

Fermilab's Future

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The Challenge

- **What is Fermilab's role in 2015?**
- **What facilities will this require?**
- **What should we be doing now to lay the groundwork?**

Mike Witherell convened a Long Range Planning Committee in spring 2003, with both laboratory and university scientists, to look into these questions.

Lots of input in working subcommittees and in open meetings of the laboratory staff

Final report is now available



Context

- **Our strengths, and thus our future, is in particle physics; but particle physics will not be the same as it is now**
- **The world's highest energy accelerator will no longer be the Tevatron, it will be the LHC at CERN in Switzerland**
- **Physics will be focused on**
 - **exploring a new world of phenomena at the “TeV scale”**
 - **Higgs, supersymmetry**
 - **exploring the new world of neutrino physics**
 - **exploring the new connections between particle physics and cosmology**
 - **Dark matter, dark energy**
- **Fermilab possesses unique assets and skills to play a very strong role in this era; but we have to evolve in important ways**



What happens to the Tevatron?

- The present CDF and DØ experiments will wind down ~ 2009
 - These are “energy frontier”, search experiments
 - Many of the CDF and DØ scientists will go on to pursue these physics goals at the LHC
 - We are setting up an LHC Physics Center at Fermilab to provide a home base for US scientists working at CERN and to ensure we maintain intellectual coherence and leadership
- A new experiment for the Tevatron collider: BTeV
 - planned to start in 2009
 - Not a search for new particles, but to exploit the high rate of standard model particle production in the collider
 - A specialized experiment for a precision study of the properties of particles containing the b-quark
 - Matter-antimatter asymmetry in particle decays
 - indirect way to see the effects of things like supersymmetry

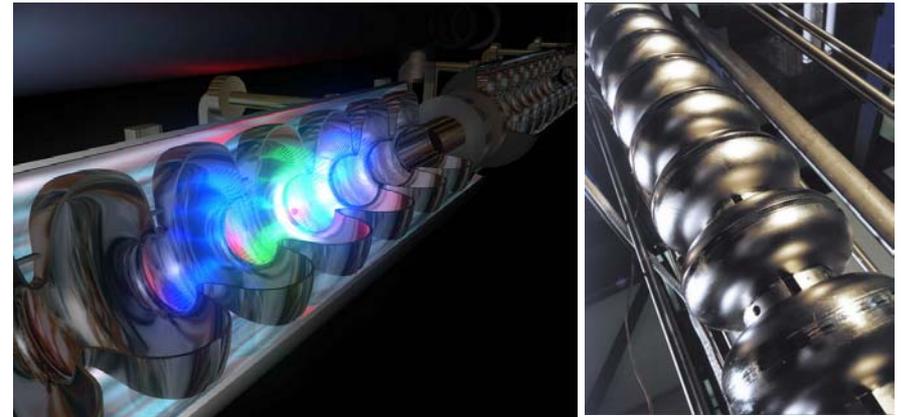
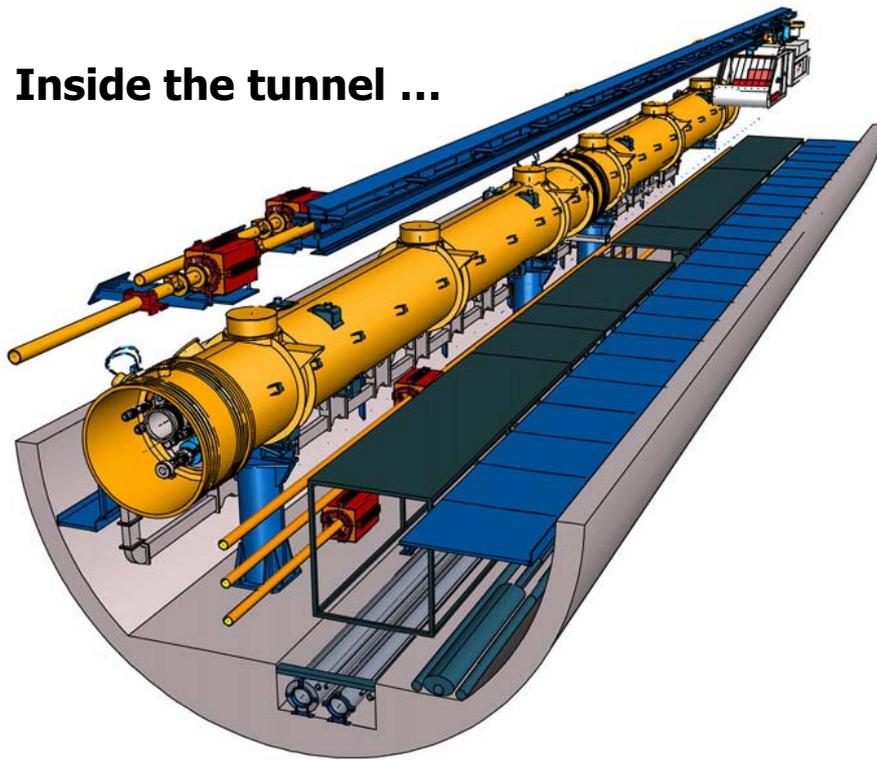


