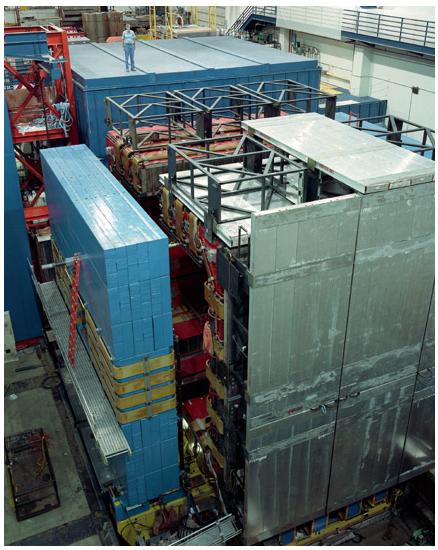
Fermilab

Major contributions of the Tevatron experiments and accelerator complex

Scientific Highlights

Collider experiments



The Tevatron's collider program began proton-antiproton collisions in 1985 and has led to about 1,000 Ph.D. degrees and about a paper a week through work on the CDF and DZero experiments.

Discovered:

- the top quark and determined its mass to a high precision
- two distinct production mechanisms for the top quark: pair and single production
- five B baryons (2 cascade, 1 omega and 2 sigma _b)
- B_c meson
- *Y*(4140), a new quark structure
- B_s oscillations

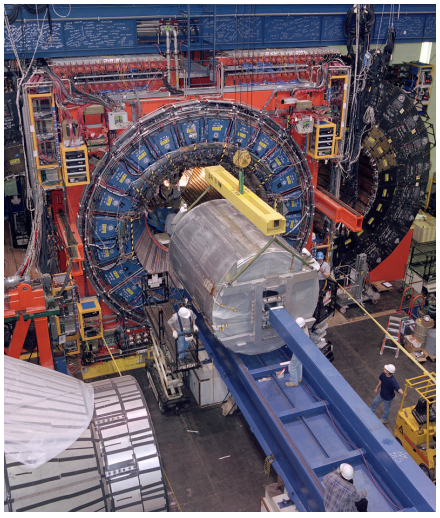
Observed:

- strongest evidence yet for violation of matter-antimatter symmetry in particles containing bottom quarks.
- evidence for CP violation in neutral B mesons

Measured:

- the bottom quark and defined its properties
- precise lifetimes of charm particles
- magnetic moments of particles containing strange quarks
- leading constraints on Higgs boson
- most precise measurement of W boson mass by a single experiment and overall
- strong coupling constant and other parameters related to the strong force

Fixed-target experiments



About 400 Ph.D. degrees and more than 300 papers were generated through work on the Tevatron's 43 fixed-target experiments operating periodically from 1983 to 2000. Many experiments involved more than 100 physicists and engineers.

Discovered:

- tau neutrino

Observed:

- direct CP violation in kaon decays
- antihydrogen atoms
- some of the earliest evidence of particle jets

Measured:

- quark content, structure of proton and neutron

Major contributions of the Tevatron experiments and accelerator complex

Major engineering achievements

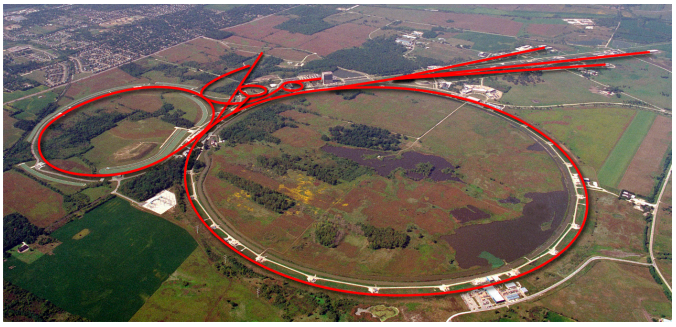
Detector technology

- First use of silicon vertex detectors in a hadron collider environment.
- Developed significant improvements in triggering, tracking and calorimetry systems.
- Pioneered Ring Imaging Cerenkov Counter.
- Developed silicon microvertex detectors for heavy quark physics.
- Developed various integrated circuit advances.
- Developed CsI photon calorimeter.
- Major advances in transition radiation detector.

Computing technology

- Helped advance the use of computer farms.
- Data analysis and storage needs helped push the development of Grid computing.
- Pioneered analysis systems to select, analyze and store unprecedented petabytes of data. CDF and DZero can each analyze a billion collisions per second, saving 200 of those to tape for future study.

Accelerator technology



- First major superconducting synchrotron.
- First electron cooling system developed for use with a high-energy beam.
- New radio-frequency manipulation techniques pioneered.
- Tevatron's cryogenic cooling system was named an International Historic Mechanical Engineering Landmark by the American Society of Mechanical Engineers in 1993.
- Tevatron's antiproton source is the most intense, consistent source of antiprotons in the world and enabled the first proton-antiproton research in the Tera-electron volt energy range.

Major contributions of the Tevatron experiments and accelerator complex

Accelerator technology *(Cont'd...)*

- The Tevatron is the world's most productive proton-antiproton collider, operating at more than 300 times its initial design luminosity, or collisions per second.
- Because the Tevatron required such a large amount of superconducting wire, it provided the motivation for the expansion of the superconducting wire industry.
- Superconducting magnet technology was developed to double the energy output of the Main Ring while cutting its energy use by one-third.
- Innovative design work on the Tevatron earned four scientists the National Medal of Technology in 1989.
- R&D Magazine gave the Tevatron four awards for the most significant technical products of the year in 1983.
- Tevatron named one of the Top 10 Engineering Achievements of the Last 100 Years by the Illinois Society of Professional Engineers in 1986.

Other significant achievements

- The top quark discovery was named among the top 10 scientific discoveries ever in the six-county Chicago region by former Chicago Mayor Richard Daley.
- Fermilab broke barriers to international collaboration, giving several Latin American countries their first opportunities to expand their particle physics work beyond theory, Russian particle physics the first chance to work at a U.S. lab and Chinese particle physicists a home during the Chinese Cultural Revolution.
- Work with the Tevatron trained personnel for the development and operation of the next-generation of accelerators, including the Large Hadron Collider.
- Three-story detectors and cutting-edge accelerators provided a unique training ground for hundreds of engineers, computer scientists, physicists and technicians, many of whom found their way into private industry.
- Planning and development for the Large Hadron Collider and its experiments relied heavily on expertise and technology developed at the Tevatron.

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