

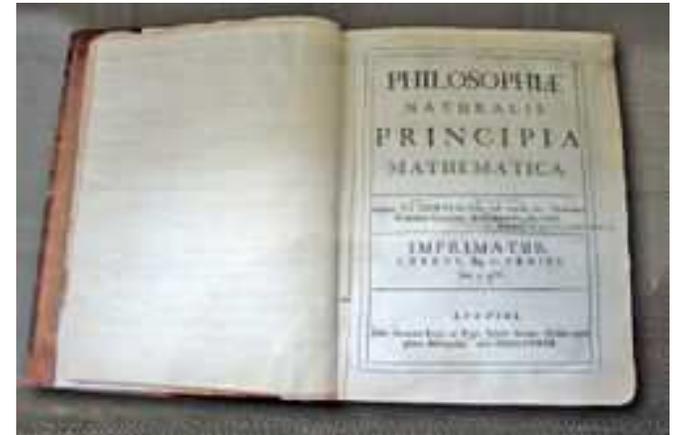
Eric Prebys

Particle & Accelerator Physicist
Fermilab



What does a physicist do?

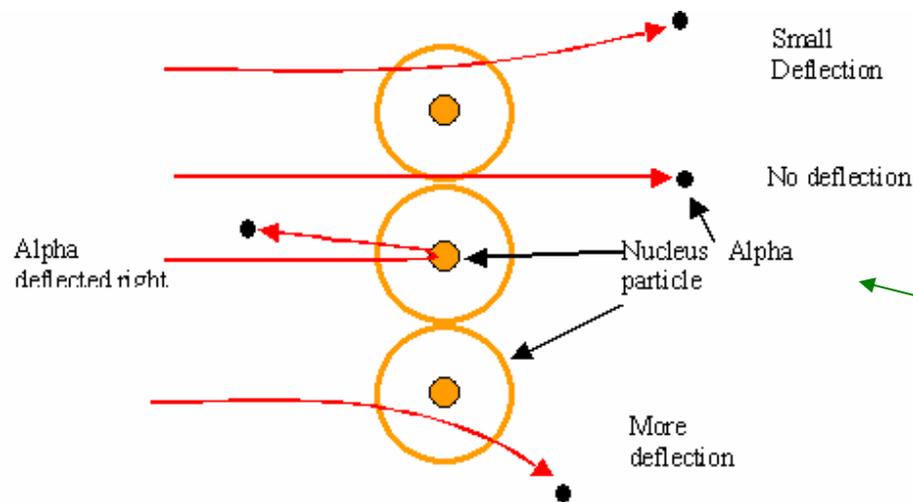
- Physicists try to figure out and use the mathematical “rules” that describe the universe:
 - People have been trying to do this since the dawn of history, but modern physics started in the 1680's, when Isaac Newton figured out that the complex motion of the planets could all be figured out from a few simple equations.
- Some things physicists think about:
 - Fundamental:
 - Why do particles have the mass they do?
 - Why is the universe mostly matter and not antimatter?
 - Practical:
 - How can we get useful energy from nuclear fusion?
 - How can we put more information on a disk (or “Why DVD blue?”)?



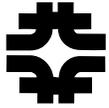


What do particle physicists do?

- Particle physicists use high energy particles to study things far too small to be seen any other way
 - Find the smallest particles
 - Find the rules for how these particles behave
 - Recreate conditions as they were right after the Big Bang
- The first “particle physics experiment” told Ernest Rutherford the structure of the atom (1911)