The next big machine

- There is a worldwide consensus about the next major particle physics facility - a Linear Collider
 - An electron collider (unlike the Tevatron or the LHC)
 - Focus on precision rather than sheer energy
 - Needed to explore this new world of “TeV scale” phenomena to do with Higgs, Supersymmetry, and all that
 - Connect dark matter with particles produced in accelerators
- Multibillion dollar scale, likely to be a fully international project, only one such likely in the world
 - Lots of politics
- Would be built underground
 - too big to be contained on the existing site (of any laboratory)
- We believe a location close to Fermilab – with the support of the local community – would be the best place in the world to locate this unique, world class research facility
 - and we are aiming for that outcome



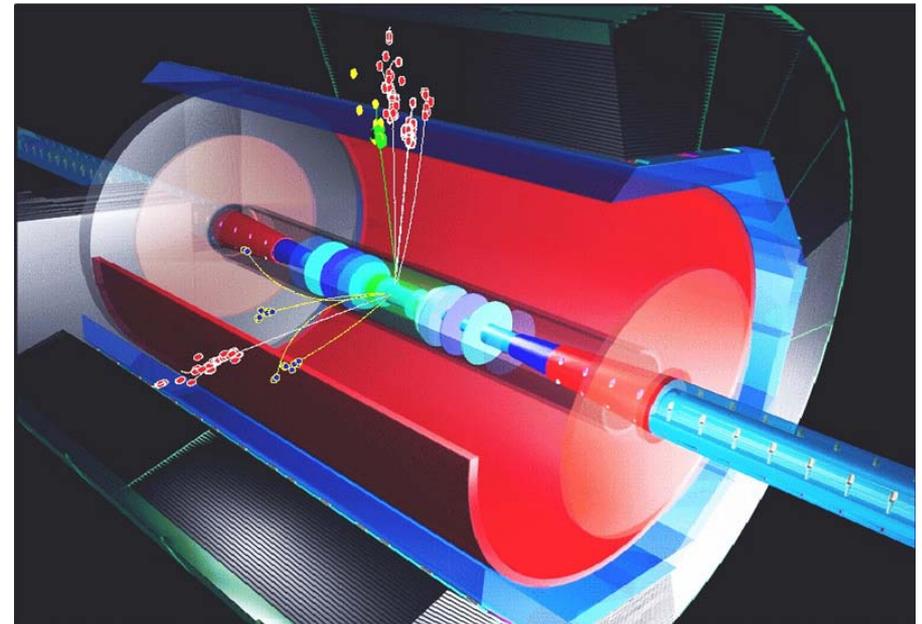
Inside the tunnel ...

