End of Fermilab's Tevatron evokes memories, pride

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The Tevatron, the world's highest-energy proton-antiproton collider, will shut down on Sept. 30, 2011. During the next few years, physicists at the University of Chicago and elsewhere will continue to analyze data, produce results and publish scientific papers based on Tevatron research. They also will pursue present and future Fermilab experiments at the frontiers of particle physics. Credit: Fermilab

(PhysOrg.com) -- University of Chicago physicists Henry Frisch and Melvyn Shochet became involved with the Tevatron particle accelerator when it was still in the planning stages at Fermi National Accelerator Laboratory in 1976.

"I'm not completely finished with it yet," said Shochet, who now focuses his research on the Large Hadron Collider at CERN, the European particle physics laboratory. Shawn Kwang, PhD'11, who worked under Shochet's supervision, recently submitted a paper summarizing the Tevatron data from his dissertation to the journal *Physical Review*.

Frisch, meanwhile, continues to analyze data from the Tevatron, which operated for decades as the world's most powerful particle accelerator. Fermilab has shut down the Tevatron for the final time Friday, Sept. 30.

"I have mixed feelings," said Shochet, the Elaine and Samuel Kersten Jr. Distinguished Service Professor in Physics. "It's been a very successful program, but like everything it has to come to an end."

Shochet served as scientific co-spokesman for the 439-member Collider Detector at Fermilab collaboration that obtained the first direct experimental evidence for the top quark in 1994. "The big advantage that the Tevatron program had, both CDF and its competitor, DZero, was the fact that we were at the energy frontier, that we could generate the highest-energy collisions that man could make," he said.

A long list of UChicago faculty members, postdoctoral scientists and graduate students have worked with the Tevatron throughout its history. The list starts with 1980 Nobel laureate James Cronin, University Professor Emeritus in Physics, who was the founding head of a group at Fermilab that in late 1976 began analyzing the technical needs involved in generating and studying high-energy proton-anti-proton collisions at the Tevatron. Shochet and Frisch soon became involved. Young-Kee Kim, deputy director of Fermilab and a professor in physics, joined CDF later.

Other UChicago scientists conducted research at the Tevatron in its fixed-target mode, including Edward Blucher and Yau Wah, professors in physics. In this mode, the Tevatron accelerated beams of protons that were diverted and then smashed into a stationary target instead of head-on into other onrushing particles.

Kaons at the Tevatron

The late Bruce Winstein, the Samuel K. Allison Distinguished Service Professor in Physics, conducted a series of fixed-target studies at Fermilab in the 1970s that culminated in the Kaons at the Tevatron Experiment (KTeV), which operated from 1996 to 2000. "We are actually just finishing the final analysis," said Blucher, who also is chairman of the physics department and now a member of the France-based Double Chooz experiment.

The LHC, which began operation in 2008 with a large U.S. contingent, currently achieves collision energies three and a half times higher than the Tevatron and within years is expected to double its capability. "LHC is a much higher-energy machine and the higher energy allows you to look for phenomena that you really couldn't study effectively at the Tevatron," Blucher said.

The LHC and its associated experiments have benefited significantly from what physicists learned at the Tevatron, he said. "It's a model for how science should work, that everything you learn ought to be passed on to the next effort, and that's what's happened."

Shochet and Blucher both have helped develop plans for the future of their field in this country as members of the federal High Energy Physics Advisory Panel. "As for any area of science it requires significant federal funding. It is a real challenge in difficult economic times," said Shochet, who chairs the panel.

"We've tried to develop a program for the future on American soil that is exciting and holds the promise for important discovery," Shochet said. During the post-Tevatron era, Fermilab will focus on high-precision, high-intensity studies, much like Winstein and Blucher's KTeV experiment.

"This will be the focus of the Fermilab program over the next 15 to 20 years and it involves studying the properties of neutrinos," Shochet said. Neutrinos are ghostly particles that pass unobstructed through matter at high speeds.

A major puzzle

More precisely determining the characteristics of neutrinos may help determine why the universe displays large quantities of matter but virtually no antimatter, a mirror-image type of matter that carries opposite electrical charges. "The origin of that asymmetry is one of the major puzzles in the field," Shochet said.

Such experiments focus on one or a handful of often technically challenging measurements. "A lot of them are very interesting from the physics point of view, but sociologically they're more challenging because one experiment will no longer satisfy 500 people," Blucher noted.

Another key element of the domestic program is to keep the United States in a position to host the next large accelerator project. "We hope to return to the energy frontier with the next machine, whatever that may be," Shochet said, and that will depend on what's discovered at the LHC.

Frisch, professor in physics, advocated extending the CDF experiment for another three years. He takes what he calls a "contrarian" viewpoint on the future of U.S. high-energy physics. He proposes building on Fermilab's proven experience with high-intensity proton-anti-proton colliders.

The LHC is a proton-proton collider. “It’s a wonderful machine, but it’s operating at a fundamental disadvantage,” he said, because a proton-anti-proton collider produces more effective energy. “You’re not getting as much bang for your buck by colliding proton and proton at the same rate.”

Frisch would like to see the United States retake the energy frontier by meshing James Cronin’s original vision for colliding protons and anti-protons at the ill-fated Superconducting Super Collider with the pipeatron concept of Fermilab founding director Robert Wilson.

The approach that Frisch favors, still a theoretical concept at this stage, would be based at Fermilab and use horizontal drilling technology to create the narrow pipe for a powerful new accelerator, with a detector potentially located in downtown Chicago.

“The American populace understands really very well one very clear statement,” Frisch said. “We want to be No. 1."

Provided by University of Chicago