Welcome!

Fermilab Community Advisory Board

February 25, 2010

U.S. DEPARTMENT OF ENERGY

Fermilab

Fermilab's future

- Fermilab envisions an ambitious, world-class research program at the Energy Frontier, Intensity Frontier and Cosmic Frontier
- We seek your input on public-related issues as we develop our plans, from vision to construction to operation, from the effects of blasting on local residents to the future of US particle physics.


Fermilab 201

First speaker:
Robert Tschirhart, Naperville
Fermilab

Our research starts with questions

The big questions:

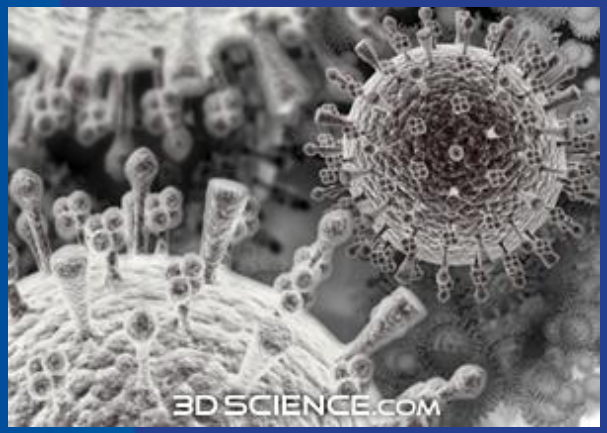
What is the nature of the universe, and what is it made of?

What are matter, energy, space and time?

How did the universe come to be and what is its future?

Our research tools work like the most powerful microscopes and time travel machines:

Image: 3Dscience.com

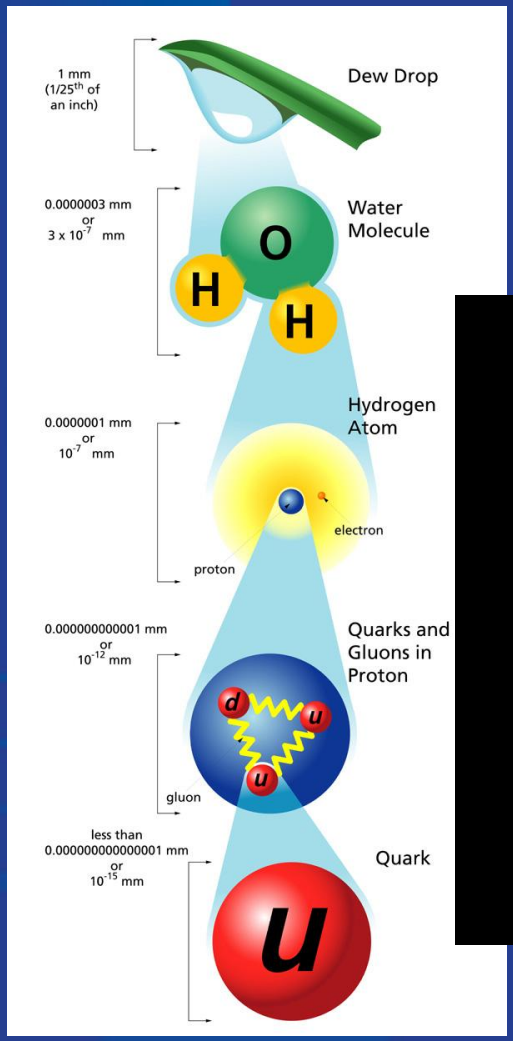


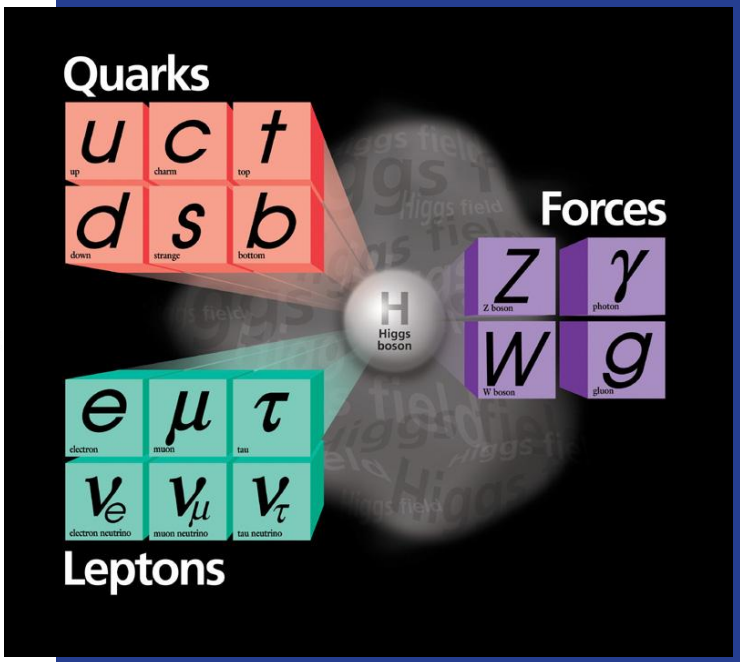
Look deep into matter and see what the universe is made of

Sloan Digital Sky Survey

Look deep into the cosmos and see what the universe looked like billions of years ago

The more we learn, the more questions we have





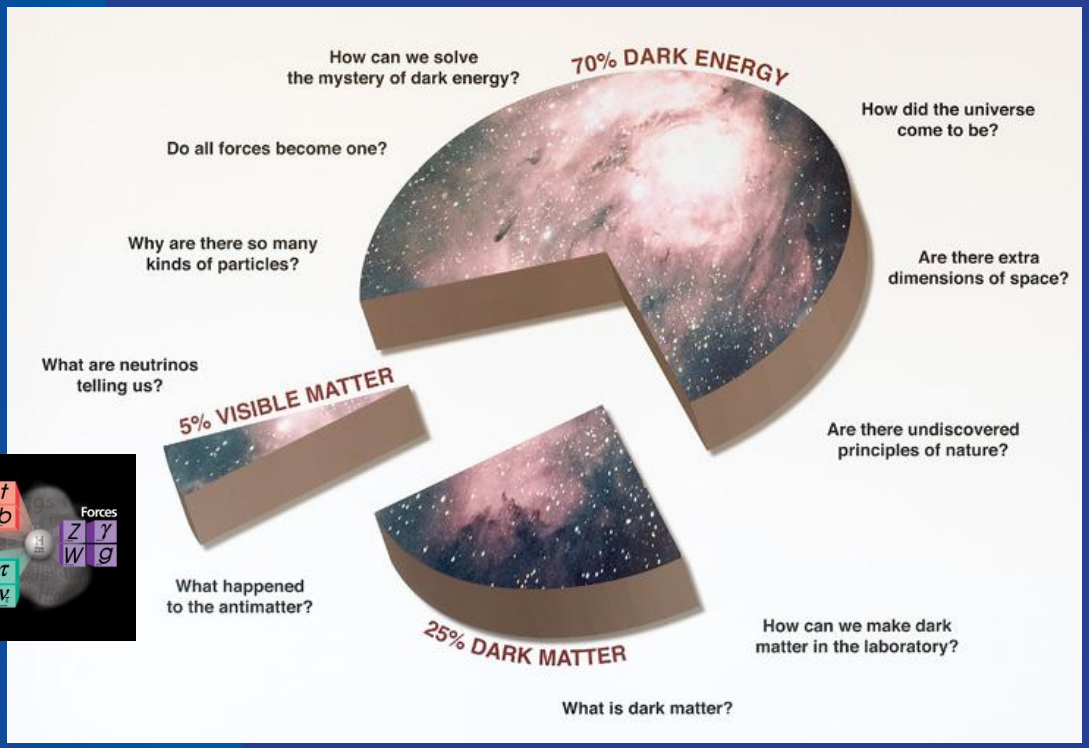
Why are there so many kinds of particles?

Why do particles have mass?

What happened to the antimatter?

Einstein's dream: Do all forces become one?

And then there are surprising discoveries that create even more questions. Many more!



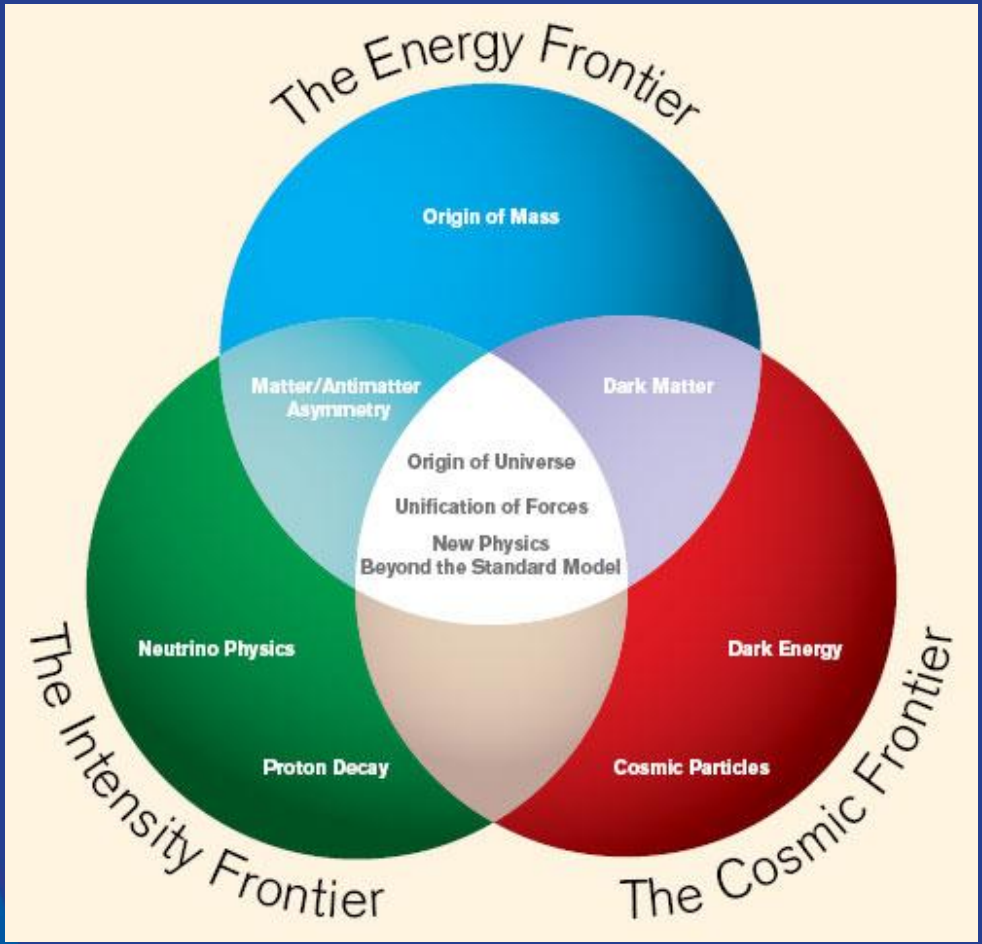
What is the mysterious dark matter made of?

What is the nature of dark energy?

Are there extra dimensions of space?

What role did neutrinos play in the evolution of the universe?

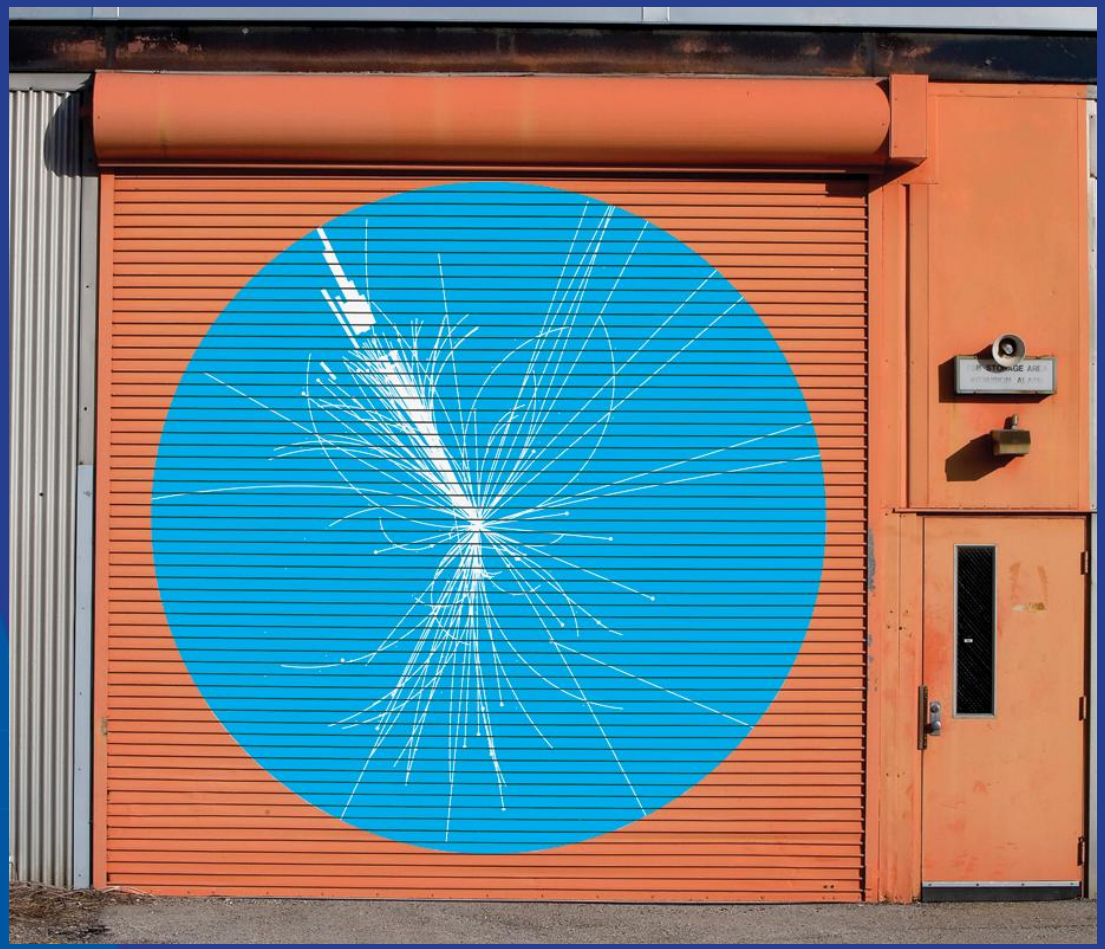
How do we find the answers?