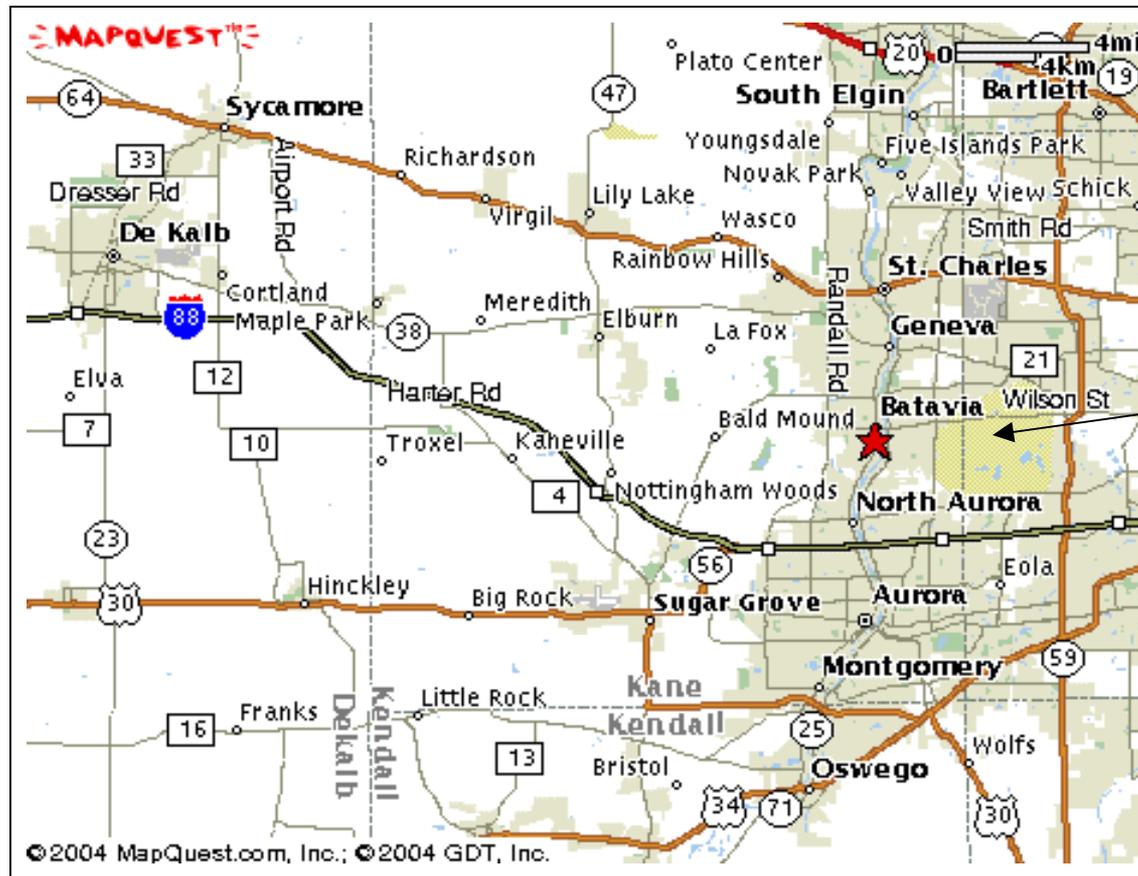


... electrons are accelerated by radio frequency electric fields in copper cavities ...

... and then collide with an opposing beam.

The collisions are viewed by a detector:





Fermilab

← 40 km = 25 miles →

LC tunnel will be 27-43km long (depends on technology choice)



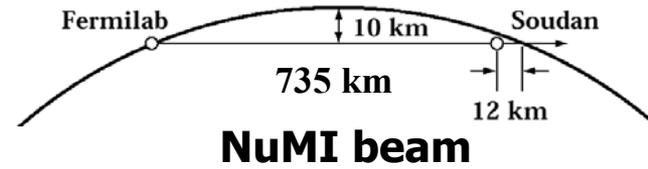
Neutrino physics

- **Fermilab is host to an exciting program of experiments in neutrino physics**
 - **Recently discovered that neutrinos have small but nonzero mass and can change from one kind into another**
 - **Totally different from how quarks behave**
 - **What is this telling us?**
 - **A way to explore “grand unification”**
 - **Origin of matter in the universe?**
 - matter/antimatter asymmetry in the very early universe
- **Want an evolving program that builds on our existing installations, especially the NuMI project**