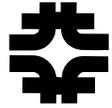


Study the way radioactive particles “scatter” off of atoms



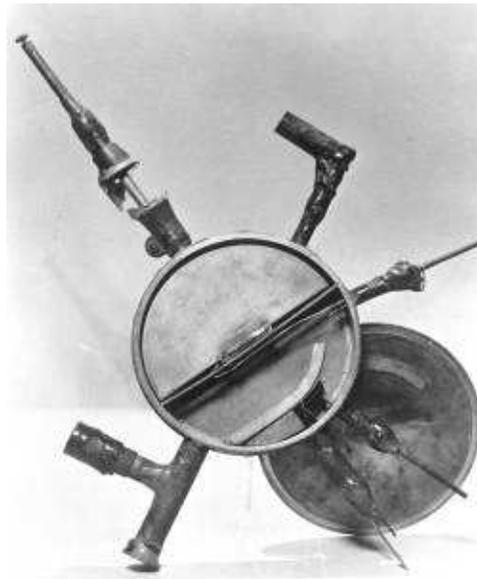
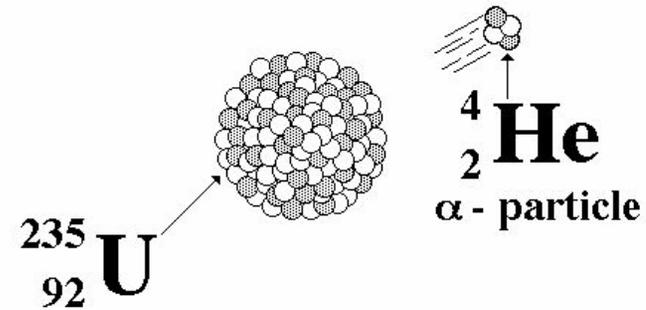
What do accelerator physicists do?

- Accelerator physicists design, build, and operate the machines that accelerate particles to high energies for use in:
 - Particle physics
 - Medicine:
 - Cancer treatment
 - Medical isotope production
 - Materials science and biophysics
 - Study detailed structure of materials, cells, proteins, etc, using
 - Electrons
 - Protons
 - Neutrons
 - Photons
 - Industrial applications
 - Electron welding
 - Food sterilization
 - Etc, etc, etc



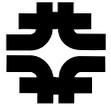
Evolution of accelerators

- The first “accelerators” were natural radioactive elements



Berkley “cyclotron” (1930)

- The first man-made accelerators would fit on a table



Things keep getting bigger



- 60" cyclotron (1935)
 - Berkeley and elsewhere

- Fermilab
 - Built ~1970
 - Upgraded ~1985, ~1997
 - Most powerful accelerator in the world (for a bit longer)