Three frontiers of particle physics

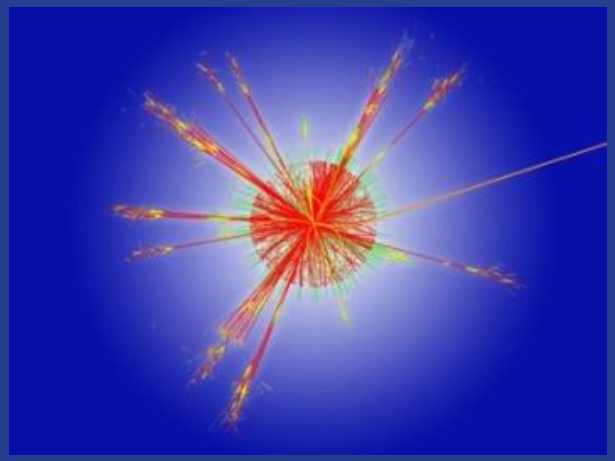
Next speaker:
Stefan Soldner-Rembold, Batavia
Manchester University, UK

Fermilab and the Energy Frontier



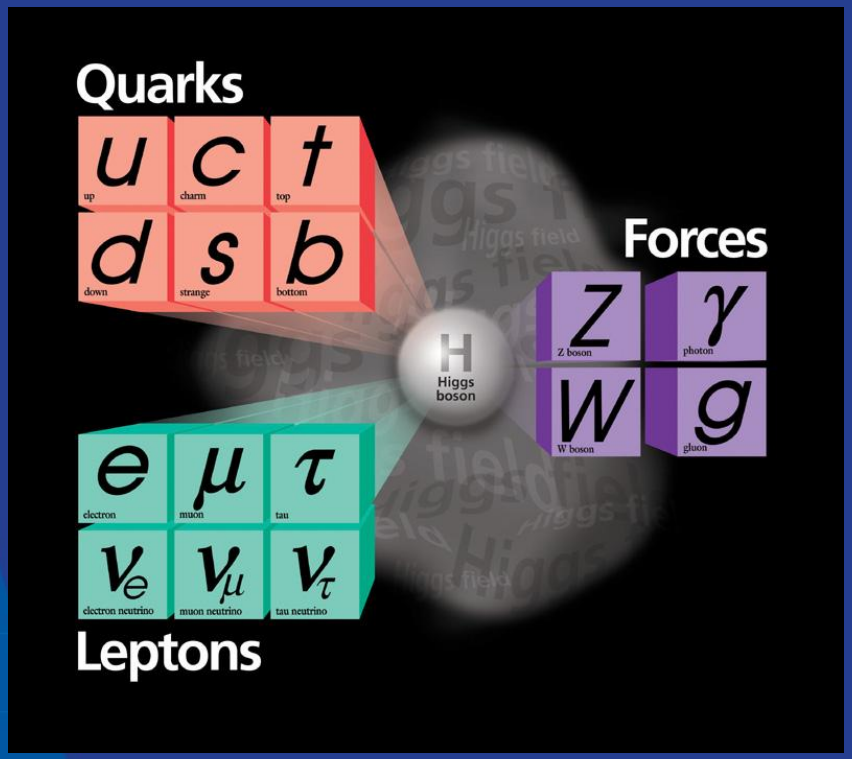
Tools of the Energy Frontier: Highest-energy particle collisions

To find answers to their particle physics questions, scientists use giant accelerators to make high-energy particle collisions.



Create matter out of energy: $E=mc^2$

Questions at the Energy Frontier:



Why are there so many kinds of particles?

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Particle colliders around the world

CERN's LHC:
Proton-proton collisions

Fermilab's Tevatron:
Proton-antiproton collisions

KEK's :
Electron-positron collisions

Beijing:
Electron-positron collisions

Fermilab and the Energy Frontier

- Until November, Fermilab's Tevatron was the world's highest-energy collider.
- Now, the Large Hadron Collider at CERN in Geneva has begun operations. Ultimately it will have seven times the Tevatron's energy.
- But don't count the Tevatron out just yet!