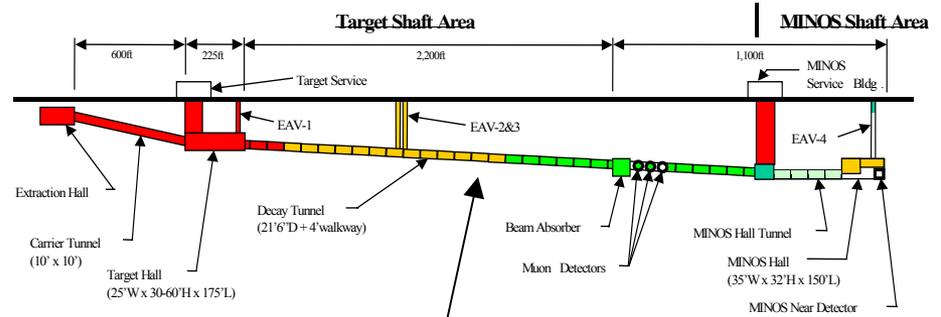




NuMI and MINOS

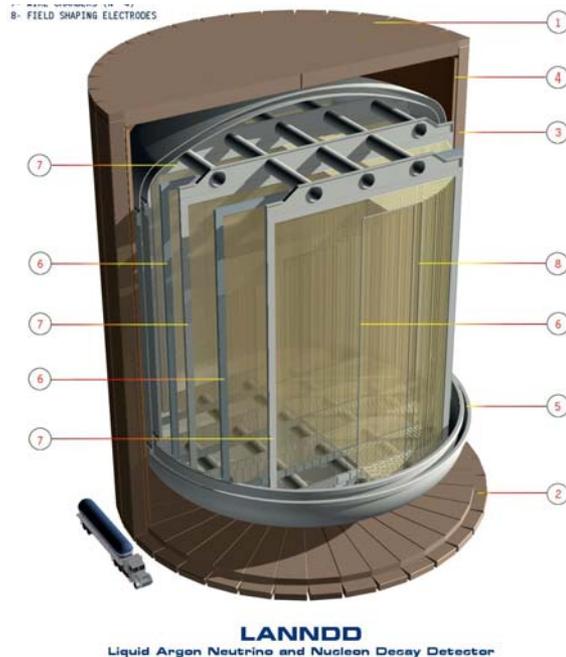


MINOS



Future neutrino program

- First an additional experiment **"NOvA"** in Minnesota using the neutrino beam to Soudan mine
- Then a new high-power, low energy accelerator at Fermilab to greatly increase the neutrino beam rate
 - **"Proton Driver"**
- Scale of program will depend on Linear Collider schedule and siting



**Concept for a very large
liquid argon neutrino
detector**



Complementary projects

- **Astroparticle physics**
 - Fermilab pioneered the connections between particle physics and cosmology
 - Expect growth in this area
- **Medical facility**
 - Fermilab's long role in neutron therapy
 - Initiative for a new Hadron Therapy center located in the technology park north of the lab
 - Fermilab expects to collaborate in this but not to "own" it
- **Accelerator, Detector, and Computing research**
- **Science education**



The future

- **Fermilab is a leading center in the world for particle physics**
- **Decades of investment by the public has built up**
 - **Excellent infrastructure**
 - **Outstanding scientific and technical capabilities**
 - **Great people**
- **Particle physics will be different ten years from now**
 - **Exciting new physics questions will require new facilities and new ways of working**
- **Fermilab's strengths mean it is well-placed to play a lead role, but it is clear that we will have to change, evolve**

Your help in this process is most important!

