Edwards (who was also a physicist) endowed a chair in accelerator physics at Cornell University (2001)
- Fermilab's "Physics of Accelerators and Related Technologies for International Students" internship renamed the "Helen Edwards Summer Internship Program" (2017)





*“Her continuous drive was something that amazed me... It seemed like nothing could slow her down.”*

--Paul Czarapata, deputy head of the Fermilab Accelerator Division

Helen Edwards in 1986

(Fermilab photo)



*“I was scientifically mesmerized by her... She had this intuitive and innate grasp of the material, and she was always absolutely right – she was never wrong in the 20 years I knew her.”*

--Tim Koeth, who studied accelerator physics under Edwards’s supervision when he was earning his Ph.D.

Helen Edwards in 1986

(Fermilab photo)



*“I saw Helen day and night, and on weekends. Every single day of the year, she was here. She was always monitoring the Tevatron’s progress. She was an inspiring and strong leader.”*

--Lia Merminga, Fermilab director

Helen Edwards in 1986

(Fermilab photo)



Helen Thom Edwards (1936-2016)

# Questions?

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# Extra slides

## 5. HINDSIGHT AND A LOOK TO THE FUTURE

It works! This is by far the most significant thing that can be said in retrospect. One tends to forget that it was not obvious that the Energy Doubler would work and that years of effort with many failures and setbacks went into the magnet and cryogenic development.

There are no major flaws in the system that we know of to date, but one should keep in mind that it is very much a prototype accelerator. It is as much an accelerator research tool as a high-energy physics tool. It will take time for the performance to become as dependable as expected from conventional accelerators.

Clipping from “The Tevatron Energy Doubler” by Helen Edwards, 1985.

(Ann. Rev. Nucl. Part. Sci. 1985. 35: 605-60)