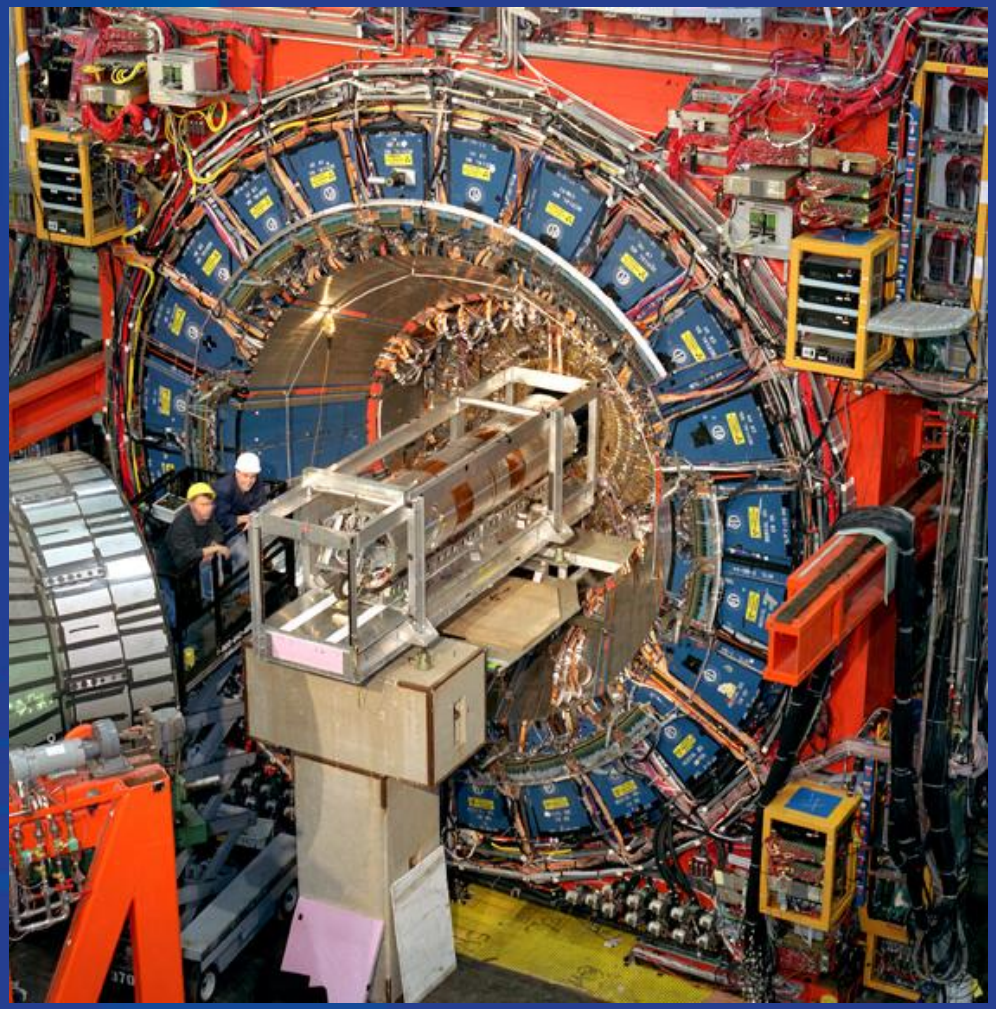
Fermilab's Tevatron

4 miles

CERN's LHC

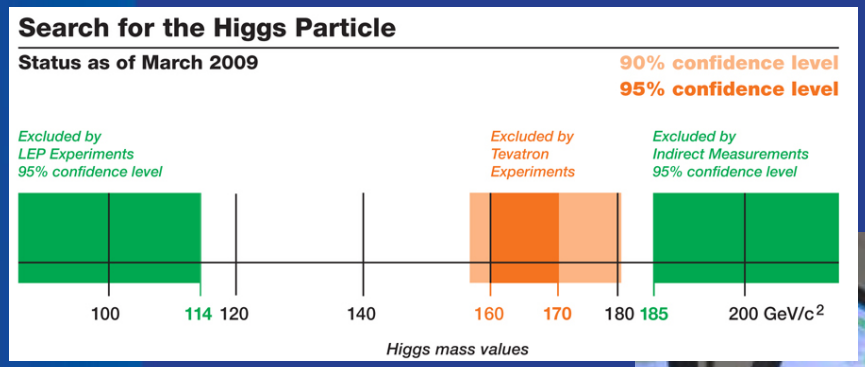
17 miles

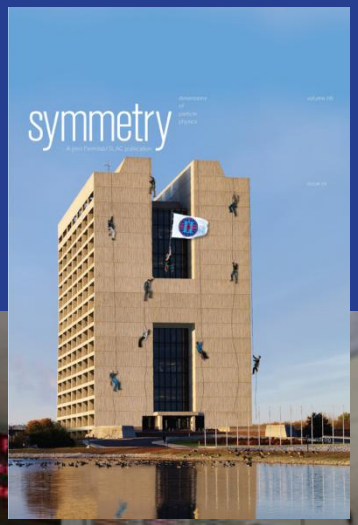
CDF

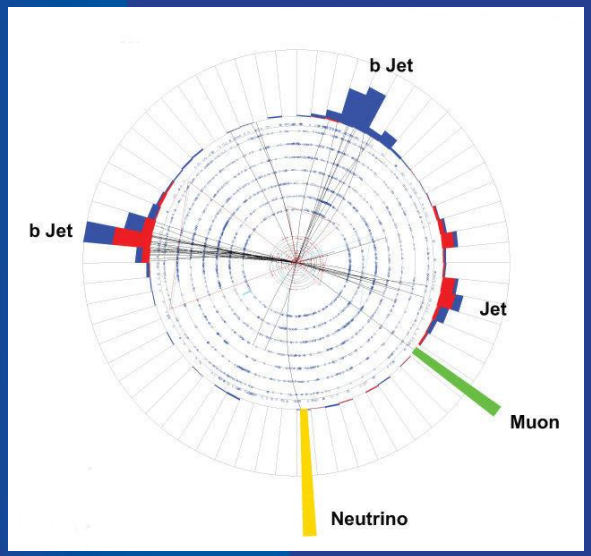


DZero

CDF and DZero





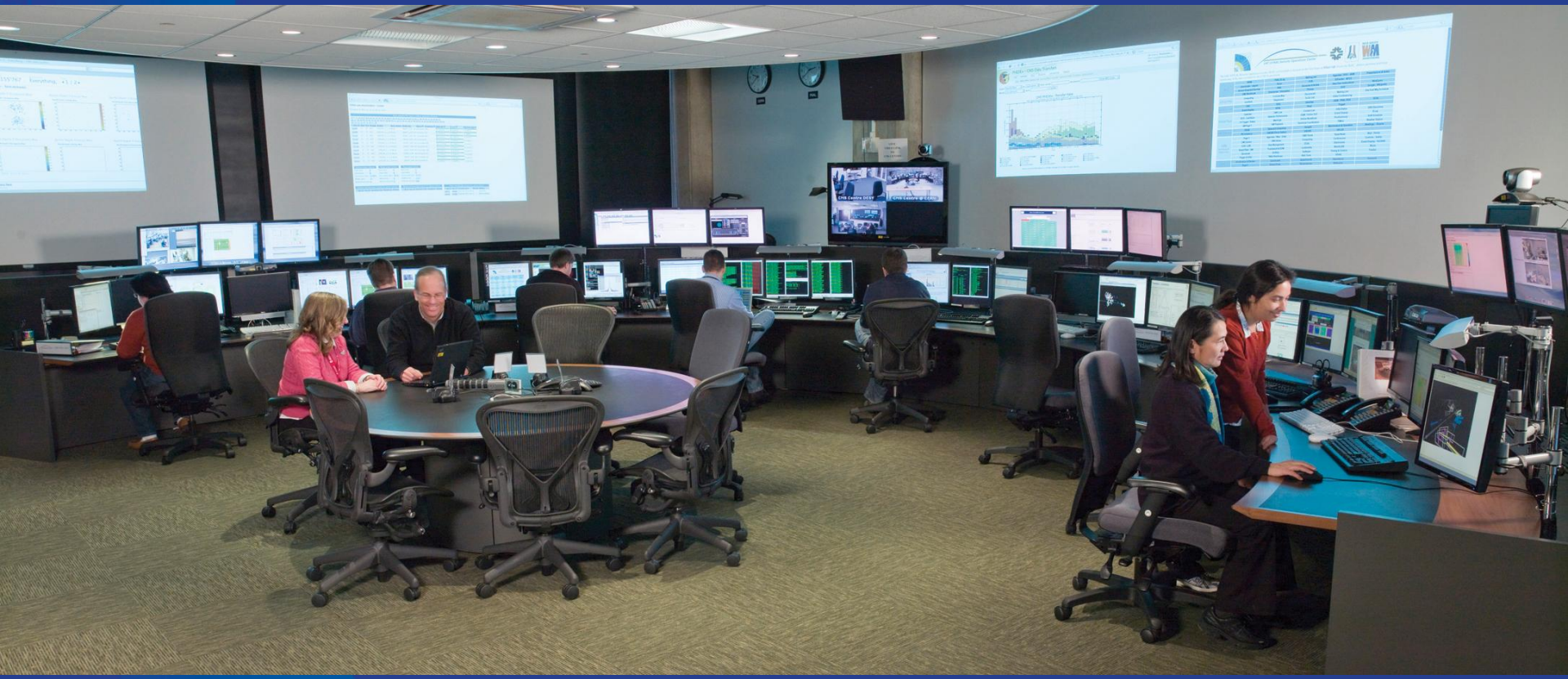


Fermilab

Many discoveries with the Tevatron

Plan: run Tevatron at least until Sept. 2011

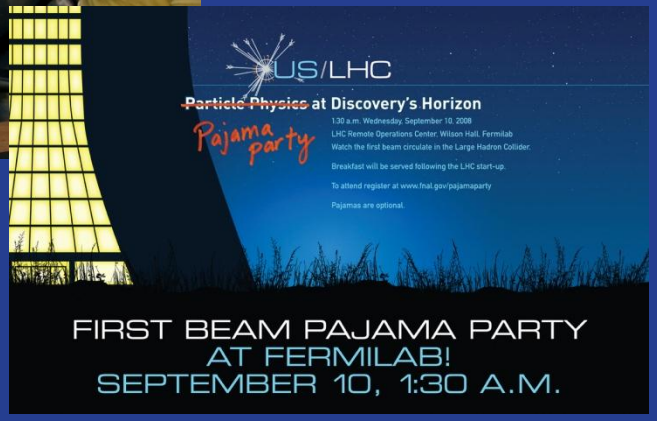
Fermilab—the U.S. gateway to the LHC

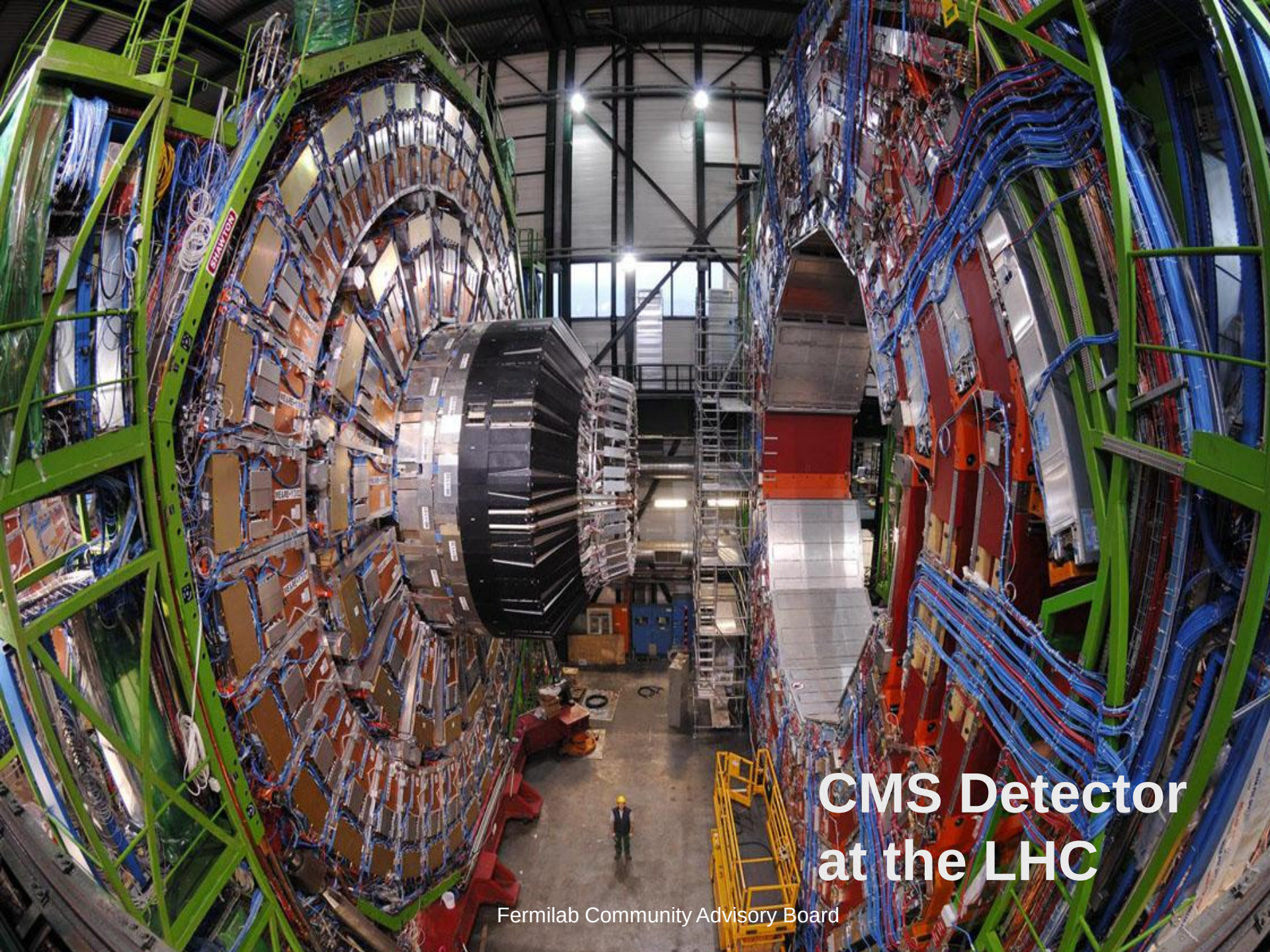


LHC Remote Operations Center at Fermilab

Celebrating the first LHC beam at Fermilab

Sept. 10, 2008



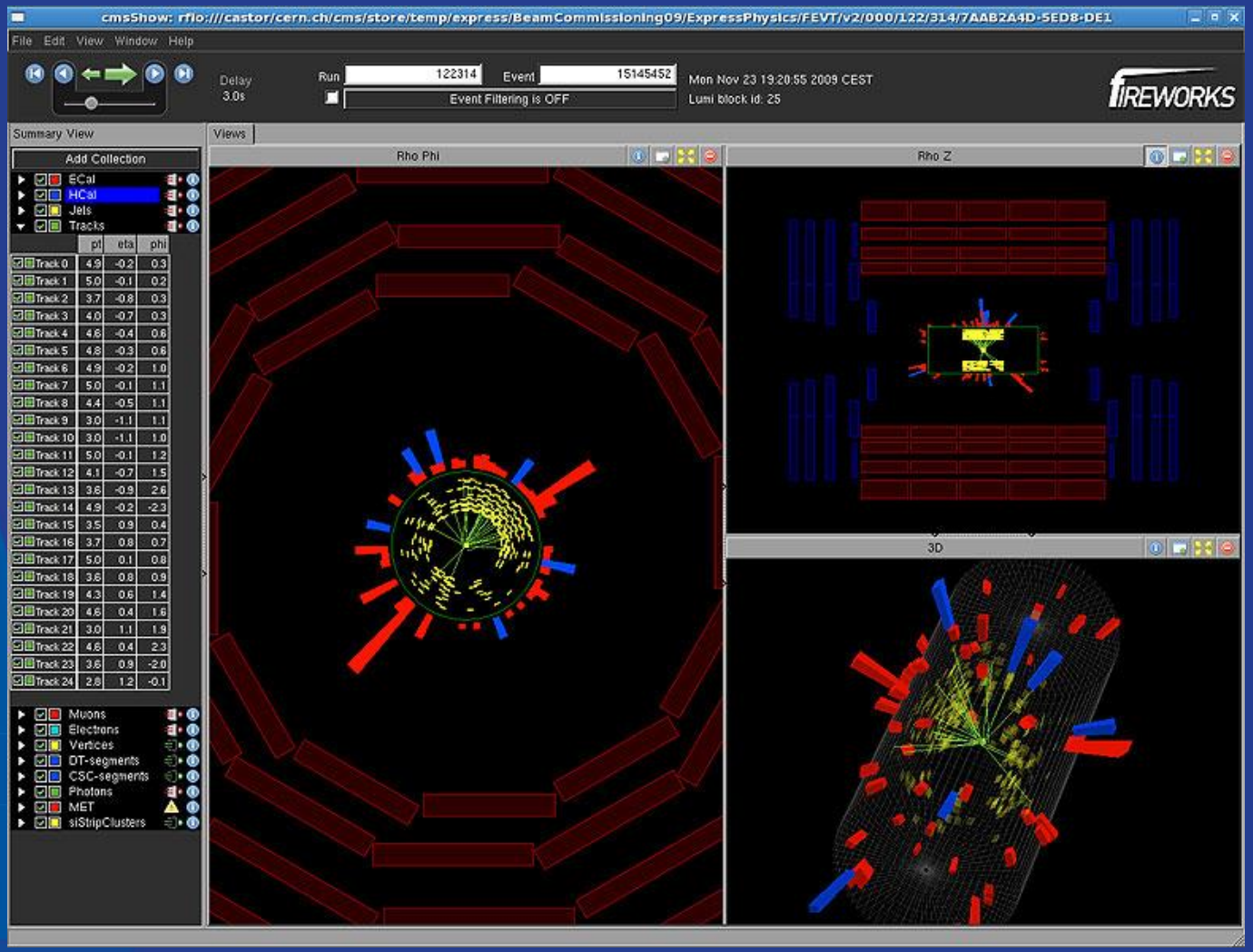


CMS Detector at the LHC

Fermilab Community Advisory Board


ATLAS Collaboration
at the LHC

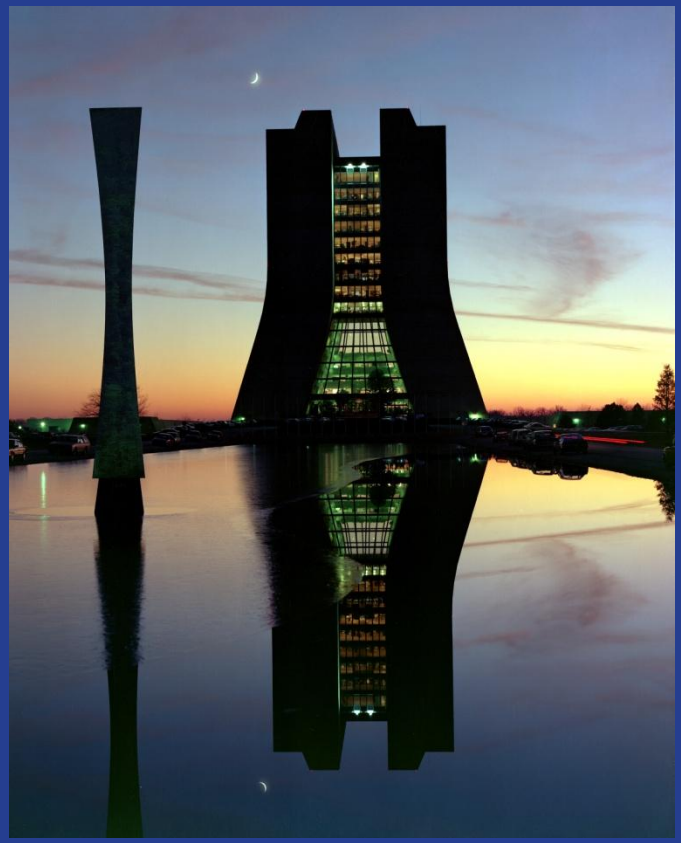
LHC's first world-record-energy collisions



