MI-31 background

Sergei Nagaitsev
Fermilab
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Welcome to Fermilab!

- Our mission is to explore Nature on its smallest scale, to understand the most basic building blocks of matter and the forces that bind them together.
- Research at Fermilab addresses the grand questions of particle physics today:
  - Why do particles have mass?
  - What are the truly fundamental forces?
  - What are the differences between matter and antimatter?
  - What is the universe made of?
  - How does the universe work?

Fermi National Accelerator Laboratory (Fermilab) is operated by Universities Research Association, Inc. under contract with the U.S. Department of Energy.

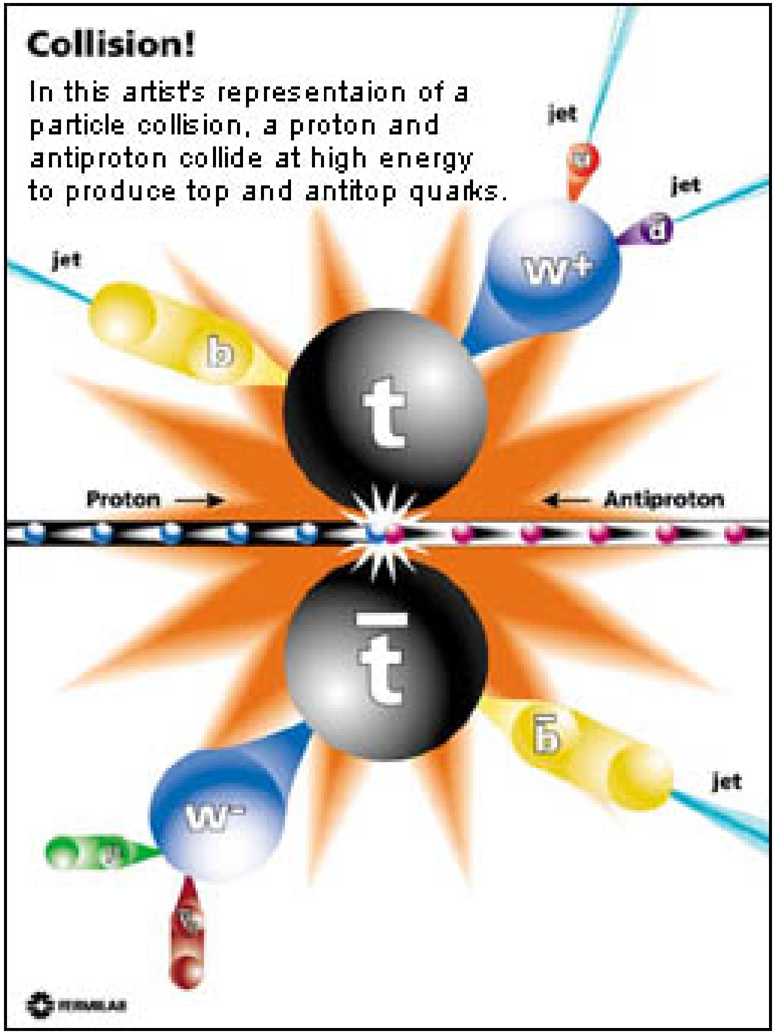
An international collaboration

- Fermilab attracts scientists, not only from this country, but from many other nations all over the world.
- Always a strong proponent of what we call "physics without borders," Fermilab is host to more than 2,400 scientists and students who take part in the lab's experiments---some 1,500 from 101 institutions in 34 states, and about 900 from 116 institutions in 25 foreign countries.