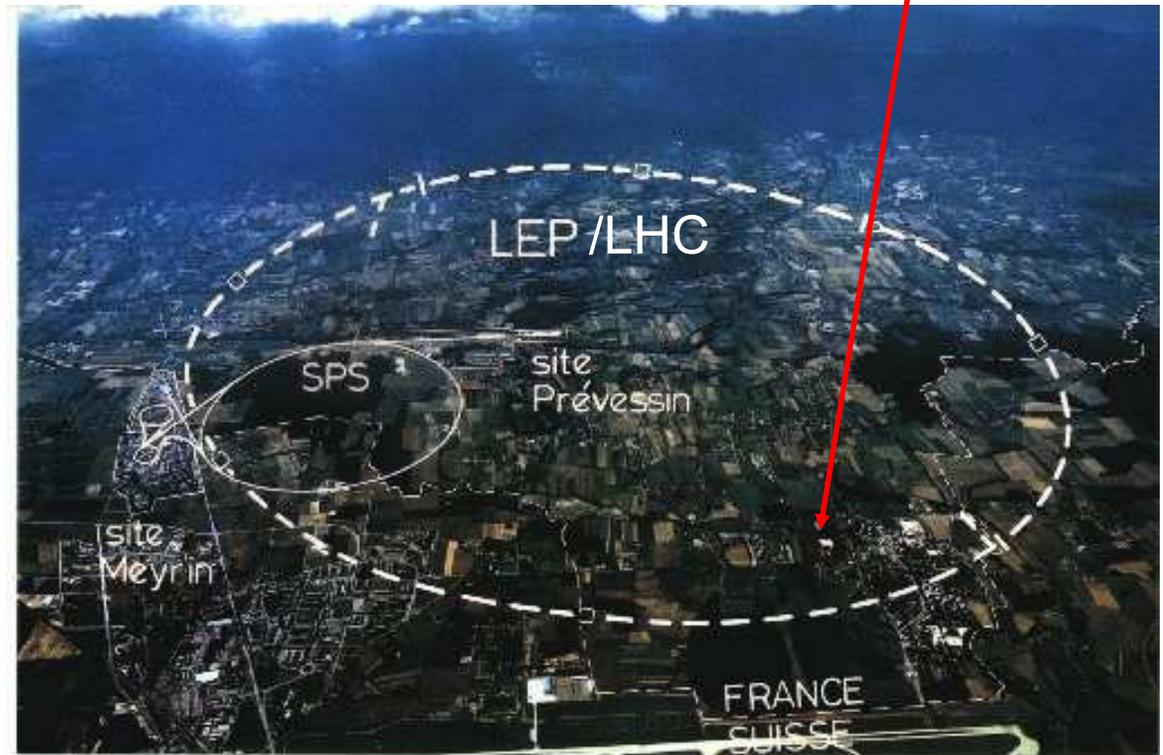




Even Bigger

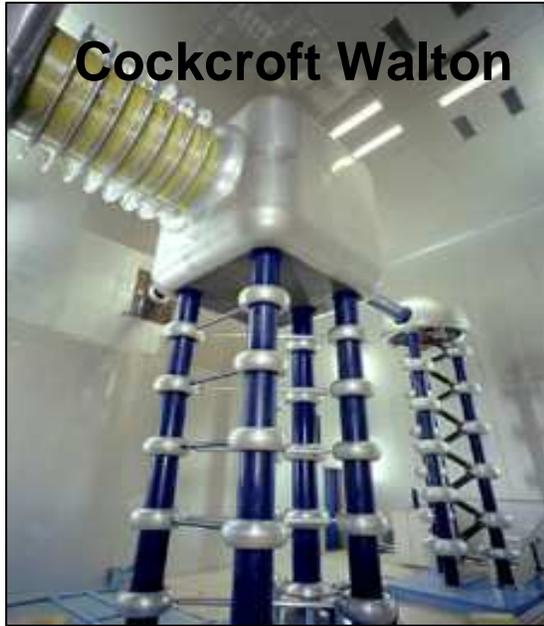
- CERN
 - On Swiss-French border
- LEP
 - 27 km in circumference!!
 - Built in 1980's as an electron positron collider
- Large Hadron Collider (LHC)
 - Being built in LEP tunnel
 - Will start up later this year
 - About 7 times more energy than Fermilab

My House (1990-1992)