Nov. 2009

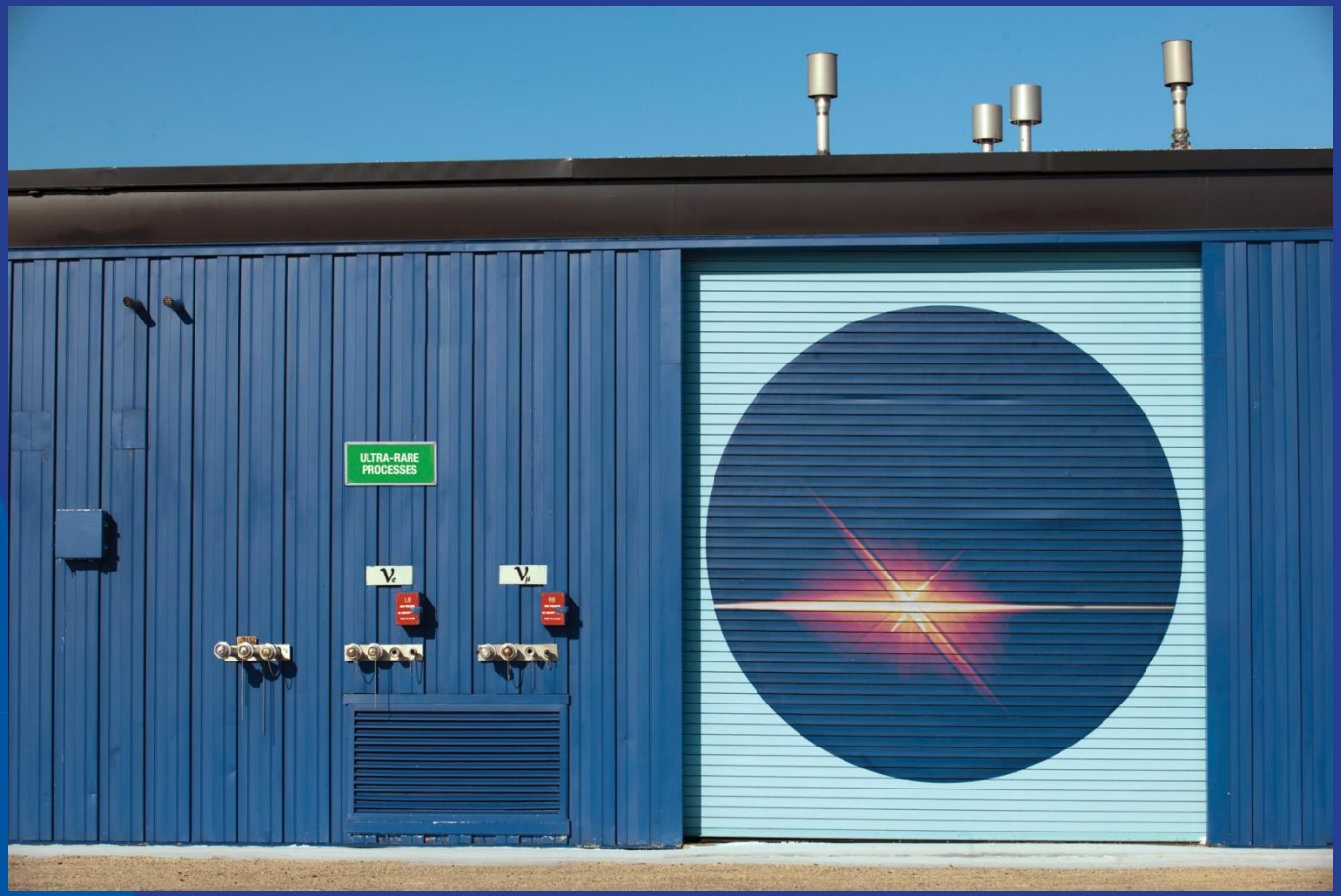
What's next at the Energy Frontier?

- Run Tevatron at least until Sept. 2011
- Collaborate on LHC: experiments will run 20 years or longer
- Conduct R&D for next collider:
  - International Linear Collider
  - Muon Collider
- When time has come, revisit recommendations of ILC Citizens Task Force



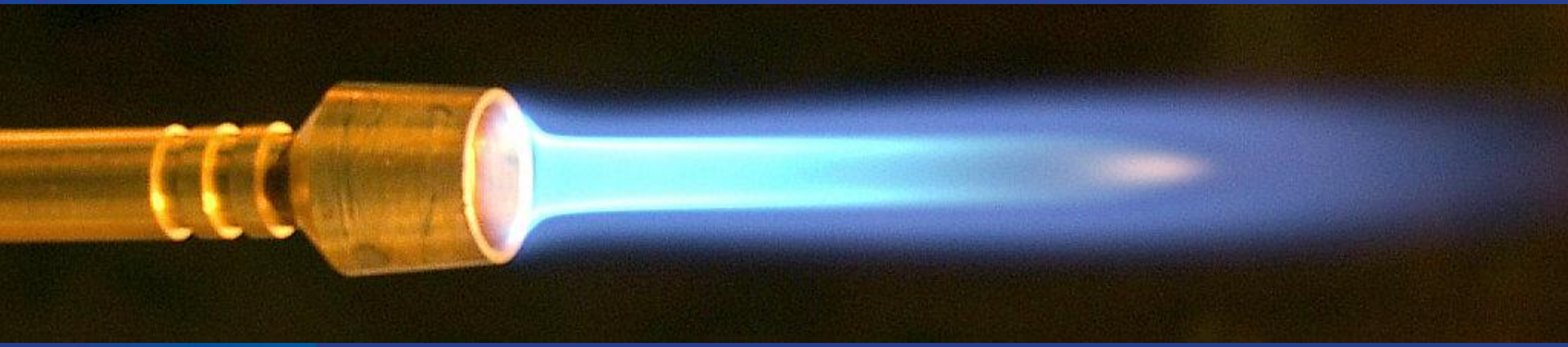
Next speaker:
Rob Plunkett, St. Charles
Fermilab

Fermilab and the Intensity Frontier



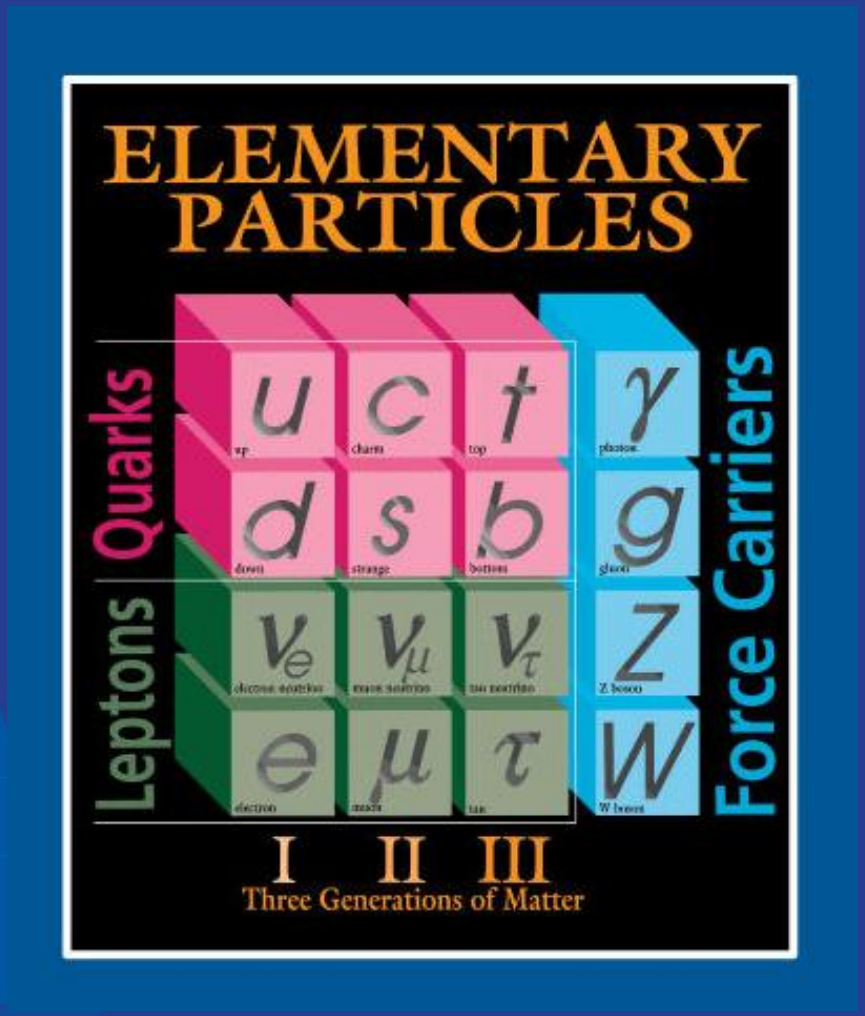
Tools of the Intensity Frontier: Producing lots and lots of particles

To find answers to their particle physics questions, scientists use high-intensity proton “blow-torch” accelerators to create vast number of particles



The more neutrinos, muons, kaons, etc, the accelerators produce, the better the chance to see something rare.

Questions at the Intensity Frontier:



Why are there so many kinds of particles?

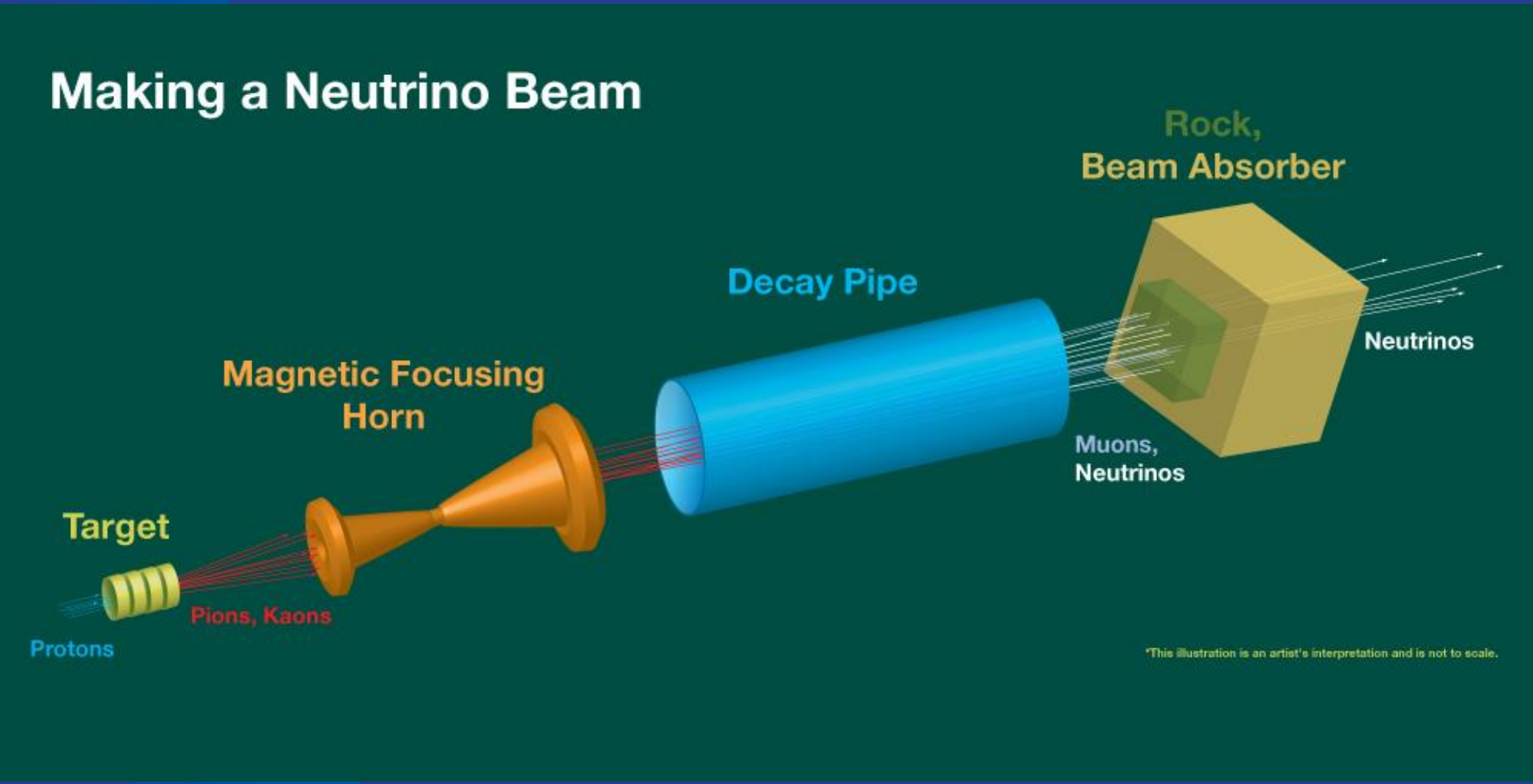
What role did neutrinos play in the evolution of the universe?

