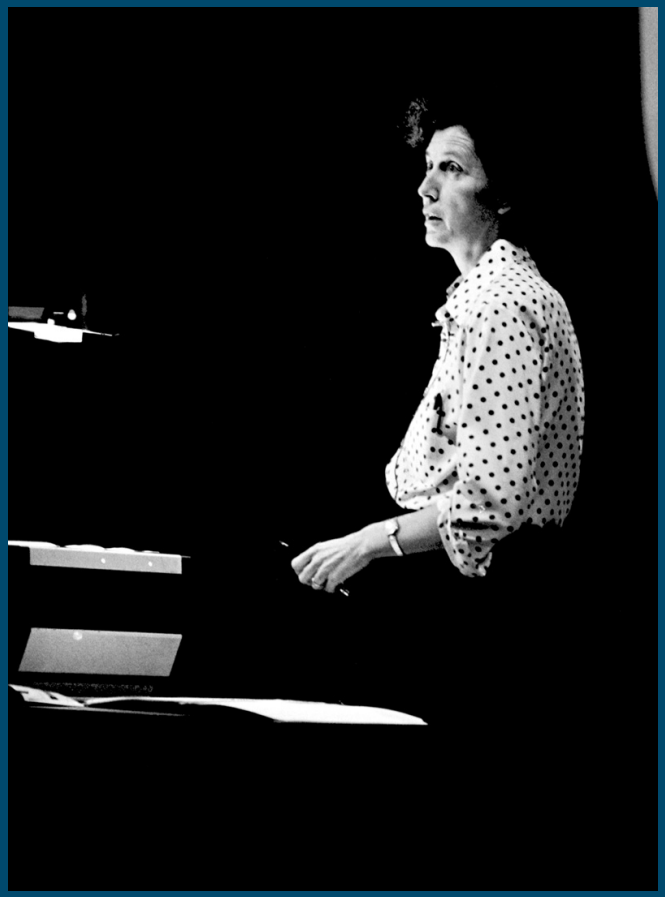


HELEN EDWARDS AND THE TEVATRON

Mike Witherell

CELEBRATING HELEN EDWARDS
April 14, 2019

BERKELEY LAB
Lawrence Berkeley National Laboratory

Helen comes to NAL

The Village Crier 3/19/1970:

> "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."

The Vision(1972-1985)

- 1972
  - 400 GeV Main Ring operational
  - Bob Wilson: Tunnel/service buildings accommodate a superconducting accelerator at 2x the energy
- ~1976
  - SC magnet program initiated
  - Rubbia, Cline, McIntyre propose proton-antiproton collider at CERN or Fermilab
    - 1E29 luminosity deemed sufficient for W, Z
    - Supported by 1E11 antiprotons/day

The Tevatron

Helen at the
1979 Users Meeting

Ferminews 1/25/1979:

"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."

Building the Tevatron Collider
June 1981: Director's Review of Tev I

- The Committee (Tigner):
  - "The design appears to be adequate to meet the goals for Pbar production and accumulation listed in the design report. However ***those goals are too modest***. "
  - "We recommend that the Laboratory re-examine the goals and develop a feasibility ***design commensurate with the full potentia***l of the Main Ring-Booster combination to produce pbars."
- Lederman directed John Peoples:
  - Develop an alternate design which rests on the considerations of technical feasibility (& not cost).
  - Provide a progress report in 40 days.

The Tevatron Energy Doubler: A Superconducting Accelerator

Some excerpts from Helen's Annual Review with this title:

"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?"

A record on 3 July 1983: 512 GeV

"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.."

Completing the Construction (1973-1985)

- July 1979
  - Tevatron construction authorized
- July 1982
  - CDF and Antiproton Source authorized
- July 1983
  - First accelerated beam 512 GeV
- 1984
  - D0 approved by DOE
- October 1985
  - First western hemisphere antiproton-proton collisions

Success

"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."