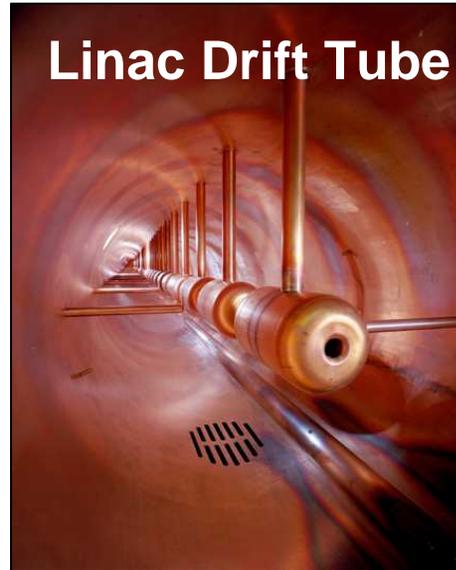




The Fermilab Accelerators



Cockcroft Walton



Linac Drift Tube



Booster



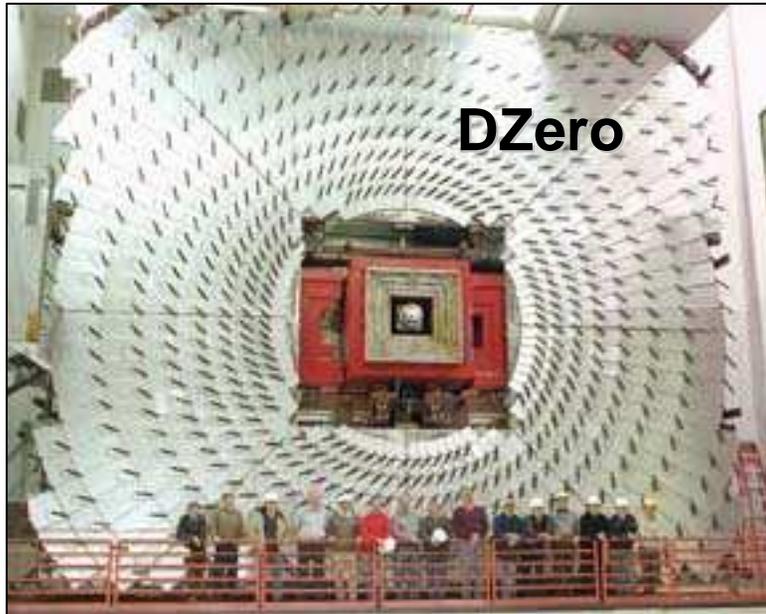
Main Injector



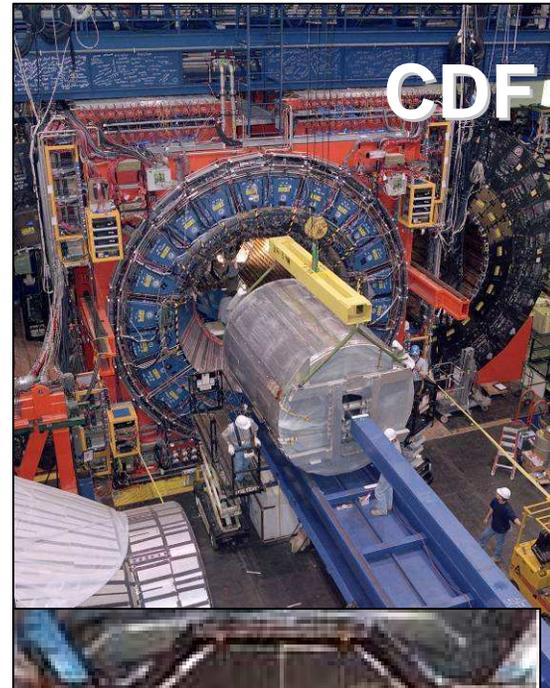
Tevatron



Fermilab Detectors: Seeing what comes out



DZero



CDF



MiniBooNE



MINOS

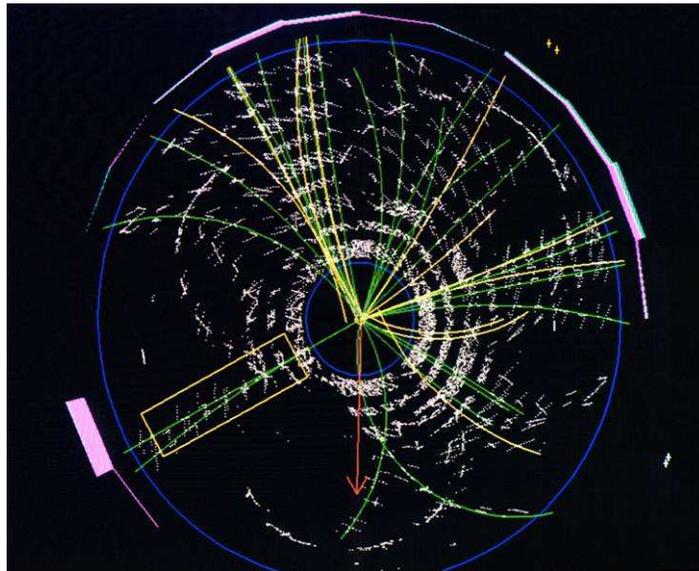
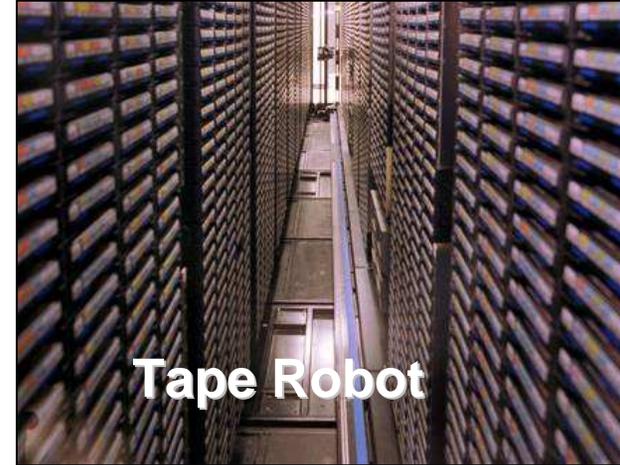