Do all forces become one?

Are there undiscovered symmetries, forces?

Use accelerators to make intense beams of neutrinos, muons, kaons, …

Intensity Frontier: Neutrino experiments



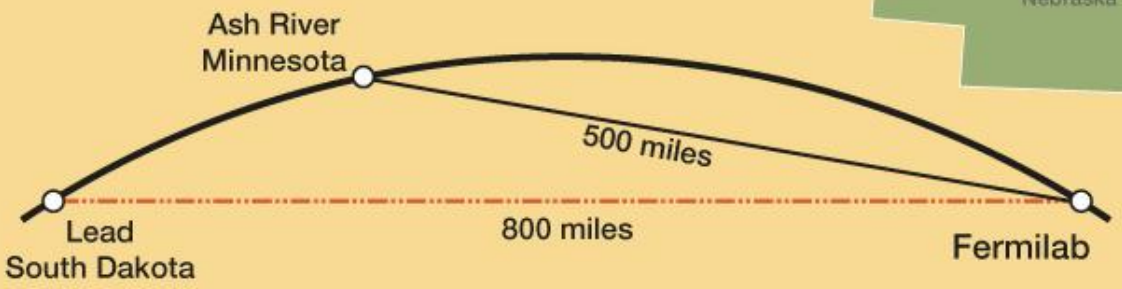
Neutrino experiments at the Intensity Frontier

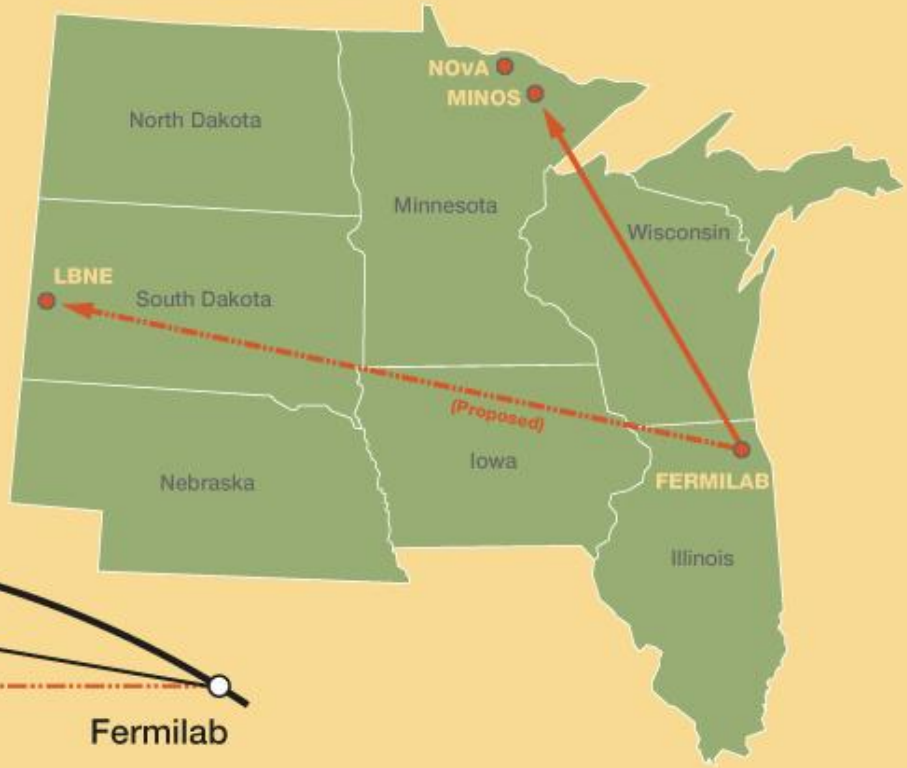
330 feet underground here at Fermilab. You'll receive a tour at the next meeting: bring your cameras!

Intensity Frontier:
Long-baseline neutrino experiments

Straight Through the Earth

MINOS	Soudan Mine, MN	2340 ft deep
NOvA	Ash River, MN	Surface level
LBNE	Homestake Mine, SD	4850 ft deep





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Intensity Frontier:
Long-baseline neutrino experiments

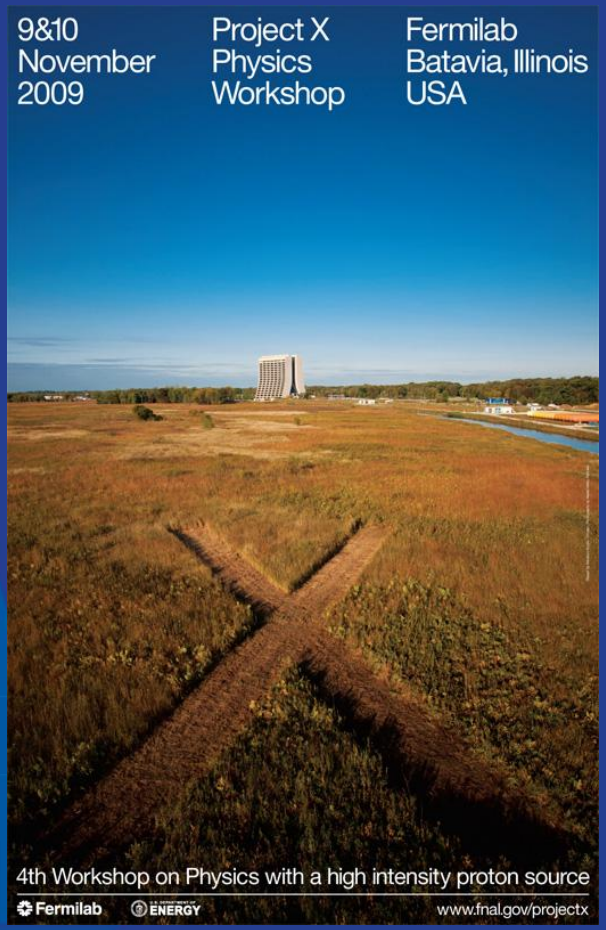
Soudan, Minnesota

Ash River, Minn.

Recovery Act: $55 million for new NOvA laboratory

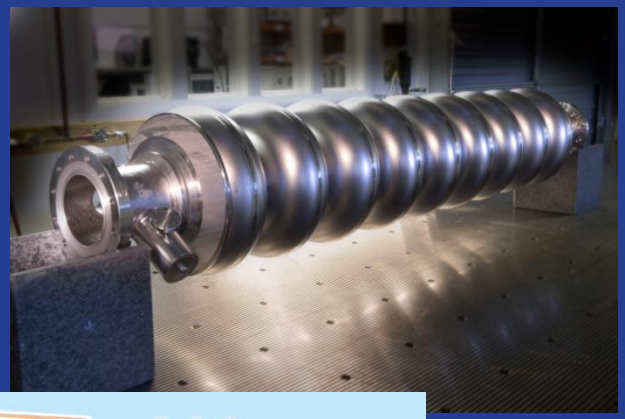
Neutrinos from Fermilab to South Dakota?

More intense beams: Project X proposal



Project X :
a unique and flexible facility with intense beams for many Intensity Frontier experiments.

Project X: first steps

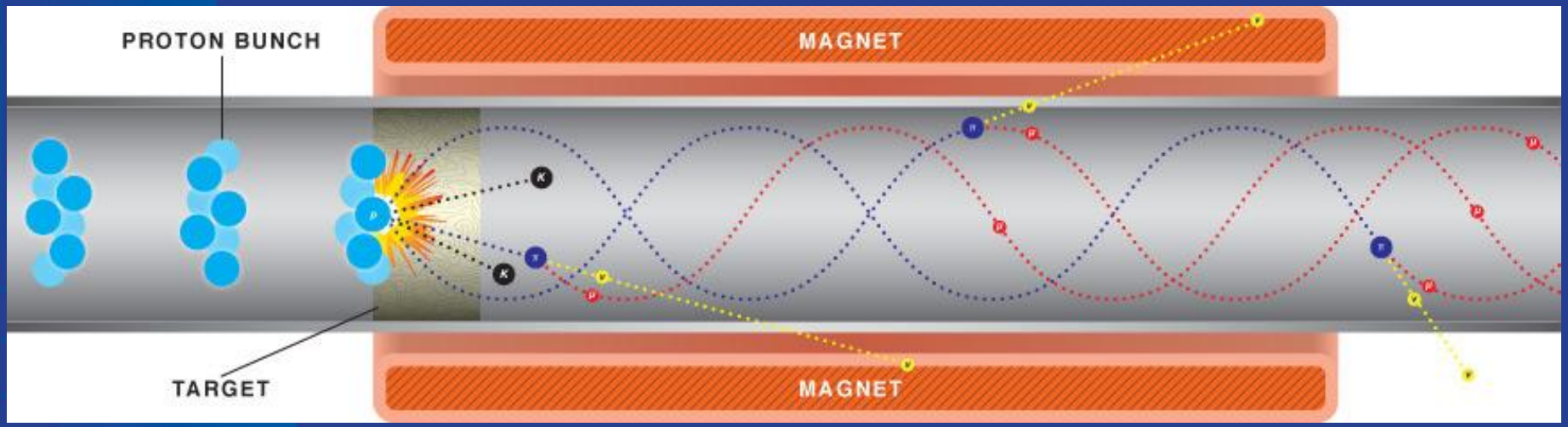


SRF: Creates synergies between R&D at the Energy and the Intensity Frontier

Recovery Act: $52 million for SRF test accelerator

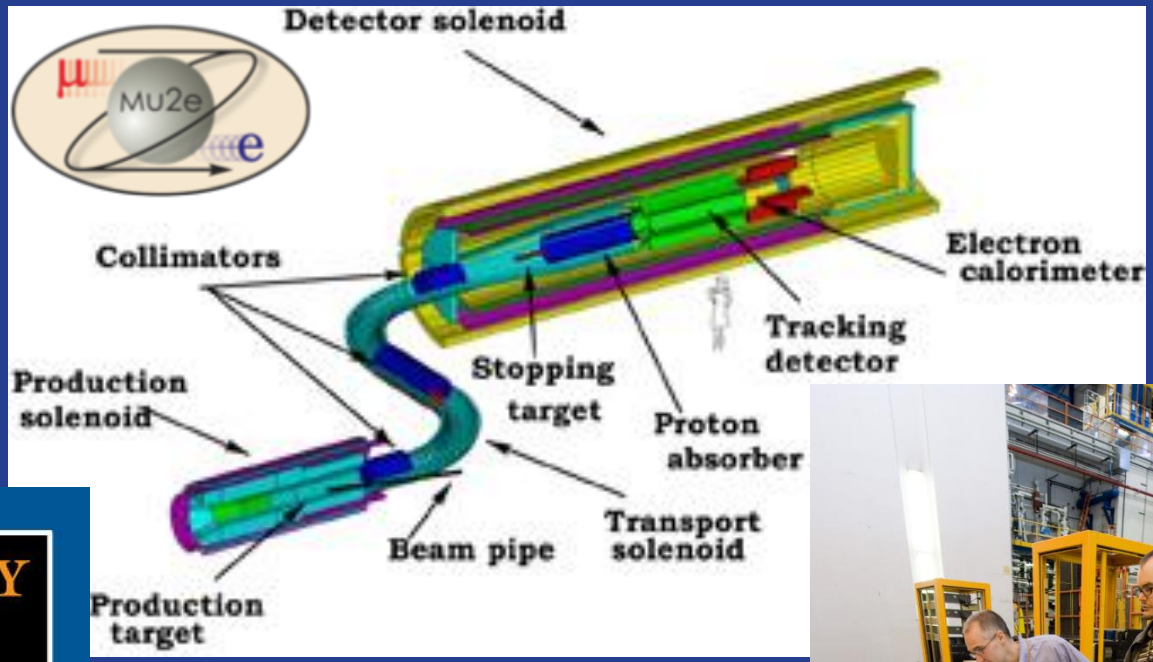
Muon experiments at the Intensity Frontier

Making a muon beam

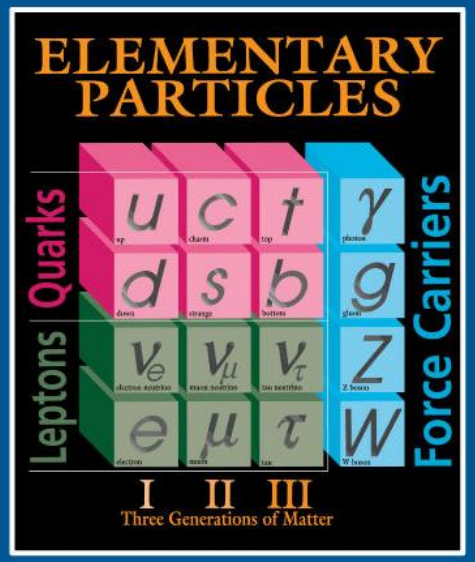


Muon = heavy cousin of electron

Looking for the unexpected: Can muons change into their cousins?