The Tevatron Collider

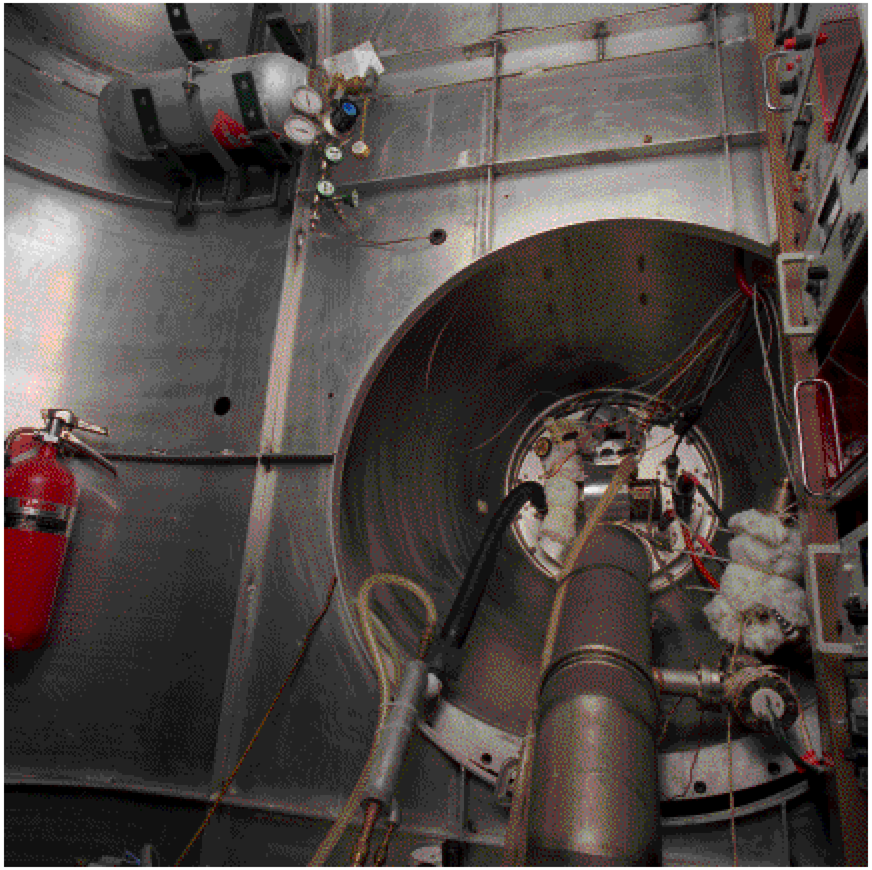
Four miles in circumference, the Tevatron is housed in a tunnel about 30 feet below the ground surface. We use a series of accelerators to keep adding energy to subatomic particles, until we have them racing around the Tevatron at 99.9999 percent of the speed of light in a vacuum. The particles complete the four-mile course nearly 50 thousand times a second.

Telescope? Microscope?



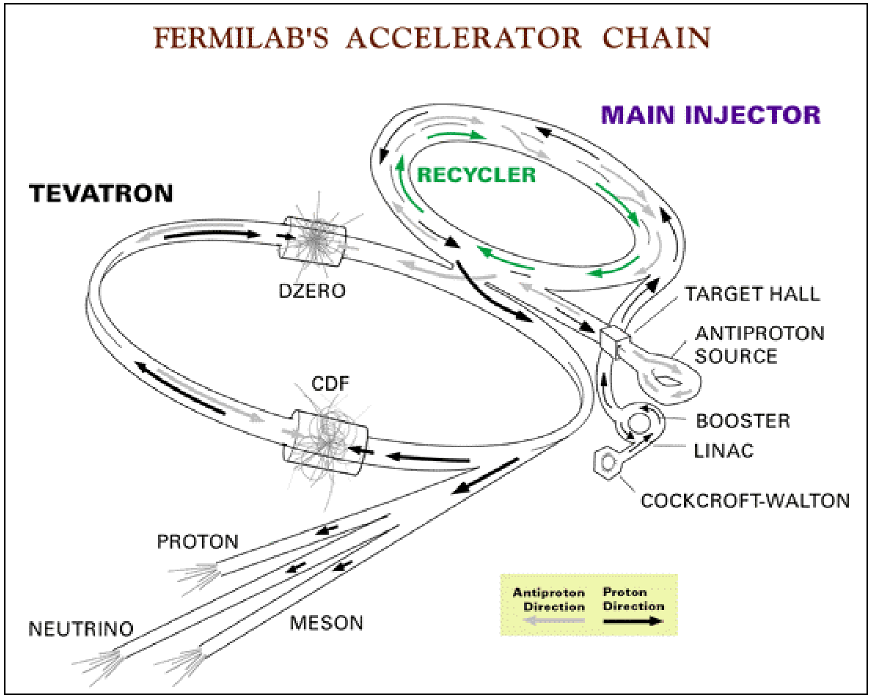
- We make discoveries by taking these speeding subatomic particles and smashing them together, to see what comes flying out.
- In the Tevatron we use two kinds of particles, protons and antiprotons, sending them around the ring in opposite directions. At two points in the ring, we steer streams of these particles (called "beams") right into each other, and watch millions and millions of collisions, at the rate of about a million each second.