1995: Discovering the top quark

FERMILAB-PUB-95/022-E
CDF/PUB/TOP/PUBLIC/3040

Observation of Top Quark Production in $\bar{p}p$ Collisions

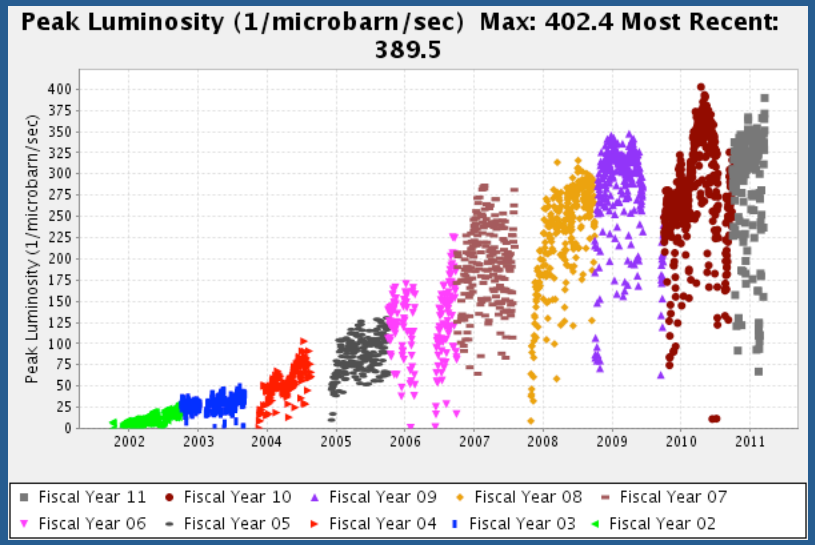
Abstract

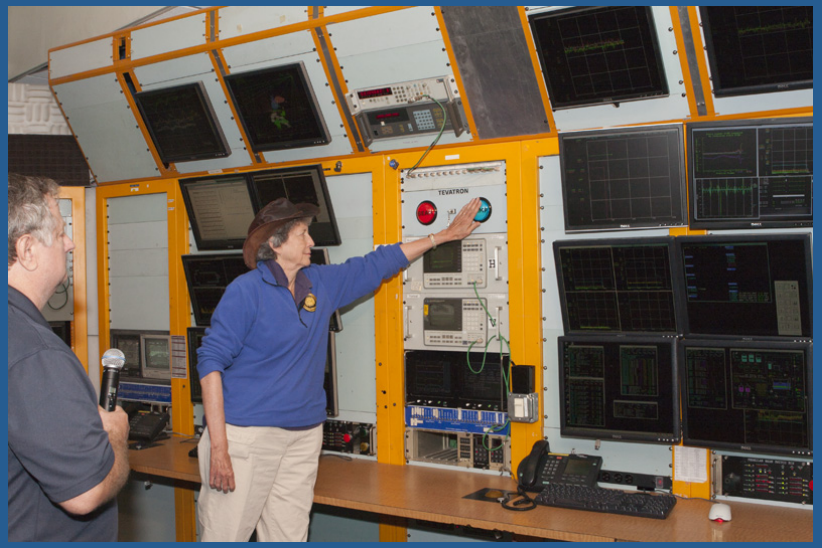
We establish the existence of the top quark using a 67 pb^{-1} data sample of $p\bar{p}$ collisions at $\sqrt{s} = 1.8$ TeV collected with the Collider Detector at Fermilab (CDF). Employing techniques similar to those we previously published, we observe a signal consistent with $t\bar{t}$ decay to $WWbb$, but inconsistent with the background prediction by 4.8σ. Additional evidence for the top quark is provided by a peak in the reconstructed mass distribution. We measure the top quark mass to be $176 \pm 8(\text{stat.}) \pm 10(\text{sys.})$ GeV/c^2, and the $t\bar{t}$ production cross section to be $6.8^{+3.6}_{-2.4}$ pb.

The CDF Collaboration

F. Abe,[14] H. Akimoto,[32] A. Akopian,[27] M. G. Albrow,[7] S. R. Amendolia,[24] D. Amidei,[17] J. Antos,[29] C. Anway-Wiese,[4] S. Aota,[32] G. Apollinari,[27] T. Asakawa,[32] W. Ashmanskas,[15] M. Atac,[7] P. Auchincloss,[26] F. Azfar,[22] P. Azzi-Bacchetta,[21] N. Bacchetta,[21] W. Badgett,[17] S. Bagdasarov,[27] M. W. Bailey,[19] J. Bao,[35] P. de Barbaro,[26] A. Barbaro-Galtieri,[15] V. E. Barnes,[25] B. A. Barnett,[13] P. Bartalini,[24] G. Bauer,[16] T. Baumann,[9] F. Bedeschi,[24] S. Behrends,[3] S. Belforte,[24] G. Bellettini,[24] J. Bellinger,[34] D. Benjamin,[31] J. Benlloch,[16] J. Bensinger,[3] D. Benton,[22] A. Beretvas,[7] J. P. Berge,[7] S. Bertolucci,[8] A. Bhatti,[27] K. Biery,[12] M. Binkley,[7] D. Bisello,[21] R. E. Blair,[1] C. Blocker,[3] A. Bodek,[26] W. Bokhari,[16] V. Bolognesi,[24] D. Bortoletto,[25] J. Boudreau,[23] G. Brandenburg,[9] L. Breccia,[2] C. Bromberg,[18] E. Buckley-Geer,[7] H. S. Budd,[26] K. Burkett,[17] G. Busetto,[21] A. Byon-Wagner,[7] K. L. Byrum,[1] J. Cammerata,[13]

26 years of science at the Tevatron





R&D collaboration with DESY

Helen established a collaboration with DESY in the early 1990s and "played a key role in developing the TESLA superconducting accelerator technology." (from DESY statement)

- Her team built 2 photoinjectors, one used for TTF (FLASH), and one that supported 20 years of accelerator R&D at Fermilab.
- This led to the development of a 3.9 GHz cavity for FLASH, and the beginning of the SCRF program that is at the heart of Fermilab today.

Why the nation needs national laboratories

- Discovery science
- Scientific solutions addressing national challenges
- Unique scientific capabilities
- Managed, large research teams
- Important technologies with long, risky R&D paths
- A diverse group of highly trained, creative, and committed scientists and engineers.

Upholding a legacy, and improving it

Radiation Lab staff on the magnet yoke for the 60-in cyclotron, 1939, including:
E. O. Lawrence
Edwin McMillan
Luis Alvarez
J. Robert Oppenheimer
Robert R. Wilson

BERKELEY LAB
Lawrence Berkeley National Laboratory

Helen Edwards
Master Builder of Accelerators: 1936-2016