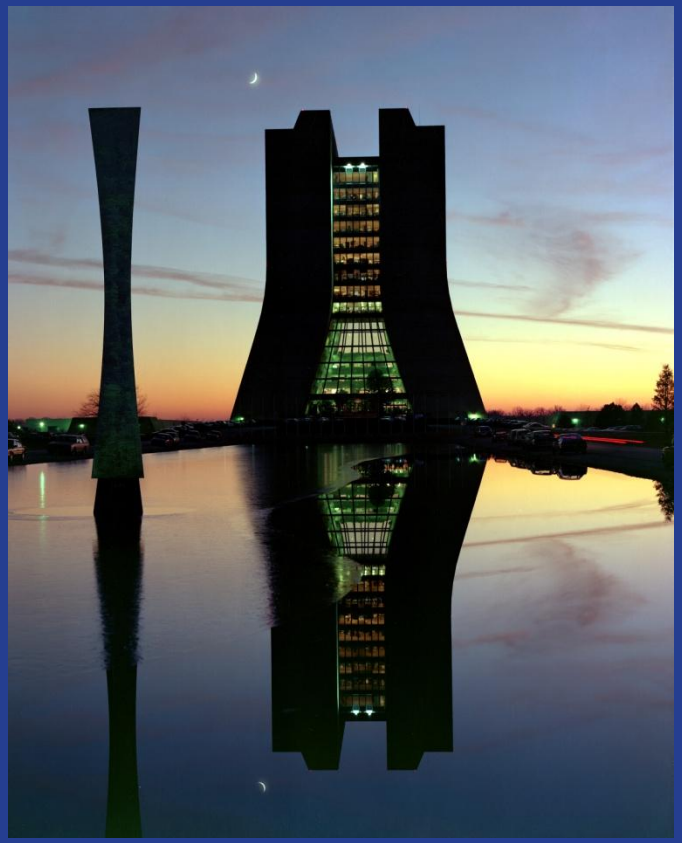


Muon-to-electron conversion experiment



What's next at the Intensity Frontier?

- Finish construction of NOvA in Minnesota and on Fermilab site
- Advance plans for Long-Baseline Neutrino Experiment from Fermilab to Lead, South Dakota
- Advance plans for Project X
- Work with Community Advisory Board to understand public-related issues such as construction and production of low levels of tritium

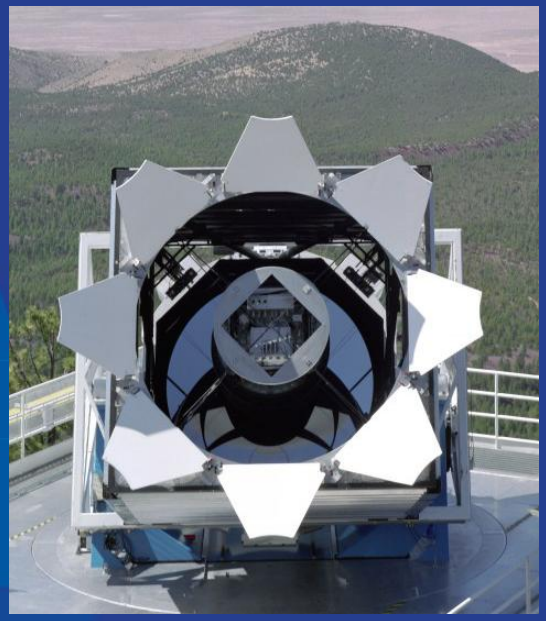


Next speaker:
Craig Hogan, Hyde Park
Fermilab/University of Chicago

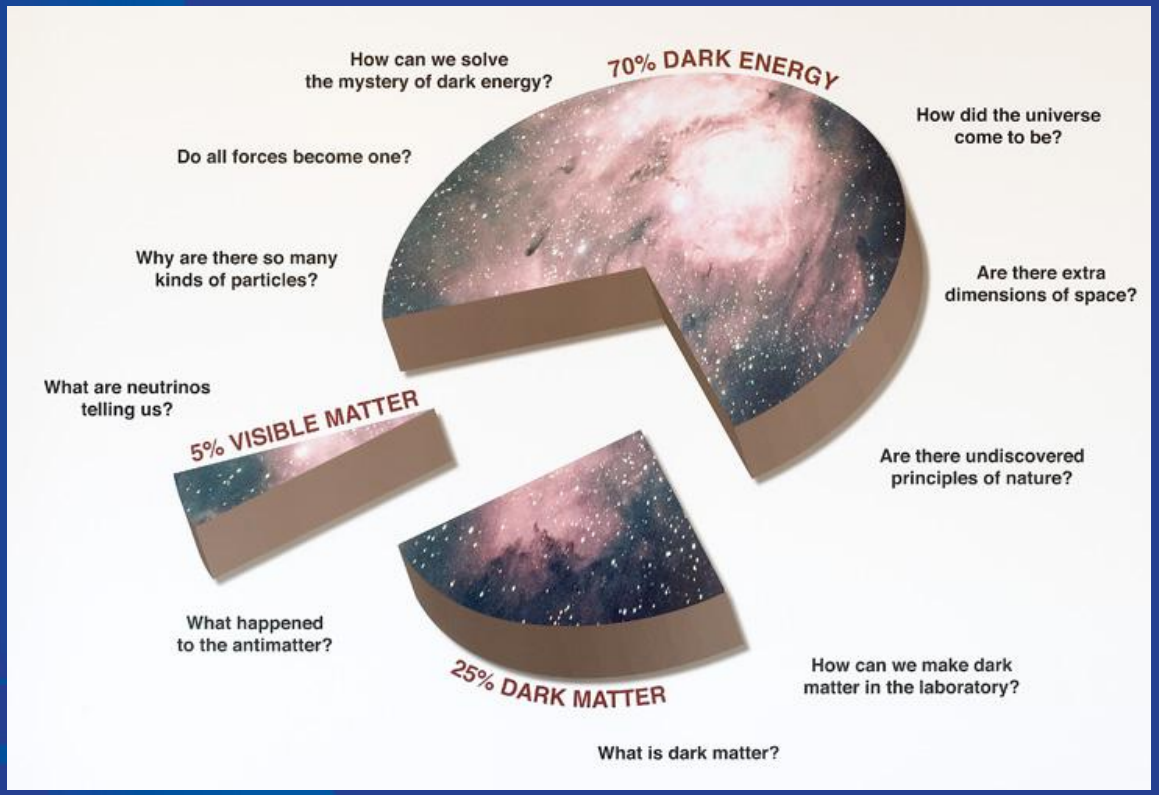
Fermilab and the Cosmic Frontier

Tools of the Cosmic Frontier: Learn more from cosmic particles

To find answers to their questions, particle astro-physicists build telescopes and particle detectors to study the cosmos and the particles it produces



Questions at the Cosmic Frontier:



What is the mysterious dark matter made of?

What is the nature of dark energy?

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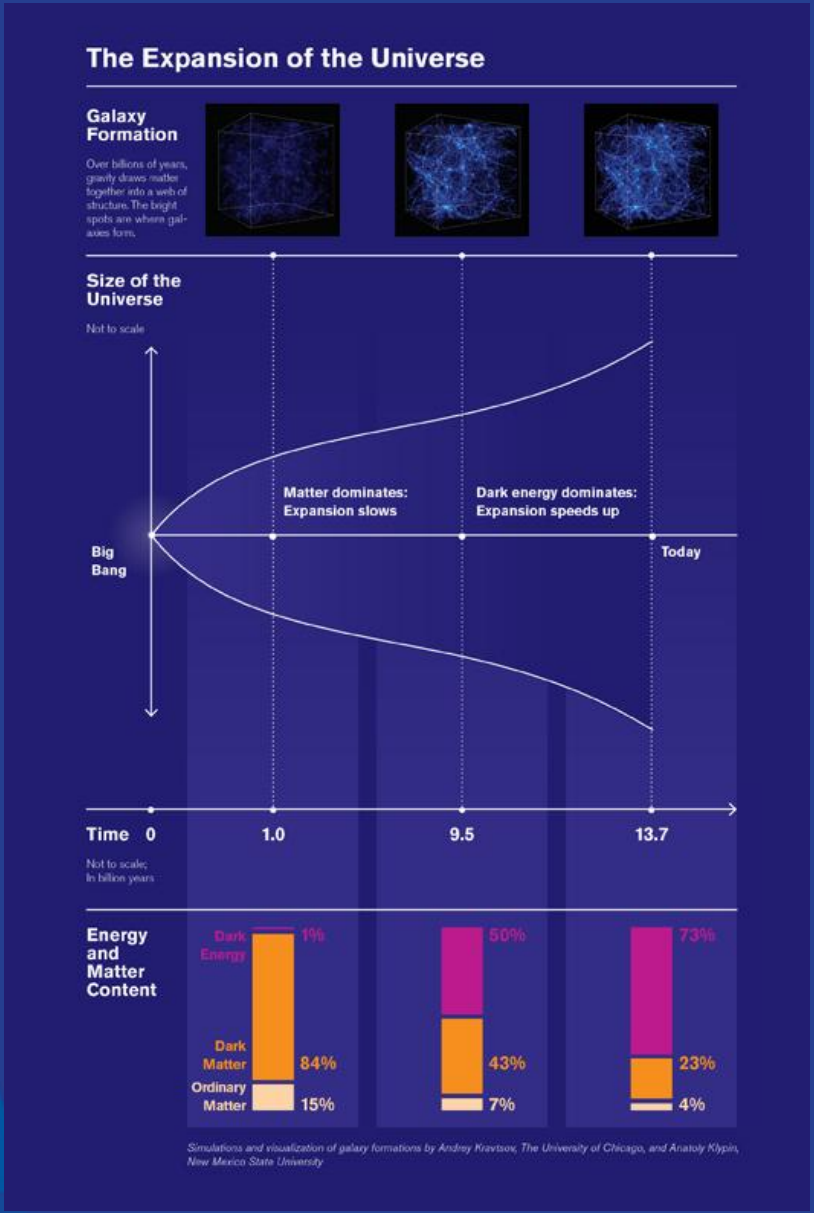
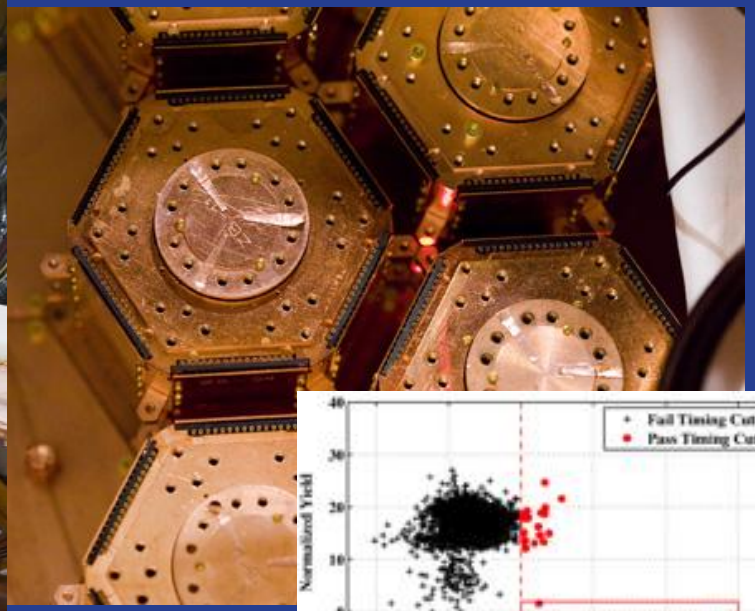
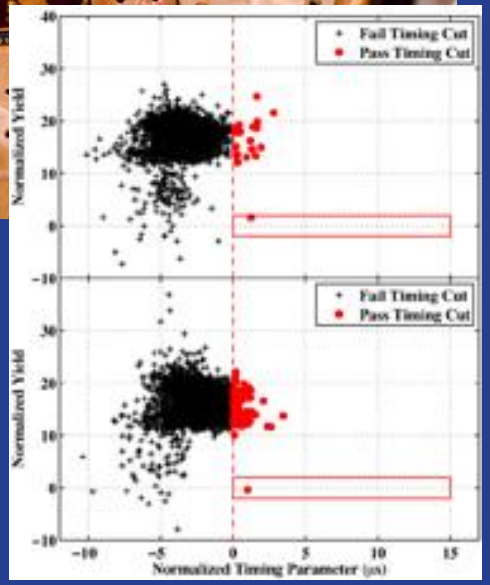


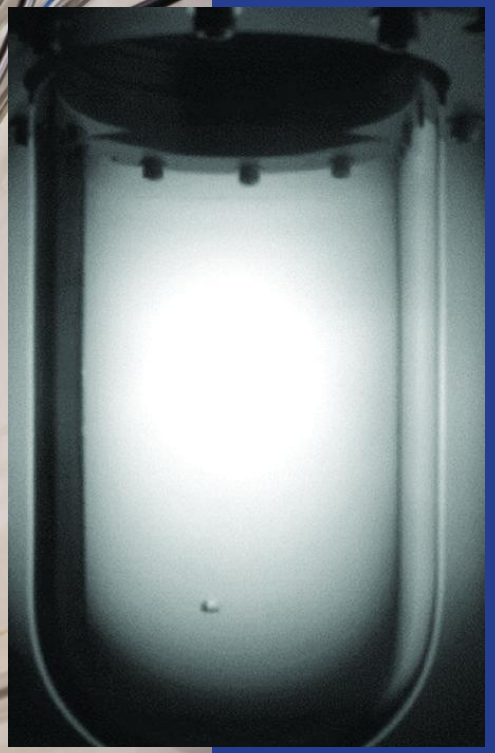
The ratio of ordinary matter to dark matter to dark energy