Where do we get protons?



- We get protons by ionizing hydrogen atoms.
- In this photo the bottle in the upper left is the hydrogen gas bottle; the complex equipment just to the right of center is the ion source.

Where do we get antiprotons?



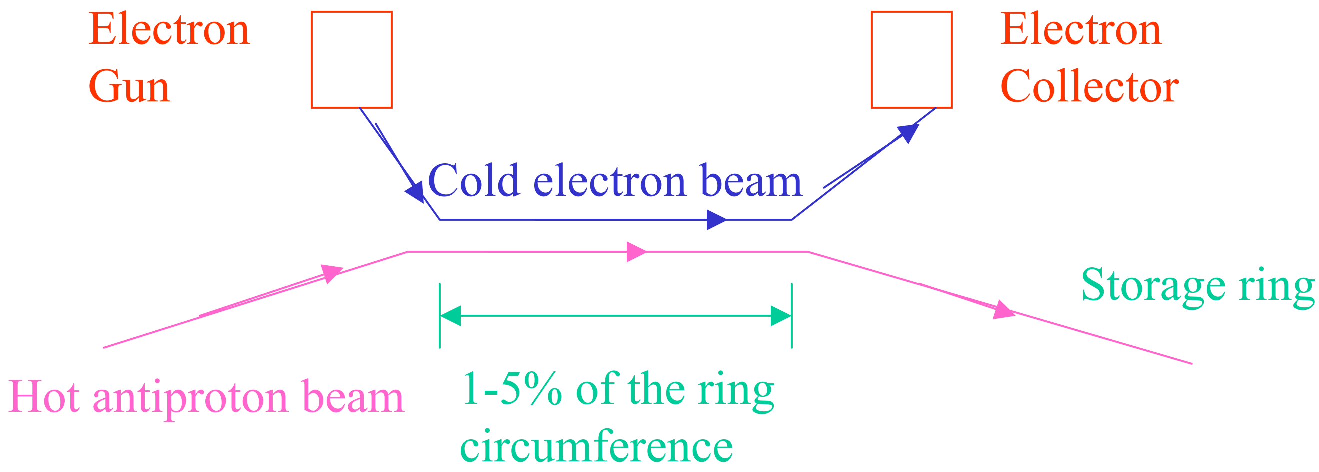
The Antiproton Source is made up of three parts. The first is the Target: Fermilab creates antiprotons by striking a nickel target with protons. Second is the Debuncher Ring: This triangular shaped ring captures the antiprotons coming off of the target. The third is the Accumulator: This is the storage ring for the antiprotons.

How do we accumulate antiprotons?

The proton collisions with the target produce various secondary particles including many antiprotons. Unfortunately, these antiprotons have a wide range of velocities and angles. Only a small portion of them can be captured. Even when captured, these antiprotons are still very diffuse – their angular- and energy spread needs to be significantly reduced before we can send them to the Tevatron.

The MI-31 building will house a device that cools antiprotons

- Electron cooling is a fast process to shrink the size, divergence, and energy spread of stored charged-particle beams without removing particles from the beam.



Electron cooling

- Electron cooling was invented and first tested in 1974 with protons at INP, Novosibirsk (Russia). Fermilab has also tested it on protons in 1980-81.
- At the time, it was thought to be too difficult to use with antiprotons and the project was abandoned.
- Today, the technology and our understanding of electron cooling has progressed. We no longer think of it being too difficult. It is difficult but doable!