Analysis: What does it all mean?

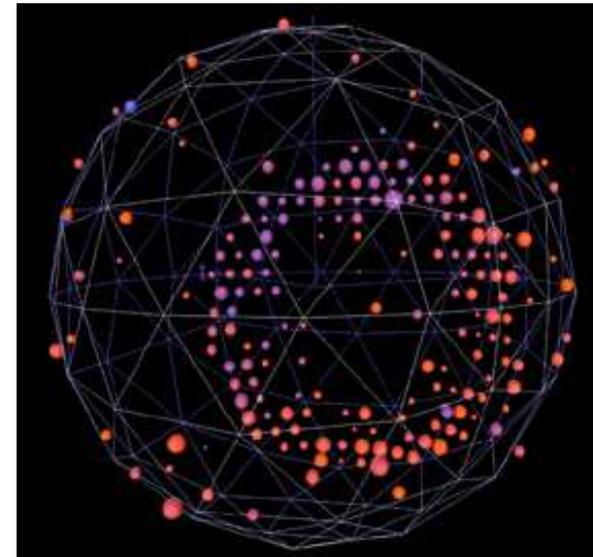
Feynmann Computing Center



Tape Robot



CDF Top Event



MiniBooNE Neutrino Event



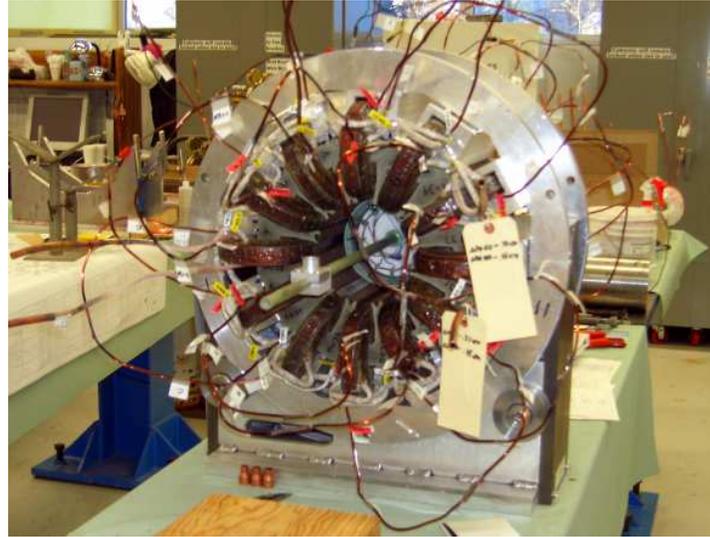
OK, but what do *I* do?

- Physicists usually do many different things over the course of their careers. A few of the things I've spent a lot of time in the past are:
 - (Fermilab, in grad school) Measuring photons to study the structure of protons
 - Involved building electronics and measuring liquid Argon purity.
 - (CERN, Geneva, Switzerland) Measuring how quarks are produced when electrons and positrons (anti-electrons) hit each other.
 - Also worked on a software "fix" for some problems with the detector.
 - (Princeton University, USA) Taught physics
 - (SLAC, Palo Alto, CA, USA) Studying what happens when a really powerful laser hits an electron beam:
 - In 1995, we measured something first predicted in 1935
 - I worked on the "readout" for an electron detector and designed a precision particle tracker.
 - (KEK, Japan) Measured the difference between matter and antimatter:
 - Helped design, test and build one part of a large detector
 - Also worked on a system to count bubbles to measure gas flow