Searching for dark matter: CDMS

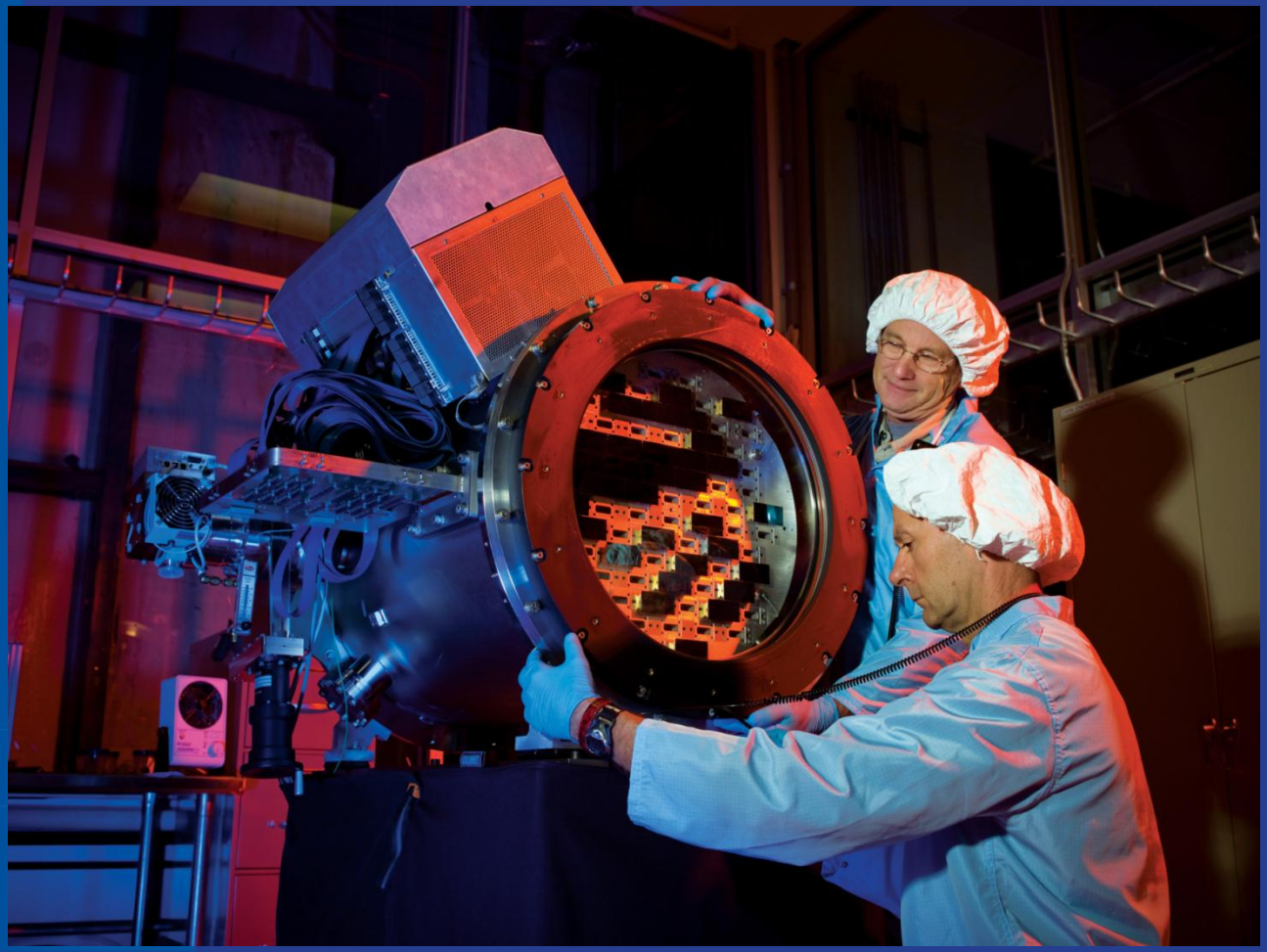




Searching for dark matter: COUPP

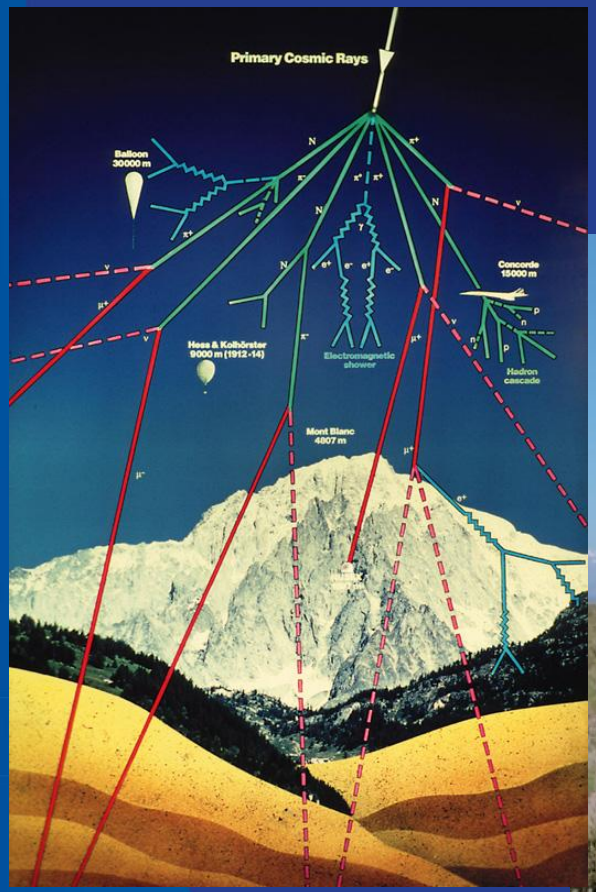


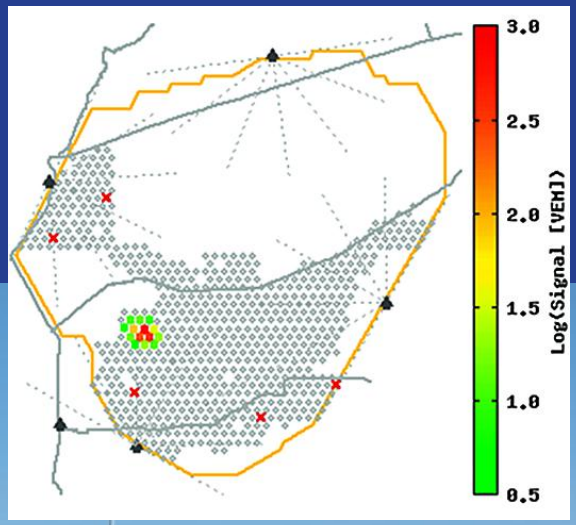
Looking for dark energy: Dark Energy Camera

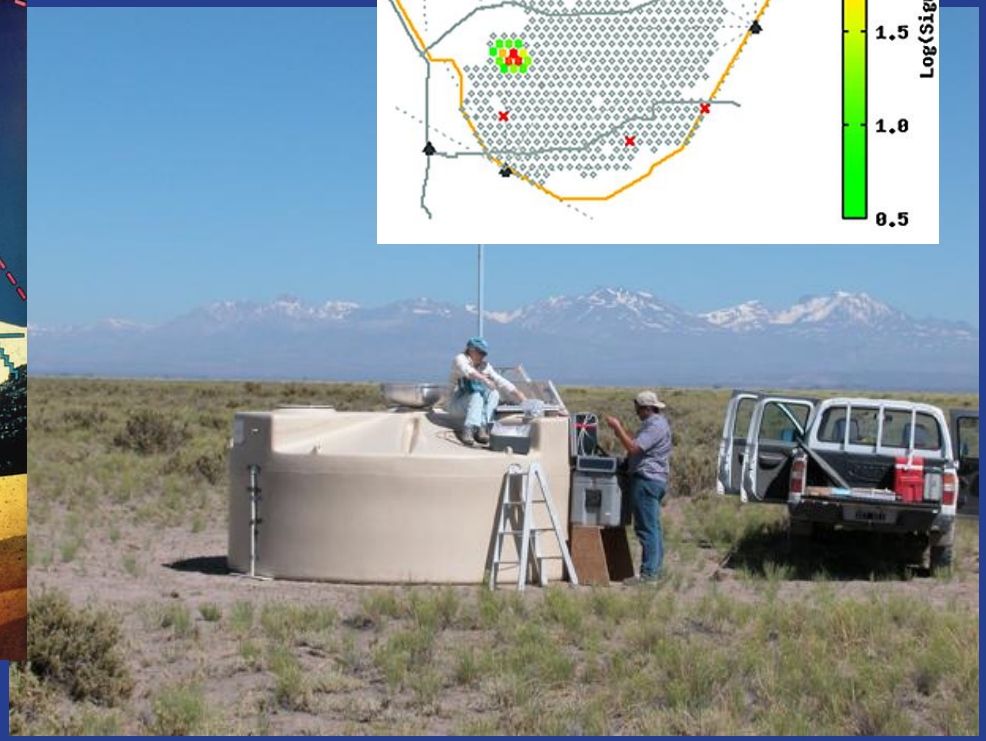


To be mounted on a telescope in Chile

Looking for the origin of cosmic rays: Pierre Auger Observatory in Argentina







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A completely different approach: GammeV

Can laser light produce new particles? Dark energy particles?

What's next at the Cosmic Frontier?

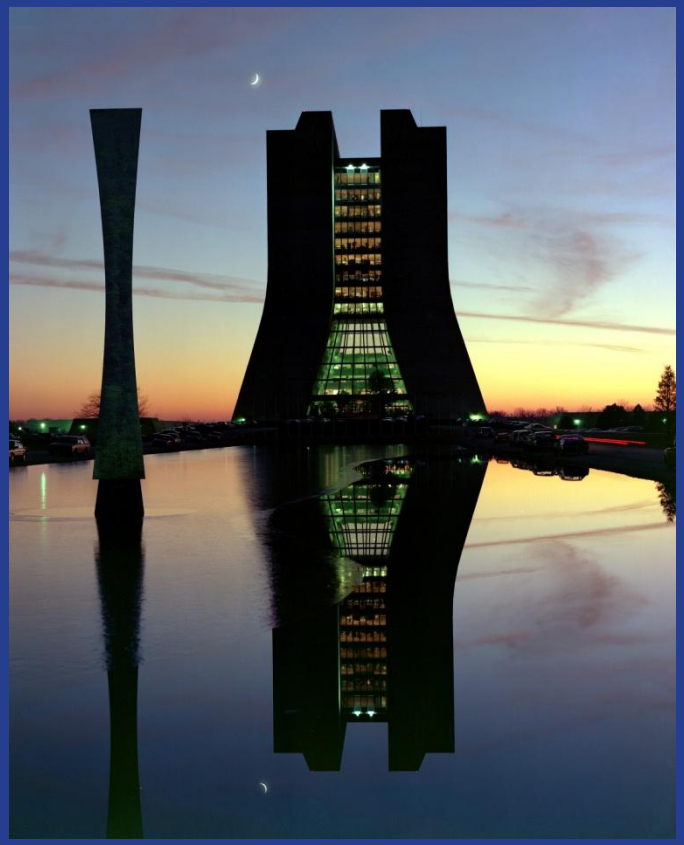
- Finish construction of Dark Energy Camera and ship it to Chile
- Advance plans for future dark matter and dark energy experiments
- Work with DOE, NSF, NASA and international funding agencies
- Ask Community Advisory Board whether there are public-related issues

Outlook:
Robert Tschirhart

What's next for US HEP?

As the energy frontier moves offshore, what is the future for US particle physics?

Can the US retain its traditional role as a leader in this thoroughly international field?