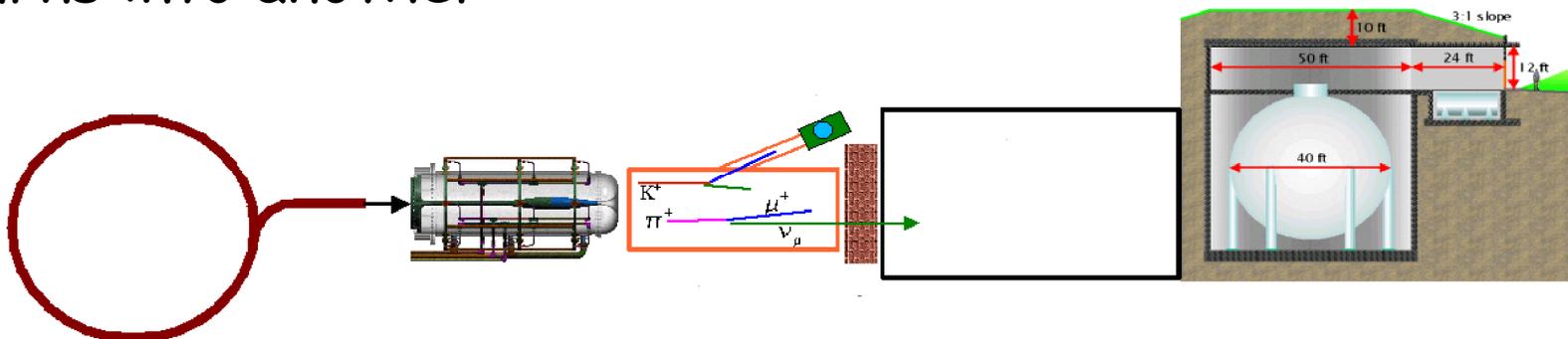


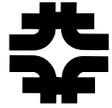
Things I'm working on now

- New system for controlling beam into a very old accelerator:



- Working on experiment to see if one type of neutrino turns into another:





What it takes to be a physicist

- Physicists must:
 - Be curious about how things work
 - Like math (and be good at it!)
- Education
 - Bachelor's degree (usually in Physics)
 - PhD in Physics
 - Takes about six years
 - Two years of classes
 - About four years doing research and writing thesis
 - Physics students are usually supported by the University during graduate school
 - Tuition is paid for
 - Small monthly living expenses
- Career
 - After PhD, the physicist will get an entry level "postdoc" position with a lab or university for 2-4 years
 - After that their "real" career begins
 - Lab
 - Industry
 - University



Pros and Cons

- **Pros**

- I get paid to do things I would probably do as a hobby otherwise.
- I'm always doing new stuff and learning new things.
- I get to use a lot of what I learned in school.
- I get to work around very interesting people from all over the world.

- **Cons**

- I spent a long time in school:
 - I got my PhD when I turned 27, which is actually a little on the young side.
- Since then, I've had to move every time I got a new job
 - Can't decide to move to a city and then look for a physics job.



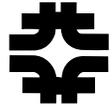
Other careers in physics

- Astrophysics
 - The physics of stars and the universe
- Biophysics
 - How living things do what they do
- Solid state and materials physics
 - Example: semiconductors
- Geophysics
 - Example: how can I find where the oil is?



Other careers at Fermilab

- About 2000 people work at Fermilab
 - 500 physicists of one sort or another
 - The rest are
 - Engineers (mechanical, electrical, etc)
 - Computer professionals
 - Technicians
 - Skilled trades (electricians, machinists, ironworkers, etc)
 - Business and financial support
 - Administrative support
 - ...
 - Also employ summer students
 - High school
 - College



For more information

- Fermilab website
 - <http://www.fnal.gov>
- Lederman Science Center
 - At Pine St. entrance
- Email me:
 - prebys@fnal.gov