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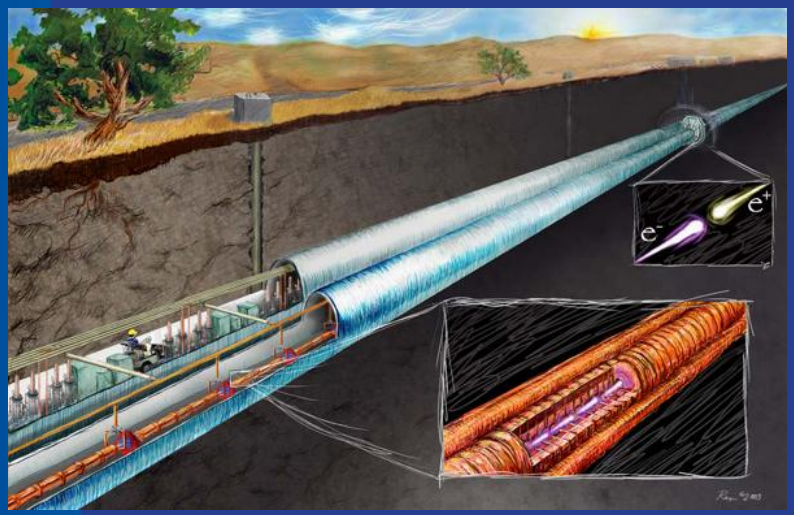
Ideas for future colliders at Energy Frontier:



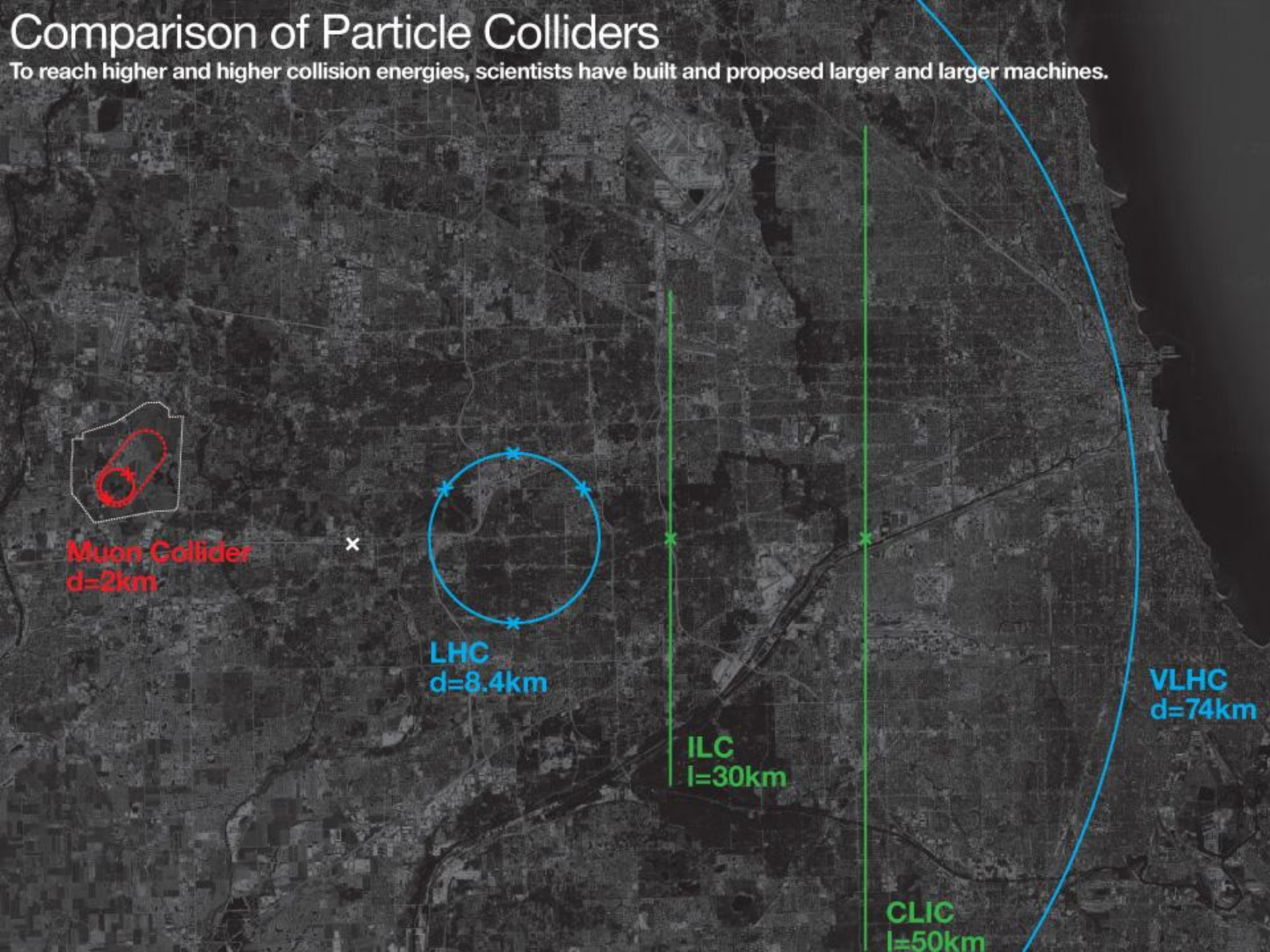
International Linear Collider:
Electron-positron collisions

Muon Collider:
Muon-muon collisions

Either one: big and expensive!

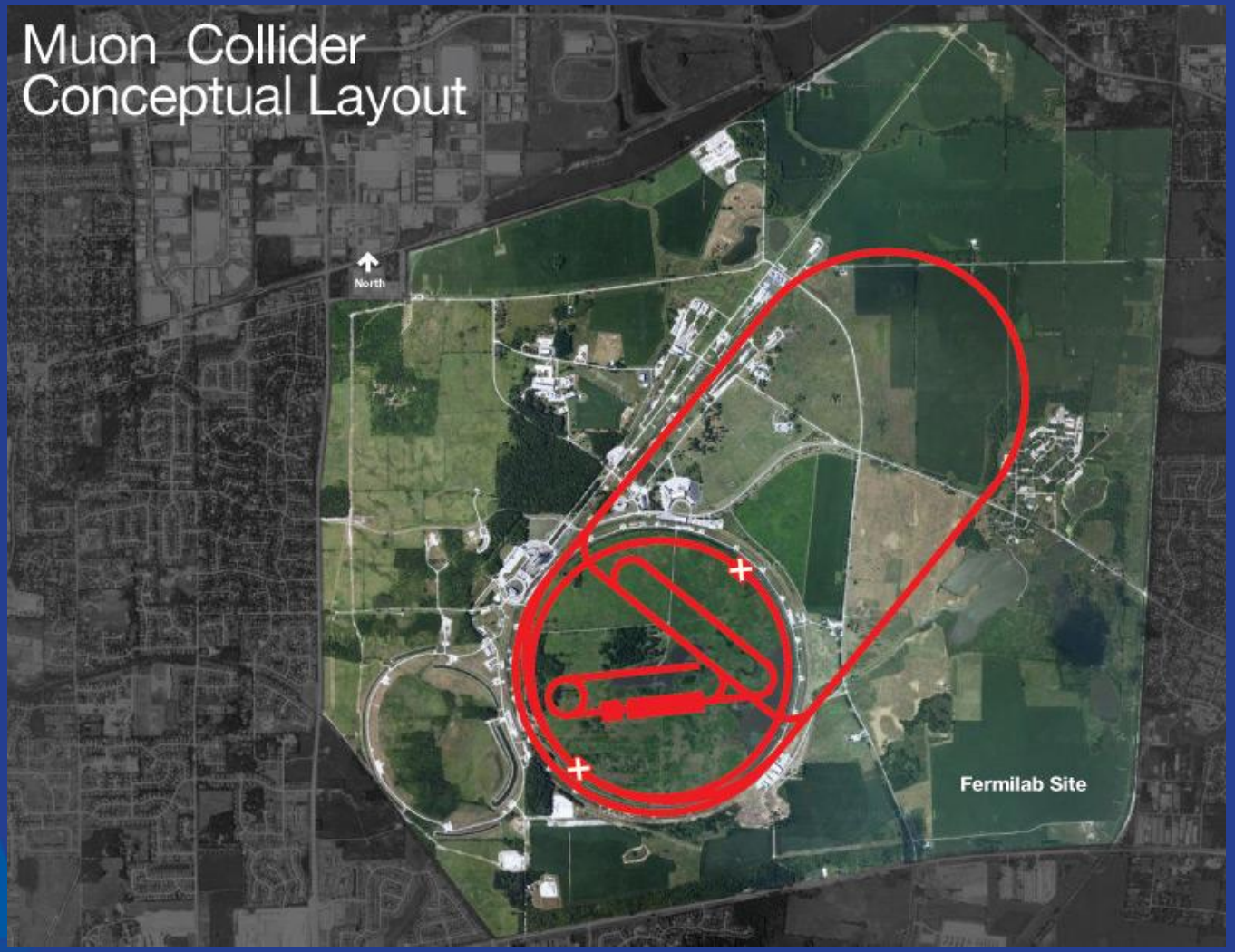
Comparison of Particle Colliders

To reach higher and higher collision energies, scientists have built and proposed larger and larger machines.



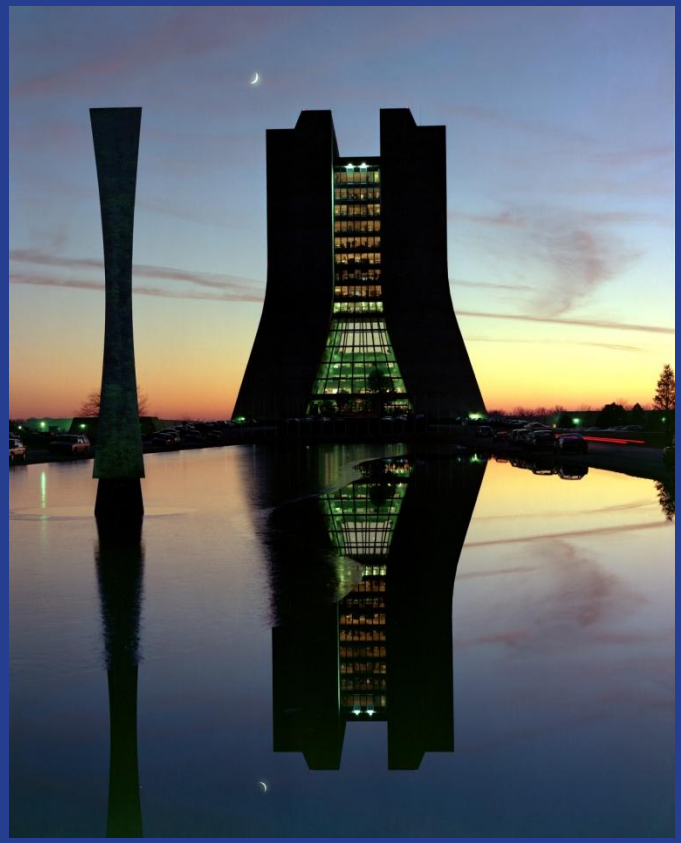
Advance projects at Intensity Frontier

Long term: ILC? Muon Collider?



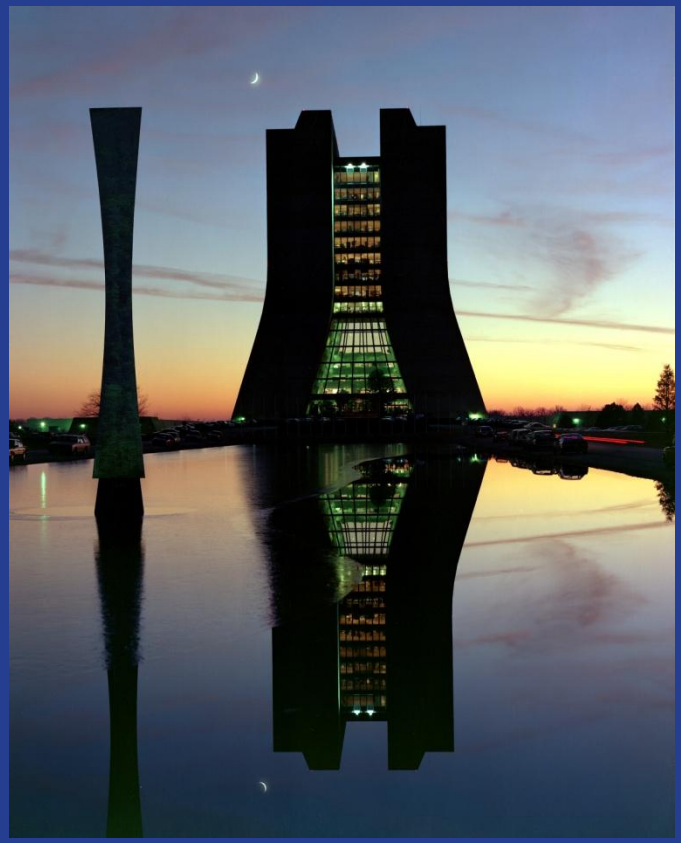
Fermilab's goals

- Continue to have world-class science programs at all three frontiers.
- Attract the best and brightest minds
- Build the best experiments
- Develop the best technologies
- Advance knowledge and benefit society
- Be a good and responsible neighbor



Fermilab's plan

- Develop a strong research programs at the Intensity Frontier to address many of the key questions of particle physics.
- Continue a strong role at the LHC and have a strong particle astrophysics program



Continue public participation

- Decisions made with public involvement are better decisions, not just for the community but for Fermilab and for particle physics.
- We need input for all big science projects, not just the ILC
- Public participation is key to Fermilab's future.